Chapter 13
Mobile Learning and Immutable Mobiles: Using iPhones to Support Informal Learning in Craft Brewing

Steve Wright and Gale Parchoma

Introduction

This chapter is a case study of the use of iPhones in informal learning processes and practices in two craft breweries. The authors suggest that actor-network theory (ANT) has a significant contribution to make in researching networked learning, particularly in *informal* contexts where the boundaries of any network are not predefined by a course, curriculum or institution but are assembled by the participants. How these networks are assembled and held together must be traced and grounded in empirical observation.

We draw on the "surprisingly enduring" (McConnell, Hodgson, & Dirckinck-Holmfeld, 2012, p. 6) definition of networked learning as:

> learning in which information and communications technology (ICT) is used to promote connections: between one learner and other learners, between learners and tutors; between a learning community and its learning resources. (Goodyear, Banks, Hodgson, & McConnell, 2004, pp.1)

ANT however emphasises a symmetrical consideration of all elements: learners, ICT and resources rather than privileging any one as the object of attention. Like one of its methodological antecedents, ethnomethodology, ANT rejects the use of predefined social categories as both topic of study *and* resource for explanation. In ANT an a priori social aggregate such as "community" can only be asserted by showing how it is formed and how it is assembled and held together through tracing

S. Wright (✉)
Faculty of Health and Medicine, Furness College, Lancaster University, Lancaster LA1 4YG, UK
e-mail: s.t.wright@lancaster.ac.uk

G. Parchoma
University of Calgary, Education Tower 602B, 2500 University Drive N.W., Calgary, AB, Canada T2N 1N4
e-mail: gale.parchoma@ucalgary.ca

the associations between its actants. Only through demonstrating and describing how such a formation emerges and the work required to maintain its existence can an aggregate such as "community" be invoked, conceptualised as an emergent networked effect. As such ANT is *not a theory of learning*. As an approach it seeks to iconoclastically pull down traditional dualisms such as agency/structure and contemporary ones such as real/virtual or digital/non-digital in order to "reassemble the social" (Latour, 2005). Rather than considering interpersonal "social processes" in given institutions such as "classroom learning", an ANT approach undertakes symmetrical consideration of how both human and non-human agencies perform realities.

The metaphor of a network is intentionally used as one which is flexible and nonhierarchical–standing in contrast to traditional sociological metaphors of "social structures" or bounded institutions. These networks are always provisional and contingent–the sociologist's job is to describe the work involved in the formation, maintenance and subsequent reinforcement or collapse of such networks through assembling case studies from empirical observation and description (Latour, 2005; Law, 2009).

In this opening commentary, we have sought to establish the relationship of an ANT-informed approach to networked learning with the broader concerns of this book. We have outlined relationships to other literature: transporting and enrolling texts from other authors in order to set out how this case study relates to the theory, design and practice of networked learning. ANT-derived terms can helpfully describe this requirement as an "obligatory point of passage" (Callon, 1986) through which our account must pass.

Defining Terms: Entangling Networked, Informal and Mobile Learning Through ANT

Engagement with ANT as an approach in educational research "has been sporadic rather than sustained" (Fenwick & Edwards, 2010, p. 1). While there is much written within ANT about knowledge and knowing, it is *not* a theory of learning. However it poses a substantial challenge to many established models, methodologies and concepts used to consider and research learning.

In an early collection of papers on networked learning edited by Steeples and Jones (2001), the variety of theoretical frameworks used to research NL are drawn together. Among these is a work by Fox (2001) that considers how ANT challenges conventional conceptions of what learning is and where and how it happens. He argues that:

> One of the first ways in which traditional learning theory should be revised concerns the hallowed notion of "the learner" and the associated notion of "the learning process"... learning at some point in a network can transform the network.... Learning is one of the processes which builds up and breaks down networks, although there may be other processes which achieve similar effects. (Fox, 2001, pp. 84–85)

In moving the focus of attention of learning away from the *individual* learner within the symmetrical analysis of human and non-human actants and agency, Fox took an ambitious step into attempting to consider how learning could be engaged with or accounted for using ANT. However Fox did not extend this line of reasoning to consider *how* learning could assemble or transform an actor-network or how different actor-networks may change as learning builds them up or breaks them down. Through our case study we seek to draw on, explore and theorise these notions.

Fox also suggests where we could productively look for such cases arguing that:

> If NL were simply to focus on educationalised learning processes through cyberspace, it would miss all the natural, informal and situated learning which occurs, through the internet as well as through other social networks and spaces, outside of deliberately designed educational activities. . .The possibility exists that the study of learning, even networked learning, which occurs 'naturally', 'incidentally', 'situatedly' and 'pervasively' in everyday life and workplaces in particular, will repay educational designers, just as clothes designers frequently benefit from the close observation of street fashion. (Fox, 2001, p. 78)

Learning that occurs naturally, incidentally, situatedly and pervasively is often classified as informal. Tusting (2003) evokes the criteria of accreditation, place, planning and power as distinguishing characteristics among formal, designed-to-happen (planned, assessed and accredited by educational institutions); non-formal, but intended-to-happen (pre-planned, organised workplace learning); and informal, learner-led efforts where learning just happens (in the absence of externally imposed criteria or authority). While these distinctions are useful, Colley, Hodkinson and Malcolm (2002) contend that such distinctions are only partial, in that "attributes of formality and informality are interrelated in different ways in different situations" (p. 9).

