

Conceptualising resourcefulness as a dispersed practice

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Conceptualising Resourcefulness as a Dispersed Practice

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ABSTRACT

In research on health and wellbeing, resourcefulness is seen as an important skill that can improve quality of life. In design and HCI literature, it has long been acknowledged that resourcefulness is about more than human skills and involves the adaptation, modification and reinvention of technologies in everyday life. In this paper we argue how certain aspects of resourcefulness have so far remained under-theorized, and present a new design perspective on resourcefulness that is grounded in practice theory. In this view, resourcefulness is conceptualised as the dispersed practice of dealing with everyday crises of routine. By elaborating on the complex interplay between means and purpose, we tease out resourcefulness as a practice of reconfiguration. The paper closes by discussing implications of this conceptualisation by zooming in on ways of capturing and designing for resourcefulness.

Author Keywords

Resourcefulness; practice theory; dispersed practice; thing ethnography.

ACM Classification Keywords

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

INTRODUCTION

Resourcefulness has been argued to reduce frustration, anxiety and depression among people facing challenging and stressful circumstances [34, 62]. When it comes to resourcefulness, older age is a particularly interesting phase of life because it is characterized by encountering challenges in daily activities due to diminishing physical and mental capabilities [40]. At the same time, research in science and technology studies shows how technologies designed for older people - an area of development referred to as gerontechnology - tend to be particularly closed to forms of situated reinterpretation and repurposing [1, 36, 52]. Such

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designs inhibit possibilities for innovation “in use” and adjustment to the varied and changing situations of use in which technologies are bound to end up [19]. Besides the ethical concerns regarding who decides what it means to live healthily and well that this tendency brings up [32], these highly scripted types of designs inhibit resourcefulness. New approaches are needed to design gerontechnologies that facilitate or even enhance resourcefulness.

Resourceful Ageing is a multidisciplinary design project that was set up to empower elderly people to live longer and more resilient lives. The aim of the project is to research how to design products and services that facilitate ageing resourcefully. The project uses a ‘research-through-design’ [77] process that enlists as participants a community of both elderly people and the mundane objects they ordinarily use and ‘misuse’ (from material artefacts to computational technologies).

We focus in particular on the understudied group of third age elderly, or young old. In contrast to what is commonly understood, Loe [46] describes the lives of the young old as in flux. Their bodies, roles, interests and responsibilities are changing. They have retired from work, but are active care givers, for parents, children and grandchildren. They are noticing signs of ageing more than before, but they are not governed by it. Instead, as Loe puts it, ‘what lies before them is time, new family configurations and opportunities for reinvention’ [46]. In spite of persistent prejudice of elderly as technologically less skilled, research has shown elders to creatively use and adapt artefacts and technologies in daily life [40].

In the project, we position the ageing society not as a problem but as an achievement [51] and view elderly not as dependent and technologically challenged, but as active participants in society, very well capable of making decisions about their own lives, and adjusting available means to their needs. Our approach is to learn from and work with ways in which elderly people creatively deal with the challenges they face as their body/minds age, in order to inform the design of products and services that facilitate and enhance resourcefulness. In this paper we report on our efforts within the project team to *jointly scrutinize and reframe the concept of resourcefulness* in order to inform our subsequent steps of capturing and designing for resourcefulness with a group of third age elderly households.

We start the paper by offering an overview of conceptualisations of resourcefulness in HCI and design literature. We then introduce a revised definition of resourcefulness which is grounded in practice theory. To illustrate the application of this new framing, we discuss the implications for HCI of capturing and designing for resourcefulness, with a view on our collaboration with a group of third age elderly households. We continue the discussion by reflecting on how the conceptualisation of resourcefulness that we propose has implications also for other areas of HCI, beyond the specific application to matters of gerontechnology.

RESOURCEFULNESS IN DESIGN LITERATURE

Although ‘resourcefulness’ is not a widely used term in design literature, the practices by which users adapt, repurpose, and appropriate existing artefacts from their surroundings have been previously formulated with different notions. One of the earliest theoretical formulations is the term *ad hocism*, coined by Charles Jencks and Nathan Silver in the 1970s, which describes the use of arbitrary objects in order to satisfy a momentary need in an improvised way [38]. The same process of spontaneous form-making was described by Christopher Alexander in the 1960s as *unselfconscious design*. In this process, users (or agents), exploit their immediate environment for resources, in order to consistently create well-fitting forms [2].

More contemporary terms for the same phenomenon found in design literature are *design-in-use* [50], and *non-intentional design* [5]. Design-in-use is defined as the ‘ways in which users take over existing products according to personal needs, and practices beyond product design. It involves the emergence of unanticipated uses, and transformations in the structure and characteristics of the product’. Non-Intentional Design, similarly, describes the spontaneous changes people make to their environment through minor or major interventions once faced with a situational problem.

Function in and through use

What is clear from these conceptualisations is that people use objects in a different way than what designers have decided in advance, and thus its function cannot be defined by designers alone. Preston, for example, differentiates between two functions of objects: the *proper function* as opposed to the *system function*: The former is what a thing is designed to do, while the latter, is a purpose a thing may serve on occasion, without having been designed to do so [10].

