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"What do you want for dinner?" – need anticipation and the design of proactive technologies for the home

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Abstract.   This paper examines 'the routine shop' as part of a project that is exploring automation and autonomy in the Internet of Things. In particular we explicate the 'work' involved in *anticipating need* using an ethnomethodological analysis that makes visible the mundane, 'seen but unnoticed' methodologies that household members accountably employ to organise list construction and accomplish calculation on the shop floor. We discuss and reflect on the challenges members' methodologies pose for proactive systems that seek to support domestic grocery shopping, including the challenges of sensing, learning and predicting, and gearing autonomous agents into social practice within the home.

Key words: Ethnomethodology, Domestic grocery shopping, Proactive technology, Automation, Autonomous agents

1. Introduction

In 2014 Kari Kuutti and Liam Bannon laid out the case for a new paradigm in HCI research that went beyond producing and analysing snapshots of interaction focused on the individual and the human-machine dyadic relationship (Kuutti and Bannon 2014). They called the proposed shift 'the turn to practice' and located it in 'a decades-long process' that has seen the social sciences come to focus on practice as 'a fundamental unit of analysis'. Drawing on Nicolini (2013), Kuutti and Bannon identify six main schools of practice theory: praxeology (Reckwitz 2002), practice as the house of the social (Schatzki 1996), practice as tradition and community (Lave and Wenger 1991), practice as activity (Leontyev 1978), practice as discourse (Foucault 1969), and practice as accomplishment (Garfinkel 1967). This paper is rooted in the latter tradition. It thus focuses on how people *do* need anticipation and, following Garfinkel (ibid.), provides an analytic explication of the ways in which need anticipation is *methodologically* organised or ordered in-the-doing. Our interest in understanding the practical accomplishment of need anticipation is motivated by the emergence of 'proactive' technologies, which incorporate elements of automation, autonomy, and agency and seek to respond to human need. Nascent forms can already be found in the home and include products such as the NEST 'learning

thermostat'[1] and Amazon's 'Dash'.[2] Proactive technologies hold great social and economic promise (McKinsey Global 2015). Key to their uptake is the prediction of anticipated need. A smart thermostat must, for example, predict *when* and at *what* temperature to operate based on an understanding of user needs. However, research has shown that this may well be problematic in practice. Yang and Newman (2013) show, for example, that the NEST thermostat's predictive features do not work well for co-habitants with *differing* comfort levels, a not uncommon situation (Devlin 2017), and ignore the ways in which temperature is collaboratively negotiated as a social practice.

The domestic environment is an important potential site for a broad range of 'smart' proactive technologies, yet the focus in HCI on 'computational intelligence' has typically focused on the efficacy of algorithmic prediction (e.g., Scott et al. 2011) and user acceptance (e.g., Forlizzi and DiSalvo 2006). In accordance with the paradigmatic shift elaborated by Kuutti and Bannon, we take a different tack and seek to understand the social nature of need anticipation as elaborated in practice, thus moving beyond a focus on the individual and human-machine interaction to study collaborative activity and the concerted use of artefacts within mundane organisational routines. We thus seek to understand how people, rather than machines, anticipate need in order that we might learn something of the challenges that confront proactive systems, especially in 'multi-user' settings.

We focus on domestic grocery shopping as it provides a 'perspicuous setting' (Crabtree et al. 2012), insofar as grocery shopping is essentially concerned with anticipating what is needed over some prospective period ahead, be it a few days, a week, etc. We are not the first to look at shopping practices (e.g., Brown 2004; Elms et al. 2016) or food consumption lifecycles (e.g., Ng et al. 2015), but we may well be the first to do so with an eye towards understanding the challenges human need anticipation raises for automated prediction in this particular context, and what the development of computational agency might therefore learn from human agency at work. Accordingly, our study attends to how household members anticipate need as a local matter and thus come to furnish themselves with the domestic foodstuffs and the other household goods they require over some prospective period of time. As made visible in the doing we explicate the mundane 'methods' or 'methodologies' (Garfinkel 1967) members accountably employ to anticipate need. These methodologies revolve around list construction in the home and calculation on the shop floor. They implicate a 'seen but unnoticed' ecology of anticipation and a distributed body of collaborative work and reasoning in their practical accomplishment. They also identify key challenges for the development of proactive technologies that seek to support domestic shopping practices. These include challenges for the physical sensing of products in the home, computational learning and the prediction of need,

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[1] https://nest.com/uk/thermostat/meet-nest-thermostat

[2] https://www.amazon.com/ddb/learn-more

and the need for proactive systems to be designed in such a way so as to gear in with the social milieu, which drives the prospective anticipation of need.

2. Studying need anticipation

Our elaboration of need anticipation is based upon a series of field studies of domestic shopping practices. These started in December 2016 and are ongoing insofar as the work presented here informs an iterative process of design, deployment and evaluation (Hughes et al. 1994) in which further studies will examine the resonance between proactive technologies designed to support domestic grocery shopping and the mundane methodologies of need anticipation identified here. The studies involve eight households based in Wales and England, comprised of three families, four couples, and one elderly person, having a wide range of professional backgrounds that include administration, education, building and engineering, marketing, medicine and local government. Recruitment was reliant upon the field-worker's social network. The primary participant's name – i.e., the lead contact in each home - has been anonymised and is used to identify each household in Table 1 and throughout the rest of the paper.

The study was approved by the University's ethics committee, and informed consent was gained from all participants contributing to the research (not just the lead contact) prior to fieldwork. Studying need anticipation entailed undertaking direct observations and engaging in informal discussions to elaborate the witnessed details of shopping's work. Observations and discussions were recorded on audio and video, producing 33 h of data, complemented with field notes and photographs.

Data was gathered during fieldwork sessions lasting between 2 and 3 h with each household and included visits to supermarkets (6 out of 8), local independent shops including butchers and bakers (1 out of 8), and online shops (2 out of 8). The specific duration of each study varied according to the particular ways in which each household anticipated need and spanned a range of activities implicated in shopping such as planning and preparation, finding specific products that will meet need online or on the shop floor, unpacking goods and placing them for use in the home, and cooking. Sequences of data were subsequently transcribed, blending audio and visual

Table 1. Participants in the study

David	Is in his fifties and lives with his wife and two children aged seven months and six years.
Charles	Is in his fifties and lives with his wife and two daughters aged 13 and 16.
Tina	Is in her fifties and lives with her husband and 22-year-old daughter.
George	Is in his fifties and lives with his wife.
Mark	Is in his twenties and lives with his partner.
Liana	Is in her twenties and lives with her partner.
Brenda	Is in her thirties and lives with her partner.
Harry	Is a gentleman in his eighties living alone.

recordings to create rich descriptions of the naturally occurring and naturally ac-
countable activities implicated in shopping's accomplishment. These were then
analysed to identify their socially organised (i.e., methodological) features, particu-
larly those implicated in anticipating need.