An influential model of "informal and incidental learning", developed by Marsick and Watkins (2001), further distinguishes interrelationships between informal and incidental learning within a range of situated practices. Informal learning is defined as contextual, intentional, "triggered" by an internal or external stimulus, "integrated into daily activities", "haphazard and influenced by chance", marked by involvement in "an inductive process of reflection and action" and importantly, "linked to the learning of others" (p. 28). Drawing on their earlier, widely cited work, "incidental learning" is further defined as a *by-product* of intentional activity that frequently occurs even though people are seldom aware of it (Marsick & Watkins, 1990). We will return to and problematise terms throughout our chapter. The intersection of informal learning with networked communication technologies which Fox considered has seen rapid expansion since the publication of his chapter. One area of particular attention in contemporary research has been the development, diffusion and widespread adoption of Internet-connected mobile devices and "smartphones" such as the iPhone. However, informal learning and smartphone use remains under-represented in the literature (Frohberg, 2006). Furthermore investigations in this field are marked by particular practices and discourses. A literature review by the authors looked at how researchers extolled the use of mobile devices but typically controlled both the devices in use and the tasks to be completed, frequently in quasi-experimental studies within formal educational settings.

We contrasted this with the self-selected use of mobile devices without such controls in informal learning (Wright & Parchoma, 2011). This chapter seeks to contribute towards increasing the representation of informal mobile learning by presenting detailed observation of the use of iPhones in the situated practices of craft brewing.

Setting the Scene: The Participants and Practices of Craft Brewing

The following post on an Internet forum was the instigator of this study:

> I just love the brew pal software. Its help [sic] me learn quite a lot about brewing, even to the point that it's helping me get ready for my first all grain, I do think if it wasn't for the app I would be months behind where I am now in terms of understanding the stuff that's going on. (Participant 1)

This unsolicited account was posted in response to a discussion thread on "iPhone and iPad brewing software". As a forum participant, the account quoted above drew our attention in its explicit linkage of a mobile smartphone application to *learning* and *understanding* and to the *practice* of craft brewing. It also implies a framing by the participant of learning as "understanding the stuff that's going on"—evoking an information acquisition view of learning. We explore the tensions of such a view with broader formulations of learning as negotiating situated actions. We seek to unpack and explore this tension further in this paper and expand the latter view through the symmetrical analysis of ANT.

The ten forum participants who posted to the thread were the purposive sample for this research project, all of whom were emailed. After receiving replies from the majority, two were selected for participant observation—one novice and one experienced brewer—based on pragmatic considerations of time and proximity to the researcher in the north of England.

In order to understand the function of a computer app in brewing, we give a brief overview of the processes and practices involved. There are three main approaches to home brewing: (1) using a premade kit where just water and yeast are added, (2) starting with malt extract and (3) starting with the raw materials of malted grain. The latter process of all-grain brewing involves steeping malted grains in water within a narrow temperature range that enables enzymes in the malt to break down starches into fermentable sugars—a process called mashing. This mixture of sugar and water, called "wort", is then boiled with hops which contribute bitterness, flavour and aroma. The wort is then rapidly cooled before yeast is added. The yeast ferments the sugars, transforming the sweet wort into the carbonated alcoholic liquid we know as beer.

In order to predict and try to control the outcomes of each stage of this process, a lot of relatively complex and highly interdependent calculations of temperature,

time, volume and density of dissolved sugars are required. An example below is a formula (Tinseth, 1995) for calculating bitterness from a hop addition:

$$\text{Utilisation} = (1.65 \times 0.000125^{\wedge}(\text{OG} - 1))$$
$$\times ((1 - 2.72^{\wedge}(-0.04 \times \text{Hop Boil Time}))/4.14)$$

$$\text{IBU} = \text{Utilisation}^{*}(\text{oz} \times (\text{AA\%}/100)^{*}7,490)/\text{Volume of batch in gallons}$$

Definitions: OG = "original gravity", a measure of sugars dissolved in a liquid as a measure of specific gravity.

IBU = International Bittering Units, one of the standard measures of bitterness. AA = Alpha Acids, a measure of bittering potential of a hop based on α acids as percentage of total hop weight.

Rather than undertaking all these calculations laboriously by hand, craft brewers use a variety of tools to support them. Reference tables, worksheets and software packages have recently been joined by apps for a range of mobile devices, including iPhones. However, it is not *only* calculations that inform brewing but also qualitative sensory judgements of taste, colour and aroma. Apps also provide support for these assessments, including predicting colour from recipe ingredients and providing standardised reference colour charts. There is little hard data on the number of home brewers using such software; however one of the apps considered here, BrewPal, has an active user base of over 20,000 users as indicated by upgrades to new versions (BrewPal, 2013, personal communication).

Methods Assemblage: Multimodal and Focussed Ethnography

ANT has its origins in ethnographic studies of scientific practices where it was "developed to analyse situations in which it is difficult to separate humans and non-humans, and in which the actors have variable forms and competencies" (Callon, 1998, p. 183). We have already sought to introduce some ANT terms such as "obligatory points of passage" and "translation" following Law's suggestion that ANT "is not abstract but is grounded in empirical case studies. We can only understand the approach if we have a sense of those case studies and how these work in practice" (Law, 2009, p. 141). We seek to continue this approach in our exposition of the two cases—introducing concepts and terminology through empirical examples rather than abstractions, via illustrating what ANT can contribute to understanding informal learning networks.