Thus, we can say that the act of repurposing usually occurs when people use an object in a manner different from their ‘prescribed’ functional intention – or when the prescribed application is not ‘honoured’ in the new use [5]. For example, when a wheelchair is used as an office chair, or a walking stick to knock on the ceiling, whenever help is needed from the upstairs neighbour [21]. If we understand the function of an artefact as its *dispositions* [72], the

‘normal’ function of an artefact is a ‘privileged’ set of dispositions intentionally produced or selected by the designer of the artefact.

One way designers account for the unexpected use of objects, is to test and try out ‘use’ during the design process. In User-centred Design, this is described by Redström [61] as *use before use*, while *design after design* is the attempt to create a larger space of possibilities for acts of defining ‘use through use’ in which the definitions of use are meant to be in-/un-determinate. In the same way, Fischer and Giaccardi [19] claim that in order to be able to accommodate unexpected issues at use-time, systems need to be “underdesigned.” In this view, instead of designing complete solutions for users, *underdesign* should provide users with the social and technical means to create the solutions by themselves at use-time.

Conditions for resourcefulness

Although we might use artefacts as resources without even thinking about their original functions, Vermaas and Houkes [72] explain that this is normally not due to a misinterpretation of their original function, but is rather rooted in our ability to see beyond the function and discover abstract or open forms [5]. Some people might be better than others in the skill of discovering new uses, but we can assume that the way artefacts are designed, perceived, or marketed, could affect whether it is easier or more difficult for users to look beyond their intended function. For example, factors which might influence the selection criterion for repurposing, include the object’s material characteristics or *affordances*; the *time* to find a solution; and the *reversibility* of the object [5, 10]. Since misusing an artefact might imply that it becomes useless for its original function, the complexity of the object also plays an important role, and most high-tech appliances are not so well suited for misuse as low-complexity ones [5].

Another two important factors which can enable resourcefulness are *ambiguity and failure*. *Ambiguity* means allowing for multiple interpretations of objects, as it can invite adaptation and tinkering, and allow users to define their own meanings, rather than accepting those imposed by designers without question [25, 67]. In the same way, failure or breakdowns can release objects and their owners from a ‘contract of use’, offering an opportunity for the users to modify them. Furthermore, the reducibility of objects to their parts, can suggest the possibility of re-assembly in an alternative configuration [5]. Along these lines, Maestri and Wakkary [47] have shown that the repair of objects in the home can be not only an act of restoration, but also an act of creativity. While Brandes [5] believes that in the modification of products there is no impulse to consciously create, Mitchell [49] claims that these kind of actions can be highly self-reflexive. Moreover, he believes that modification practices can be transformative, and amplify consumer’s agency: Since the designer’s position of authority dictates the ‘correct’ use of the object, it divides the

field of possible uses into authorized and unauthorized zones. For this reason, users are faced with a degree of resistance during the act of modification, which by overcoming it, challenges institutions or existing structures. Within this approach, conditions such as the material constraints and affordances of objects, as well as the cultural narrative or personal history, could be seen as a way to both assist and limit the acts of modification.

RESOURCEFULNESS IN HCI

A common term in HCI literature is *appropriation*, the process by which people adopt and adapt technologies, incorporating them into (working) practices. This might involve customization in the traditional sense, but also making use of the technology for purposes beyond those for which it was originally designed, to serve new ends [13]. In the same way, Wakkary and Maestri [73] describe appropriation as the remaking through use of designed artefacts and structures in ways that were often not intended, which lead to adaptation and evolution of unique design systems.

Maestri and Wakkary [47] have conducted research on *everyday design*, and shown evidence on how families appropriate artefacts and surroundings, leading to the design of everyday systems, which continually evolve through design-in-use [73]. These appropriations are described by them as *resourceful*, *adaptive*, and *emergent*: people appropriate artefacts and surroundings, adapting them and forming systems and routines through design in-use, which allows for emergent properties to arise [73]. These properties are crucial, because although resourcefulness is commonly understood as a temporary use, the authors show that it can also become part of a routine integral to daily life, and be combined to create ongoing systems. Taylor and Swan also suggest that technologies must be designed to accommodate the rich and diverse ways in which people organize their homes (and time), providing them with the resources to ‘artfully construct their own systems’ rather than enforcing ones that are removed from their experiences [71].

Eglash [16] distinguishes between three different stages in the appropriation of technology: *reinterpretation*, *adaptation* and *reinvention*. Reinterpretation is defined by a change in semantic association with little or no change in use or structure. Adaptation is a change in both semantic association and use, involving creativity to look beyond assumed functions and recognize new possibilities, but keeping the underlying structures unchanged. In reinvention, however, semantics, use, and structure are all changed: If adaptation requires the discovery of a latent function, reinvention is the creation of new functions through structural changes. The view that transformations in the structure and characteristics of the original product are necessary for design-in-use actions, is also mentioned by other authors [6, 50, 73].

