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# Kitchen Kinesics: Situating Gestural Interaction within the Social Contexts of Family Cooking

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**ABSTRACT**
HCI research and practice have moved into the kitchen, and alongside screen-based technologies, a number of tangible interaction designs are emerging to support home cooking. However, we note that the designs of tangible technologies for kitchens have, to date, emphasized the work of cooking rather than the social significance or context in which it occurs. Building on this growing interest in cooking and the kitchen, we report on ethnographic research with intergenerational family members cooking together in their homes. We analyze the social, material and embodied contexts of *kitchen kinesics* – the non-verbal gestural communication observed in family cooking interactions. Based upon these social, embodied, and material contexts of gestural interaction in the kitchen, we identify a number of contextual concerns for approaching the design and understanding of the role of gesture in familial cooking. Ultimately we highlight the significance of collocated gestural interaction and gestured interaction over a distance to understand the opportunities and limitations afforded by the design of new technologies in the kitchen.

**Author Keywords**
Gesture; Kitchen; Cooking; Kinesics; Tangible interaction; Family; Home; Ethnography

**ACM Classification Keywords**
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

**INTRODUCTION**
HCI has enthusiastically moved into the kitchen over the last decade (e.g. Bell et al., 2002; Chi et al., 2007; Grimes et al., 2008; Paay et al., 2013). Yet the designs of technologies for the kitchen have typically been motivated by a desire to improve task efficiency and thus correct assumed problems in cooking (Grimes et al., 2008), rather than support or complement the existing social experience and significance of cooking. Some recent screen-based technology designs have addressed such limitations by supporting social interaction in and between kitchens (Jaffe, 2006; Terrenghi et al., 2007). However where kitchen technologies incorporate tangible interactions, designs remain dominated by more corrective approaches. Typically tangible designs instrument appliances with sensors and actuators to gather data and provide feedback for advice or instruction – they address the task of cooking rather than the social contexts in which cooking occurs. The focus on gestural interfaces has largely become abstracted and disassociated from the *social, embodied and material contexts* in which gestures take place – in this case the family kitchen. This is unsurprising given that the functional requirements of material objects in the kitchen tend to be more apparent than the social context. But if we wish to design tangible technologies that make use of gestural inputs or interactions, as part of the future of increasingly ubiquitous computing, then we need to look beyond the interface to the situations and meanings in which such interaction is located.

Guided by calls to locate design approaches to domestic cooking in the physical and social contexts of the home (Bell et al., 2002, 2003) and by calls to situate gestural interaction research in the real-world contexts where they take place (O'Hara e al, 2013), this paper reports on a study of *kitchen kinesics*. By kitchen kinesics, we mean the non-verbal gestural interaction and communication in the kitchen setting. We explore the ways in which gestural communication occur within intergenerational family interactions when preparing and cooking food together, in order to inform tangible technology design. By investigating the ways families interact in the process of preparing food and passing down cooking knowledge, we can identify opportunities and implications for domestic technology design that is sympathetic to the practices and experiences of family cooking.

We begin by providing an overview of related work on household and family cooking, noting contrasting understandings and approaches to this space. We then consider tangible design projects for the kitchen, before discussing the ways gestural interaction has been researched within HCI. We build on this work by recognizing the social, embodied and material contexts in the kitchen and suggest the use of ethnographic techniques to inform design (Widgor et al., 2011). We report on findings of our study of kitchen kinesics, and offer some contextual themes for tangible design approaches within this domain. Based on these findings we identify a number of contextual concerns for the design of tangible technologies, which consider social, embodied and material contexts rather than the specific task of cooking. We describe these concerns in relation to kitchen designs for collocated gestural interaction and gestural interaction over distance.


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## BACKGROUND

Domestic kitchen spaces are significant sites of everyday life. Kitchens carry and convey symbolic weight – evoking ideals of home, family and domesticity. Kitchens are places of social interaction, where family memories reside, culinary traditions are created and exchanged, knowledge is shared, self-expression and care are performed. Kitchens are also physical and functional spaces where people work, cook and clean, which have evolved over time through the adoption and inhabitation of a range of technologies, appliances and devices.