In seeking to describe how mobile devices are *used* in the informal situated learning practices of craft brewing, we frame this investigation through Humphreys' (2006) analysis of visual ethnographic methods for examining mobile phone uses. Humphreys argues that well-considered analyses of photographic artefacts from field studies can "add significantly to our understanding of how mobile devices are contextually defined and used" (p.55).

Marcus (1998) proposes that ethnographic studies should adopt a multi-sited methodological approach to investigating field sites which are interconnected with other locations wherein:

> Research is designed around chains, paths, threads, conjunctions, or juxtapositions of locations in which the ethnographer establishes some sort of literal, physical presence, with an explicit logic of association or connection among sites that in fact defines the argument of the ethnography. (Marcus, 1998, p. 90)

This concept of following connections aligns to the ANT sensibility to *follow the actors* (Latour, 1987) by tracing their chains, paths and threads which assemble a network and can include materials, participants' accounts, images and media files. These chains and paths are traced outward from the site of observation, which is bounded by a "brew day" of around 7 h duration in the participants' home breweries. In observing time- and location-bound intensive activity, we draw on methods associated with "focussed ethnography" "a form of short-term ethnographies [sic] by which information relevant to the development or change of technological systems are collected in an intensive and rapid way" (Knoblauch, 2005: 8), making extensive use of audio, video and photographic records to supplement traditional field notes.

By following chains and connections and using a network metaphor, an ANT approach rejects and seeks to "bypass" (Latour, 2005, p. 22) the binary divisions and a priori categories of much of social theory such as natural/social, micro/macro, structure/agency and subject/object, which are instead seen as *effects* of the process of assembly and collapse of the networks of relations between heterogeneous actants. This, together with its principle of symmetrical consideration of all elements—both human and non-human—has practical effects on the method of participant observation. A praxiographic orientation is required which "allows and requires one to take objects and events of all kinds into consideration when trying to understand the world. No phenomenon can be ignored on the grounds that it belongs to another discipline" (Mol, 2003, p. 158).

Within a praxiographic approach, objects, materials, yeast, grains, gas, burners, welding, iPhone apps, videos, conversations, accounts and actions all require attention. The observer should not pre-select one single human actor alone as object of attention and interest nor preconceive that they alone are where "learning" is to be found, thereby excluding other processes and practices as belonging to "science" or "nature". Attention is directed to neither "the social" nor "the natural" but the material-semiotic relationships among these networks of elements that *perform* such dualisms (Law, 2009). This approach gives "an unfamiliar take on many familiar issues" (Fenwick & Edwards, 2010, p. 2) and may involve following or starting with an unlikely actor as a research subject. An exemplary example within networked learning theory is by Thompson (2012) who starts from the delete button and uncovers issues, tensions, politics and dangers as people and professional practices are enmeshed with Web 2.0 technologies.

In the two cases described in this paper, we follow non-human actors, tracing the movements of recipes through two different breweries, enmeshing and assembling

a network of actants including a brewer, brewery equipment, an iPhone, apps, podcasts, YouTube videos, grains, yeast, hops and more. First we describe each case in detail, giving an account of the practices supported by illustrative photos, screenshots and other images collected from the fieldwork. The images show the arrangements and juxtapositions of materials, technologies and practices and are organised sequentially. Our focus on sequence and temporality is an intentional response to the current paucity of studies of the use of mobile devices in informal learning practices. Furthermore, a thick description and detailed illustrations can travel to, be enrolled in and translated into other accounts and conceptualisations where a gloss would lose the richness of relevance. Detailed description also allows us to anchor and illustrate terms and concepts we use.

Fieldwork Site 1: Novice Brewery, Mobile Device and Immutable Mobile Recipe

We use the term "novice brewery" intentionally to consider symmetrically *all* of the elements, human and non-human alike, as novices in a newly assembled brewery rather than to isolate the brewer as the singular repository of "experience" or location of "learning" (a theoretical consideration we return to in our discussion).

One of the authors observed this site during the brewery's second ever all-grain brew day. Participant 1 (P1) had previously been brewing for "9 years on and off" using premade canned extract kits to which only water was added. In the construction of the brewery, his iPhone was used to take photos of aspects of assembly and welding and to post these images along with text descriptions and requests for advice and solutions to issues on the Internet discussion board previously mentioned.

Following Latour (2005, pp. 224–225) we present a series of images in Fig. 13.1 to illustrate actants and sequences. We then describe the images introducing terms from actor-network to explicate the socio-material practices observed. We emphasise that the diagram shows a sequence of actions and practices which can be explained through concepts of "moments of translation" or the "assembly of a network" but the diagram is not a visualisation of those ideas per se, for which we would direct the reader to the diagrams in Callon (1986).

The diagram is a closed loop with the start and end of a commercially produced beer (1a) called Cocker Hoop, made by Jennings Brewery in the UK. Participant 1 had purchased two bottles of this beer to compare with both the unfermented wort and with his finished product once packaged and matured.

