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POSITIVE AND NEGATIVE CONTAMINATION IN USER INTERACTIONS

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Abstract

The purpose of this paper is to present contaminated interaction as a design construct. Interactions with an object can be altered, positively, neutrally or negatively, due to some prior use. In such cases, the interaction departs from the designed condition and is said to be contaminated. This is particularly significant as objects, physical or non-physical, have multiple uses or are shared amongst users. We propose an ontological model of contaminated interaction based on a review of literature and an analysis of user experiences. The model outlines the process of contaminated interaction including the drivers and outcomes. In a negative context, contamination can lead to consumers misusing, negatively experiencing, or avoiding the object altogether. Positive contamination sees the opposite effect in which usability can increase, users report more positive experiences and users seek out or cherish the object. Together, this model presents an approach to understanding and addressing contamination in the design process to enable the creation and maintenance of meaningful experiences.

Keywords: Experience design, Design theory, Evaluation, Contaminated interaction

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1 INTRODUCTION

In the early 20th century a single ball would be used for the better part of a professional baseball game in the United States. At that time, pitchers would often try to impair the batter's visibility by spitting on the ball with tobacco-laden saliva while at the same time try to improve their control of the ball by altering the surface of it through scratching or other means (Childs, 2011). These altered balls became known as "spitballs" (James and Neyer, 2008). For many pitchers, the spitball was critical to their careers as it gave them an edge over the batter. For batters, however, the impaired visibility was problematic and, in at least one instance, may have led to a fatal incident (Hample, 2011). Organized baseball has long since banned any ball tampering and has become very sensitive to any imperfections on the ball. The result is that a single ball lasts only a few pitches before it is deemed unfit for use and taken out of the game as to avoid tainting fair play.

The baseball example speaks to a larger subject of how increases in use and users can lead to contaminated interactions. Contaminated interaction is the idea that an interaction with an object can differ from its natural or intended condition due to another interaction by someone or something (Baxter et al., 2016a). In other words, contaminated interaction reflects a change in the contextual meaning presented to an individual prior to acting in a situation (Krippendorff, 2005, p. 58).

Examples of contaminated interaction are many and varied. Shopping habits change when others are present (Luck and Benkenstein, 2015). Worn and crisp currency are spent differently (Muro and Noseworthy, 2013). Altered recyclables are mistakenly sorted as trash (Baxter et al., 2016b; Trudel et al., 2016; Trudel and Argo, 2013). Recycled water is avoided (Rozin et al., 2015). Remanufactured items are sometimes seen as disgusting (Abbey et al., 2015a, 2015b). Shared product quality is questioned (Liu et al., 2009) or negatively experienced (Bardhi and Eckhardt, 2012; Petworth, 2016). Finally, objects owned by celebrities appreciate (Argo et al., 2008; Hood, 2009; Newman et al., 2011; Newman and Bloom, 2014) while those owned by criminals are often destroyed (Hood, 2009). Contamination directly influences perspectives on the future way of living and will thus impact the values associated with sustainability (Blevis, 2007). Specifically, in terms of material utilisation, contaminated interaction may threaten new business opportunities, lead to premature disposal or cause downcycling (Baxter et al., 2017).

Contaminated interaction extends to the digital sphere as well. Facebook users are influenced by the presence of their parents and others on social media (Barrett, 2015; Brandtzæg et al., 2010). eBay restricts the selling of items owned by murderers or Nazi leaders (see restricted items list on www.ebay.com). Youtube star PewDiePie deactivated his comments section for a short time due to the amount of spam making it not possible for him to interact with fans (Stuart, 2014). Facebook has developed tools to help people detach from former partners without the discomfort of constantly seeing joint content (Winters, n.d.). Several high-profile people have left social networks following a series of negative or even abusive experiences (Cohen, 2014; Gibbs, 2016). Amazon has filed lawsuits against fake reviewers in attempt to establish the integrity of its processes (González, 2016). A move that may be particularly important given the disproportionate bias users give to reviewers (Langhe et al., 2016).

The presence of contamination is further seen in design interventions intended to prevent it. Noise cancelling headphones allow us to better focus on work. Facemasks are used in an attempt to improve breathing outside despite air pollution. Social media allows you to block people with whom you do not want to interact. Finally, hand dryers in public restrooms are made with sensors and paper towel dispensers are designed to be used with your elbow or to avoid contaminating your hand.