Another framework that could be related to resourcefulness is *resilience* [22, 23], which identifies the intelligent ways in

which systems go right despite adversity – due to poor behaviour, poor design, or poor circumstances. Resilience strategies, could include for example creating cues to remember things, separating similar objects and tasks so that there is less likelihood of confusion, and checking you have got the correct resources before committing to an action [22]. These strategies, together with the skills, and competencies that comprise a system’s responses to threats and vulnerabilities, are part of a resilience repertoire, while resources, are the constraints that influence whether a strategy can be enacted [23]. This means that if the threat is too much for the system to handle, and its resilience repertoire insufficient or misapplied, then system performance will degrade or fail.

Lastly, similar concepts could be found in *domestication of technology* studies, which not only analyse the processes of acceptance, rejection, and use of technology, but also what technologies mean to us, how do we experience them and what are the roles they play in our lives [35]. The psychological dimension of objects, which reaches beyond their mere purpose, and mirrors the identity of their owners, has also been developed in the areas of sociology, ethnology, design and psychology (for a summary see [42]). It is argued that by endowing objects with meaning that reaches beyond their pure purpose, people take possession of them, providing them with emotional qualities [5]. This is especially important in the group of elderly and the field of assisted living, as certain objects could be stigmatizing to the users, which could be one of the reasons for misuse or lack of use at all. For example when a specially designed chair for showering is now used as a flower-bench [21] or when a hiking stick is preferred to a walking cane because it makes people feel sporty rather than old.

Digital resourcefulness

The modification of existing services and the collaborative re-design of existing products, has been widely developed within communities of software and Open Source projects in the past decades. In computer systems, the term *workaround* is often used to define what users do intentionally to evade designed limits in hardware or software [43]. Botero et al. [4], conceptualises the opportunities given to users as the *design space*: an area of possibilities for realizing new designs, which extends beyond the original area of designers, into the realm of design-in-use. However, until recently, people without particular technological expertise have had very limited possibilities to modify technologies. Currently, this is gradually changing with the emergence of new collaborative digital tools (such as blogs, wikis and feeds), which have made active participation in software development available to a wider audience, and have opened possibilities for contributions that are not limited to developers alone [4]. Prototyping platforms and digital fabrication spaces, like FabLabs [48]; as well as communities such as Ikehackers.net, in which people share their modifications on commercial products.

More broadly, the framework of *meta-design* [19, 26, 27] explores the design space, and the opportunities at use-time, creating digital environments that allow end-users to act as designers. Rather than restricting users to just use a system, meta-designed environments provide end-users with opportunities, tools, and social reward structures to extend the system to fit their needs. In this process, the user becomes a co-developer, learning to operate a system and adapting to its functionality. In response, the system is modified to be adapted to the practices of its users. Thus, in this co-adaptive and reciprocal process, the system can evolve at use time, supporting more complex interactions than traditional, linear user-centred processes.

Within a similar approach, and drawing on Alexander's notion of *unselfconscious design* [2], Wakkary et al. [75] have developed the concept of *unselfconscious interactions*, a form of interaction with computational artefacts that is motivated by ongoing corrections and improvements of the fit among artefacts, environments and people within specific context of use. According to the authors, these interactions can act as catalysts to promote incremental engagements with artefacts, while the artefacts themselves serve as resources if they are purposely designed with non-existent or weak use goals.

In the previous chapters, we have recognized different notions which are related to resourcefulness, both in design, as well as in HCI literature. These notions conceptualise the way people adapt and repurpose objects in their everyday life, adding new functions or appropriating them into their own routines. Firstly, we have discussed how this phenomenon might affect our idea of function. Secondly, we have summarized some of the concepts that can be seen as the conditions that enable resourcefulness, such as reversibility, ambiguity and failure. Lastly, we have discussed how designers deal with this phenomenon and proposed different strategies in order to allow users to act as designers and use objects resourcefully.

In the next section we depart from these notions by introducing an alternative conceptualisation of resourcefulness as a dispersed practice, after which we will make the link back to this literature in discussing implications of this view for HCI research and design.

RESOURCEFULNESS AS A DISPERSED PRACTICE

Building on the practice turn in HCI [18, 45, 56], our research draws on theories of practice to frame resourcefulness. Theories of practice is a group of theories from sociology that take social practices as their fundamental unit of social analysis [60]. Practices are conceptualised as collectively shared ideas about normal and appropriate ways of proceeding in daily activities such as bathing, cooking, driving, playing, meeting, having a coffee and so on, that are recursively shaped and reshaped through repeated performances by people. In other words, all human activity is viewed as manifestations of socially shared 'blueprints' of normal behaviour, referred to by Schatzki as the

'organization dimension' of practices [65], and by others as the 'practice-as-entity' [7, 68, 76]. These 'entities' are in turn maintained, as well as modified by individuals adhering to or deviating from them when they act them out in the particular situations they face, i.e., when people are 'engaged in' [65] or 'performing' [64] the practice. The practice-as-entity consists of constellations of elements, for which the grouping into the categories of materials, competences and meanings proposed by Shove et al. [68] is the one most widely used in HCI. In everyday activities, individuals combine these elements into unique constellations that 'work' and 'make sense' in the particular situation at hand.