A recipe for making a copy of this beer was published in the book "Brew Your Own British Real Ale at Home" (1b). This book has outline instructions on brewing methods, along with a collection of recipes for reproducing commercial beers. The recipes list quantities of malts and hops together with calculated measurements including bitterness and gravity. Participant 1 owned a copy of this book but had not

Fig. 13.1 Translations of an immutable recipe in a novice brewery

read it in detail and did not refer to it while brewing. He preferred to use apps as they were "more interactive" describing how with "a book you've got to sit through it and read it and if you don't absorb it yeah you've lost it by the time you've flicked the page over; whereas with an app, you flick back to it and all the information's just there for you". He had previously entered recipes from the book into the BrewPal app and then varied quantities and added, subtracted or substituted ingredients and looked at the calculated outcomes of these simulated variations. The role of simulation in this setting and its relationship to creativity and the transition towards mastery is explored further in Wright, Short and Parchoma (in press).

Some of the recipes from the book had been selected by a web-based home-brew merchant, "Worcester Hop Shop", who had partially reproduced the recipes on the company website (1c). The recipe has now moved through intermediaries from book to web page to printout but it is not "translated". In ANT terminology the recipe is here an example of an "immutable mobile". Despite moving from book to web, it has retained its form and fidelity.

The company offers a service to assemble and send out the recipe as a weighed and packaged kit of ingredients accompanied by a printed copy of the recipe. Here the transformation of the recipe and its dispatch enacts the ANT concept of "translation". Translation is set out as a four-stage process by Callon (1986) and

is taken from the French word *traduction*, which carries different implications than those associated English word "translation" with its focus on language (a point we shall return to). In step 1 of the translation process, the home-brew supply company has "problematised" an issue: how to get the right quantities and ratios of ingredients to transform a recipe from words into a beer. Through their website they act to interesse (step 2) home breweries by providing a solution to this problem: they transform the written recipe into measured and packaged materials. By ordering the kit P1 is "enrolled" (step 3) into their actor-network as a "customer". Their construction and transformation of the recipe becomes authoritative. Their interpretation now acts as a "spokesperson" for the recipe-as-materials. We again encounter an "obligatory point of passage"—the web ordering system—for making *this* version, *their* version, of the recipe. They then engage in step 4, "mobilisation of allies" (couriers, customers, etc.), to complete the translation and send the materials to the home brewery. Through this process, they are, in turn, enrolled into other actor-networks of transportation: deliveries, vans, drivers and a distribution network of a courier company that transports the materials to the brewery. Once at the brewery, the materials will be further translated as the assembled equipment enrols them into its actor-network. The concept of translation thus involves much more than mere changes of state or movements of materials or ideas. The materialisation of an authoritative account (here a pre-packaged recipe) reinforces its power, which is where the material-semiotic approach of ANT builds on and extends Foucaultian notions of discourses and knowledge as power. It does this through the symmetrical analysis of the agency of humans *and non*-humans that we use here to consider how materials reinforce and make durable structures of knowledge and power.

We return to the diagram where the sequential paths now split and run in parallel. On the "inner circuit" are the material transformations and processes of brewing. On the outer circuit are the inscriptions and accounts of these transformations. The two are related in our case studies and the iPhone is entangled in both. As we shall see, at times the iPhone acts as an *intermediary*: merely moving information without alteration. However, at other stages, it becomes a *mediator*, transforming and changing relationships.

On the inside track, the recipe-as-materials (1d) comprises preweighted and mixed grain, preweighed and separately packaged hops and a packet of dried yeast. Water is heated to the temperature prescribed by the recipe and the grain is mixed into the water (1e). Brewing processes (mashing, boiling with hops and cooling) are all carried out. Each stage involves measurement and is recorded on the outer circuit. Finally the beer is run off and cooled (1f) and the gravity of the liquid is measured (1 g). Here the brewer holds a thermometer in his right hand, recording the temperature, while a hydrometer gives a reading of the specific gravity; however, this reading is affected by temperature. In his left hand the participant holds the iPhone using his thumb on the touch screen to enter the gravity and temperature readings which are then corrected by the app. Afterwards he writes this information down on the whiteboard. Cooling completed, the packet of yeast (1 h) is pitched into the wort. The yeast ferments the wort into beer which is then bottled,

matured and eventually drunk and compared for taste, aroma and colour with the originating beer (1a).

Participant 1 described how the equipment in use (1f) was constructed with reference to videos on YouTube, which he accessed on his iPhone (R2). He had supplemented this by posting images taken with his iPhone and descriptions of the equipment to the Internet forum along with questions when he encountered problems. Messages from other forum members identified methods and materials he could use to construct equipment such as the cooling coil from garden hose, copper pipe and plumbing fittings.

Alongside and enmeshed with these practices are inscriptions of their progress: recorded actions, measurement and outcomes of calculations. These form the outer circuit of images and illustrate how the iPhone does not stand alone as a device but is entangled with other practices and materials—supporting the documentation of processes.

The brewer has several apps installed and has changed his phone background to an image of the bottle label of the commercial beer he is copying (1i). He opens up the BrewPal app (1ii) and the screen displays the ingredients to be used along with calculated gravities, volumes and alcohol, as well as a predicted colour. Other screen displays show volumes of liquids required and calculations for hop bitterness.