Inspired by these observations, the purpose of this research is to present a contextual understanding of contaminated interaction as it relates to design. In so doing, we hope to increase design knowledge around when and why contamination occurs so the design community can be better equipped to successfully identify and address it. This paper adopts a method of combined literature review and primary data collection regarding instances in which someone else's previous interaction with something enhanced or diminished the individual's interaction (interpersonal contamination). Three types of interaction contamination are confirmed through the analysis: hygiene contamination, utility contamination and territory contamination. Findings are further summarised to develop an ontological model describing contaminated interaction. We end by discussing how the discussion around contamination can be incorporated into design.

2 METHODS

This paper aims to better understand contaminated interaction. We investigated this in an iterative process of analysing existing literature and gathering real experiences. A literature search was carried out on the related concepts of contagion and contamination. Such literature is typically published in psychology and marketing contexts and emphasizes user evaluations of products. The search was expanded to consider contamination as a part of interaction design in terms of what people do, feel, and understand about a system (Moggridge, 2006). Included then in this exploration were products or features explicitly designed to overcome contamination. The resulting dataset included over 60 examples of such products and features in addition to over 50 relevant academic publications. The resulting dataset was used to find initial themes and patterns that were further explored through collecting actual user experiences. Themes and patterns were refined through an iterative process of contrasting literature to the related user experiences.

The collection of user experiences consisted of two parts. In a preliminary study, 41 participants (Mean Age=26.3, SD=12.8, 28 Female) listed items they felt were contaminated due to some prior use. The intent of this exercise was to gauge the range of products listed as well as the ease at which items were identified. Results from this pilot study indicated that more direction was needed to investigate the phenomenon in terms of what to identify and how to describe the reasoning behind how it was being assessed. Accordingly, in the second part of the study, interviews with ten participants were used to gain a deeper understanding of those things positively or negatively influenced due to someone previously using the object. Participants were briefed a few days before the interview to allow time to think about possible objects they might discuss. The interview consisted of asking for an object enhanced (diminished) due to some prior use. We then asked questions regarding how it was used previously and what contributed to enhanced (diminished) value. Specific attention was given to inquiring about both physical and digital products as well as environments. Results from both phases of the study were regularly compared to relevant literature to identify trends and themes.

The age of participants varied from 21 to 70 years old and was evenly split between men and women. Educational backgrounds varied significantly from those who have not finished high school to individuals with PhDs. Occupations also were varied. Included in the survey was a student, a management consultant, an entrepreneur, a medical doctor and a designer amongst others. The interviews, including the initial prompt, typically lasted between 30 and 45 minutes. Audio recordings and notes were made for each interview. Following each interview, the audio recording was transcribed and analysed for recurring themes.

The analysis of the interviews and literature gave special attention to the types of objects used, the scenarios through which the objects were engaged and the underlying reasoning behind why the experience with the object was perceived to be better or worse.

In what follows, we present the combined insights from literature and the collection of primary data.

3 CONTAMINATED INTERACTION IN CONTEXT

Extending previous work (Baxter et al., 2016a), literature and primary data on contamination reduced to three categories relating to health (Abbey et al., 2015a, 2015b; Greed, 2003; Muro and Noseworthy, 2013; Nemeroff and Rozin, 1994; Rozin et al., 2015; White et al., 2016), functional value (Abbey et al., 2015a, 2015b; Andrews, 2015; Liu et al., 2009; van Weelden et al., 2016), and personal space (Alias et al., 2014; Argo et al., 2008, 2006; Bardhi and Eckhardt, 2012; Belk, 1988; Goffman, 2009; Griffiths and Gilly, 2012; Hood, 2009; Kim and de Dear, 2013; Luck and Benkenstein, 2015; Newman et al., 2011; Newman and Bloom, 2014; Smith et al., 2015). We term these hygiene, utility and territory, respectively. Together these determine the value changes creating positive or negative contaminated interactions.

These drivers are not mutually exclusive and often occur together but are distinct in their underlying causes. The drivers also vary in the extent to which they can be considered dynamic or static interactions. Dynamic interactions often occur within environments where the contaminant is often transient: fleeting smells, other people, noises, etc. For products, the contaminant was most often static as the contamination is not ongoing. Digital products display a general variation of the two.

