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Designed and accidental humor in the Smart Digital Wild[1]

1. Introduction

The concept of Smart Cities has been introduced some decades ago. How can information and communication technology help to manage a city and make it smart? Management can concern issues such as the distribution of energy and water, traffic control, public transport, surveillance, safety, and data networks. We can say that Smart Cities are ruled by data that is gathered using all kinds of sensors, while decisions based on this data are made by 'intelligent' actuators, including humans and computing devices [1]. However, sensors and actuators will appear everywhere in our urban environments. In public spaces, in street furniture, in buildings and in our homes. With our smartphones and other wearables we transform ourselves into smart nodes and controllable nodes in the Internet of Things. In 'Project Jacquard' Google teams up with Levi's to make smart jean jackets that allow touch and gesture interactivity. It is illustrative to see the transformation from the well-known Ada Lovelace's (1843) description of programming Babbage's Analytical Engine (*"The Analytical Engine weaves algebraic patterns just as the Jacquard loom weaves flowers and leaves."*) to Mark Weiser's (1991) quote about ambient intelligence *"The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it."* and the quote from the Jacquard project (2015) *"Project Jacquard makes it possible to weave touch and gesture interactivity into any textile using standard, industrial looms."*

Smart city governance can organize who has access to sensors and actuators or the data that is collected. Civic hackers can use this data in order to program new applications that are useful for them or the communities they come from. However, we can certainly also expect local city communities, civic hackers and gamers to explore such networks of sensors and actuators and exploit and use them to address problems such as safety, pollution or traffic noise or to introduce applications that allow community members to discuss and to decide about planned changes in their environment or implement desired changes themselves. Here we should mention Dutch architect Constant Nieuwenhuys who already in 1974 predicted a future city (New Babylon), where indeed citizens have access to telecommunications and audio-visual media in order to transform their environments [2]:

> *"They wander through the sectors of New Babylon seeking new experiences, as yet unknown ambiances. Without the passivity of tourists, but fully aware of the power they have to act upon the world, to transform it, recreate it. They dispose of a whole arsenal of technical implements for doing this, thanks to which they can make the desired changes without delay."*

Nowadays we can indeed think of architectural space made of robotic systems, kinetic structures and interactive walls with embedded and controllable intelligence and we can think of roving robots that construct architectural elements [3,4]. Hence, sensors and actuators (available as smart architectural elements and robotic systems) can be used to reconfigure living environments and maybe do this in unexpected and unpredictable ways.

We can also expect applications and control of sensors and actuators for playful applications that provide fun and amusement and invite city dwellers to become active in events and organizing events, to take part in urban games and to engage in social community activities. Playfulness often involves humor. There is enjoyment, there are smiles and there is laughter. There are unexpected situations and behavior that cannot be predicted. What can be the role of digital technology in helping to introduce playfulness and humor in smart cities? Can we have algorithms that control sensors and actuators in such a way that humor will emerge or that the chance of humor occurrences increases? For example, one might think of an artificial humor director agent, as we have movie and sitcom directors, who monitors activities in a smart environment and decides about the introduction of humorous events. We rather consider the possibility that city dwellers with access to smart technology, preferably spontaneously, create humorous events by making changes to their environment by reconfigurations of networks of sensors and actuators and their properties.

Humor can be designed and canned, for example as it appears in videogames, sitcoms or amusement parks We often have humor professionals that have responsibility for this inclusion of humor. Humor can be designed for a particular occasion, for example in an April prank. However, in real life we often see humor appear spontaneously, for example when interacting with someone or we see something funny happening. We have a conversation and we see the possibility to enter a humorous remark, where the remark is 'construed' using information that becomes available from previous conversational exchanges and from the context of the conversation or interaction. We have control of our contribution to the conversation and can construct a humorous act [5]. In an augmented, virtual reality or smart environment we can have a similar kind of control, using available (real and virtual) sensors and actuators that are present in these environments. In addition we can have accidental humor. Both in conversational and digitally enhanced environments accidental humor is often about misunderstandings: misunderstanding a conversational partner or a situation, or how to use technology. In the case of technology it is also about technology failures and bugs.

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[1] Keynote speech in this congress.