The recipe has been input into this device by reading from the printout of the recipe (1c, 1d) and selecting menu items using finger or thumb on the touch screen to select items displayed in menus. However through this process the immutability of the recipe falls apart. While it has been held together as it moved through intermediaries, from book to website to reproduction on printed page, here it is mediated—becoming transformed as it moves. The iPhone app can be understood as having agency enrolling both the brewer and the recipe through problematising the complex calculations and offering a solution. It has also enrolled the brewery and become a spokesperson for the performance of the equipment. However, through interaction with the brewer and the problematic touch-screen selection interface, this translation from page to electronic version and now to whiteboard has encountered a betrayal. A slip of a finger on the iPhone screen has resulted in a different hop being unintentionally selected from the menu.

The term "translation" has been identified as encompassing an ever-present potential for breakdown; thus it is a difficult term to translate from its origins in Callon's work in French to an English discourse. Both French words used by Callon, *translation* (meaning movement) and *traduction* (meaning linguistic transformation from one language to another), are translated into English as "translation". Implicated within both is the idea that when something—a word, a "fact" or an object—moves from one setting to another, there is always the risk of "*trahison* [treason and difference]" (Law, 2003, p. 10). This may happen through a new context and assemblage of relations serving to change the associated status, implication or meaning of the object. It can also result from a breakdown when a translation is left incomplete or disrupted. We see the results of just such a breakdown enacted here at the interface of human and screen.

Despite the much-vaunted functionality of the touch screen and app to enable updating information during the brewing process, this is not enrolled in the process observed. The participant takes time to re-inscribe the recipe from the iPhone onto a whiteboard (2iii) accounting for this change as

> "with the mobile problem you got is you got to get it in and out of your pocket all . . . time if you want to look at it".

This is not only difficult to do but risky too: a dropped phone will break while a dropped marker pen will bounce. On the whiteboard the recipe is easily visible, accessible but also mutable. Erasing and rewriting can break down what was previously held together as immutable: recognising this P1 also attaches a copy of the recipe printed out from BrewPal to the whiteboard as a reference.

Having written information from screen to board, the brewer then re-inscribes the information copied to the whiteboard into a different app "BrewTimer" on the iPhone (1iv, 1v) because moving the information digitally is not prevented. This app is used to measure times and sound alarms to start a new practice or process, such as adding hops to the boil or turning the gas off to end the boil.

The process of comparing the inscription on the packaged hops as containing "41 g Challenger" to the inscription in BrewPal now reproduced on the whiteboard and being input into the BrewTimer App of "Cascade" leads to a major disruption. Once this discrepancy is identified, the participant described his confusion as:

> I should have some centennial hops, why have they sent me challenger? . . . I think it must be the recipe. . . I'll have to go have a look at recipe on't website.

This observation leads to the only use during the brewing process of connection to the Internet (R1) as the phone's mobile data connection and browser app are used to view the recipe on the supplier's website and check this against the versions of the recipe on the phone apps and whiteboard. This requires work and effort and the assembly of a new network of technologies and connections to retrace a route and the previous translations, to undo them and return the mobile recipe to its prior form.

We see here shifts in the configuration of the network. The whiteboard becomes the spokesperson for the recipe: it becomes the authoritative source and is updated and revised from information retrieved from the supplier's website through the phone browser. The status of the other accounts (those in the two apps) was left uncorrected as evidenced by screen shots from the device emailed at the end of the observation. However, the coexistence of differing accounts is glossed over as the pressure of time required action and a single corrected account on the whiteboard was sufficient—the iPhone's role as spokesperson now supplanted by a different medium.

This pressure of time is also measured and compartmentalised through the mobile device. The Brewtimer app is started, translating the problem of time measurement and reminders of action into a countdown clock and sequence of alarms and onscreen messages. As these sound they prompt action in the brewery as taps are opened, liquid pumped and new timers started.

At the end of the brew, the whiteboard (1vi) is a composite record of the physical transformations: a checked-off list of completed actions and a record of the

outcomes of calculations, times and measurements. These results of situated actions are entered into the app and juxtaposed and contrasted with the plans and predictions of the recipe and apps. A smaller volume of wort at a lower gravity (density of sugars) was produced, indicating inefficiency in equipment and processes.

Some records of volumes and gravities from the white board are also entered into another app which is used to track fermentation activity and outcomes over the next week, as well as sensory evaluation and assessment of the finished product (1vii).

The final calculations indicated substantially lower outcomes than predicted. An explanation of lower than expected outcomes was developed through subsequent equipment checking and cleaning. P1 found several areas where unused liquid remained latent in different parts of the brewing process. This "dead space" affected the overall efficiency of the brewery and thus impacted on the calculations made from an assumed "typical" iPhone app representation of an effective brewery. In response to this mismatch of prototypical calculated brewery and the brewery assembled in use, multiple changes were enacted to equipment through subsequent re-engineering, realignment and other adaptations and reconfigurations of brewery equipment. These changes to material configurations also brought changes to human/machine practices with accounts of these changes shared through images taken using the iPhone and posted to the online forum and via twitter. We return to consider the relationship of these changes to learning from an ANT viewpoint after exploring continuities and differences of equipment and practices in an experienced brewery.