Results showed a wide range of physical and digital products and environments. Physical products included clothes, books, guitars, jewellery, furniture, and instruments among others. Physical environments included a car, public transportation, work environment, restaurants and schools. Digital

products included webpages, mobile phones, television, and other consumer electronics. Digital spaces included social media, personal website accounts, and online forums.

In a negative context, contamination can lead to consumers misusing, negatively experiencing, or avoiding the object altogether. Positive contamination sees the opposite effect in which usability can increase, users report more positive experiences and users seek out or cherish the object. A summary of results from the three drivers is given in Sections 3.1-3.3.

3.1 Hygiene

Hygiene considerations respond to feelings of disgust. Disgust is thought to be an evolved revulsion to pathogens (Curtis, 2013; Curtis et al., 2011). This was highlighted by the various adjectives used by participants to describe hygienic contamination: clean, sick, sanitary, gross, sweaty, contagious, smelly, and dirty. More familiar sources of contamination (i.e. germs from a loved one) are reported as being less severe than less familiar contaminants (germs from a stranger) (Nemeroff, 1995). Similarly, feelings of contamination will increase if the object is more intimately used and subsequently has a higher chance of carrying and transferring a harmful substance (Abbey et al., 2015b, 2015a; O'Reilly et al., 1984). The nature of hygiene is such that it is mainly seen with physical products and nearly always moves from positive to negative.

In the present study, no instances of positive hygienic contamination were identified. This is not surprising since this would require that an object go from dirty to clean and this rarely happens due to prior use. This is, however, a theoretical possibility and one can imagine situations in which positive hygienic contamination occurs such as the simple process of a dirty room being cleaned.

Examples of negative hygiene were prevalent. Responses related to concerns over the transfer of natural substances such as bodily fluid, and artificial substances such as pesticide on the outside of an apple. It was enough to imagine and not see prior use such as disgust towards the prior touching of a door handle. In this sense, respondents often created a narrative of how the object must have been used. The narrative existed in some cases even if the source had been completely recycled.

3.2 Utility

Utility considerations concern an assessment of the functional value of an object. Functional value includes technical function but also social, aesthetic, or economic functions of the user (Aurisicchio et al., 2011). Adjectives used when describing utility contamination include: faster, better, damaged, worn, cheap, broken, and ruined. We expect changes to an object that deal more closely with the functional value of an object to have higher sensitivity to contamination. This category is the broadest in scope and the most obvious in terms of where current design has been implemented, e.g. design for durability.

Positive utility is about enhancing the functional aspects of a product. In the simplest form, this is a return on investment of time, money and energy on the part of the user. Unsurprisingly then, several respondents talked about how previously used things were better since the upfront investment of cost or time was lowered. Other instances of positive utility involved lower risk of issues with the product due to prior use as seen with cars and houses.

As the perceived functional value of a product diminishes it is produces negative utility contamination. Many examples are simple and relatable. For instance, a phone scratched due to prior use or a used computer full of the previous user's files. Other common examples were the diminishing value of an object with time or with other users as seen with lending out an item that is returned damaged.

3.3 Territory

Territory considerations respond to assessing desired personal space. This included physical elements such as smells, noise, and markings (Goffman, 2009) as well as non-physical elements such as valuing something because it has been touched by someone (Belk, 1988). Territory includes products and environments that evoke feelings of comfort in one's personal space and sentimental objects.

Positive territory focused on things used by a loved one or a person of high esteem. This extended to physical and digital environments. For instance, the perceived value that comes from sharing a school or restaurant with a certain demographic. In other cases, respondents noted the enhanced value of other users with social media.

In contrast to positive territory, negative territory concerns address unwanted others who previously owned an object or who share an environment. Others spoke of the sense of place an object affords that

can be ruined by others. In a digital context, territory was often about unwanted others appearing in social networks.

4 MODEL

Through this investigation, we have created an ontological model of contaminated interaction. The idea of the model is that a **contaminator** creates a **contaminant** with a given **status** that changes user **evaluation** of an object thus producing a **contaminated interaction**, see Figure 1. The model was developed in an iterative process relying on insight from the literature review and the interviews conducted for this study. Importantly, the model refers to a specific user-object interaction. Thus, prerequisite to using the model, the user and the target object must be identified. This is meant to be a generic model for which the target object may be a product, environment or any other interactive entity. Like other ontologies in design (Dong and Yannou, 2016), this is meant to provide designers with a foundational understanding from which they may begin systematically approaching the concept.