Within the social sciences and the discipline of food studies, the ordinariness of home cooking has tended to be overlooked by analyses of more dominant themes in food research: globalization, industrialization, and consumption (Short, 2006). The small body of research literature on domestic cooking has predominantly focused on health, nutrition and 'culinary deskilling' in the face of commercial and convenience food systems (e.g. Fernandez-Armesto, 2001; Jaffe et al., 2006).

Some recent studies have, however, begun to look at families' perspectives, practices and experiences of home cooking (e.g. Kaufmann, 2011; Short, 2006; Simmons et al., 2012). Short's (2006) seminal kitchen studies, for example, explored vernacular cooking skills in the family home, finding that it was not simply a purposive activity in which a specific task was achieved, and that learning to cook was not a solely cognitive process passed down from expert sources using written or verbal communication, such as recipes or instructions. Instead, her research showed that learning and communicating in domestic kitchens occurs through informal arrangements, tacit knowledge and embodied interactions involving the senses of sight, sound, smell, taste and touch. Thus, cooking traditions, recipes and techniques are shared within families over time – often around special occasions – and are shaped through many non-verbal interactions including physical proximity, bodily movement, and gestural communication.

### HCI in the Kitchen

Traditionally kitchen technologies have been designed to improve time and resource management rather than support more non-utilitarian experiences such as enjoyment (Bell et al., 2003). Early HCI work argued that instead of trying to optimize cooking, design approaches should draw on ethnographic research in order to support the social richness of cooking traditions, rituals and practices (Bell et al., 2002). Despite this, technology designs for the kitchen have typically sought to correct perceived problems or deficiencies associated with 'human-food' interactions (Grimes et al., 2008). A review by Grimes and Harper (2008) found an emphasis in research on a 'corrective' approach, included reducing inefficiency in the kitchen through systems such as fridge content displays (Blythe et al., 2002), compensating for a lack of cooking experience or expertise through screens that display recipe steps (Nakauchi et al., 2005), or trying to improve people's nutritional knowledge through systems that, for example, display nutritional data about ingredients (chi et al., 2007).

In contrast to such 'corrective' technologies, Grimes and Harper (2008) proposed approaches that celebrated and supported social interaction in ways that are sensitive to and augment the experience of cooking. 'Celebratory' principles for kitchen designs include: creativity, pleasure, family connectedness, and relaxation. Based on these principles, the authors identified a number of design ideas, including a *memory microwave display,* which displays digital photographs when heating foods, and the *HomeBook* – a screen embedded into the kitchen table which displays digital content about people's day for discussion around the dinner table. They also identify a number of projects aligned with this 'celebratory' approach, including a community menu-planning support system for neighbors to share information about, and ingredients in their cupboards (Kanai et al., 2011); and the *Living Cookbook* (Terrenghi et al., 2007), which uses a touch screen tablet PC device with camera to be able to record and share cooking experiences, practices, recipes and tips. Terrenghi et al describe this approach to fostering social kitchen communication as *computer supported collaborative cooking* (CSCC).

Thus, whilst past designs of screen-based technologies, may have been dominated by approaches that sought to correct cooking behavior, more recently design paradigms have shifted to accommodate social interaction around food preparation and cooking. The following sections discuss the significance of social interaction, and in particular gestural interaction, for the design of tangible technologies in the kitchen.

### Tangible Technologies

Alongside screen-based technologies, a range of tangible interaction designs have been developed for household kitchen spaces and cooking support. Designs of tangible technologies in the kitchen typically use sensors attached to appliances to gather data and provide feedback. For example, the 'panavi' project used sensors attached to frying pans to measure temperature and movement as part of a system to train domestic cooks to follow professional recipes (Uriu et al., 2012). Similarly, Kranz et al (Kranz et al., 2007) augmented a cutting board and kitchen knife with sensors to provide users with data about food weight and cutting techniques, to provide cooking tips and instructions. Thus, recent design approaches have included tangible technologies, which extend computer interaction in physical, spatial, and bodily ways. Nevertheless, these tangible designs typically repeat previous kitchen design approaches that address functional problems or work-oriented tasks, rather than trying to support the social experience and meaning of cooking through design.

Recent research by Paay et al (2013), suggests there are opportunities for digitally enhancing the experience and sociality of cooking if we shift to more ethnographically-inspired rather than technologically-focused research. They analyzed spatial interactions on YouTube videos of people, food, physical objects and spaces within kitchen environments and recognized that cooking together is an important part of everyday life involving shared histories, social relationships, bodily negotiations, and physical

communication. They argue for the importance of designs that are relevant to the social activities and physical interactions that occur while cooking together.

