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Empowering Users through Design

Interdisciplinary Studies and Combined Approaches for Technological Products and Services

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Chapter 8
(Mis)behavioral Objects

Empowerment of Users Versus Empowerment of Objects

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Abstract While the movement toward granting ever more power to users is very real, can we understand it not from the viewpoint of humans, but that of the objects? How can we design the empowerment of both users and objects, but starting from the objects? Could the object then change its status and become a subject, or at least an agent? With that as our starting position, we pose the hypothesis, theoretical and

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practical, that in order to engage with such prospects, the objects in question must be endowed with behaviors. And rather than resorting to types of expression related to the morphology or dressing of the objects, we want to focus on the expressive capacity of movement, on the objects' power to act as embodied fundamentally by movement, by actions that give shape to what would then be possible to describe as "behaviors". Our approach is first and foremost a matter of art and design, while entertaining a dialogue between two other disciplines: robotics, to put into practice our reflection, and cognitive science, to better understand and prepare this new form of interaction "object-human" that we are seeking. More specifically we are looking to develop objects that misbehave, as a way for these objects to go against the function they have been designed for, and thus develop a certain subjectivity that could enable an affective relationship that is valid for itself. From a state of knowledge in art and design, and from an analysis of behaviour from the point of view of action perception, we propose a design space based on the behaviours produced and the interpretations they elicit in terms of mental states. This conceptual apparatus is put into practice through workshops during which we propose a form of collective experimentation, with the help of our modular robotics toolkit *MisB* KIT, open-source and accessible both to non-programmer practitioners and to developers. Following a first series of workshops, in particular the one held at TEI 2014 conference, along with the Tangible Media group from the MIT Medialab, we draw some conclusions and discuss some new perspectives regarding the development of (mis)behavioral objects.

8.1 Introduction

At a time when users, and even consumers, are increasingly involved in the production cycle of products and services, what is the situation for objects? While the movement toward granting ever more power to users is very real, can we understand it not from the viewpoint of humans, and in particular of users, but that of the objects, relative to their power to act, their "agency"? How can we design the empowerment of both users and objects, but starting from the objects, and on which purpose? Might the empowerment of objects contribute to questioning our relationship to them, as well as the very meaning of their production? How do we experience that reversal of perspectives in attempting to perceive the world through the "eyes" and the "sensibility" of objects? Could the object then change its status and become a subject, or at least an agent? Admittedly, objects, from the logic of usage, have an ability to make us do things, presenting themselves as means for completing tasks—with them and thanks to them. But aside from that utilitarian nature, how can an object establish a relationship that is valid first for itself, an experience made possible by an "object-human" dialogue of which the object is the initiator? And if the object could initiate a relationship more emotional than practical, how could that relationship be maintained and repeated without losing its relevance?

While this thinking applies to many fields and disciplines, so invasive has been the interactive dimension in every sphere of our lives, our approach is primarily one of art and design in dialogue with two other disciplines: robotics, to put our ideas to the practical test, and the cognitive sciences, to better understand and prepare for this new form of "object-human" relationship we are pursuing.

With that as our starting position, we pose the hypothesis, theoretical and practical, that in order to engage with such prospects, the objects in question must be endowed with behaviors. And rather than resorting to types of expression related to the morphology or dressing of the objects, we want to focus on the expressive capacity of movement, on the objects' power to act as embodied fundamentally by movement, by actions that give shape to what would then be possible to describe as "behaviors".

Throughout the 20th century, domestic robotics has evolved within an imaginative universe largely dominated by anthropomorphism and zoomorphism, pursuing a master-servant relationship that claims to help empower the user. Yet robots have failed to find a legitimate place within our habitat. We are working from the assumption that this is largely due to the uncanny feeling they tend to elicit. We are interested in exploring a plausible alternative. We hypothesize that endowing objects with behaviors (or misbehaviors) is a route to facilitating the acceptance of robotic objects that is worthy of investigation. If animated objects had autonomous behaviors, they could create a new perspective on our everyday life, and we could contribute to a shift from a master-servant relationship towards a sort of social contract between the user and the object. But how can we facilitate the design of an expressive behavior, with fairly rudimentary technologies and a crude artificial intelligence? How can we endow a non-figurative object with something that can be construed as a genuine behavior?