Our analytic approach complements the tradition of work within CSCW that
adopts an ethnomethodological perspective to inform the design of technologies
for the home. Recent exemplars include studies of the use of domestic goods and
services within everyday practices (Crabtree and Tolmie 2016), the perfor-
mance of collaborative data work in the home (Fischer et al. 2016, 2017)
and digital privacy practices (Crabtree et al. 2017). Such studies ground us, as
Crabtree et al. (2012) put it,

> "... in the inter-subjective organisation of human activities and put us onto real
> world *topics* that are relevant to the future technologies we wish to develop."

The 'in vivo' work (Garfinkel 2002) of observation and discussion with participants
was essential to understanding the intersubjective organisation of shopping's work,
and subsequently enabled the appreciation of an array of practical matters and
practical methodologies involved in and reflexively organising need anticipa-
tion. We identified the rhythms and routines involved in shopping by
employing the 'horizontal and vertical slicing' technique (Crabtree et al.
2012). This allowed us to map out the local order of shopping's work in
each household, which became apparent through our observations of shop-
ping activities as they were taking place and when spoken about in dis-
cussion. The mapping exercise sensitised us to the details of shopping's work
and helped us tease out the 'animal in the foliage' (Garfinkel et al. 1981). That is, the
methodological ways in which need was and is anticipated in the doing of
domestic shopping across participating households in the face of the 'disparate
concerns' (Crabtree and Rodden 2004) or the particular needs that marked out each
home as unique.

Our analysis of the methodological ways in which domestic shopping is organised
was particularly attentive to the life cycle of items from 'shelf-to-shelf'. This
included mapping out when items were used in the home, disposed of, arranged to
be bought, found in a store, chosen, paid for, unpacked and placed back on a shelf (or
fridge, cupboard, etc.). The temporal order of this cycle invited a closer inspection of
how need was anticipated in the course of everyday life, in which products are
embedded and used. This led to a focus upon two grossly observable features of need
anticipation: shopping list construction in the home, and calculation on the shop
floor. This is not to say that all a proactive system needs to do to support domestic
shopping is calculate some variables and construct a list. As we shall see, while
extremely mundane, list construction and calculation in domestic grocery shopping
are complex methodological matters that raise significant challenges to automated
need anticipation. They should be seen at this point then as real-world topics that

provide us with 'coat hangers' (Garfinkel et al. 1988, unpublished manuscript) off which to hang our analysis and unpack our findings.

3. Anticipating need through list construction

Our participants used two types of lists: physical and digital. David, Charles, Tina, Mark and Harry used physical (paper) lists. Liana and Brenda used digital lists, including lists on smartphones and lists provided by online grocery stores. George used neither. Given their predominance in our study, we first treat the assembly of physical lists, which were compiled over an extended period of time before shopping (e.g., over the week) and completed just prior to the shop or, alternatively, constructed 'here and now' on the day of the shop itself as needed.

It is notable too that physical lists were situated amongst the arrangement of cupboard space, shelves, and work surfaces to provide for ready access and use. Thus, physical lists were placed in sites where a high throughput of goods takes place, typically in or near to the kitchen 'work triangle' (Lange 2012) where food items in particular flow through the home at speed, which in turn occasions frequent entries being made on the list. This traffic shapes the very placement of lists and is accompanied by the assemblage of resources: paper, pads, pens, and vouchers, which are placed to enable and to reflect the potential anticipation of need. Physical lists are situated then within a physical *ecology of anticipation*.

Our studies also revealed that physical lists were constructed on the fly, and unique in that no two lists in the same home were the same week after week. There may be recurrent items on a list – e.g., milk, bread, cereal, etc. – but every list is different. It was also noticeable that entries on lists are 'specifically vague', which is to say that items are not described in detail, but only in terms sufficient for the list writer to identify the items required. Thus, and for example, someone might write 'beans'. To the outsider what is needed may be opaque, but to the list writer this clearly specifies the kind, brand and quantity of beans needed. The clarity of the matter is provided by the list writer and reader's membership competence. As a member of this home they thus know what 'beans' means here.

Lists were at one and the same time recognisable to us as outsiders and yet largely unintelligible when it came to specifying just what was anticipated. Item entries and annotations are evidently 'indexical' (Garfinkel 1967) to, and thus get their definite sense from, the local ecology of anticipation and the cohort that produced them. Lists are thus 'procedurally encounterable' (Wieder 1999) and acquire their sense from the practical activities and reasoning that provide for their construction. We find, for example, that annotations support the accomplishment of shopping, marking out where items are located in a store and the order of shopping. It is towards unpacking the indexicality and procedural encounterability of list construction that we turn next, focusing particularly on how lists are both *incidentally* and *intentionally* assembled and how need is mundanely anticipated in the course of these accomplishments.

3.1. The incidental anticipation of need

It was plain to see in our studies that need is often anticipated incidentally in the course of doing *something else*. List writing is interleaved with a contingent array of domestic activities that one might find in any home. A recurrent way in which need was incidentally anticipated was when items *ran out* or could be seen to be *running low* in the course of their use. In the following example, we see how the arrangement of item entry is configured with regard to the practical circumstances at hand, and involves Tina taking down a container of assorted dried herbs from the cupboard while making spaghetti bolognaise.

> Tina: Ah we're running out of thyme (shakes thyme pot, picks up pen and adds it to the list on the fridge)

Here, the addition of an item to the list is occasioned in preparing a meal. When getting the thyme out from the cupboard, just at the point when the process of cooking occasions its addition, Tina notices that it is running low. This triggers a series of actions that acknowledge and register prospective need, before returning to cooking the bolognaise sauce. As the example makes clear, need is *contingently* anticipated in the doing of mundane domestic activities, often at the point an item is taken from a shelf or cupboard or when it is disposed of, and turns upon seeing and noticing the numbers, quantities and/or amounts of remaining items. It is also the case that the *recurrent* nature of many mundane activities in the home (e.g. making tea or coffee or toast, etc.) provides ongoingly for incidental monitoring and drives a local *life cycle* of need anticipation.

It became evident in our studies that the incidental monitoring of items was *differentiated* in each household, in that not all members used or monitored the same items in the same ways. Thus, incidental monitoring is *distributed* across a division of labour, as described here when the fieldworker asked about the nappy bags on David's list.

> David: Well my wife uses them

> Fieldworker: Yeah.

> David: predominantly, so she's the one that notices when they're empty.

Where the use of items is bound to the undertaking of particular activities, in this case the changing of the baby's nappy, the practical task of making sure that those items are restocked is also routinely carried out by the individual who largely uses them. Anticipating incidental need is, then, *bound* to specific individuals who are responsible for doing certain 'jobs'.

The anticipation of need may also occasion *mutual monitoring*. There are certain items that people do not want to run out of. In our study toothpaste and toilet roll were often cited, and participants sought to avoid running out of them by ensuring that they had more than one of these in stock.