4.1 Contaminator

The contaminator is the person or thing that creates the contaminant. The contaminant can originate from the user, other users, the object or other objects. When coming from the user it is a form of self-contamination in that the user taints her or his own subsequent interactions. A clear example of this is seen in recycling behaviour. When common recyclable characteristics such as form or size become altered—by the user or otherwise—recyclables tend to be subconsciously categorized as waste rather than recycling (Baxter et al., 2016b). The result is that recycling rates can drop to less than one half of the original rates (Trudel et al., 2016; Trudel and Argo, 2013).

When others are responsible for the contamination, it is referred to as interpersonal contamination. Goffman identifies six types of interpersonal contamination: (1) violation of personal space, (2) touching or bodily contact, (3) glancing, looking and staring, (4) noise pollution, (5) talking to or addressing, and (6) bodily excreta (fluids, odour, body heat, markings left by the body) (Goffman, 2009). Though these are discussed in terms of the physical world, they are either applicable or have equivalents in the digital world. Russell Belk has indicated another form of interpersonal contamination in which an object intimately associated with another person is contaminated by that person (Belk, 1988).

If the object itself acts as the source of the contaminant it is called innate contamination. For instance, the natural degradation of things (e.g. food) leads to changes in their own properties, which can alter how people interact with them.

Finally, other objects produce extrinsic contamination. Object here is understood broadly to include products but also other entities such as non-human animals. Extrinsic contamination is likely to happen when objects are placed in proximity to others. In some cases, objects in proximity with others may be seen to transfer their properties and subsequently contaminate it (Hou et al., 2015; Morales and Fitzsimons, 2007). In other situations, the presence of additional objects in a user's view may taint how they would otherwise interact. An unsavoury advertisement on a webpage may lead the user to move along more quickly. Another example is how additional objects on supermarket shelves lead customers to buy less and feel less satisfied with their purchases (Iyengar and Lepper, 2000).

4.2 Contaminant

The contaminant is that which alters the meaning of the target object. It is identified through information foraged through sensory, environmental, and cooperative means (Argo et al., 2006; Baxter et al., 2016a; Pirolli, 2009, 2007; Pirolli and Card, 1999, 1995).
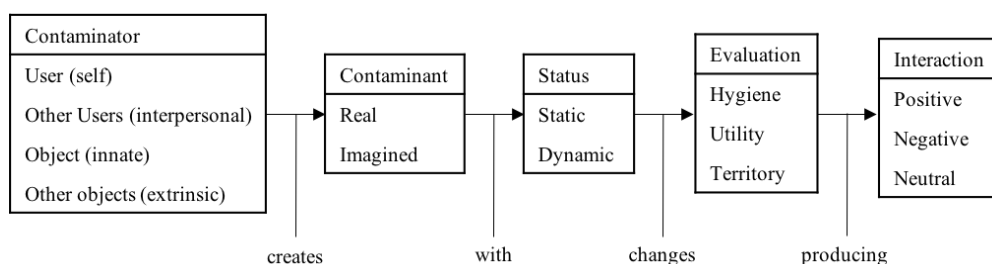

Figure 1. The ontological model of contaminated interaction

Contaminants can be real or imagined. Real contaminants can be objectively examined and are, in some way, perceptible. This includes the physical presence of a contaminant or an alteration to the object's properties. The presence of a contaminant might be a noise or smell for a physical object or it could be an advertisement or comment from another user in a digital context. Altered properties may relate to the colour, smoothness, and other indicators of use for physical objects. For digital objects this may be changes to digital indicators of use, such as likes, upvotes, and reviews.