Fieldwork Site 2: Experienced Brewery and the Fluid Object of a Recipe

Fieldwork location 2 was in a more experienced brewery. Participant 2 (P2) "started kit brewing 4 years ago . . . all grain for 2 years and 3 months" and had been brewing approximately 2–3 times per month. He estimated that about half of his brewing was based on published recipes and the other half his own formulations.

Figure 13.2 follows a similar pattern to the one used for P1, once again illustrating the temporal and sequential ordering of practices and arrangement of materials. The simpler construction of the diagram is not intended to evoke simpler processes nor more sophisticated practices but rather reflects development in fieldwork methodology and a more coherent and explicitly sequential capturing of the images used here

The original beer (2a) is an American Ale which the brewer knows well and likes. A recipe for "cloning" the brew is published in a book (2b) which P2 is using for the first time. He reports that he wants to take a beer that he knows quite well to "see how it matches up [but] if it's miles apart [I] probably won't brew anything else out of it". Unlike P1, for P2 the published recipe is not just a resource to follow and guide practice but is itself a topic of investigation. This evaluation is informed

Fig. 13.2 Translations of a fluid recipe in an experienced brewery

by P2's regular listening to podcasts on brewing different beer styles and recipes from "The Brewing Network" he downloads to his iPhone (R1) and listens to while commuting to work or during breaks on a night shift.

The recipe is entered into "BeerAlchemy" on P2's computer (2d) as he "prefers to use a keyboard" (helping to avoid the errors in translation when using a touch screen, as witnessed with P1). The recipe is then transferred via intermediaries: a printer to render a printed version on an A4 sheet of paper (2f) and via a Wi-Fi connection to sync with the BeerAlchemy app on P2's iPhone (2e). P2 describes the use of the app on a brew day as being "for the calculations really ...you can do all the adjustments on here, the amounts and everything". The recipe has changed form and location but merely passed through these intermediaries—retaining its fidelity, remaining immutable.

The next moment of movement requires change as the recipe is translated from words and figures on screen and printed page through calculations and measurements into materials: grains, hops and yeast (2 g) which are weighed and combined. The brewery has an inventory of grains stored in sealed containers and hops in a freezer drawer. However, in the process of weighing out, it becomes evident that there is insufficient pale ale malt available and substitution is required. Here the recipe is changed.

The calculations for this change are written down on the printout: the quantity of pale ale malt available and used is recorded first. Then other potential substitute ingredients in stock (lager malt and wheat malt) are identified and weighed then recorded using pencil, paper and an iPhone calculator app (1 h). The calculator app is closed and the BeerAlchemy app reopened. The figures from the paper-and-pencil inventory audit are input into the onscreen recipe which calculates new predictions from the change in ingredients. Adjustments are made in the app so that the predicted outcomes match the guidelines of the original recipe. The substitute grains are then weighed out using the amounts from the new recipe version displayed on screen and the grains are mixed together for mashing.

In this complex process, the more structural four-step sequence of translation drawn on in P1 becomes inadequate: the recipe emerges at the end translated into grains but in a new though recognisable configuration. Rather than working to maintain immutability, the work is to enable and adapt to changed circumstance. The recipe is no longer something "immutable" but instead has shifted its boundaries. This shift from immutability to fluidity is reflected in later work derived from and responding to early ANT. de Laet and Mol (2000) studied the diffusion, spread and variation of a bush pump for delivering clean groundwater in Zimbabwe. They note how its spread, adoption and installation required it to be adaptable to local situations and that it enrols other technologies in its network but these are variable by situation rather than fixed in advance. However these are not vague or random. "The Bush Pump's various boundaries define a limited set of configurations. They each, one might say, enact a different Bush Pump. But these different Bush Pumps have in common that they are indeed a pump" (p.237–8). De Laet and Mol argue that "the Zimbabwe Bush Pump is a fluid actor. It brings a lot about, but its boundaries and constitution vary and its success and failure, instead of being clear-cut, are a matter of degree". This *fluid technology* reinforces its mobility not through immutability but through adaptation and change. In the adaptation of this recipe in the experienced brewery, where it maintains its overall form but becomes fluid through the substitution of some ingredients, we suggest that this concept is a useful one—and will return to consider the possible implications with regard to learning.

Once the recipe is adapted, water is added to the grains and the temperature measured. The temperature attained is too low so the mobile app is used to make a rapid calculation of how much boiling water will need to be added to bring the temperature up appropriately (2i). The kettle is boiled, the measured amount added and the temperature achieved with a thermometer used to check the outcome against the app's prediction—they match.

Hop additions are measured and separated out with the iPhone placed next to the scales and the recipe displayed on the app screen (2 k). At the end of the boil, P2 uses the same methods and materials as P1 to measure and temperature-correct the specific gravity the specific gravity reading of the wort using a hydrometer of the app (2 l). Finally yeast is pitched and fermentation starts rapidly and ferments fully.

On the other side of the brewery was a set of new equipment (2 m) which was being customised—including a household hot water tank, a steel tank and an

insulated catering pot to create a new larger capacity and more flexible brewery enabling greater volumes and variations of beers to be made from one mash.

The final assessment was that the beer was "very good!", though *not* a very close approximation of the original beer. However, P2's account did not specifically attribute the non-approximation to any particular factor such as the situated adaptation of the grains used. As noted at the start of this case, another aspect of the practice was evaluation of the recipe book. P2 reported subsequently brewing another recipe from this book, a "Lagunitas IPA". However that was *also* adapted from the published version, though not in response to resource limitations but with reference to "expert information" from a podcasted interview with the Lagunitas head brewer who gave a different formulation of the hop blend used compared to that written in the book.