> David: We usually keep spare toothpaste in stock but my wife forgot to put it on the list so this time I bought three.

In addition to demonstrating that mutual monitoring is not fool proof, the example also demonstrates that it turns upon *agreed measures* of what constitutes 'running low'.

Incidental anticipation turns upon methods that differentially distribute anticipatory rights and responsibilities across household members. Members do not all have the same rights and responsibilities: there are individual rights and responsibilities, where the anticipation of need is bound to specific individuals and activities; and there are mutual rights and responsibilities, where all members share the anticipation of need. These rights and responsibilities are each prefaced by the *entitlement* to add entries to the list, which some members do not have. In the homes we studied, children did not have the right to add items to the list themselves, for example, but instead had to ask those with entitlement rights to do so.

> Fieldworker: Custard creams (reading from the list)?

> David: Now I don't usually buy custard creams but my daughter [aged 6], er, her friend, when she goes to her house, they always have custard creams.

> Fieldworker: OK right.

> David: So she said Daddy can we have some of those custardy biscuits and I said yeah course we can. We usually buy something else for her, so she'll get those instead.

In addition to being differentially distributed then, the local life cycle of need anticipation is also *managed* for some members of the home, and is organised with respect to the local social and moral order. Thus, and for example, managing his six-year old daughter's intake of biscuits and what it is appropriate for her to have is, for David, an accountable feature of parenting, made visible through the work of assembling the list.

3.2. The intentional anticipation of need

The social and moral ordering of need anticipation is a dynamic and evolving matter. As children move between dependent and independent states the anticipation of need

shifts from one of managing their rights and responsibilities to one involving them in the exercise. Thus we find that participants with teenage children often *consult* them, at least if they are around when lists are being collaboratively assembled. The collaborative making of lists marks the *intentional anticipation* of need and is concerned to identify items that are required on *this* occasion of shopping to fulfil need for the prospective period of time ahead. This is demonstrated in the example below, where Charles is preparing to go to the shop and seeks the help of his wife Julie and teenage daughter Fran in deciding what the family needs.

Charles: What kind of things do we need so I can get a sense of what we are out of?

Julie: OK, Bread.

Charles: Bread.

Fran: Bagels.

Charles: What?

Fran: Bagels.

Julie: There's bagels there (in the bread bin) Fran.

Charles: (Gets up to check bread bin) We need bread.

Consulting household members as to what is needed routinely occurred as the doing of the household shop drew closer, e.g., the night before, the morning of, or just before the shop. As the above example makes visible, the intentional anticipation of need is routinely articulated through proposing *candidate items* (e.g., bagels) whose need status is determined through practices of *looking-and-checking* (e.g., looking in the bread bin, where it is found that what is actually needed is bread).

We found that looking-and-checking was often bound to individuals and their responsibilities and personal needs (e.g., a mother might check that items required by a baby go on the list as do items required by herself). Looking-and-checking often involves establishing how much of an item or items is left and what condition they are in (e.g., that they are still edible). It is also organised around cohorts of things, e.g., 'stuff' for the bathroom or cleaning. Looking-and-checking not only occurs as a preface to the shop, it is also *temporally distributed*. It can, for example, be anticipated in the incidental course of use that an item is needed, but that need is not registered and thus inscribed on a list until the moment of intentional assembly, as seen in the following extract where potential breakfast items are being discussed.

Julie: Coffee maybe. Actually, you don't have coffee do you

Charles: No? Well, actually I need coffee, thanks for that.

Julie: because Sarah Johnson I think had the last of it yesterday when she came round.

Charles: Oh did she now.

As can also be seen above, the collaborative assembly of the list is a matter of making what is needed *accountable* to the person who will add items to it, here and now, at just this moment. It is also a moment that provides for *clarification* of anticipated need, as can be seen in the following example.

Charles: What cereal?

Julie: Girls what cereal?

Charles: Not the chocolate ones.

Julie: Fran have you stopped eating malt wheats?

Fran: They've done something to the malt wheats, I don't know what they done but they've done something.

Fieldworker: They've changed have they?

Fran: They've done something and its not me being picky, they've done something.

Julie: Right so you don't want malt wheats. What do you want?

Fran: Rice Krispies.

Clarification may be required from specific members as above as to just what is wanted, and also to what has been previously written on the list (e.g., when an illegible or unfamiliar entry has been made). Discussion of food categories may also occasion members being called to account for not eating certain items and wanting other items instead (as again can be seen above).

Need is also intentionally anticipated in expressly *planning* for the prospective period ahead. This is done with reference to *established preferences*. That certain items are preferred does not mean that they are purchased every week, however. Their need is anticipated with respect to cycles of use, including *seasonal* cycles. So,

and for example, crumpets may be a preferred item, but only in winter. Thus, while it is certainly the case that households have established preferences, this does not mean the cycle of their consumption is static. Planning for and purchasing items that satisfy established preferences depends on such matters as time of year and weather. This means that just what preferences are anticipated 'here and now' in planning ahead is, in many respects, a 'movable feast'. The same applies to *established routines*, which are drawn upon by household members as a key driver for planning. However, despite the fact members can readily anticipate that they will routinely eat breakfast, prepare packed lunches, sit down for dinner together, etc., what they need is not so clear cut, as can be seen in the following vignette when Amy asks Mark what he wants for lunch next week.

Amy: Do you want umm four days worth of roasted veg and rice, or shall we do like two, three days and maybe do something else again?

Mark: Umm, well is there anything in there that you could have for lunch the next day?

Amy: No. Not really.

Mark: Do you want to do pasta instead one day?

As Amy and Mark make visible, planning with reference to established routines turns on building *variability* into them. After all, most people do not want to eat the same things day after day.

Planning not only turns on deciding what food to share, it also turns on deciding what to eat and when and with whom. Thus planning is wrapped up with the broader social demands that accompany being a household, a family, a couple, etc., and of what might aphoristically be called 'breaking bread together'. The anticipation of need therefore turns in significant respects upon people's *schedules*, and intentionally assembling a list is seen and treated as an occasion to announce these and articulate their *prospective implicativeness*.

Charles: Mum's away Friday Fran, what do you want for dinner then?

In the course of planning, the implications of persons availability on what might take place and when is taken into explicit account, and shapes what goes on the list 'here and now'. Wrapped up in this are considerations as to just *who* making a shared meal might fall to, with an individual's competences driving just *what* goes on the list. Charles, for example, is not as accomplished a cook as Fran's mum, which results in them discussing 'easy' meals to make on Friday. Just who has to provide for the routine's accomplishment (e.g., eating a shared dinner) may even occasion alternative options (such as a takeaway). It is also the case that guests and visitors are

factored into determinations of what is needed when considering the impact of schedules on the intentional anticipation of need.