Imagined contaminants are common. The only indication that something has been contaminated might be the information it carries with it. For instance, land often carries a stigma regarding criminal activity, murder, disease, and ghosts that are not identified through any perceptible means (Reilly, 2000). The same is true of the changed value placed on recycled water (Rozin et al., 2015), products used by celebrities (Hood, 2009; Newman et al., 2011; Newman and Bloom, 2014), items touched by attractive others (Argo et al., 2008), and possessions of criminals (Hood, 2009). These cases seem to operate according to the related laws of sympathetic magic and contagion which posit that a source magically transfers its properties to a target through proximity and touch and that the source will continue to influence the target even after it is removed (Mauss, 1972; Nemeroff and Rozin, 1994; Rozin et al., 1986; Rozin and Nemeroff, 1990). This is seen in several studies in which the contaminated object goes through a purification process but users still claim it is affected (Hejmadi et al., 2004; Rozin et al., 2015). Treating a contaminant of this type can be particularly difficult (Hood, 2016).

4.3 Status

The status refers to the process state of contamination. There are two options for this. A static condition means that the object has been contaminated but the process of contaminating is now over. In the baseball example in the introduction, for instance, an alteration to the ball is considered a static situation since the ball is later evaluated as contaminated. A digital equivalent might be an unwanted comment placed on a social media account. The alternative to this is a dynamic status in which the contamination process is in flux. This most often happens in environments. An example in the physical world is the constant noise, smells, and air pollution to which people are exposed. A digital example is that of a person, such as a parent, whose mere presence alters how another engages with an online community.

4.4 Evaluation

Users evaluate perceived changes and information to determine how to act. If the perception is meaningful, the interaction will alter and thus be classed as a contaminated interaction. Often, however, perceptions are meaningless or trivial. For instance, the presence of background noise in an office or advertisements on a website may be trivial to users and cause no altered interaction. A cautionary note, however, as perceptions need not be conscious to alter interactions. As discussed previously, there are three drivers thought to influence user meaning: hygiene, utility, and territory. The positive, negative, or neutral charge of these drivers influences the presence of contamination.

4.5 Contaminated Interaction

Altered interactions are deemed contaminated. They are contaminated in that they deviate from how they would exist in a natural or undefiled condition (Duschinsky, 2011). Interaction is considered in terms of what people do, feel, and understand about a system (Moggridge, 2006). If any of these interactions are enhanced, interactions are thought to be positively contaminated. If diminished, they are thought to be negatively contaminated. If they change but cannot be considered positive or negative, they are considered are simply contaminated in a neutral way.

Judging whether interactions are positively or negatively contaminated requires contextual understanding. The direction of contamination is marked by a shift in value statement. For instance, we may find that a person spends more time on a webpage when advertisement A is present when compared to B. The presence of the advertisement (i.e. the contaminant) alters (i.e. contaminates) the interaction with the webpage (i.e. the target object). The contaminated interaction remains neutral until it can be deemed positive or negative. Positive or negative contaminations can be considered from the user's point of view or from some external reference such as the designer/company's ideal.

4.5.1 Positive and Negative Contamination

In the baseball example in the introduction, the pitcher experienced a positively contaminated interaction with the ball because performance was better due to use. For the batter, it was a negative contamination because his interaction with the ball was greatly impaired. Expanding the baseball example to how balls are currently used helps explain the presence of positive and negative contaminated interaction as it moves between uses and users. The description which follows is summarized in Figure 2.

New baseballs do not have enough grip and have too much shine. Official rules dictate that mud must be rubbed on dozens of balls before each game and the umpire must ensure that the balls "are properly rubbed so that the gloss is removed" (MLB, n.d.). The contamination, in this context, is positive as the action enhances subsequent interactions. The value judgment is one of utility as the ball goes from unfit for use to fit for use. Once in play, a ball may only be pitched a few times before deemed unfit for play. A ball may be unfit if it is discoloured or marked in some way. The contamination in this context is negative since it negatively threatens future play. The value judgment reflects a utility driver as it moves from fit for play back to unfit for play.

Unfit balls are removed from play and may, through several channels, make their way to fans. For fans, the value a ball carries that has been used in play is higher than those that are new or even those that were rubbed and not used. In this context, contamination is positive as the value of the baseball increases. The value judgment goes from low to high as it has been touched by professional baseball players. This reflects territory since people have a desire to collect those things that have been used by famous others with a belief that the touched object carries the essence of those who used it before. Thus, in a way, the fan incorporates part of the baseball player into their personal space.