These findings highlight opportunities for research that situates the design of interactive systems that support non-verbal interactions, such as gesture, within the everyday contexts in which cooking is located. Instead of trying to introduce screens or smart appliances in the kitchen that are used to, for example, convey detailed information about the cooking of a recipe, the contents of a fridge or the temperature of a pan, we explore what kinds of social, material and embodied contexts of cooking could be augmented by tangible computing.

### Gestural Interaction

We gesture whenever we interact with the world. People gesture when they talk and interact – gestures may involve movement of the hands, face or other parts of the body. Gesturing is universal, occurring across cultures, ages and tasks, however gestures are culturally-specific and can convey different meanings in different social or cultural settings (Morris et al., 1979), and are thus studied within anthropological and psychological literature. Goldin-Meadow (Goldein-Meadow, 1999) examined gestures that *substitute for speech* and gestures that *accompany speech* with a view to understanding the role each plays in communication. McNeill's (1992) work on the relationship between gesture and language demonstrated the importance of gestures for both communicating and thinking, identifying a number of spontaneously produced gestures which speakers routinely use when they talk; whilst Kendon (2004) classified gestures along a continuum according to their communicative function and how closely they related to speech. The relationship between gesture and communication highlights the degree of dependency meaning has on the on the cultural, embodied or physical context in which gesture is located.

The study of gesture in HCI, adapts work from these disciplines in an attempt to create more natural and intuitive ways to interact with technology (e.g., Quek et al., 2002; Widgor et al., 2011) Karam and Schraefel (Karam et al., 2005) developed a taxonomy of gestures in HCI. From these different analyses of gesture, we can organize gestures into categories that describe their relationship to social context:

*Symbolic gestures* have symbolic meaning which has been codified in culturally shared and learnt ways. These include sign language, semaphore and emblems such as the gesture for 'ok'.

*Semantic gestures* contain semantic content that conveys information in a representational or referential manner. Examples of *semantic gestures* include iconic, pantomimic, metaphoric and deictic gestures, which use mimicking or pointing actions to indicate the identity, shape, movement or location of an object.

*Idiosyncratic gestures* do not in themselves communicate meaningful information. Examples of *idiosyncratic gestures* include beats and meaningless gesticulations, which may be used to emphasize a point, or simply reflect habitual movements.

Both semantic and idiosyncratic gestures are expressive but intimately connected to and dependent on their social context. Deictic and manipulative gestures tend to dominate gestural interaction research in HCI. Deictic, or pointing, gestures are used in HCI in areas such as desktop computing, virtual reality applications, and mobile devices (e.g. Patel et al., 2004; Zimmerman et al., 1995) amongst others; whilst manipulative, or control, gestures are used in areas such as interactive surfaces (e.g. Rekimoto et al., 2002; Wu et al., 2003).

The focus on gestures has, however, largely become disassociated from the *social, embodied and material contexts* in which these gestures take place (e.g. schools, hospitals, the family home). This is understandable as design gestural technologies often take place in a laboratory or institutional setting and only after rigorous testing is a system deployed in situ, if at all. There is an emphasis on the technical aspects of human physical interaction with technology, e.g. the accurate sensing of movement. However, if we wish to design for gestural interactions in the kitchen, we need to look beyond the interface to the social, embodied and material contexts of gesture. Recognizing the context in which interaction takes place requires broader-based sociological approaches such as ethnographically inspired studies of HCI to inform design (e.g. O'Hara et al., 2013; Paay, et al., 2013; Waakary et al., 2007).

This research points to the ways ethnographically-based gestural research within HCI may lead to a deeper understanding of contextual opportunities and constraints informing the design of gesture-based interaction, which guides our approach to kitchen kinesics in family cooking.

## RESEARCH DESIGN

In this study we build on our team's research on intergenerational interaction (Davis et al., 2008; Vetere et al., 2009), and studies of cooking together in the kitchen (Davis et al., 2014; Paay et al., 2012, 2013), to explore how families interact with each other, and with technologies in the kitchen, when preparing food. Our aim is to ethnographically explore families cooking together, focusing on kinesics in the kitchen, to inform the design of tangible technologies to augment and support cooking interactions and social experiences.