In HCI, practice theory has been drawn on in a diverse range of studies and theoretical reflections, including second hand interactions [55], reflecting on the effectiveness of energy feedback [54, 70], less resource intensive forms of bathing [44], sustainable behaviour [74] ecologies of artefacts [41], and material experience [29]. Theories of practice have been argued to present a new paradigm in HCI [45] that offers a spatially and temporally situated perspective on daily life beyond specific technologies and their (intended) use. This is particularly relevant in relation to resourcefulness, because it relates so closely to unintended and unanticipated forms of use, repurposing and reinterpretation. Such forms of use can be argued to be difficult to study using an 'interactions paradigm', as Kuutti and Bannon [45] describe the prevailing mainstream HCI paradigm, as they risk being labelled as misuse, or viewed as usability problems.

Everyday crises of routine

While resourcefulness does not feature explicitly in theories of practice, the concept can be positioned in relation to the practice theoretic framework. We argue that from a practice theoretic perspective, resourcefulness occurs in situations that are in some way exceptional, non-standard, non-routine or non-mainstream. Reckwitz [60] refers to these situations as 'everyday crises of routines', specified as 'constellations of interpretative indeterminacy and of the inadequacy of knowledge with which the agent, carrying out a practice, is confronted in the face of a "situation".' (p255). The inadequacy of knowledge here refers to the issue that in such situations of crises, there is no tested, routinized, socially agreed way of proceeding in the practice. In relation to this idea of crises, Warde [76] adds that 'people in myriad situations adapt, improvise and experiment' (p141). In fact, therefore, people do know how to proceed in situations of crises because skills of adapting, improvising and experimenting are common human skills.

However, as discussed above, resourcefulness is about more than human skills, because it involves artefacts as well. Turning to Schatzki, these common skills could be considered as 'dispersed' practices [64]. Dispersed practices are agreed ways of proceeding that are common across many practices, such as for example having a conversation, writing, arguing, describing, etc. Schatzki positions this concept in relation to integrative practices [64], which are

practices with a more particular form and social domain, such as bathing, cooking, driving a car, etc.

Conceptualising resourcefulness not as a human skill but as a dispersed practice brings materials back into the equation, because, although dispersed practices tend to rely primarily on know-how [76], coining them to be practices means that they can be viewed as constellations of interconnected elements, including materials. Writing, for example, is a dispersed practice that cannot be performed without the use of material artefacts (e.g., a pen) or computational technologies (e.g., a Word processor).

Importantly, this view also conceptualises meanings and purpose as part of the configuration. To further explain the implications of considering resourcefulness as a dispersed practice, we will now discuss relations between means and purpose in this practice in more detail. The discussion was inspired by, and uses examples from a small scale exploration conducted within the project team, which consisted of a homework assignment to collect examples of resourcefulness from our everyday lives and a workshop in which these examples were discussed and mapped on various scales.

Purpose and means in practices of resourcefulness

Roughly put, materials and competences together can be viewed as the means to achieve a purpose, each with particular, related meanings associated to them. For example, people may assign different meanings to the same purpose in different situations: having a cup of tea, or the cup and tea itself could be associated with relaxation, catching up, a break, an outing, being sick or warming up. In theories of practice, materials, competences, meanings and purpose are not seen as personal attributes but as elements or qualities of the practice in which an individual participates [60]. Crucially, this implies that the relation between means and purpose is recursive, and when focusing on implications of this view for design, Ingram et al. reiterate that while things tend to be designed to fit certain purposes, they 'also make the purposes for which they are fit' [37].

Resourcefulness can be a purpose for certain actions in itself, so we can speak of practicing resourcefulness. But while someone can be resourceful for the sake of being resourceful, being resourceful is generally directed at the integrative practice in relation to which it takes place. In the project we are looking at everyday life and therefore are dealing with mundane everyday practices and purposes, i.e., not purposes such as optimizing a production line, defeating an enemy, or winning an election, but everyday ones such as making a cup of tea, ordering groceries, taking a bath, meeting a friend, posting a photo, getting some exercise, going out, annoying the neighbours, disciplining the cat, and so on. In dealing with such mundane purposes, crises can occur one-off or repeatedly, and with more or less urgency. As such, different relations between means and purpose within resourcefulness can be described.

Adjusting means to purpose

Resourcefulness can be viewed as a form of adjusting means to purpose in crisis situations where designated means are not available for the purpose at hand. When viewed from the perspective of artefacts, this means that things that are at hand, or accessible with the skills and knowledge available are not appropriate for this particular situation.

Such a crisis may occur for two main reasons. One, because a 'solution' exists, but is not available in that situation, i.e., the person(s) involved are not aware it exists, do not have the means to obtain it, or skills to use it, or have it out of reach (e.g. using a handbag to fend a sudden downpour). Two, because an appropriate solution for this particular problem does not exist. For example, using chopsticks for pulling a small piece of bread out of the toaster (Figure 1). In such circumstances, resourcefulness entails the adjusting of available means to achieve the purpose at hand in a satisfactory manner. This does not mean however, that the original purpose can be fully maintained.



Figure 1. Pulling toast out of the toaster with chopsticks.