Notwithstanding established routines and preferences, there is a strongly *negotiated* character to planning and need anticipation, which turns upon manifold variations and contingencies including item turnover, the weather, the season, who is available, when, who carries responsibility for cooking, and who else may be in attendance, all of which drives just what is put on the list 'here and now'. One final matter is also key to the intentional anticipation of need. It was observable that list construction was also done with an eye to *cost*, with the candidacy of items being established as commensurate with what could be afforded. It was the case for some of our participants that the party who paid for the shopping had a direct impact on the anticipation of need. Thus we find that while people may co-habit, they may have independent financial arrangements and different levels of income to the effect that one party does not attend especially to cost whereas the other does. This may result in fewer, or smaller, or lesser amounts of things being added to the list, or them not being added at all. The anticipation of need is, then, not only wrapped up in the economics of the household but also in the economics of the interpersonal relationships within it.

3.3. Anticipating need online

As noted above, not all of our participants constructed physical lists in the course of need anticipation. Brenda and Liana used digital lists, including smart phones (typically for a handful of items required off the cuff) and those provided by online stores. Online shopping is possessed of many of the methodological features found in anticipating need during physical list construction. Thus we found participants looking and checking, consulting one another, planning with reference to preferences, routines, schedules and scheduled events (e.g., birthdays, parties, and guests), and cost. However, in the digital world the methodological construction of the list reflexively provides for the completion of the shop, i.e., in anticipating what is needed online participants are not only assembling a list but actually *doing the shopping*.

While sharing similar methodological features of physical list construction, need anticipation in the digital world is possessed of its own unique features too. One of the most grossly observable differences in our study is that, unlike their physical counterparts, digital lists are not specifically vague but consist of precise specifications of items. It is observable too that the temporal character of looking-and-checking is constrained by the digital. Digital lists are not situated in the ecology of anticipation but removed from the sites where a high throughput of goods takes place. They are only temporarily situated in the ecology of anticipation on the actual occasion of shopping (e.g., by placing a laptop on the kitchen table), thereby inhibiting incidental anticipation to noticeable effect.

Liana: See like coconut milk, I don't know if we've got some and like, sometimes I just get it anyway and sometimes I get up and check.

Liana's anticipation of the need for coconut milk is occasioned by her looking at her 'favourites' list, i.e., a list of previously bought items provided by a digital shop. As with so many other items, the potential need for coconut milk was not encountered incidentally, but intentionally *in checking* the favourites list, which sometimes prompts looking and checking elsewhere in the home.

While digital lists inhibit incidental need anticipation, they do have their unique affordances. Favourites often provided a starting point for the current shop for our participants. Once exhausted they turn to other resources provided by online shops such as product 'categories', which are routinely used to identify items. Identification presumes that persons know what they want, and both shop furnished categories (e.g., 'meat', 'fruit', 'toiletries' etc.) and self-formulated categories (e.g., 'mince beef', 'bananas', 'deodorant', etc.) are used to *locate* sought after items. Furnished or formulated categories are also exploited to anticipate need, as can be seen in the following vignette where items for Christmas are being sought.

Brenda: Right, what else?

Frank: Just write Christmas things.

Brenda: (Types 'Christmas things' in search bar; the category Christmas is also furnished by the website).

As Brenda and Frank make visible, shop furnished categories or self-formulated ones (e.g., 'Christmas things') are leveraged to surf and browse digital shops to *discover* candidate items and *find* just which amongst them will satisfy their needs.

Need anticipation is also driven by *reviewing* the assembled online list, which our participants did to establish whether or not they had satisfied their prospective needs. This 'review' would typically involve assessing the meals provided by the items on that list and then supplementing it with further items if needs be. On completing the list, and moving to check out, participants would also be presented with *automated anticipations* or candidate items proposed by the online shop. These were seen by participants as items that may have been forgotten or that they had run out of based on prior shopping activity. Being presented with these items occasionally triggered looking-and-checking.

Liana: I don't know if I've got cheese actually (gets up from sofa and goes to the fridge, finds they have not got much cheese; searches for cheese deals and adds one to the online list).

Clearly there are various *pathways* whereby need is anticipated in the course of online shopping, but in each case the exact number, size, quantity, weight, amount or brand needed is determined at the interface in light of available *choices* on just this occasion of shopping. Choosing inevitably involves comparing and making selections from amongst multiple available items. Comparing and selecting turns upon striking a balance between a broad range of practical concerns to do with item selection – e.g., best deal, the look of an item, preferences, fit with meal plans, etc. – and the cost of the shop as a whole. Choosing items thus turns upon *calculation*, which is a complex matter that also plays out, and in richer ways, on the shop floor.

4. Calculation on the shop floor

Calculation is a prominent feature of need anticipation on the shop floor. While there is a sense in which a constructed list brings anticipation to a close, it reopens in the face of the manifold contingencies occasioned by *choice*. It may be that established preference rules choice out in some cases, but in many others a decision as to just what item should be chosen to meet anticipated need must be arrived at 'here and now'. Thus we find that when at the 'shelf face', shoppers seek out and parse information that is relevant to locating items that meet their needs. This is a not necessarily a simple matter of retrieving an item off a shelf, but occasions manifold kinds of calculation to decide what and whether to buy just this or that item.

George: Get a few jacket potatoes, those ones look alright.

Fieldworker: What are you looking for here?

George: Dents. Blemishes. Anything. That's why I often pick my own because if they are in a pack you can't do anything about it.

Calculation often turns, as it does for George, on 'sensing' items in order to choose the most suitable to meet his anticipated needs. The extract shows how sensing the specific physical conditions of the potatoes underpins this. Thus, choosing from a container of potatoes is a calculable matter demonstrated in seeking out potatoes that do not have blemishes. Of course, this particular kind of sensing is contextually bound to choosing potatoes and reveals what it is that people know about the items they are buying, e.g., that potatoes are not sensed in the same way as avocadoes, which are squeezed in various ways in order to determine their ripeness.

It was observable how items required a varied use of the senses, e.g., shower gel was smelt and meat looked at in order to sense specific features of these products. Feeling, looking and smelling were key to assessing the *quality and condition* of

items in order to meet anticipated need. Determining just what to buy also involved manipulating shelf-face arrangements, e.g., moving boxes and crates to see the contents of other ones and looking underneath or behind stacked items. Where the shoppers themselves could not accomplish this, shop staff made items available for inspection in or behind counters, enabling our participants to choose items upon the grounds they found reasonable. Sensing is also tied to the *prospective use* of items, as Charles makes apparent when buying bread.

> Charles: I want something that feels springy, and I look at the size of it - I hate thin bread because when you toast it, it turns really dry, you know?

In this case the sensing of the bread is tied to its prospective use in making toast, along with Charles' personal preferences on the matter. It was observable too how the prospective use of items was tied 'here and now' on the shop floor to the places our participants anticipated using them. Thus, and for example, tinned sardines in BBQ sauce were bought instead of sardines in oil as there is 'less waste to deal with' on the building site where one participant worked.

The situated work of calculation also turns upon the *occasioned use of labels*, as seen here when Harry speaks about a tin of peaches he has just looked at and put back on the shelf.