### Method

The research design involved ethnographic in-situ methods within participant family homes, with researchers visiting family homes to undertake a tour of participant's kitchens, interviewing the family about their cooking habits and traditions – in particular how cooking knowledge and skills are passed between generations – and then observing the preparation of a typical dish or meal.

### Participants

This study involved five intergenerational family pairs, comprised of a parent and child, or grandparent and grandchild. Participant families were selected through

opportunistic procedures, based on professional and social networks of the research team.

### Data collection

Data collection involved researchers visiting participant's homes and conducting a physical tour of the kitchen space and the artifacts and technologies that reside there. During this informal, conversational technology tour (Blythe et al., 2002), participants were asked to provide descriptions of the kitchen space – its history and uses – as well as significant objects or artifacts in their kitchen, outlining their origins, purposes, and usefulness (or lack thereof). Researchers then observed the pair of family members (see Table 1) preparing and cooking a familiar or typical family dish, which was significant or important to them as a family. The aim was to explore the ways in which family members interacted socially and physically in the kitchen while cooking together. During and following the cooking session participants discussed their family practices, habits and traditions of cooking generally, and specifically what and how cooking knowledge and its social significance were exchanged between generations.

All data collection was recorded using two video cameras – one mobile and hand held to capture cooking processes up close, and the other static and placed to capture a wide shot of the movement interactions in the kitchen. The duration of each fieldwork session was 1-2 hours.

| Family | Relationship | Age and gender | Dish prepared |
|---|---|---|---|
| 1 | Grandmother - Granddaughter | Female, 70 Female, 12 | Pastitsio |
| 2 | Father - Daughter | Male, 65 Female, 37 | Veal chasseur |
| 3 | Father - Son | Male, 60 Son, 18 | Asian seafood risotto |
| 4 | Mother - Daughter | Female, 65 Female, 32 | Lasagne |
| 5 | Grandfather- Granddaughter | Male, 77 Female, 17 | Calzone |

**Table 1: Participant relationship, demographics and dish prepared.**

### Analysis

Video data was analyzed using interaction analysis (Jordan et al., 1995), whilst interview data was coded and analyzed using an inductive thematic approach, and then combined with observation notes taken by the researchers. The entire set of data was analyzed as a unit to look at emerging themes and patterns, specifically with relation to intergenerational and gestural interactions around cooking and kitchen practices.

## FINDINGS

This section discusses findings from our examination of familial interaction in the domestic kitchen space. We do not address the issue of proxemics (i.e. how participants physically orient to each other within the space of the kitchen) as this has been addressed elsewhere (Paay et al., 2013). The findings are presented in four sections. The first section identifies the key *gestural styles* in the kitchen. The subsequent three sections explore the paper's central theme of the *social*, the *embodied* and the *material* characteristics of gestural interactions in the familial cooking.

**Figure 1: Iconic Gesture: Using a hand to measure rice**

### Gesture styles in the kitchen

Our analysis of video-recorded interactions highlights examples of *semantic* gestural interaction such as pointing (deictic), and pantomiming (mimic, iconic) (e.g. using the hands to 'draw' the shape of a book). We also observed idiosyncratic *gestures* such as beat and gesticulation. We show how many gestures are particular to the domestic kitchen and the social, material and embodied contexts of familial interactions.

An overview of our video recorded observations of familial interactions found that non-verbal interaction typically accompanied verbal interaction. We found evidence of both semantic and idiosyncratic styles of gesture in the domestic kitchen, and these were coupled with verbal interaction in varying degrees of association or dependence, according to the gestures themselves, as well as the social relationship and context of communication.

**Figure 2: A deictic gesture of pointing to a hot plate**

**Figure 3: A pantomimic gesture mimics deglazing a pan**

*Semantic gestures*

Semantic gestures convey information in a representational or referential manner. We discuss three types of semantic gestures: iconic, deictic and pantomimic.