Drawing Together

We have focussed in particular on the methods used by actants in particular actions and sequences of events. The iPhone strengthens the localised brewery networks through its provision of timely calculation and measurement recording, segmenting and combining units of time, volumes and weight. Its apps support refinements to brewery practices through predicting and assessing outcomes of brewer, brewery and material actions. In the novice brewery, once the mobile *has* become part of the network, it becomes an obligatory point of passage for the recipe as a centre of calculation for prediction and assessment. Across the broader actor-network of the craft brewing community, it distributes comparable evidence (e.g. images and measurements) that influences changes in socio-material practices.

In both breweries the iPhone is used around this situated practice of a brew day. Constant Internet connectivity is peripheral to the primary uses of the iPhone. The apps stand alone and other functions are self-contained. The Internet connection is used at moments of breakdown for reference to online text. The online connection is also used before and after practice—both to retrieve information and post accounts of development and equipment construction and adaptation. Both participants use it to access expert knowledge delivered in didactic form. P1 makes reference to videos from YouTube which he watched and which informed the construction of his brewery and methods of brewing. These he watched on his mobile device when he had time: mobility and flexibility to access a demonstration lecture are key parts of his account. P2 referred to downloading and listening to podcasts by master brewers on particular styles on his commute to and from work. Both brewers post regular accounts of their broader practices using the Internet to post images of ingredients, equipment and processes and exchange text accounts of recipes and evaluations of processes and products such as tasting evaluations on Twitter and the brewing forum.

The iPhone's touch-screen interface leads to problems and resulting disruption and confusion for P1. Its account becomes authoritative despite a betrayal in

translation as the app becomes a mediator rather than intermediary. Other problems with ingredients also became evident from the screenshots. However work and effort are expended trying to make the instructions from the BrewPal app fit the ingredients in hand and to maintain the immutability of the recipe. In contrast P2 acknowledged this issue and bypassed it by using a keyboard instead, then synced the data with the mobile device. However, making notes and recording actions and calculations primarily remain the prerogative of simpler assemblages of inscription devices: pencil-and-paper or pen-and-whiteboard.

Without the iPhone the calculations would be delegated to computer spreadsheet or software. If these were not available, then the worksheets and reference tables in books along with calculator or pencil-and-paper would support the processes of calculation. These would be *far* slower and more laborious making the rapid fluidity of P2's adaptation of the recipe a more complex process requiring movement away from the assemblage and arrangement of the other materials required for these calculations: the scales, pencil, paper and grains. Mobility of calculation device is important. In P1's brewery the possibility of simulation for recipe variations when time is available—on the bus to work was given as an example—would also be excluded by more fixed arrangements.

By contrast in the experienced brewery, the iPhone is used to support change and substitution. All the elements are configured to enable and support fluid changes, recipes become fluid as they enter the brewery and the brewery is configured to perform such fluid objects. The app supports and undertakes the complex procedure of calculating extract potentials and colour changes resulting from ingredient substitutions. P2's experience with the ingredients suggests likely minimal effects on flavour. These practices starkly contrast with the constraint and work to maintain immutability in the novice brewery. The concept of a fluid object provides a useful vocabulary to describe not only how the recipe here changes as it is transformed, its ingredients shift a little but its overall configuration remains recognisable, but also as a point of contrast to rigid immutable objects in a novice actor-network. Such a vocabulary also evokes metaphors used specifically to learning such as the rigidity of scaffolding for a novice compared to a fluidity of an accomplished master. However it also brings with it the sophisticated nuances of exploring interaction and agency of technologies which we suggest has a particular perspicacity for researching *networked* learning.

Extending Out: Some Implications

From this fieldwork we draw three implications relating to the three domains of concern: the design of mobile learning apps, theorising informal networked learning and the challenge ANT makes to the epistemology of networked learning.

Implications for Mobile Learning Application Design

As we have shown by drawing together the two accounts, the iPhone is central to practice and the assembly of a network of resources, tools, peers, devices and the accounts of practice in both breweries. A dedicated app or suite of apps are used to plan, support, record and create persistent records of situated practices. These apps are designed for this purpose and enable simulation (used extensively by P1 in varying materials in recipes to see outcomes). Echoing Fox's suggestions that observations like this of informal educational practices could "repay educational designers, just as clothes designers frequently benefit from the close observation of street fashion" (2011, p.78), we suggest that the development of mobile learning in formal education could draw useful inferences from our fieldwork which demonstrates the effectiveness of developing specific tools for supporting simulation, calculation and recording of situated practices (e.g. fieldwork, research data gathering).

Recording and sharing of situated observation, measurement and calculation has commonalities with many learning and teaching practices in further and higher education—especially in the many disciplines which use fieldwork and data gathering. We suggest that these observations of how such practices unfold in informal learning have productive application in the selection or development of apps to support mobile learning in formal education. Such a move would stand in contrast to the current vogue for the development of information-aggregation apps to disseminate and "push" official institutional information to students such as timetables and notifications rather than development of apps to support practice, and through that enabling situated learning.