> Harry: Usually those just say 'in light syrup', but then cinnamon, yuck. Perhaps that's why it's cheap because not many people would buy that, with cinnamon. So with these shops, you've got to look beyond them a little bit.

> Fieldworker: You've got to be careful?

> Harry: Yes. In fact I do read labels a lot.

In the above extract Harry takes more than a cursory glance at the peaches. A close reading of the label on the tin allows him to get a detailed sense of its contents, which is key to deciding whether 'just this' item in hand will meet anticipated need. This determination turns upon Harry's knowledge of buying 'this kind' of product in 'these (budget) shops' and displays his anticipation of the features it may have that he may or may not want. It is a common feature of calculation on the shop floor that a label is appealed to in order to make a choice when a degree of specificity about an item's features may not be possible to determine by other means. Thus, we saw labels being read to find out about contents, nutritional value, quantity, how long something takes to cook, and various other product features that turned upon, and served, a disparate range of preferences, interests and activities.

Routinely *checking labels* was also a behaviour for which household members were held accountable, as seen here when choosing milk.

Fieldworker: So you check the dates on each one.

Amy: I do. You don't, so much (looking at Mark).

Mark: I normally do because I get a bollocking if I don't.

Cleary 'the (use by) dates' on products is a key calculation in anticipating need on the shop floor and determining just which items to buy. Cost labels were also routinely checked and were found on items themselves and on the shelves. These were used in *comparing prices*, which included those currently on display and those previously seen, as described by George while heading towards the cakes.

George: Cakes will be the next thing. We don't eat a lot of cake. Sally might have some. Again, I'll check. If the price is good I'll have them, if not I'll wait another week. It's not a problem.

Checking the price allows George to calculate whether or not 'here and now' is a good time to buy cake. The calculation turns upon his local knowledge of costs, which is drawn upon to make sure he buys items when the price is low. George, like many of our participants, routinely kept a stock of certain items in order to prevent him from being forced to buy when the price is higher. Thus, choice is often calculated based upon shop specific *cycles of costs*, *sales and offers*. Our participants also considered the prospective costs of the same or similar items in other shops being visited that day while at the shelf face.

Reading labels as a feature of calculation is an important part of need anticipation on the shop floor. Key too is *discovery*. Discovery is a serendipitous feature of shopping, not that it is necessarily haphazard. On the contrary, our participants routinely 'scanned' shelves as they walked up and down aisles for items that were not on the list but were anticipated as needed *upon being seen*.

Tina: Ah, Flora. This is where I get excited. You see (picks up two large tubs and puts them in the basket).

Here Tina's anticipation of need is calculated upon seeing tubs of Flora (a butter-like spread) *on sale*, a discovery that makes her 'excited' as saving money is not an inconsequential matter. We found that many of our participants kept their 'eyes peeled' for bargains as they went about shopping, and certain sections in certain stores would be routinely visited in order to see 'what they had on offer', all of which means that our participants routinely bought more items than were on the list. We found too that where items were serendipitously discovered but had not been tried before, then our participants employed a distinct calculative strategy as seen here when Harry notices a stack of tinned tomatoes on sale.

Harry: Well I haven't heard of this brand before, but they're very cheap.

Fieldworker: Yes, that is very cheap isn't it.

Harry: So I might buy two and try 'em, see if they're any good. It says that it's just tomato so that's more or less the same – salt – more or less the same as the usual ones. But its an unknown brand to me. But at twenty-five pence I can't go wrong.

Fieldworker: You would usually buy four?

Harry: Yes I would usually buy packs, but these are twenty-five pence in the singular (puts two in basket).

Discoveries of unknown items, as in the case above, would often involve buying a small amount of the item to try out. This enabled participants to manage the risk that accompanies spending money on items whose ability to meet anticipated need has yet to be determined. Thus methods for anticipating need are routinely bound up with contingency plans to make sure that risk is minimised.

Calculation is also done with respect to the *intended recipients* for whom particular items were being bought, as the example below demonstrates.

Charles: Now I am in a quandary (looking at yogurt) because I can't remember what they eat.

Fieldworker: Do they change the type of yogurt they want often?

Charles: Well Harriet (daughter) demands these ones, and she thinks it's hers and won't share.

Fieldworker: Right.

Charles: And if she were here looking at it with me now I would say no you're not getting this one to yourself.

This extract makes it perspicuous how items are bought, or not, with regard to how they may be received and treated by other household members, in this case by Harriet one of Charles' teenage daughters. All of our participants routinely undertook such calculations, which are bound to the social and moral order of domestic life and the potential *impact* of particular purchases on that order. Calculation is also done with respect to the preferences of others, as seen below when Mark finds himself with a different dessert to Amy who has chosen a more 'chocolaty' one.

Mark: Happy with that?

Amy: Yeah, yeah.

Mark: I feel a bit left out though. I feel as though I should probably get the same, so I don't get food envy (puts dessert back on the shelf and picks up the same one as Amy).

In this it can be seen that the *prospective consumption* of food is a calculative matter that shapes the anticipation of need 'here and now' on the shop floor not only in the face of manifold product choice but also in the face of the choices *made by other members* of the home. It is not only the qualities or properties of 'things on shelves' that matter then, their prospective relationship to people and the events they engage in is important too.

To this we would add that the *ecology of the home* is a key ingredient in calculating just what will meet anticipated need. Choosing just which items to buy in the face of manifold choice is inevitably bound to what will *fit in* the home. It was routinely the case then that our participants brought ecological considerations to bear when choosing items, particularly with respect to the size or the amount of items required to meet anticipated need. Thus, calculation was done 'here and now' on the shop floor with respect to the *unique* design and layout of space in each of our participants homes, for when they return home with their purchases each has to be situated in its place within the ecology of anticipation, e.g., in a cupboard, drawer or on a shelf, ready for retrieval and use.

5. So what?

Following issues raised in discussion of this paper, we first consider our study's relationship to practice theory before summarising our results and turning to consider implications for the design of proactive systems supporting domestic grocery shopping. We note, then, that in elaborating the 'turn to practice' Kuutti and Bannon (2014) suggest the 'practice as accomplishment theory' is primarily associated with ethnomethodology. The authors also remark that it is 'not fully correct' to call ethnomethodology a theory, and for reasons touched upon indirectly by Schmidt (2014) in elaborating the 'concept of practice'. In doing this Schmidt observes that the concept has 'moved centre-stage' in social theory.

"The motivation … is that 'practice' is seen as a means for providing social theorizing with an 'ontological' (or transcendental) foundation, i.e., a foundation prior to building a framework bottom up from actual empirical studies. So far, without luck, for the concept of 'practice' is notoriously unfit for doing *that* kind of work. As a result, the term 'practice' is being used in confusing and confused ways: as another word for 'activity', 'culture', 'tradition', 'paradigm', 'embodied action', 'knowing how', and so forth." (ibid.)