*Iconic gestures* were used when, for example, a father cups his hands and uses it to measure the amount of rice needed for the dish (Figure 1). This is accompanied by an explanation of how much rice is needed for the dish, which is dependent upon the gestural referent. He cups his hand over the pot and pours rice directly into his hand, saying:

*"put in about this much, that's enough for one person"*
*(he rotates the hand sideways, tipping it into the pot)*
*"two persons"*
*(repeats the action, pours and tips)*
*"three persons"*
*(pours and tips)*
*"and a bit more"*
*(pours directly into the pan)*

This interaction demonstrates an entanglement of gesture and speech, which cannot be separated in communicating the measurement.

*Deictic gestures* were commonplace in the kitchen. Cooks would point in the vicinity of objects or utensils that were needed to continue the task, towards spaces in the kitchen (e.g. put it over there), or in warning of potentially dangerous situations. For example, when an adult daughter pulls plates out of the oven she says "be very careful it's very hot" accompanied by a pointing gesture to indicate the plate (Figure 2). Such pointing gestures typically accompanied speech, though the meaning of these gestures could be inferred through context alone rather than relying upon the content of speech.

*Pantomimic gestures* were used to mimic an action or behavior, such as the use of a utensil for a particular task. In Figure 3, the younger cook uses an open-handed gesture in a circling motion to imitate stirring the pan with a large spatula. The pair discusses the best procedure for deglazing – the daughter's gesture accompanies a question:

*Daughter: you are kind of deglazing the pan?*
*(mimicking the father's movements with the spatula)*
*Father: yeah we are getting the pan juices and stuff out of the pan with the chicken stock cube"*

**Figure 4: A gesticulation with an open handed gesture**

In this interaction the daughter's hand gesture pantomimes the movement of the utensil in the hand of her father. Thus, such mimicking gestures often accompanied speech in ways that added, rather than substituted, to the verbal interaction.

*Idiosyncratic gestures*

There were many examples of gesture beats, in which hands were emphasized a point with a repetitive action or motion. Yet we also saw *beating gestures* expressed through the use of a utensil in the hand of a cook, so that the gesture and the task became entwined in the act of communication. These included the rhythmic banging caused by the cook using a small mallet to tenderize veal, a metal spoon to beat eggs against the side of a bowl, or a knife to slice mushrooms or dice onions. The rhythms of these physical activities served to both structure and define the interaction, but also at times became entangled with beating as a form of gesture to emphasize a point. So, for example, the rhythm of the beat may be slower at the beginning and end of the interaction, and more established and rhythmic in the middle as the user establishes a steady beat. Yet, there may be a pause or change in rhythm of hammering veal for example when emphasizing a point in conversation. The rhythm of younger cooks were generally slower than that of elder cooks who had more experience using specific utensils (such as a granddaughter using a knife to dice onions). Thus, rhythmic gestures were also used to demonstrate, or in the performance of, a cooking process.

*Gesticulations*, such as the example of an open-handed gesture (Figure 4) served as meaningless filler to verbal interaction, particularly when a cook was having difficulty with verbal expression. These gestures were tightly bound up with the verbal content of communication, though largely empty of symbolic content. Instead they were more of a non-expressive and idiosyncratic accompaniment.

Whilst we observed a range of semantic and idiosyncratic styles of gesture in the domestic kitchen, from iconic and deictic to pantomimic and rhythmic, it was the multiple forms of gesticulation that were most prevalent. Moreover, we observed that expressive gestures were dependent upon specific familial interactions and social relationship, embodied in relation to particular cooking techniques and experiences, and entangled with the use of cooking ingredients and utensils.

**Figure 5: 'I am done' A gesture indicating turn taking**

Thus we realized the importance of locating gestures and gestural communication within the *social, material and embodied contexts* in which interaction takes place.

**Social context of gesture – familial relationships**

Our findings showed, in several situations, the importance of social context for gestural interaction. Thus, relationships between pairs of participants were particularly important for gestural interaction in the kitchen. Our video analysis reveals differences in the degree to which older participants use verbal and non-verbal communication in their social interaction with younger family members. The older participants tend to *talk* to their adult children about the cooking process or social significance of the dish, whereas they tend to *show* younger children what to do as a way of passing down family culinary tradition.

An older cook, a grandmother, watches her granddaughter cooking mincemeat in a fry pan by using a wooden spoon in a pushing motion. She steps forward, takes the spoon and demonstrates how to do it using a stirring motion. Accompanying this action, she says "Like this, mix it and swish it". She then lays the spoon on the side of the pan, steps back and flicks all her fingers open and outwards at the pan, with her palms facing downwards as if to signal that she has finished demonstrating and the granddaughter can return to stirring (Figure 5). Thus the elder cook demonstrates how to stir the mince. The interaction included both verbal and non-verbal communication, though the non-verbal communication was primary.