Adjusting purpose to means

In a practice paradigm, purposes are viewed as part of practices in which they are routinely shaped and reshaped through repeated performances, in relation to other elements, and to other practices. What it means and requires to make a proper piece of toast, for example, has a socially shared rough blueprint. If at some point the purpose is to have toast, but the piece of bread is too small for the toaster, then this can be considered a crisis. Ways to go about dealing with this crisis are to decide to have the bread untoasted, to wait until the bread is cooled down to pull it out, to hold the toaster upside down, to unplug the device and pull it out with a knife, or as in this case, to pull it out with wooden chopsticks.

Importantly, in all of these cases the original, blueprint practice of toasting cannot be maintained, because this would

involve the bread popping up high enough to safely pull it out with ones fingers. So, in this type of crisis, all types of resourceful responses require at least some modification of the integrative practice. This modification can also be considered too extensive, for example when burning ones fingers. There is a fine line here, but in our view, *the response to a crisis ceases to be resourceful when it becomes a form of bearing with the situation. This is where the link between resourcefulness and wellbeing can be made.*

Deriving purpose from means

There is another type of crises where the purpose or problem is more exceptional and unique and arises from a particular situation without a simple matter of something lacking or failing. This can be explained using an example from our project that was gathered in our joint exploration of the concept of resourcefulness. In the example, sports gear was kept in an otherwise unused bathtub in a bathroom situated near the main entrance of the home (Figure 2). In this example, the unused bathtub that happened to be close to the entrance became a means for the thus far suppressed purpose of keeping the floor of the hallway free from sand and dirt.



Figure 2. Sports gear in the bathtub.

A crisis, a non-standard situation can be more or less urgent. On one end of the scale, something can hinder the normal course of living significantly, with an emergency or life threatening situation as the extreme example. A mild nuisance can be seen as the other end of the scale. In case of an emergency, resourcefulness can be lifesaving and any means available may be used for this purpose (e.g. a heavy object to break a window and get the neighbour's attention). On the other end of the scale, resourcefulness is likely to be much more subtle and will tend to occur when means are presenting themselves relatively obviously (such as in the case of the unused bathtub near the door). In these cases purpose is not explicit but rather derived from the means presenting itself in a situation. Between these two lie the responses to everyday crises of routine in which means and purpose recursively shape each other.

Resourcefulness in a practice paradigm

Considering resourcefulness as a practice and positioning it within the practice theoretic conceptual framework brings a new perspective to the concept compared to the ways in

which it is currently considered and discussed in design literature.

Understandably, HCI literature approaches resourcefulness from the perspective of the qualities and characteristics of the computational technology, intended as a material artefact to interact with - thereby highlighting the importance of openness, ambiguity, modularity, and so on. In its definition of resourcefulness, this literature focuses on how artefacts are used by people – in ways different from those intended by their developers. There is also some attention for the ways in which artefacts are perceived and how the process of being resourceful requires not only skills of creatively looking beyond intended functions, but also skills of re-association and transforming the meaning of an artefact, but so far there is no theoretic framework to support this view.

Viewing resourcefulness as a dispersed practice shifts the perspective. Importantly, it positions resourcefulness as a form of reconfiguring the normal, (integrative) practice in relation to which it occurs. What this means is that being resourceful requires stepping outside of collectively established and tested frames. While in the design literature, resourcefulness tends to be viewed as something positive and desirable, this view highlights that it is also an inherently risky pursuit that requires courage to act out of the ordinary, and goes hand in hand with feelings of social uncertainty. As Scott et al. describe it, coming up with new configurations of elements 'requires creativity, courage, and the ability to envision something entirely new' [66].

Moreover, viewing resourcefulness as an act of reconfiguration also highlights how making one modification in the coherent configuration of elements that make up a practice can have a snowball effect on other aspects of that and other practices that also need change in order to continue to work and make sense. Moving from an interaction paradigm to a practice paradigm therefore allows a shift from a narrow focus on the qualities of the artefact to a horizontal view of ecologies of artefacts as part of webs of linked (or linkable) practices. We will return to this point in our discussion where we make the link between this conceptualisation and designing products that are digitally connected.

Finally, this view implies that if a resourceful reconfiguration that works becomes routine and spreads among other carriers of the practice, the modification becomes collectively accepted as normal and acceptable, and can therefore strictly speaking no longer be considered as resourceful.

Reframing resourcefulness

In summary, when viewing resourcefulness as a (dispersed) practice, being resourceful is about *using the materials (including other people) available in the situation as resources to solve problems or challenges arising from non-standard situations, i.e. (everyday) situations that are not part of common practice and for which there are neither*

commonly agreed nor widely 'tested' ways of proceeding. This can mean that the situation is in that moment new to the person(s) involved and there is no agreed proper way of proceeding known to them. Or, the situation is familiar to the person(s) involved but not part of common practice. In these non-standard situations, *we identify resourcefulness as the adjusting of means to purpose, which inherently involves also adjusting purpose to means, up to the point where purpose becomes derived from means.* Being resourceful means that rather than bearing with the situation, artefacts and technologies are deployed in uncommon ways (as resources) to proceed in a satisfactory way in spite of more or less challenging circumstances. While this necessarily implies that purpose is to some extent adjusted to means, we identify resourcefulness when the person(s) involved are not feeling a victim of circumstances, but rather feel in control of the situation.