The aim of this paper is to gather aspects of humor that we need to consider when creating humor in digitally enhanced physical worlds. In particular we look at smart outside environments, such as urban environments and playable cities. However, where useful we will make references to other smart worlds and humor creation in general as well. Section 2 provides some background on the various ways we can look at humor and the emotion it induces from different theoretical viewpoints. Section 3 is devoted to the functions of humor and whether and how these functions can be present in digital environments. In Section 4 we discuss various worlds in which humor can be introduced, we look at the design of humor and the design of interfaces that facilitate the emerge of humor. There is no automatic creation of humor involved. Rather we see design observations on where and how to use humor techniques and design principles that, although introduced for different reasons, help to realize interfaces with unexpected and not always appreciated behaviors, increasing the chance of a humorous event. Finally some conclusions follow in section 5.

2. Humor as the object of amusement

In [6] Noël Carroll introduces the emotional state ‘comic amusement’ The object of comic amusement is humor. Comic amusement is an emotional state, just as fear and anger are emotional states. In his view humor is the general name for all objects that give rise to this comic amusement emotion. It is well-known that the main theories of humor emphasize different aspects of humor. The incongruity theory emphasizes the cognitive viewpoint. The comic amusement is caused by perceiving the ‘object’ in two contrasting views. The object can be a joke and while the joke is told we have to replace an initial, usual stereotypical, interpretation by a less stereotypical, unexpected and opposing interpretation of the situation. The situation itself does not change, the main actors and objects are still there, but we need a re-interpretation of the situation. In a joke the correct interpretation becomes clear from its punchline. In cartoons there is the immediate display of two interpretations, where it might be the case that the incongruity is cross-modal. That is, the incongruity follows from contrasting information in text and image. Also in products, behavior and in activities we can have incongruities, including cross-modal incongruities [7]. The relief or release theory emphasizes a psychological or emotional viewpoint. In that case comic amusement involves releasing ‘censors’ that in real life prevent us from talking about certain topics, prevent us from following certain types of reasoning, or from accepting certain situations, activities or behavior as appropriate or logical. Superiority theory addresses the function of humor. The particular object of comic amusement includes aspects of failure, misfortune, or stupidity and we can feel superior to those who are mentioned in a joke or are the subject of an unhappy situation. Usually all three viewpoints can be distinguished in ‘objects’ of comic amusement.

From the point of view of designing humor for smart environments or playable cities the incongruity point of view is the most important. Humor can be created by introducing incongruities, whether it is in a conversation, in a cartoon, a product, behavior or an activity. But not every (perceived) incongruity is humorous and leads to comic amusement. We already mentioned the contrasting views that need to be present in the different interpretations. In the case of verbal jokes there needs to be a narrative in which both contrasting interpretations fit. The change from one interpretation to the other can be called a cognitive shift. It should be sudden and not involve complex problem solving. The shift has also affective aspects, it should be accompanied with positive feelings. Although humor does not necessarily result in laughter, Morreall [8], searching for an incongruity humor definition, mentions that “Laughter Results from a Pleasant Psychological Shift,” where laughter expresses the feeling that results from the cognitive shift. The feeling might be called ‘amusement’ or ‘mirth’.

Carroll [6], also emphasizing the incongruity point of view, elaborates on the conditions of being in the state of comic amusement: (i) the object of one’s mental state is a perceived incongruity which (ii) one regards as non-threatening or otherwise anxiety producing, and (iii) not annoying and (iv) towards which one does not enlist genuine problem-solving attitudes (v) but which gives rise to enjoyment of precisely the pertinent incongruity and (vi) to an experience of levity. This latter condition is related to the recognition that the challenge we are confronted with is only amusing and we are ‘unburdened cognitively’. Many other authors have emphasized the non-threatening aspect of humor. Nevertheless, recently it has been claimed to be a new ‘theory’ of humor, the benign violation theory [9], where the authors mention that “ …humor only occurs when something seems wrong, unsettling or threatening (i.e., a violation), but simultaneously seems okay, acceptable, or safe (i.e., benign).” As mentioned, similar observations have been there in the past, but also attempts to provide more detailed descriptions of the conditions that help to define humor as the object of comic amusement.