Schmidt subsequently attempts to steer a way through the confusion, elaborating the emergence of the 'modern' concept of practice, from Bacon through to Diderot and Kant, and the dissolution of the preceding and dominant Aristotelian concept-pair 'theoria' and 'praxis'. Thus, the modern concept of practice dissolves the distinction and ties 'reasoning' and 'action' together in a mutually constitutive relationship. Furthermore,

> " … the Modern concept of 'practice' … focus[es] on the ways in which the competent actor in his or her action … [takes] particular conditions into account while committed to and guided by … general principles [plans, rules, procedures, etc.]. When studying a practice we are [then] focusing on ***how*** … practitioners determine the nature of a situation, how they select effective and efficient techniques (materials, implements, bodily postures, methods, etc.), determine deviations from what has been assumed in … rule formulations, deal with routine troubles, recover from breakdowns, etc. (ibid., our emphasis)

Ethnomethodology might put it differently and say that practitioners operate under the 'gambit of compliance' (Bittner 1965; Tolmie and Rouncefield 2011), but it would not fundamentally disagree in this at least. It would, however, have us take a further step beyond the 'how' of the matter towards understanding practice as matter of understanding how action or interaction is accomplished methodologically. As Kuutti and Bannon put it,

> "For ethnomethodology practices are locally produced by using a selection of certain 'ethno-methods' of interaction that make practices, and thus all social activity, possible. These ethno-methods are the central object of ethnomethodological studies."

They are, but it is not that ethno-methods, or members' methodologies, 'make practices possible'; it's not as if there are ethno-methods on the one hand, and practices on the other, with the former having a causal relationship to the latter. Rather, it is that 'ethno-methods' and 'practices' are *identical*. These are but different names for the same naturally occurring and naturally accountable phenomenon, 'born in obscurity' as Schmidt (2014) puts it or 'seen but unnoticed' in ethnomethodological parlance and left unexamined by social theory (Hutchinson et al. 2008). The notion of 'ethno-methods' was coined by an 'incommensurable, asymmetrically alternate technology of social analysis' (Garfinkel and Wieder 1992), which is fundamentally incompatible with a technology of social analysis that proceeds by theorising practice and thus abstracting from what it is that people actually do in order to build (typically explanatory) frameworks from actual empirical studies (Lynch 1997). This alternate technology of social analysis (Garfinkel 1988) was subsequently taken up in CSCW, where it came to be referred to as 'studies of work' or 'work practice', a concept as Button and Harper (1996) point out,

> " … that needs to be grounded in *analytic explication* of work rather than in theoretical abstractions … … …. capable of revealing the methods through which the situated contingencies of activities and interactions are contextually managed as orderly courses of work. (our emphasis)

In explicating the ethno-methods providing for need anticipation in the mundane work of domestic grocery shopping we do not offer a theory of shopping practices then, or seek to relate our findings to social theories of practice more generally, but offer instead an analytic explication of the methodological ways in which need is anticipated *in practice*. In doing so we have focused on what Garfinkel et al. (1988, unpublished manuscript) termed 'unmotivated observables', i.e.,

> " … practices of such unquestioned efficacy and banality that no motive ordinarily exists, either in commonplace settings or professional inquiries to make an issue of their methodic character."

The turn towards proactive systems has given us motive and we find, when we look, that something as commonplace and 'banal' as constructing a shopping list and handling the manifold contingencies of choice on the shop floor in anticipating need has a rich 'methodic' or methodological character. We can see in the first instance that physical lists and resources for their construction are situated in an *ecology of anticipation*, amongst high density traffic in the flow of fast moving consumer goods. This is no accident, but a methodological feature of list construction found across the homes participating in our study, which enables need to be anticipated incidentally on the fly and to be intentionally provided for as a preface to or during the actual shop. Both incidental and intentional need anticipation are shot through with methodological characteristics, as is calculation on the shop floor, and we summarise each in turn as a preface to considering the implications of these methodological matters for the design of proactive technologies to support domestic shopping.

5.1. The methodological character of incidental need anticipation

Our studies make it perspicuous that need is often anticipated incidentally in the course of doing routine activities in the home, within which items or products are used. It is, then, a methodological feature of incidental anticipation that need is *contingently encountered* in the making of meals, bathing, cleaning, washing, etc., as items *run low* or *run out*. It is not simply that items run low or run out that matters, however. It is that in being encountered the *prospective need* to replace them is anticipated. The contingent anticipation of need is not a 'one shot deal' either, something simply encountered in the moment of seeing that items are running low or running out, but is methodologically provided for as an ongoing matter through *incidental monitoring*. Thus members actively 'look out' for items running out or

running low *over the course* of their use. A further methodological feature of incidental monitoring is that it is *socially distributed* amongst household members and *bound* to the undertaking of *particular activities* by *particular members*. In some cases, with respect to particular categories of product, especially those that members do not want to run out of, incidental monitoring is also bound to multiple members and turns, methodologically, on *agreed measures* as to what constitutes 'running low'. It is a methodological feature of need anticipation too that the entitlement to add items to a list is differentially distributed, with young members of the home being excluded from direct item entry (and this would also appear to extend to visitors and guests). Thus the anticipation of need is, for certain members of the home, a *managed* matter, though we note younger members have their own methods for getting items onto the list.

5.2. The methodological character of intentional need anticipation

It is perspicuous too that need is also methodologically anticipated in intentional ways as a preface to the actual occasion of shopping. Thus members are *consulted* to identify items required on 'just this' occasion of shopping. Consultation turns, as a matter of method, on members making what is needed accountable to the person who will add items to the list, here and now, and is done methodologically through members a) *proposing candidate items* and b) through *looking-and-checking*. Looking-and-checking is *socially distributed* and bound to individual responsibilities and personal needs; it is *spatially distributed* and requires as a matter of method that members search the home to anticipate need, including checking *cohorts of products* (e.g., bathroom items); and it is *temporally distributed* spanning both incidental and intentional need anticipation. Methodologically, the job of consultation also provides for the *clarification* of anticipated need, including previously inscribed articulations of need and the candidate status of prospective articulations. Need is also anticipated through *planning*, which is possessed of various methodological characteristics. Thus, need is planned for with reference to *established preferences* (individual and collective), *cycles of item usage*, and *seasonal cycles* where the need for specific items changes periodically. Need is also planned for with reference to *established routines* and with respect to the need to build *variety* into them; with explicit reference to *sharing*, particularly with respect to *food items* and *specific occasions of eating together* during the prospective period ahead (including all manner of social events; and with explicit reference to members *schedules* to determine their availability, not only in terms of who may be present at a shared event but who the job of making food might fall to. The availability of members implicates their *culinary competence*, and provides methodological grounds upon which to anticipate what might therefore be needed. It is also the case that the anticipation of need is as a matter of method planned for with reference to cost, which is not reducible simply to money but to who is paying to satisfy need on 'just this' occasion.