Resourcefulness can arise from uncommon configurations of elements that present themselves, are recognized and acted upon in a situation, and that turn out to work, and may then be repeated. *Resourcefulness, therefore, is not the same as everyday design.* Everyday design is about using artefacts in ways unintended by the designers and therefore has overlaps with resourcefulness, but forms of everyday design such as hanging your coat over a chair, an example used in [12], are in our view considered part of normal practice. Therefore, this is not considered as an example of resourcefulness in our view.

Resourcefulness as a configuration of elements

When considering resourcefulness as a practice, it can be described as a configuration of elements in itself. Our literature review and small scale exploration offer some clues as to how it may be configured.

Skills of resourcefulness in health research refer to 'a repertoire of coping strategies' for dealing with stressful situations [63]. Based on this view, Gonzales et al. [34] present a method for enhancing resourcefulness that contains six modules: problem identification, gaining confidence and motivation to solve it, brainstorming multiple solutions, comparing possible solutions and choosing the best one, implementing it, and evaluating it. This idea of resourcefulness as having similarity to a design process returns in HCI and design literature, where it has been conceptualised as everyday design or design-in-use. Other perspectives deformatize this process into more general skills of discovering abstract or open forms in objects, looking beyond assumed functions and more practical, technical skills of repairing, modifying and reprogramming.

These skills imply certain purposes and meanings involved in the practice, such as proceeding in the face of a challenge and avoiding stress, together with meanings of being resourceful as a challenge in itself, because somehow training is needed to practice it, including the building of confidence and motivation. This idea aligns with repurposing

as a form of unauthorized use and our conclusion that being resourceful requires courage.

Regarding the material elements of resourcefulness, it becomes clear that the things used are somehow transformed either physically, or in terms of their intended or common meaning. The thing becomes '*something else*', for which there isn't always a name: the bathtub a 'sports-gear-storage', the wooden chopsticks 'small-toast-removal-tools'.

This description of resourcefulness as a practice reveals that there are many caveats in existing knowledge about resourcefulness as a configuration of elements. Moreover, while any practice can be described in relatively general terms, understanding practices always requires empirical data on the particular practice under study. The following section will go further into how issues of data collection and interpretation might be further explored in our project and HCI more broadly.

CAPTURING AND ENHANCING RESOURCEFULNESS

Resourcefulness is of interest for HCI research and design in various respects. As argued in the introduction, resourcefulness is important for human wellbeing. Moreover, resourcefulness can be linked to technologies, and the way they are designed. Although there is always a case of people and artefacts coming together, there is a notion of artefacts being more or less open to repurposing and reinterpretation, and thus the way they are designed can either inhibit or enhance resourcefulness. Research in social gerontology moreover, has shown designs for elderly people to have a tendency to be particularly closed for resourceful repurposing.

In our project, we therefore focus on designing systems and devices for elderly people, and in particular the relatively understudied group of young old, that facilitate and enhance resourcefulness. However, because resourcefulness emerges from the ways in which people and artefacts work together in particular circumstances, this designing is not a simple matter of making ambiguous, open, modular or underdesigned systems and devices. To design for resourcefulness, insight is required into the particular circumstances, skills and broader ecology of artefacts involved in these situations.

Considering resourcefulness as a dispersed practice has implications both for gaining insight into its current manifestations in the everyday lives of people, and for designing artefacts to facilitate and enhance it. Questions arise like what strategies are used in situations of crises, what meanings are attached to uncommon reconfigurations and what makes reconfigurations that deviate from common practice and normal routines acceptable in that situation? How are new skills of resourcefulness acquired and how do they develop over time in interaction with new and existing things, other people and practices? This section touches upon a number of themes that begin to address these topics.

Capturing resourcefulness

We have reframed resourcefulness as the dispersed practice of adjusting and reworking the conventional relation between elements in normal practices—in particular the relation between means and purpose—to address unexpected or uncommon situations. During these reconfigurations, objects at hand are deployed in uncommon ways as resources, to proceed in a satisfactory way in spite of the challenging circumstances. As such, *we see resourcefulness as intimately linked to improvisation rather than already socially normed forms of everyday design*. The challenges and opportunities that such a conceptualisation of resourcefulness reveals for capturing resourcefulness concern primarily understanding how means and purpose come together to make a reconfiguration ‘work’; this includes ‘giving meaning’ to an *improvised solution* that may ultimately lead to habituation and later to socially accepted, shared forms of everyday or even commercial design. This means orienting our methodology to gain insights on how and why the same object serves different purposes across different practices [28] – for example, at how a tub is used both for bathing *and* for putting away dirty sport gears. But also the reverse: how the practice of putting away, organizing objects makes a ‘thing’ such as stairs (Figure 3).



Figure 3. Stuff organized ‘as stairs’ to indicate where eventually items should be put away in the house.