Assuming that comic amusement is an emotional state we can also look at the conditions under which this particular emotional state will appear, as we can look at conditions under which other emotional states appear. When and whether comic amusement as an emotion appears should be able to decide from appraisal models, for example the OCC model [10]. Unfortunately, these models do not yet include explicit humor-like stimuli to emotion generation. The object of comic amusement, i.e. humor, needs to be there. But the object is not yet sufficiently satisfactorily described in terms of necessary and sufficient conditions. Moreover, there are humor conditions that go beyond the conditions of simple appraisal models of emotions. People have different senses of humor and can appreciate or dislike particular types of humor. In the latter case there will not be comic amusement. Apart from different senses of humor, depending not only on personality and culture, it also depends on the role someone has in the humor process. People can appreciate humor and laugh because it is someone else and not them who act stupidly. You can initiate humor and make someone else the butt of the humorous act that you create. There can be other recipients: listeners, bystanders, co-creators. And even if you are the butt of a humorous event, it may cause comic amusement to you too. For example, when you are among friends, feel at ease and are in a playful mood. Or when you start exploring a game or a unfamiliar environment in search of bugs or situations and events that have not be foreseen by a designer and that, from the viewpoint of the explorer, are humorous and probably make them feel superior to the designer.

Humor is the object of the 'comic amusement' emotional state. But can we always assume that our current or maybe neutral emotional state can be transformed to this particular emotional state? In the previous paragraphs we already made clear that this cannot be expected. Someone being displayed to humor may have emotions that conflict with this comic amusement emotion and therefore no amusement will emerge. Someone being displayed to humor may be in a mood that is not open for humor and no comic amusement will be experienced. Various authors have discussed the mental state that is required to appreciate humor. Usually they mention that subjects have to be or have to be guided into a 'playful state'. As an example, when in a meeting of friends one of them starts with 'Do you know this joke?' it is already clear to friends that they are expected to enter this playful state, where you expect and agree to be exposed to descriptions of irrational, non-stereotypical and inappropriate behavior and that these descriptions are meant to make you laugh, that is, to evoke comic amusement. More general observations on the state of mind in which we are open to play and humor can be found in Apter [11]. He distinguishes between the *telic* and the *paratelic* state of mind, where the *telic* state of mind is associated with our more serious goal-directed activities and the *paratelic* mind is associated with play and humor. During the day we can change from one mode to the other and stay for shorter or longer times in a specific state, depending on our activities and the context in which we perform them. When we are in the *paratelic* state of mind we have created a small world "into which the outside world of real problems cannot properly impinge." We have created a "psychological safety zone."

In this section we discussed the many aspects of attempts to characterize humor as the object of comic amusement. Among them are aspects of incongruity, relief and superiority, cognitive shifts, benign violations, not being annoying, not requiring complex problem solving capacities and inducing levity, but we also need to take into account other factors such as being in a playful state. In deciding about where, when, and how create humor in smart environments we need to take these aspects into account.

3. Functions of humor in digital environments

Why should we want to create humor in smart environments such as smart homes, smart public spaces and smart urban environments? A simple answer is that our future life will be lived in those smart environments and just as we prefer play and to be exposed to humor and sometimes be humorous ourselves in our present-day environments and interactions, our appreciation of play and humor will probably and hopefully not decrease when living in smart environments. Our focus in this paper is on how humor can appear, be designed and experienced in environments with digital technology embedded in walls, floors, ceilings, street furniture, objects, devices and people. So, how can this digital technology be exploited to allow play in future smart cities and to introduce interactions and events that will be considered as humorous? Can we use sensors and actuators just as we can use words, speech, prosody, gestures and facial expressions to create humorous events and interactions in a playable city?

We will briefly discuss some of the functions of humor. It can be useful to be aware of them when we discuss humor in smart environments, but we certainly keep to our simple observation that reaching and being in a positive emotional state of comic amusement or mirth is usually more preferable than emotional states that reflect negative feelings. Obviously, there can be situations where negative or non-amusement feelings are more important to us, and we are not always in a mood to appreciate humor. Nevertheless, when we want to create humor in smart environments in which this digital and computational smartness plays a role, can we or need we to go beyond an observation that the more, whether it is fun or people involved, the merrier? Other functions of humor have been distinguished. When discussing definitions of humor we already mentioned that humor can be accompanied with a release of negative, stress related feelings or that humor can induce positive feelings because the misfortune you see happening to someone else does not happen to you and the stupidity someone else shows will never be shown by you, you assume.