An interaction between a father and adult daughter provides a contrast. The father instructs his daughter how to slice mushrooms. In this interaction he watches her actions, and verbally communicates instead of showing:

*Daughter:* *Do you use the stalks?*
*Father:* *Yes the whole lot. Halve it and then slice it finely. Then across that way*
*Daughter:* *How fine is fine?*
*Father:* *That's nice, just like that*

The father verbally expresses his preference for using the whole mushroom, not wasting parts, as well as his preference for how it should be sliced (Figure 6). These interactions are specific to the social dynamics of these pairs of cooks – relying upon a longer history of cooking experience and knowledge.

**Figure 6: Slicing mushrooms finely**

The dynamics of verbal and non-verbal content within kitchen interactions is clearly dependent upon the social relationship. Social contexts include the age of participants (younger participants require more showing and supervision), ethnicity (often expressed in the chosen dish), the social relationship of the participants (indicated by an easy familiarity between participants) and people's history of food interaction (participants had developed relationships with food over time such as the value or importance of avoiding waste).

**Embodied context of gesture – feel and techniques**

Our observations of familial interaction in the domestic kitchen space highlighted the importance of embodied context. Knowledge and experience of cooking skills are built up through practice over time, and techniques are often known in ways difficult to express verbally. Thus the experiential nature of cooking is often easier to illustrate through non-verbal communication, as shown when a father and teenage son seek a glossy texture to a risotto dish:

*Father:* *Would you describe that as glossy?*
*Son:* *(staring into the pot) mmm*
*Father:* *It's absorbed a bit of the liquid?*
*Son:* *Yeah … should we put this in? (holds up paste)*
*Father:* *OK whack some in*
*Son:* *How much? (holding up a teaspoon full of paste, **Error! Reference source not found.**)*
*Father:* *Put that in, I'll tell you [when to stop]*

The son holds the teaspoon in right hand and jar in the left, spoons in a teaspoon full of paste. Both father and son look at the contents in the pot:

*Father:* *More*
*(Son tips another teaspoonful in the pot)*
*(Both look at the contents in the pot)*
*Father:* *More*
*(son tips another teaspoon of paste)*
*(this exchange occurs four times until father nods)*
*Father:* *Now give it a stir and toss it around*
*(father walks away)*

**Figure 7: "How much paste?" Showing measurement of paste**

**Figure 8: An example of collaborative cooking paste**

What is interesting here is that the father does not tell his son to stir in four teaspoons at the beginning, rather each measurement is carefully compared against the look (or glossiness) of the mixture. Only when the father considers that the mixture is the right color and consistency does he tell his son to stop adding paste. This reflects the experiential nature, the feel, of cooking – the dish is not 'right' until it meets a range of criteria that cannot be easily expressed verbally, such as look, heat, color, consistency, smell and taste. This knowledge can only be built through ongoing observation, action – such as spooning paste into the pot – and considered analysis of the mixture. The desired result is not found in a finite measurement, such as four teaspoons of paste – rather, one has the sense that the cooks would continue to add paste until the mixture represented a vision of how the elder cook thinks it should look. The father only tells his son to stop adding paste when this criterion is met.

Cooking knowledge is embodied in context, the overall result (a completed dish) should not necessarily look and taste the same each time it is created; rather it is a flexible artifact which conforms to the feel of the cook and the tastes of the consumers, at that particular time and place. So for instance, the dish might include less spice if it was to be eaten at lunchtime, less paste if children were expected at dinner, or fewer ingredients if a diner had allergies.