When considering resourcefulness as a dispersed practice of dealing with everyday crises of routine in a variety of integrative practices, it becomes clear that because of its mundane, everyday character, resourcefulness is a practice that is relatively hidden from view and consciousness. Moreover, because of its characteristic of creating reconfigurations of normal practice, people may be insecure about the social acceptability of their particular solutions and inventions, or have trouble talking about it because no designated vocabulary exists to describe it. These

characteristics make resourcefulness something that is particularly difficult to capture.

We believe that a thing-centred approach to research methodology may be suitable to address these challenges and opportunities, because it acknowledges the material and socio-cultural dimensions of artefacts in social practice, and see humans and artefacts relationally and symmetrically, in contrast to user-centred approaches conventionally more focused on human needs and wants.

A thing-centred approach

Our approach makes use of a ‘living lab’ of people *and* ‘things’ (i.e., artefacts that matter to our participants and have been instrumented with sensors) to loop qualitative ethnographic research in which artefacts record the world around them in the way ethnographers would try to record the world from a human’s perspective, and quantitative insights from machine learning analysis.

As such, our approach links together several ongoing as well as recent developments in HCI, from living labs to thing ethnography and the use of machine learning in design research. We provide here a brief description of how these are understood and combined in our attempt of capturing resourcefulness.

Living labs form a diverse set of research methodologies that involve observing people’s behaviour in real life settings [17]. Resourcefulness occurs in unexpected situations and can therefore not be realistically staged in a lab setting. It therefore has to be captured in real life situations. In the set-up of a living lab aimed to capture resourcefulness in a specific context, the characteristic of resourcefulness as a socially sensitive practice needs to be taken into account. When reconfigurations are acknowledged by the research team to be acceptable when they make sense to participants, as experts of their own situations, feelings of social insecurity might be turned into pride of creatively dealing with everyday challenges.

While research in the field must remain aware of and sensitive to what people feel and why they behave they way they do, a living lab for capturing resourcefulness must include artefacts too as ‘participants’ in the lab. To this end, thing ethnography [30] provides a methodology to establish a symmetrical feedback loop between people and things. Thing ethnography builds on the growing idea that artefacts have a different perspective on everyday life than people (e.g., Sensing the City [39], Davoli and Redstrom [11], BinCam [9], just to cite a few). From their particular perspective on daily life, artefacts ‘see’ what people cannot see, or would not notice [31]. Things cannot be directly interviewed, but developments in sensor technology, memory and wireless communication make it possible to obtain their point of view.

Equipping a number of carefully selected artefacts with sensors is therefore expected to be able to uncover some of the hidden events and actions involved in everyday

resourcefulness. In addition, enabling these artefacts to talk to each other is expected to reveal links between different practices and how resourcefulness may be constructed across, and at the overlap, of these practices. For example, being able to observe that the same artefact is used as a different means, for a different purpose, within different situations, and as part of different practices, may render insights about relations and dependencies between artefacts and practices. It is at the crossover of these often unnoticed interdependencies that resourcefulness is expected to play a role, and using thing ethnography in a living lab set-up may help capture precisely such critical interdependencies (which designers often improperly refer to as misuse).

Putting machine learning in the loop

As introduced by Cila et al. [8], the main contribution of machine learning (ML) to the design field is expanding the processing of the data gathered by things beyond human capacity and skills. ML can be used as a way to identify novel patterns of use within the data that is streamed through the interaction between people and things, and things and things. Through a better understanding of what data can tell us about how we use things in practice, new understandings of use may emerge and inform the development of design concepts and prototypes. The identification of relevant patterns can also constitute an opening towards the radical ideation of new products and services in which different kinds of meanings and values are exchanged ‘in use’ [69].

When it comes to capturing resourcefulness from a thing-centred perspective, the way ML is performed requires careful consideration. Pattern recognition in ML can be classified as supervised and unsupervised [8]. Supervised learning can be used for discovering patterns by specifying for which attribute the patterns should be discovered. Any of the attributes could be at the center of the inquiry; e.g., toaster being on, type of bread inside, time of the day, and so on. Once the attribute is selected, the algorithm looks at other related attributes as to discover variety of patterns. For instance, in the case with the toaster being on, there might be patterns that include time of the day (everyday between 8am–9am), presence of certain individuals or objects (such as plates on the counter), and actions (such as opening the fridge). Supervised learning is particularly useful when there is a clear hypothesis to start with, but less applicable when interdependencies are hidden and may vary over time. In this case, unsupervised learning may prove more insightful. Unsupervised learning is a broader pattern search technique in which the algorithm decides for which attributes the patterns will be discovered. It uses an iterative process to identify patterns in the data, creating clusters on the basis of similarity on *emerging* categories. These categories and patterns can subsequently be used as a basis to identify outliers, exceptions and deviations from routines, which are the type of events that can then be investigated further within the living lab through interviews. These interviews can use the machine learning outcomes to help participants and the

design team reflect and develop insights into people’s everyday strategies of resourcefulness in the living lab.