Other functions of humor are less directly related to the object of comic amusement and more related to context and motivation to create a humorous object or humorous act that is supposed to induce comic amusement. In the future we should more thoroughly discuss how these functions can relate to digital technology. It will be useful to be aware of them for a future research agenda that looks at the generation of humor in smart environments.

Humor plays a role in social and professional communications, in educational and training environments, in meetings and negotiations, in healthcare and in workplaces [12]. It can help to release tension, help to change the subject of discussion, and reduce possible embarrassment. Self-deprecating humor can help to make a person's poor performance more acceptable. Negative humor, for example cynical and derogatory humor can help a person to cope with stress. Smart and playful technology can help in designing and also real-time configuring by inhabitants of smart environments to introduce humorous events that can release tension in many situations or periods where that is useful [13]. One can argue whether we should intentionally introduce technology that helps in facilitating negative, aggressive or mischievous humor. Do we introduce digital workplace harassment? However, whatever smart technology we introduce, it can be used or misused to create these types of humor too. We can see examples in video and pervasive games, where these types of humor are used in trolling, griefing and bullying. This is not always negative humor, it can be part of play, that is, the negativity is there but it is considered to be part of the play, and it should be answered in a similar way 'negative' way. You are cynical, I'm even more cynical. So, it may be the case that we can have similar humorous play in real-life smart environments.

Interesting is also the function of self-deprecating humor. Digital technology is not perfect, or put it differently, we use digital technology in applications where it cannot yet function perfectly. We can blame the technology, we can blame the users who put too much trust in the technology, and we can blame the human-computer interaction designers and computer scientists who accepted that limitations of the technology were not well explained to the general audience and users of their technology. One way to deal with this is self-deprecating humor. It is not a human, but the smart environment, a robot, or an embodied agent, that tells a human user, in a humorous and task-dependent way that it is not yet able to perform a particular task.

Other functions of humor have also been distinguished. Humor in cartoons or stand-up comedy can be used to criticize people or provide original and unexpected comments on actual public and political events and situations. Although we don't think that nowadays cartoonists or stand-up comedians adhere to this view, Bergson [14], maybe biased towards French comedy theater as the plays of 17th-century playwright Molière, mentions that humor is also meant to correct for deviancy in the social order. In contrast, Spanish cartoonist Junco [15] mentions that humor has a useful function of exploring borders and contrast mainstream ideas with other views. These views can be considered as belonging to the social functions of humor. Some views distinguish between 'reinforcing humor' (consolidating cohesion and existing social order) and 'subversive humor' (challenging the 'status quo') [16]. In the latter paper it is mentioned that in their investigated organizations more than 40 percent of humor at the workplace is subversive. Subversive humor may be a good candidate to profit from digital technology.

Minsky [17] also introduces a cognitive view on the function of humor. He introduces the notion of cognitive bugs in heuristic reasoning and notes that humor can make such bugs visible. Cognitive bugs become apparent because in many stereotypical situations we follow heuristics rather than following rational thought. Humor makes clear that we shouldn't always follow our heuristics and it provides us with insight about our thought processes. Will digital technology lead to other cognitive bugs that are addressed by digital humor rather than by jokes?

We may conclude that in addition to 'good-natured' humor, meant to achieve pleasure not only for the joker but also for the recipients, other types of humor and humorous events with other functions will also appear in smart (urban) environments, as well. The events can be designed in advance, they can be created spontaneously, and they can appear because of 'imperfectness' and bugs that can lead to humorous events that were not intended, neither by designers or users of the technology. It can be the case that users intentionally explore imperfectness in order to create digital humorous events, such as is happening in videogames [18,19].

4. Towards designing digital humor in smart environments?

4.1 Humor in the digital wild and in controlled environments

Humor is created in a particular context of a location, a period and one or more people involved. An event can be humorous for an observer without being created by a human being or without, apart from the observer, a human being involved. Often we have a human creator of a humorous event, maybe co-creators, maybe people who are tricked and maybe others who observe what's going on. Some of the latter may belong to the insiders, they share interest in the event (e.g. friends or colleagues), while others are just bystanders or passersby, not necessarily understanding or interested in what's going on. A humorous event can happen or can be created in a public space. In that case we can expect that not by everyone the event is appreciated or understood. For example, when a funny thing happens or is created in an urban game, then it is humorous for some of the participants in the game and some of them may be the target of the humor. But there can also be witnesses who don't understand what is going on and even feel threatened by it. There are examples where as in an April prank large Mario Question Blocks were installed in trees and then mistaken for a terrorist threat and Pokémon Go players who were shot at because they acted suspiciously in the eyes of a Florida homeowner. Humorous events can also be created in public social media, not really different form the situation sketched above, especially when social media and augmented reality worlds converge. And the same holds for distributed digital workplaces that will allow digital humor, whether it is 'subversive' or 'reinforcing'.