5.3. The methodological character of anticipation on the shop floor

Need anticipation does not stop with the completion of the list. This may close the matter 'here and now' on the occasion preparatory to shopping, but it reopens on the shop floor in the face of the manifold contingencies occasioned by *choice*. Thus, need anticipation continues on the shop floor and is methodologically organised through situated practices of *calculation*. These practices include *sensing* items through look, touch and/or smell (just which sense or senses apply turns on the kind of item being sensed), and occasionally doing so in collaboration with shop staff, to determine the suitability, condition and quality of candidate items and to make particular selections from amongst them. *Product labels* and *information posted on shelves* are also drawn on methodically to determine the suitability, condition and quality of candidate items, with members drawing contingently upon various *categories of information* (nutritional value, sell by dates, prices, offers, etc.) to make particular selections from amongst the range of choice. Determining an item's suitability is not only concerned with various categories of product-related information, but methodologically tied to the shopper's retrospective and prospective knowledge of *cost cycles* and *projected reductions* for particular kinds of items in and across particular stores, which is to say that shoppers know what constitutes a 'good deal' and keep an eye open for their (re)occurrence. As a matter of method shoppers also keep their 'eyes peeled' for serendipitous discoveries by *scanning shelves for offers or reduced-price labels* on items. It is notable too that novel serendipitous discoveries are as a rule purchased in *small quantities* to in order to determine their suitability. Calculation is also methodologically bound to the *prospective use* of items and choices are thus made with respect to the *occasion of product use*, the *choices* made by those they are shopping with, the *recipients* they are buying products for, and the *social implications* of making particular choices (e.g., the negative impact of certain choices on certain members behaviour and the need to avoid such situations). Finally we note that need anticipation is done methodically with respect to the *available storage space* in the home.

6. Implications for design

Our studies make it perspicuous that anticipating need even in the case of such a 'banal' commonplace activity as domestic shopping is a complicated business whose accomplishment turns on and is reflexively organised through a rich assemblage of members methods. We make no claim to have uncovered or described all this assemblage might consist of, only that it exists, is there for anyone in 'western' cultures at least to see even though it typically goes unnoticed, is taken for granted, and ignored. Nonetheless this methodological assemblage of practices is consequential as the anticipation of need turns upon its unquestioned efficacy and we see no reason why it won't continue to do so as we turn to the proactive technologies and autonomous systems. Here we wish to consider the challenges the methodological

organisation of need anticipation raises for the design of proactive systems that aim to support domestic shopping practices. In particular, we reflect on how proactive systems might be designed to fit in with the physical ecology of anticipation in which the incidental as well as the intentional anticipation of need is situated. This raises design challenges around *sensing*, and includes informational as well as physical properties. Furthermore, in effectively bringing the shop floor into the home, proactive systems will, as digital systems currently do, rub up against the range of calculative practices surfaced by our study that are bound up with need anticipation. This raises challenges around *learning and prediction*. Finally, the collaborative and social nature of need anticipation inevitably situates proactive systems in a *division of labour*, which we also discuss below.

6.1. Sensing in the physical ecology of anticipation

Making proactive systems fit in with the *ecology* of anticipation would appear to lend itself well to the application of Internet of Things (IoT) technologies. The potential 'connectedness' of the physical fabric of the home and products within it may support the fine-grained *monitoring* and *looking-and-checking* implicated in incidental and intentional need anticipation. A connected future in which 'smart products' are coupled with a local sensing infrastructure to monitor product lifecycles from cupboard shelf to waste bin would be a first key step towards proactive need anticipation (Cognizant 2015). Existing work has designed and studied sensor-based interventions at various stages of this lifecycle, many of which rely on self-reporting (see Comber et al. 2014 for an overview). For example, Ng et al. (2015) used wearable cameras to study the overall food consumption lifecycle, while Hupfeld and Rodden took a photo diary approach (Hupfeld and Rodden 2012). A significant body of work has focused on understanding food waste management and design to support its avoidance (Comber and Thieme 2013; Ganglbauer et al. 2013, 2015). In this space, interventions aimed to increase awareness and reduce waste have relied on cameras placed in rubbish bins (Thieme et al. 2012), and the fridge (Ganglbauer et al. 2012), and have also explored automated recognition through additional colour coding of items in the fridge (Farr-Wharton et al. 2014).

Other work draws on continuous monitoring of kitchen spaces. It includes research that has instrumented a kitchen worktop with weight scales and overhead cameras to estimate nutritional value using a Wizard-of-Oz approach (Chen et al. 2010), motion-triggered cameras over the stove (Clear et al. 2013), and measuring the contents of containers using a sonic sensor (Fan and Truong 2015). Amutha et al. (2012) demonstrated that combining load sensing with UHF RFID technology allows for a more detailed view of product usage. Their monitoring of item stock thresholds via the 'smart kitchen cabinet' has also demonstrated that automatic shopping lists can be crudely constructed. More generally, load sensing has been suggested as a robust way to gather 'contextual information' in everyday environments (Schmidt et al. 2002). However, while load sensing may be promising to

monitor products and anticipate need, the challenges of implementing load sensing are not just technical and practical (i.e., fitting load sensors in the right place). Our study also instructs us that monitoring turns as a matter of method on *locally agreed measures* as to just what constitutes 'running low', which trigger the anticipation of need. Thus, it is not simply that items run low or run out that matters, what matters is how those measures are locally established and sustained. Sensing alone then, does not provide reliable measures to anticipate need, and interaction mechanisms are thus required to enable users to create and manage situationally relevant monitoring arrangements.

Insofar as the digital brings the shop floor into the home it will also be necessary to marry sensing/monitoring to product information and thus enable calculation in the face of manifold choice. The availability of detailed product information is an important part of need anticipation, as our study has shown for example in practices of *appealing to* and *checking labels*. In order to support the anticipation of need appropriately, digital alternatives need to make at least the same information available as physical labels do. Related work has explored the recognition of product information through OCR of scanned shopping receipts (Mankoff et al. 2002), and Reitberger et al. sought to exploit existing food databases to retrieve product information (Reitberger et al. 2014). However, the findings from Reitberger et al.'s study confirm our own investigations that truly open and comprehensive product databases are lacking. While some supermarket-specific open APIs exist in the UK, for example, data is generally kept in proprietary systems behind paywalls, making open innovation and development difficult, despite initiatives such as the Open Data Institutes' Food Data challenge.[3] This seems to us to create a particularly thorny barrier to the development of proactive systems in this context, for as our study makes it plain to see, it cannot be assumed that an item will be replaced with the same or even at all. Detailed information is required to enable effective need anticipation.