In our efforts to provide answers to these theoretical as well as practical questions, we are developing an interdisciplinary research that is leading us to adopt empirical and reflexive approaches—simultaneously or alternately—supported by theoretical work. That technique seeks to advance our practice as well as the associated theoretical understanding. It is part of the current international dynamic of developing practice-based research in art and design.

While this text has neither the vocation nor the ambition to develop a methodological model for practice-based research in art and design, we shall nonetheless briefly summarize how we organized the multiplicity of our approaches. That organization also determined the outline of this text.

As in any research project, we must consider the scope of references and state of knowledge that will allow us to better position our project and to support it. We must do so within the various disciplines we refer to, but first in our fields of reference in art and design. That will therefore constitute the first part of this essay. Taking a pragmatic approach, we use as our foundation the current state of knowledge in the cognitive sciences, and in particular the psychology of action, trying to transform it into a set of criteria upon which to base the development of our practical experiments. In turn, the observation and analysis of those experiments help consolidate and develop that set of criteria, the constraints and perspectives that provide us with a context for work and experimentation, a "design space". The second and third sections of our text are dedicated to that two-directional exchange involved in developing a "design space". We understand "design space" to mean a set of constraints considered relevant for the tool offered to designers, those constraints being organized to stimulate creativity.

At the intersection of practical and theoretical approaches, this design space is also measured in terms of the concrete possibilities it creates. How to create the conditions—conceptual, of course, but also practical—for producing experiments and, consecutively, artifacts relevant to art and/or design, for our research subject: behavioral objects? The design space is therefore associated with an instrumental approach aiming to provide us with—and, if necessary, to produce—a set of practical tools that can satisfy our creative ambitions. That is why we are developing a hardware and software toolkit—*MisB* KIT[1]—of modular robotics that are open-source and accessible both to non-programmer practitioners and to developers. The presentation of that instrumental approach and of the toolkit is the subject of our fourth section.

Finally, to test the practical and conceptual conditions we have set out, we are creating possibilities for experiments, most often collective—and, when possible, public—in the form of "workshops". These then become fields of observation that enrich our thinking both for our design space and, more broadly, for our theories that aim, first and foremost, to revive and enrich our practices in art and in design (Fig. 8.1).

In the fifth section of our text we present a workshop that was particularly stimulating for our work: *The Misbehavior of Animated Objects*, held in February 2014 in Munich,[2] in dialog with the Tangible Media Group at the MIT Media Lab, and in particular with its founder and director, Hiroshi Ishii. The experience of that workshop clarified an issue and some hypotheses (a why and a how), in particular from a design standpoint: how does the empowerment of objects contribute to

[1] The *MisB* Toolkit was developed by the *Reflective Interaction* team, under the direction of Samuel Bianchini, by Didier Bouchon, Cécile Bucher, Martin Gautron, Benoît Verjat, and Alexandre Saunier, in the context of the project *The Behavior of Things*, coordinated by Emanuele Quinz on behalf of Labex Arts-H2H. All elements of the *MisB* KIT, hardware and software, are under an LGPL license, with the exception of the proprietary Bioloid modules, principally the Dynamixels motors, and parts from the K'Nex construction game, used here as structural elements. This toolkit was initiated with the *Sociable Media* team (led by Rémy Bourganel) with Émeline Brulé and Max Mollon in particular, for the workshop "The Misbehavior of Animated Objects", TEI 2014, with support from Labex Arts-H2H and the Bettencourt Schueller Foundation and its Chair for Innovation & Expertise, and with the participation of Jean-Baptiste Labrune and Nicolas Nova. We are grateful to Génération Robots for their sensible advice, as well as to Marie Descourtieux, Hiroshi Ishii, Emmanuel Mahé, and Élodie Tincq. For more information, URL, July 9, 2014: http://diip.ensadlab.fr/fr/projets/article/the-misb-kit.

[2] 8th International Conference on Tangible, Embedded and Embodied Interaction (TEI 2014). February 2014, Munich. URL, July 9, 2014: http://www.tei-conf.org/14/studios.php#s9.