In general we cannot expect people present in a public space or workspace to be in a playful state of mind. It will be different when they play an urban game or enter a game like World of Warcraft. It will also be different when they visit theme parks, amusement parks, or adventure playgrounds. Cities usually have designated playgrounds and yearly activities that offer entertainment and invite play. For example, the Playable Cities initiative in Bristol, UK, has led to invitations to design studios and artists to compete with proposals for playful and often humorous interactive installations in the city and the winner earns an implementation that can be played by city dwellers during some weeks or months.

Regional or local policymakers control the realization of these parks, playgrounds and playful installations. Citizens do not participate in the design process and can act only as end users. Obviously, although negative kinds of humor among participants can appear in these designed play environments as well, the technology that is implemented is meant to be playful and in this way induces a playful state of mind that is also more receptive to humor. Using and exploring the play technology that is available can accidentally lead to humorous situations and that in turn can invite exploration behavior that is meant to create humorous situations.

4.2 Designing humorous products and surprising interfaces

Most humor research is on analysis and not on creation. Moreover, most humor research is on verbal humor. Humor principles can be learned from verbal humor analysis and we mentioned some of them in section 2 of this paper. and we will come back to them later. But before doing this we want to briefly survey what interaction and product designers, not humor researchers, have said about designing interfaces and humorous products. Can we learn from their principles and heuristics and use this knowledge to create humorous events, either by us, or with a little help from us, by smart technology? Usually designers want to deliver products that are pleasing for their users. This will be the topic of subsection 4.2.1. In subsection 4.2.2 we consider user interface design that not necessarily aims at user-friendliness and may invoke inappropriate use and unexpected and surprising events. Hence, although humor is not guaranteed, employing such design principles may increase the chance of humor emerging while interacting with such interfaces.

4.2.1 Design principles for products with a smile

We consider humorous product design. No complete literature review is given. Rather we discuss some illustrative approaches that mention principles of humorous design that can be further developed into design heuristics. Especially in the work of Ludden and her co-authors, e.g. [7, 20], the emphasis is on designing sensorial incongruities. With five senses (vision, audition, touch, smell, and taste) we can have 10 incongruities (visual-auditory, ….) and if we take into account sequential processing we have 20 possible cross-modal incongruities when we perceive a product. In various of their papers it is investigated how such incongruities are experienced. In [7] considerations for designing humorous products based on a selection of such incongruities are presented.

The incongruities considered in [7,20] are representational incongruities. They don't address how the product is meant to be used or where it is meant to be used. Yu and Nam [21], on the other hand, don't consider cross-modalities. They confine themselves to the visual or 'shape' modality of a product (appearance, material, size color). The tactile, auditory, olfactory or taste modalities are not included in their observations. However, in addition to a shape incongruity they distinguish 'context of use' incongruity (use a product in an unusual context) and operational incongruity (use of a product in an unusual way). For each of them three classes of design principles are introduced: from the point of view of emotional superiority, from the point of view of relief from social violation, and from the point of view cognitive incongruity. This framework has been used to illustrate and guide the design of a humorous water fountain. Adding cross-modal incongruity examples to their observations would make their approach even more worthwhile.

Klein 22] mentions that major kinds of humor associated with product design include puns, irony and paradox. Visual puns can be obtained by merging two images, contradictions in images may lead to irony and we can have paradox by unusual juxtaposition of image, form, and material. Klein mentions various techniques designers can use to create sensory incongruities. The techniques she mentions (association, transposition, transformation, exaggeration, disguise, and appropriation) mainly address the introduction of incongruities related to representation and 'context of use', as in [21], but the results are described in terms of puns, irony and paradox.