Yet the sharing of such embodied knowledge is challenged by shifting household dynamics. Our study illustrated that changes in household dynamics (in particular children moving away from home) was often accompanied by a sense of nostalgia for or loss of past shared cooking activities. As one participant observed:

> *Before you learnt from your parents because everybody used to live together and so you saw your mother do it and you cooked with her. Whereas that doesn't happen now.*

**Material context of gesture – food and utensils**

The different foods and utensils populating the kitchen help to create a space that is dynamic, busy and often messy. Cooks engage with many different kinds of ingredients and pick up and use many utensils in the process of turning a collection of ingredients into a meal. The process of constructing a dish requires the use of multiple ingredients, with different consistencies, many of which can be wet, hot or sticky prompting one participant to observe that: "you want your electronics away from food". And, in fact, we found that the use of media and digital technologies in the kitchen was often limited – radios, televisions, and computers tended to sit on the periphery of kitchens, and be used to accompany the act of cooking through background music, for example, rather than actively mediate it. Even when looking up recipes online, it was more common to do this outside the kitchen:

> *[It's] definitely too hard having the internet in here…I really don't like any interruption while I'm cooking. You have to concentrate while cooking. Background music would be alright*

Kitchen utensils and tools, however, were obviously used for a range of food-preparation purposes, such as hammering (mallet), cutting or chopping (knives), sifting (sifter), stirring (spoon), measuring (spoon, cup) grating (grater), whisking (whisk) or simply holding things (oven mitts) and so on. Many utensils are also appropriated for alternative or multiple purposes (Wakkary et al., 2007), e.g. a cup can be used to drink from, used as a unit of measurement or used to contain ingredients. On some occasions parts of the human body are used to replace the role of a utensil, such as when the hand is cupped to measure rice.

There were a number of interactions where older cooks instructed younger cooks on how to use particular utensils, including advice on which tools to use for which task "Don't use a serrated knife. You shouldn't use a serrated knife to cut anything I reckon", and how to hold a particular utensil "like this, not this". Sometimes this advice is given verbally, but more often it is indicated non-verbally, which is particularly the case with younger cooks, knives and other potentially dangerous tools. Older cooks tend to take the utensil from the younger cooks hand and show them how to use it, or reposition it

within the younger cook's hand. Cooks also position particular utensils so that they are available when needed.

There are many utensils within the kitchen space, both within sight (e.g. on counter tops, attached to walls) and out of sight (e.g. in drawers, under benches). Similarly many ingredients are placed within reach or put away depending on their use or need. Familiarity with kitchen layout and contents means that a specific utensil is usually easily located for a particular task or food interaction. Yet, the hands of cooks move about a bench top, having to navigate the multiple ingredients and artifacts to find a particular item. It is commonplace to observe many utensils and many hands in use as a dish is constructed (Figure 8). This material interaction is built upon experience and knowledge of using tools and ingredients over a period of time, in the performance of many different tasks. It is this knowledge and application that older cooks try to impart to younger cooks in the construction of the dish. This knowledge may be questioned or negotiated as the cooks compare different cooking practices:

*Father:* *Use the hot water please. Run the tap until its nice and warm*
*Daughter:* *Will the potatoes go cold? Is that it?*
*Father:* *It will speed things up a little that's all*

What we have shown through these examples is that cooking is a collaborative process, involving social interaction, moving bodies and different cooking materials. The process of cooking is social, material and embodied – it is context specific, and particular to the social relationships of the actors taking part, the food and utensils which they use, the language used to explain and negotiate the process and, the non-verbal gestures incorporated within the kitchen space.

## DISCUSSION

While we recently have witnessed an increasing interest in HCI research in relation to kitchens and cooking, much of this research has focused on improving task efficiency (Grimes et al., 2008) rather than supporting or complementing the existing social experience and significance of cooking. Thus, based on research calls on domestic cooking in the physical and social contexts of the home (Bell et al., 2002, 2003) and on calls to situate gestural interaction research in real-world contexts (O'Hara et al., 2013), we investigated how gestural communication occurs within intergenerational family interactions as people prepare and cook together – we refer to this as kitchen kinesics.

Our study showed that gestures operate in relation to additional contextual influences. Firstly, gesture is dependent upon the social context. That is, the social circumstances, the time and place in which it is oriented, and the social relationships in which gesture is located. Secondly, we recognize that gestures are embodied in context; in this setting the embodied context refers to the cooking techniques, specific skills, feel, and familial histories called upon to create and share knowledge about a particular dish. Thirdly, gestures operate in relation to the material context. That is, in reference to the food, appliances and technologies utilized in the domestic kitchen.