By utilizing ML, a multitude of patterns could be discovered. However, many of the patterns might not be as meaningful. For example, ML may find a variety of obvious patterns for “the toaster being on”: temperature increases when the toaster is on, toaster is on when the indicator light is red, toaster is on when a piece of bread was just inserted in the slot, toaster is on if it is not dark in the room. From the ML perspective all of these patterns are quantitatively very strong, yet in practice many might be of no value for designers. However, while most patterns might not be as interesting from a qualitative standpoint, some might provide an interesting insight that might not have been discovered otherwise (e.g., sometimes when the toaster has just been on, chopsticks are used in close proximity to it). Ultimately, by looping ethnography and ML, the multitude of patterns produced by ML could expose designers and participants to reflect and develop insights on a variety of aspects. In turn, feedback from examination of these patterns could be incorporated into the ML algorithms as to make the search for patterns more efficient and useful, and combine quantitative and qualitative forms of inquiry in a feedback loop [8]. Eventually, this work may provide deeper insights into the make-up of resourcefulness as a dispersed practice.

Designing for resourcefulness

Challenges in designing for resourcefulness relate to understanding diversity in skills, uncertainty about the use situations in which an artefact will end up, the norms and values that may facilitate the expression and construction of a resourceful identity. Therefore, while capturing resourcefulness may help identify design opportunities at the crossover of a unique web of practices, *it must be concerned also with learning how to keep the design open to appropriation in the variety of situations in which certain artefacts may end up*. By complementing qualitative data, the use of sensor data and machine learning algorithms serves here the goal of helping identify potential dimensions of openness of the digital artefact that will be offered to the elderly to facilitate and enhance resourcefulness in their everyday lives. A focus on understanding and supporting the dimensions of openness of the artefact is contrary to the way in which Internet of Things (IoT) infrastructures are commonly used for monitoring and optimization of existing products and functionalities.

But it is not at odds with the process of connecting houses to the internet, which is in itself a practice that requires skills of digital resourcefulness [53]. In contrast to the ideal and linear way in which IoT is often pursued by companies, it is actually expected that IoT will be highly heterogeneous, encompassing objects completely different in terms of functionality, technology and application fields [3, 14]. People will bring these different objects in different times and it will be a dispersed and discontinuous process. This phenomenon is defined by Edwards and Grinter [15] as the

"accidentally" smart home: a home which contains technological components embedded in it but has not benefited from a holistic, ground-up approach to design and integration (which would necessarily require a pre-conceived, holistic idea of normal and acceptable household life).

In designing for resourcefulness the "accidentally" smart home is somehow embraced. In our design approach, data and ML are used as a means in the participatory set-up of the living lab for empowering both people and 'things' to act as co-ethnographers but also as co-designers 'in use'.

In this sense, the infrastructure for capturing resourcefulness might even form the beginnings of a design for resourcefulness in itself. After all, technologies like IoT are inherently "configurational technology" [20]—a platform, a form of open-ended systems that need configuration in specific contexts to work at all, that are not ready for use upon purchase [33]. By understanding how things and people work together, designers can expand their scope and begin to design entanglements, or ecosystems, rather than isolated products and services. For example, we could envision more dynamic 'families of objects', which share information among things that belong to the same temporal or spatial arrangement. New services could be spontaneously arranged and digital interfaces could adapt according to their proximity to other things. For example, when glasses are not around, the text in the tablet could suggest to be enlarged. Or, in the case of things that are always used together, the system could give cues to the user about the missing object and where to find it, and eventually suggest new objects to be added to or removed from families of objects that are initially defined by the user [24]. More speculatively, we can even explore how things could be bestowed with resourceful agency and identity themselves, and imagine what could they do in situations of crises, for example when facing ethical questions [58], or changes in their power relations [59]. In all these scenarios, the design would enable people or things to make use of the IoT underlying infrastructure as a configurational technology or platform, and to resourcefully improvise a novel assemblage of artefacts in response to a situation of crisis (i.e., I cannot find my glasses or I am faced with an ethical dilemma).

By understanding how things and people work together, and using IoT as a platform for design, designers concerned with resourcefulness may also expand their temporal framework and begin to design flows rather than fixed functionalities. Once able to observe how things are used over longer periods of time, designers could create systems that can be resourcefully adapted to new situations depending on how they are used and appropriated. Especially in the area of health and ageing, time is crucial, as changes happen at a slow pace. Thus, a system that has been designed for change, could be able to adapt to new needs as life and circumstances change. For example, in a design for the elderly this could mean that the same system of exchanging

newspapers that is used today to communicate messages within the family, could perhaps serve later as a gentle notification system when something is wrong. Additionally, designers could envision new kinds of design processes where things are aware of how they are used and misused, incorporating changes into the next generation of products, or rearranging services accordingly. Or, once objects know they are not used anymore, they could report back to their designers, or even demand to be moved to a new home where they are more needed [57].

CONCLUSIONS

In this paper we have presented a new conceptualisation of resourcefulness that is grounded in theories of practice, and illustrated how this conceptualisation has methodological implications for HCI research and design. Viewing resourcefulness as a dispersed practice that emerges in everyday crises of routine can be argued to reveal new challenges and opportunities that link to a wide range of existing concepts in HCI, as well as design opportunities for digital technologies, in particular IoT.

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