We conclude that designers are developing design principles for creating humorous products. They provide details about how to play with incongruities, that this can be done from the various humor theory's viewpoints and that specific types of humor can be aimed at. It is not yet a framework that provides design guidelines for creating all the various kinds of humor that exist. It can't be because it is aimed at products 'only'. Another limitation is that all humorous products that are considered don't have embedded digital technology and don't or hardly assume interactivity. So we clearly need to reconsider and probably extend these design principles when considering humorous design of digital interactive devices, tangibles, and interactions and events, where the technology includes sensors and actuators that are embedded in our environments.

A difference between this humorous product design and 'humor in the wild' is that once the product is there, it usually cannot be modified. It is a kind of visual pun that is meant to give pleasure to its buyer or user. All the observations on humorous product design that we discussed above do not take into account interactivity, the sharing of humor and accidental humor. Notions such as 'context of use' and 'operational' incongruity should be extended or new categories of incongruity are needed when we want to include humans, human behavior and human activities in similar observations on incongruity. Moreover, with 'humor in the wild', not all participants necessarily have a pleasant experience and feel comic amusement. Delaney [23] discusses heuristics in a humorous user-centred design approach, illustrated with the design of signs and posters. There we have observations on conditions related to appropriateness of humor, the ego of the designer, and the target audience's relationship with humor. The choice of humorous elements or strategies such as, for example, the choice of incongruities or the display of humor needs to be done while taking into account these conditions.

4.2.2 User interfaces and unintended humorous events

As mentioned, research with a focus on the design of interactive humorous products has hardly been done. It does not mean that there are no interactive humorous products. However, it is usual the interactivity to a product or service in which we can find the humor. The humor can be intended. There can be canned humor and there can be humor that is created on the fly, based on a user's verbal [24] or other interactions. We can as well have accidental humor. Interfaces, just as any device, can contain bugs. They are not always robust. Not every user behavior has been anticipated by the designer. Users can start exploring and interface, just as can happen with a game, in order to see whether something unexpected and funny will happen. However, in the last decade we have also seen the introduction of user interfaces or devices that are not necessarily user-friendly, that can embarrass users, that are inconvenient in use, or uncomfortable. Other interfaces have been designed in such a way that they allow a user to adapt an interface to a task not directly foreseen by the designer. Although these interfaces have not been designed to create humor, their use will often lead to humorous situations, whether they are accidental or were intended by the user.

In [25] we find the search for design principles that promote hackability. The design of serendipity is discussed in [26, 27]. Design principles for facilitating appropriation are discussed in [28]. Interfaces that are designed using such principles will probably have a higher chance of accidental humor occurrences. With uncomfortable interactions [29] we have some physical or mental suffering. However, as mentioned in [29], they can be designed into cultural and entertainment experiences, and although uncomfortable, there can be benefits at the end, similar to benefits we achieve from a discomforting artistic performance, an offensive stand-up comedian, or highly demanding physical or mental game play. As an example of the latter, using sensors and actuators, we mention 'Remote Impact – Shadowboxing over a Distance' [30]. Watching people engaged in this interaction (boxing with the shadow of an opponent) is fun, it certainly has elements of incongruity in it, and this incongruity makes it humorous, for the audience, but also for the person who has the stage and is shadow-boxing.

Behavior that leads to embarrassment can be fun for bystanders. A dignified person who loses control over his limbs when he slips over a banana peel can expect laughter from bystanders. Displaying incompetent behavior or behaving inappropriately in public can lead to embarrassment and some nervous laughter. However, we can also be amused by embarrassment or by the situation that led to this embarrassment. With friends and being in a playful mental state embarrassment can turn into a good laugh, both for the audience and the laughingstock. In [31] it is mentioned that due to the pace of innovation and change in HCI it is rife with embarrassment potential. And although in HCI avoidance of embarrassment is a main issue, the authors also ask the question how we can 'design for embarrassment as a desired experience in art, education, or activism?' Embarrassment plays a role in abusive games [32]. In that paper five modalities of abuse are discussed with examples from existing games. They are: physical abuse (e.g. fatigue), unfair design (e.g. breaking rules of 'good practice' level design), lying to the player (e.g. pretending to delete data), aesthetic abuse (e.g. distorted perspectives), and social abuse (e.g. disrupting players' social relations). Hilarious situations can occur although not everyone will appreciate the mischievous and cruel humor that is part of the games.