Designing interactive technologies for kitchens and cooking raise several interesting opportunities and concerns, e.g. how do you design for the embodied context of gestures? Such embodied context was beautifully illustrated with the father and son example when cooking risotto together as they added paste continuously. Further, the material context of gesture when cooking involves situations that are informal, messy, and often quite busy. Thus, from a gestural point of view in relation to new technologies, we need to design interactions that are embedded into the context, thus they should either be non-obtrusive or more durable and able to withstand mess. Based upon these additional contexts of gestural interaction in the kitchen, we identify a number of concerns for approaching the design and understanding of the role of gesture in familial cooking. We are inspired by previous research on e.g. technologies that support over-distance interaction (Davis et al., 2008; Vetere, 2009), and we illustrate opportunities (and limitations) for the design of technologies for kitchens with a particular focus on collocated and gestural interaction over distance.

### Designing for Collocated Gestural Interaction

As we studied collocated intergenerational cooking, it is quite natural to consider how interactive technologies could support cooking activities when socially collocated. Watching families cook together highlighted that the hands of cooks are often busy or fully engaged, using utensils, picking up ingredients, or communicating with gesture. Touchless technologies might be useful here; however the gross physical movements required by contemporary gestural sensors (e.g. Microsoft's Kinect), may be problematic in the cluttered domestic kitchen space which often involves many simultaneous movements, including fine motor movements. The amount of movement in the kitchen, comprising bodies moving in the space, as well as hands moving about to communicate and undertake cooking tasks, has implications for designs attempting to capture specific inputs or clear communication.

Furthermore, the uses of computing, media and digital technologies in the kitchen were limited, tending to operate in an ambient rather than engaging manner as cooks preferred not to be disrupted while cooking. These findings suggest limitations to design approaches that intervene too directly in cooking activities, such as attempts to recreate rich collocated interaction, which may distract from rather than complement the experience of cooking.

Finally, kitchens are already full of 'stuff' – appliances, foods, activities – and introducing new technologies just because we can, does not fit well with a contextual approach to user-centered design in the kitchen. Instead, tangible technology design could consider approaches that aim for constraint with interaction limited to particular activities or by supporting gestural interaction through the use of kitchen objects. For example, tangible designs could seek to augment everyday kitchen objects

to find ways to record and communicate the ways they are handled, habituated and embodied as part of cooking practices. Such an approach could support communication that is phatic rather than informational, such as networked ambient displays that reveal patterns of use of these objects to signify their role within familial cooking practices or rituals.

### Designing for Gestural Interaction over Distance

Our study illustrated that kitchens are places in which memories reside and where weekly routines are enacted, yet these uses change as families evolve. Family members' cooking together was not a daily occurrence, but instead tended to concentrate around particular rituals, events or occasions – such as a Sunday lunch, a birthday, or at Christmas time. Given that families are more geographically distributed, historical traditions of families sharing cooking skills or knowledge in collocated ways through showing and observing physical techniques maybe becoming less common.

Our findings suggest several opportunities for designing tangible technologies to support special occasions and rituals of getting together rather than everyday use. Or as an alternative, designers could develop tangible technologies to support non-verbal kitchen interactions over a distance. Whilst screen-based and social media support interaction at a distance, these are limited to audio and visual sense modalities, and do not accommodate the haptic feel offered by tangible feedback and interaction, which as we observed was a significant feature of embodied gestures and their social contexts in the kitchen.

Finally, the social context of gestures could promote design of technologies that allow vocal input from an older person, whilst a younger person interacts with it through gesture, would support different embodied capacities, histories, and preferences around the act of cooking, the social experience of cooking, and their computer mediation. For example, older cooks might be helped by a visual modality with speech input, younger cooks might benefit from sensors which respond to grip, allowing the user to understand how tightly to grip something, or how much pressure to apply.

## CONCLUSION

In this paper, we have reported on ethnographic research with intergenerational family members cooking together in domestic kitchen spaces. We have noted that current design of tangible technologies for the domestic kitchen emphasizes the work of cooking, whereas our focus is augmenting the social interactions and experiences of cooking. We highlight the relevance of ethnographic research techniques for the study of gesture in the domestic kitchen, arguing for the importance of social, embodied and material contexts of gestural interaction in this space. Based upon our ethnographic observations, we identified a number of contextual concerns for approaching the design of technologies for kitchens which focus on collocated and gestural interaction over distance.


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