6.2. Learning and predicting calculative practice

Our study makes perspicuous the situated and contingent array of calculative practices through which choices are made, which inhibit simplistic 'if-this-then-that' style actuation. For example, that something was consumed last week, and even many weeks and months before that, does not mean that it will be required next week (or whatever the prospective period may be). Nonetheless, a designer may posit that many of the resources drawn on in calculation may usefully be drawn upon by proactive systems: preferred products, ingredients, nutrition, use by dates, cost, offers, storage and product size, stock levels, frequency of use, recipients, etc., once sensed and connected to a user model are all computable. It would appear then on the face of it that machine learning techniques such as preference learning (e.g.,

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[3] See http://www.nesta.org.uk/closed-food-open-data-challenge

Fürnkranz and Eyke 2010), pattern recognition, and the prediction of use cycles presents itself as a promising solution to the problem of need anticipation in proactive systems. There are challenges of course, particularly gearing algorithms into *fine-grained local patterns* (Crabtree and Tolmie 2016) rather than large scale clusters of preference, including deliberate variability of routines, seasonal variation, and individual's schedules, but these are not, in principle at least, technically insurmountable. Further limitations include extensive 'bootstrapping' and training of proactive systems to learn local preferences and to handle the shortcomings occasioned by decisions outside of the learned behaviours, which can lead to undesirable outcomes (e.g., Yang and Newman 2013).

However, the contingent nature of calculation explicated in our study suggests it may be unwise to attempt to automate decision making entirely. Instead, our findings indicate that in most cases we should design proactive systems so that users can inspect, influence, and take control of machine decisions *on demand*. Research has demonstrated interactive approaches to intelligent systems that make predictions and act on the user's behalf - Costanza et al. (2014) present a washing machine agent that charges a battery based on time slots the user provides to the agent through a booking interface, for example, and Alan et al. (2016) present a Tariff Agent that helps users switch energy tariffs while offering user-definable levels of autonomy. This work shows how proactive system decision-making can be designed to involve the user at key moments.

6.3. Situating proactive technologies in the division of labour

Our study suggests it is also critical that proactive systems supporting domestic grocery shopping (and we suspect the issue might apply more broadly in a domestic context) respect the sociality of need anticipation and therefore fit into the *division of labour* that provides for its routine accomplishment. As our study has shown, the efficacy of need anticipation turns upon the differential distribution of rights and responsibilities. In shared environments at least, no single 'agent' is responsible for anticipating need then. Rather, anticipation is tied to particular activities and the particular individuals who do them, and we have seen too that need anticipation may occasionally be shared and turns in such cases on agreed measures. We have also seen that the socially distributed anticipation of need is provided for through an array of locally enacted practices implicated in and organising incidental and intentional monitoring and calculation in the face of choice. An irremediable feature of these situated practices is that they trade on, and always will trade on, *implicit* local knowledge, i.e., knowledge that need *not* and *is* not spoken of or in other ways made manifest. This raises a significant challenge for the design of proactive systems, for how is a proactive system to know that a certain brand of yoghurt may cause trouble in 'this' house or that Dad being tasked with cooking rules out a whole range of options, etc., when these are rarely if ever *articulated* (other than in the company of a fieldworker)? As Suchman and Weber (2016) remind us,

> "Most importantly (and problematically) for the project of designing autonomous systems, plans or any other form of prescriptive specification presuppose competencies and in situ forms of interaction that they can never fully specify."

While it may be possible to build 'in situ forms of interaction' into proactive systems to support monitoring, looking-and-checking, consultation, proposing candidates, clarification, and planning, it will not be possible to build in all the competencies involved in anticipating need. There is, then, need to build the human into the proactive loop.

Thus we suggest that the efficacy of proactive systems will turn on their ability to assume an *accountable role* within the division of labour and social organisation of need anticipation. We are not the first to introduce the idea of roles into the design of proactive systems (e.g., Woolridge 2009). However, an important challenge here is to move beyond modelling the unique responsibilities, permissions, activities, and protocols required of *computational agents* to support need anticipation (Woolridge et al. 2000). It is also key that the *users* of proactive systems can *configure* the particular role proactive systems play in anticipating need in 'this' home. It is important then to enable users to assign specific responsibilities to proactive systems, be it with respect to anticipating need for particular activities for example, or monitoring specific products with respect to agreed upon measures, or constraining proactive need anticipation to the making of suggestions or proposal of candidates, whatever and whichever as users see fit. Key too then is the need to build interaction mechanisms into proactive systems that enable users to *mesh* the actions of such systems *in with* the distributed practices that provide for the efficacious anticipation of need (Schmidt and Bannon 1992). For even if the technological challenges of instrumenting the home with sensing, and learning and predicting calculative practice can be overcome, the essential problem of anticipating need on just 'this' occasion 'here and now', with all the contingencies that accompany it and the unspoken competencies involved, still have to be addressed and their implications resolved.[4]

7. Conclusion

Proactive technologies that sense, predict, and respond to changes in their environment are finding their way into everyday life. However, research has shown that they

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[4] The issue was raised in discussion of this paper how proactive technologies like NEST or Amazon's Dash "deal (or not) with the acquired understanding of anticipation"? The answer is they don't, which is why they are experienced as problematic in practice, especially in multi-user settings as Yang and Newman (2013) unpack. It is also why we have undertaken this study, to try and understand what proactive systems need to get to grips with if they are to deal effectively with need anticipation in multi-user settings. In short, they will need to get to grips with and gear into the methodological ways in which members anticipate need in their respective application domains. What we have considered here is what that might amount to with respect to the design of proactive systems supporting domestic grocery shopping.

may fail to anticipate need appropriately in multi-user contexts. This paper presents the results of an ethnomethodological study of domestic grocery shopping, a commonplace activity implicating multiple parties that is essentially concerned with anticipating need, in a bid to understand key challenges confronting proactive systems in such settings. Our study reveals that the anticipation of need is situated in a distinct ecology of anticipation and articulated through an array of differentially distributed practices implicated in incidental and intentional need anticipation in the home, and calculation on the shop floor. If proactive systems are to anticipate need with a similar degree of efficacy as human beings - and that they perform efficaciously seems to us a key requirement, otherwise it is hard to see what need we would have of them - then they will need to fit into the ecology of anticipation and support the incidental and intentional anticipation of need.

Furthermore, in effectively bringing the shop floor into the home, proactive systems will need to support an array of calculative practices that need anticipation turns upon in the face of the manifold contingencies of choice. The tangible limitations of autonomous reasoning also make it important that proactive systems occupy an accountable place, as household members occupy an accountable place, in the social milieu that continuously drives need anticipation. Proactive systems must, then, become a part of the division of labour implicated in need anticipation too, rather than behave as agents operating in their own right. These issues raise challenges for physical sensing of products in the home, computational learning and the prediction of need, and the need for proactive systems to be designed in such a way so as to mesh with the social division of labour in the home. This includes tying sensing to locally agreed measures of monitoring and the product information required to determine just what is needed; gearing algorithms into fine-grained local patterns of preference and the variability of routines, seasonal variation, and individual's schedules; and enabling the users of proactive systems to configure the role proactive systems play in anticipating need including the ability to inspect, influence, and take control of machine decisions on demand.

Acknowledgements

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