4.2.3 Summarizing

In the previous section we looked at product design and user interface design. In the case of product design we have a designer who can use his or her intuition and creativity to design a humorous product, but, as should be clear from section 4.2.1, we can identify some principles that, in a very modest way, may pave the road to more explicit guidelines for designing humor. Such guidelines are not only useful for product designers, but they should give insight in humor creation whether designed, spontaneous or accidental, in general as well. That is, this knowledge can as well be used in user-created humor in smart environments and in humor models that inform sensors and actuators about desired behavior. In the case of user interface design (section 4.2.2) we looked at principles that can help to generate potentially humorous situations. Also in this case, these principles give insight in conditions that help to create humor, whether these conditions are recognized or implemented by designers, users of smart environments who want to create humor, or included in humor models that can become embedded in the sensors and actuators of a smart environment.

4.3 Humor typologies and design principles: towards a research agenda

We recall our ultimate aim. Our smart environments and cities have embedded sensors and actuators. We ourselves are equipped with smart sensor and actuator technology. It is available in our smartphones, smart watches, glasses and it will be woven in our clothes. Smart robots and tangibles in our environment can move around or can be moved. How can this technology be used to make our presence in our everyday working and living environments more humorous?

What has been said in the past about the possible ways humor can emerge in physical environments? Various humor typologies have been introduced [8, 33, 34, 35], but usually the emphasis is on different kinds of verbal humor. We discussed them in [36], here we just mention the physical humor categories mentioned by Berger [34]. They are: deficiency in an object or person, one thing/situation seeming to be another, coincidence in things/situations, incongruous juxtaposition, and presence of things in inappropriate situations. Clearly, when discussing in the previous sections humorous products and humorous situations that can arise from interactions with digital technology we saw already examples that fit in these categories. When designing humor in physical environments we or rather the environment itself can choose a category depending on the real-time situation and try to create a humorous or potentially humorous event with the available smart technology. Trying to create a humorous event then requires looking at possible incongruities that can be introduced. We, or the environment, can have a possible function of the humor in mind. Moreover, we can take into account a cognitive, relief or superiority point of view that can modify the kind of incongruities we want or can introduce.

As noted, existing typologies do not take into account digital technology. Therefore, research questions for the future are:

- How can we more easily realize the events and behavior that fits in these categories with the help of digital technology? Can we introduce new events and behavior that will cause comic amusement but that are not yet present in these typologies?
- How can we realize or enhance the incongruities that underlie many of these events and behaviors using digital technology and can we think of new incongruities realizable with digital technology? Can we use augmented reality techniques to introduce incongruities? What about artificial taste sensors and digital scent technology?

We also need to investigate the roles of the participants in the humor creation processes.

- Designers can provide us with humorous products and with humorous interfaces. This humor is ‘canned’, built-in. Designers can also provide interfaces that require interactions that can lead to humorous situations. Humor is not guaranteed, and it is not the aim of the application, but there is a high chance that it will occur.
- Designers can provide users of smart environments with tools to reconfigure embedded sensors, actuators and microprocessors in ways that can lead to humorous events. Spontaneous creation of humor in a smart environment requires that it can be done in real-time.
- The smart environment can predict or suggest to users humorous events. In the former case the environment can try to implement this humorous event by re-programming its sensors and actuators. In the latter case the environment can suggest the user to make such changes. See also [37].

5. Conclusions

In this paper we surveyed the literature on topics that are potentially related to the creation of humor in digitally enhanced physical environments. We looked at humor theories and the functions of humor. When we look at humor in smart environments we need to investigate the impact of smart technology on these functions. There is not much research on creating humor, let alone humor creation using digital technology. However, the design of humorous products (not including digital technology) has extensively been discussed in the literature and we survey the main results that have been obtained in the hope that we can learn from them in order to be able to introduce design considerations for humorous events in smart environments. For the same reason we have discussed interface research that aims at introducing user interfaces that act in unforeseen ways and in ways that surprise or embarrass users. Design guidelines for humor creation cannot yet be given. However, by distinguishing the various ways environments, designers and users can create humor or can be confronted with accidental humor, we can make a first step towards such guidelines. In future research we hope to introduce more examples of digital humor creation in order to recognize similarities that can help to obtain design principles. Our aim is to introduce humorous events, whether it is by designers, users, or smart technology in smart environments and use humor to make cities more playful [38, 39, 40].

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