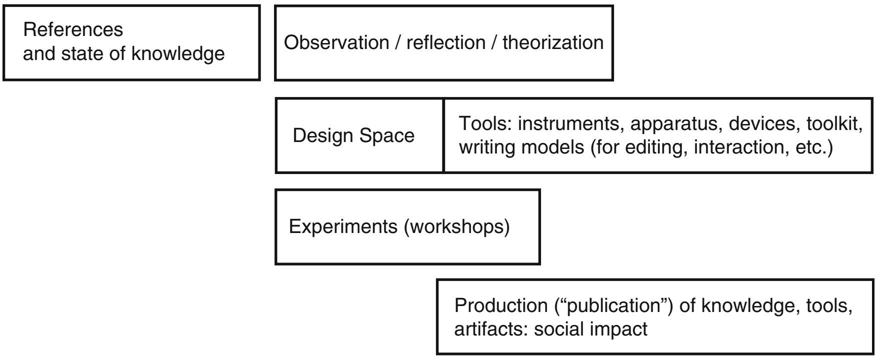

Fig. 8.1 Behavioral objects: organization of work for practice-based research in Art and Design

questioning the relationship we maintain with them and the meaning of their production? We hypothesize that behavior, and specifically misbehavior, offers two avenues for exploration: 1. The moralizing behavior of the object tends to question us as users and to make our own behavior change toward a new reflexive form of empowerment of the user. 2. The behavior of the object, which is imperfect, creates empathy and affect, maintaining interest in it and prolonging the relationship or even our use of it.

8.2 Behavioral Objects: References and Perspectives in Art and Design

There is a tradition of behavioral objects in art. Robert Breer’s *Floats* (1970), the nearly animal robot by Edward Ihnatowicz (*The Senster* 1970), Jeppe Hein’s ball of granite (360° *Presence* 2002), the closed but moving simulator by Fabien Giraud and Raphaël Siboni (*The Outland* 2009) are examples of animated objects for which it is difficult to grasp what accounts for their movements (Fig. 8.2).

In art, parallel to the better-known tradition of anthropomorphic or zoomorphic animated objects—automatons, the tradition of which dates back to Hero of Alexandria—there exists an alternative genealogy at the margins of science and design: abstract objects with basic, minimal forms (such as cubes or spheres), or even daily objects (such as tables, chairs, etc.) endowed with movement. By their shape, but above all through their actions that evoke behaviors, such objects remain fundamentally enigmatic: the projection of intentionality they inspire is always biased by doubt. By creating an interruption between animate and inanimate, between organic and inorganic, between artificial and living, between human and non-human, they are both real and fantastical, they fascinate and unsettle at the same time. The psychological projection that such objects provoke is essential to defining them: they are objects we think of as subjects.

Fig. 8.2 Robert Breer, *Float*, 1970–2000—Fond régional d'art contemporain (Frac) Franche-Comté Collection. *Robert Breer* Exbition view, Frac Franche-Comté, Besançon, 2007 (*courtesy* gb agency, Paris; *photo* C. H. Bernardot)

We must look back to the early 20th century, to the experimental proliferation of the avant-gardes, to find the first examples of moving objects, the first kinetic sculptures. But it was in the 1950s that the first dysfunctional machines were produced, no longer as examples of the functionalist myth of the industrial revolution, but as instruments critical of that very myth: from Bruno Munari's *Macchine inutili* (1953) to Jean Tinguely's immense self-destructive mechanism, *Homage to New York (1960)*. At that time, art was crossing paths with research in cybernetics, which was then developing computer programming, robotics, and artificial intelligence: in that domain, the notion of behavior played a central role in the definition of the relationship between human and machine. Cybernetics, like the philosophical stage, develops—in the words of Andrew Pickering—"*an ontological theater between human and non-human.*" (Pickering 2009) As a result, interest in behavioral machines began to spread, as illustrated by many iconic exhibitions: *Men, Machine, Motion* (curated by Richard Hamilton—Independent Group, London, ICA, 1955), *The Machine as Seen at the End of the Mechanical Age* (curated by Pontus Hulten, New York, MoMA, 1968), *Cybernetic Serendipity* (curated by Jasia Reichardt, London, ICA, 1968), *Software* (curated by Jack Burnham, New York, Jewish Museum, 1970).[3]

[3] A selection of works from those exhibitions was shown recently in *Ghost in the Machine* (curated by Massimiliano Gioni, New York, New Museum, 2012), which demonstrates the renewed interest in the mythology of the machine.