5 IMPLICATIONS FOR DESIGN

Through this work, we hope to increase design knowledge around where and why contaminated interaction occurs so that designers can be better equipped to tackle it in the design process. This suggests a new way of framing design problems in which objects are considered as they exist in a given state and how they may travel through many states during their lives. This becomes increasingly important when considering sharing or circular economy initiatives in which material is transferred within a system rather than drawing on virgin material. In such a situation designers need to understand how to maintain positive user experiences as a product moves between uses and users (Baxter, 2017).

Describing the situation is the first step in creating meaningful design solutions. The ontology presented in this paper offers an overview of various scenarios under which contamination can occur. This is useful in that each scenario will likely require a different approach to address contamination. The ontology provides a vocabulary and foundation to describe and understand the process of contamination. Future work should focus on creating a prescriptive approach to dealing with contaminated interaction.

There will likely be a finite number of strategies used to deal with contaminated interaction. For instance, the process of blocking someone in social media is no different, when abstracted, to blocking a contaminant (i.e. meat) from infecting the things next to it. The term "blocking" might then be proposed
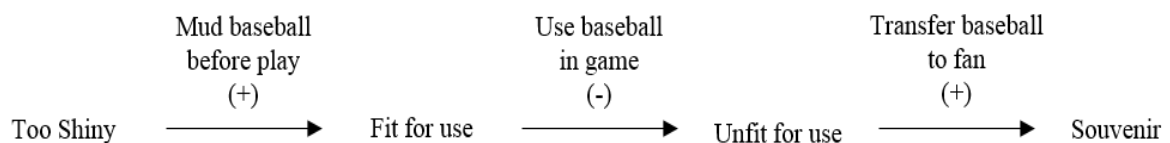

Figure 2. Example of contaminated interaction as a baseball moves between uses and users. Value judgments are given along baseline. The contaminating actions are given above each transition with the positive or negative value marker

as a general design strategy. Together, such a list of strategies could prove a useful technique for informing the direction of design.

A recurring theme in this research has been the up-front effort required with so many products. We refer to this effort as a process of "breaking in" a product. Objects that are broken in improve as they conform to our personal style. Instruments and shoes, for instance, are broken in overtime and appreciate in how they respond to the user. Similarly, online music accounts, movie streaming services and cable programming also require an upfront effort to make them meaningful. Several offerings have designed features that allow you to break in a product. Cars, for instance, are 'broken in' through adjustments of

the mirrors, seat, steering wheel, temperature control and audio preferences. New cars often will remember these preferences across users to allow for multiple people to have their own territory that transforms for their use (Baxter et al., 2015a). A similar pattern is completed by Netflix when signing up for a new movie streaming account. When registering, it asks you to pick favourite movies that will be used to then guide the setup of *your* account. These same techniques can be used to better transition between users in other contexts and customize, to at least some extent, the user experience.

The issue may be more complicated with used items. In the case of previously-used goods, breaking in an object will often require a non-trivial extra step of cleansing the object before it can be fully used (Baxter et al., 2015b; McCracken, 1986). We do not suspect that users are willing to engage in this behaviour if the perceived benefit is small. For instance, in short-term access models, we think users will often opt to endure a negative experience rather than take steps to make it positive. Some evidence of this is seen with car-sharing schemes. Extra effort should go into enhancing the process of breaking in objects for use to minimize contamination.

The nature of this paper is that it offers directions rather than prescriptions. Additional work is needed to further explore contaminated interaction and its implications. A starting point should further validate the ontology as a useful tool to describe various offerings. This may include expanding the current data set and coding responses. It will also include investigating other non-interpersonal sources of contamination more fully—a limitation in the present study. Another direction, as mentioned earlier, would identify design strategies that could be used to mitigate or enhance contaminated interaction.

6   CONCLUSION

This paper has presented an ontological model of contaminated interaction. The model was informed by existing literature and an analysis of reported user experiences. Although the interviews focused on interpersonal contamination, both positive and negative, the model itself is generic and can be applied to a range of issues. Describing contaminated interaction is the first step in addressing it. This is particularly important in the case of negative contamination that can be detrimental in how it can lead to users avoiding, misusing, or negatively experiencing offerings. Positive contamination differs in that it enhances usability, provides positive experiences and encourages users to engage with the offerings. Through the model, designers will be better equipped to analyse and describe the contamination processes underlying the contextual issue they are facing. We also suspect this will be useful in guiding design directions. Under this model, for instance, we have begun to identify what we believe to be a finite number of strategies used to address negative contamination.

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