Assembling and Differentiating Informal Networked Learning

In tracing practices in two home breweries, attending to participants' accounts and following the paths left by their practices, we see an informal learning network being constructed. Both access didactic content as podcasts or videos, choosing to access them when they can and when they are useful. Both also submit ideas and experiences as text and images and engage in discussion with peers in an online forum and via microblogging. Both also met with peers in person through a local home-brewing club. Additionally they submitted beers for informal peer assessment at these meetings subsequently posting accounts of the responses to forums, as well as more formal assessment by recognised experts (beer writers, brewing industry professionals and accredited judges) in competitions. These acts of seeking out expert assessment in informal learning contexts are explored further in Wright et al. (in press).

This assembled informal network has clear continuities and similarities with networked learning practices and structures in formal educational settings such as those surveyed in McConnell et al. (2012). Participants' informal learning practices include sharing resources, undertaking self-directed study and engaging in collaborative knowledge construction supported by expert direction and peer review.

If *informal* networked learning is assembled in such a similar way to *formal* networked learning, can, or should, we meaningfully differentiate the two? Marsick and Watkins (2001) claim that informal learning can be differentiated from formal learning by context, intention and how it is "triggered" by an internal or external stimulus. They further suggest that informal learning is marked by involvement in "an inductive process of reflection and action;" and importantly, that informal learning is "linked to the learning of others" (p. 28) which reflects findings from this study. However, other aspects of the model are more problematic: in particular, the suggestion that informal learning is somehow different by virtue of its being "integrated into daily activities", and "haphazard and influenced by chance", (p.28) while incidental learning is defined as a by-product of intentional activity that frequently occurs even though people are seldom aware of it (Marsick & Watkins, 1990).

As we have shown, drawing such *clear* distinctions between occurrences of formal and informal learning is problematic and posits that a more nuanced view wherein "attributes of formality and informality are interrelated in different ways in different situations" (Colley et al., 2002, p. 9) is more appropriate. Recognising such heterogeneity and situational specificity seems a more productive way of differentiating these areas of learning rather than attempting to differentiate the learning processes themselves. Furthermore, and also in contrast with Marsick and Watkin's (2001) claim that informal learning "generally takes place without much external facilitation or structure (p. 30), our participants activity sought out didactic learning experiences and incorporated these externally structured experiences into their learning processes. Participants' purposeful inclusions of instances of learning as knowledge acquisition within their broader range of self-directed, empirical, experimental and peer-to-peer learning choices provide evidence of contextualised attributes of formality and informality.

Through considering situated mobile app use in practice as an example of mobile-supported situated practice and noting some of the developments participants made to their equipment configurations in response to differences between app predictions and outcomes of practice, which in turn influenced calculation and assessment activities, we identify distributed learning occurrences. Whereas the agency of the iPhone in providing flexible access to apps is valued in both breweries, P1 and P2 enrol supplemental technologies to avoid iPhone interface problems during the brewing process. Where BrewPal, BrewTimer and BeerAlchemy apps each play specialised roles in supporting brewery effectiveness, their effectiveness as translators and mediators is negotiated both within brewing practices and via participants' engagements with peer learners in Internet forums. Thus mobile technologies in relation to evolving practices are at once active

subjects in mediating learning processes and objects of reconfiguration. It is to these reconfigurations of assembled socio-material networks we now turn.

Speaking Back to Theory: Extending NL with ANT

In setting out an ontology and epistemology of networked learning, Hodgson, McConnell, and Dirckinck-Holmfeld (2012) argue that networked learning theory "attempts to transcend the dualism between abstract mind and concrete material social practice"; however, the role of technology is reduced to mediating "connections within and between a learning community and its different actors" (p. 293). Mediation in this construction appears closer to what ANT considers an *intermediary* devoid of agency or merely a transporter of meaning rather than a conceptualisation of mediation as active agency within a process of translation. We argue that it is this sophisticated vocabulary and set of understandings specifically developed to analyse complex networks of humans and technologies and how they are assembled that ANT brings to researching networked learning. It addresses many of the concerns of the epistemology of networked learning Hodgson et al. (2012) set out—in particular resisting technological determinism and seeking to transcend dualisms. By adopting ANT's view of mediation as agency, rather than reducing it to a vehicle for the transportation of an agency that is "a fundamentally human characteristic" (Hodgson et al., p. 302), we gain a more nuanced view of how the agencies of technologies can disrupt or support, interfere or make durable processes such as learning.

This is the argument that Latour (1991) makes in proposing that "technology is society made durable" wherein ostensibly interpersonal actions are delegated to technologies which both reinforce and substitute for them. He gives the example of signs asking hotel guests not to take keys away and how these are reinforced by the simple technology of attaching a weighty fob, persuading guests not to carry heavy keys but instead to check them in at reception. By following this line of argument and its extension to networked learning through Fox's (2001) suggestion that we abandon a singular focus on the individual learner, we become free to explore the practical outcomes of adopting a symmetrical praxiographic approach to fieldwork. Rather than beginning with a priori categories such as "a community" or "an institution", we become free to trace heterogeneous associations and to look at the ways translation and mediation work to enrol and distribute agency and change. We can then consider learning as it is occurring and how it is reconfiguring *all* of a socio-material network rather than restricting ourselves to just considering or evaluating changes only in its human elements.

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