The concept of the “bachelor machine”, invented by Duchamp in the 1910s, was at the heart of Harald Szeemann’s exhibition of the same name (*The Bachelor Machines*, Kunsthalle Berne, Biennale di Venezia, etc., 1975) that reconstructed a parallel history of the machine, not of high-performance machines, but of useless, parasitic, disturbing ones, by way of Kafka, Roussel, and Jarry. Even if they cannot function in reality, bachelor machines produce, as Szeemann said, “*a genuine movement in the imagination.*” (Szeemann 1975)

Those exhibitions constitute a repertory of images and projects that question the projections autonomous objects arouse in the imagination—from allegory to myth, by way of fantasy.

In analyzing the fantastical projection dimension that animated objects conjure up, Jean Baudrillard, in *The System of Objects*, wrote: “*To the collusion of form and function is substituted a symbolism that is no longer that of primary functions, but of superstructural functions: man no longer projects his gestures, his energy, his needs, the image of his body onto automated objects, but the autonomy of his conscience, his power to control, his very individuality, the idea of his person.*” (Baudrillard 1968)

In Baudrillard’s system of objects, this automated object, embodied by the robot, occupies a special position surrounded by an aura of fascination—like a mythical figure that unites absolute functionalism and absolute anthropomorphism. In its triumphalism, the myth of the robot—which is superimposed upon the myth of the machine—turns out to be disturbing and ambiguous through its mimesis, and summons again the romantic figure of the double, which is always a source of anxiety, of the uncanny (Das Unheimliche) identified by Freud when he discussed, in point of fact, an almost-perfect, and therefore almost-human, automaton.

If we adopt a functionalist perspective, the robot indeed embodies the ideal object because, as Baudrillard again explains using the conceptual matrixes of the era, it actually embodies the slave. It has every human quality—with the single exception of sexuality (the machine is always a bachelor)—but is entirely in the service of man. However, alongside positive (and positivist) images, we see a multiplication of threatening fictions and figures: the subjectivity that haunts autonomous objects can turn to subversion, to revolt, and to destruction. It is a recurring theme in science fiction that also feeds artistic experimentation: in the 1960s, images of rebellious machines emerged to counterbalance the triumphalism of a socio-economic system of production, opposing instead a system of psychological projection.

Today it is more a system of communication and information, of generalized interactivity, that is infiltrated and questioned by behavioral objects. Their agency once again makes them disturbing, vaguely threatening.

Worried and worrying, like the hysterical robots presented in *Technological Dreams* (2007) by English designers Anthony Dunne and Fiona Raby: not high-performance robots, but pathological ones—like the strange funnel system that cries desperately when you go near it. In Dunne and Raby’s vision, these strange objects are pretexts for stimulating debate about a possible future, for

Fig. 8.3 Anthony Dunne and Fiona Raby, *Technological Dreams Series: No.* 1, Robots, 2007. *Robot 3*: *Sentinel* (*Photo* Per Tingleff)

"dramatizing" our interactions with machines, "*in order to make visible the dark side of their psychological impact*." (Dunne and Raby 2001)

To that end, the posture that Dunne and Raby defined as *Critical Design* (an attitude that, in reality, dates back to the radical Italian design of the 1960s, and even further: Dunne 2005; Dunne and Raby 2013)—namely a conceptual design that borrows the instruments of art and cinema—uses fictional and narrative universes, and presents more than just objects. There are also behaviors and a whole repertoire of transgressive uses, abuses, and diversions. The goal of such design is to criticize the values conveyed by industry and authorities. And in that context, the behavioral object—by nature dysfunctional and subversive—is endowed with a critical mission, that of provoking doubt, a discrepancy, or a state of consciousness (Fig. 8.3).

8.3 How to Define Behavior, How to Design a Misbehavioral

To include our approach in these non-functionalist—indeed dysfunctional—artistic approaches, we have chosen to work primarily on misbehavioral objects, whose action serves primarily to assert personality rather than to serve some productive efficiency. But how, then, to define and implement such misbehavior in an object?

To insure that a robotic object demonstrates misbehavior, it first must demonstrate any behavior. Ideally, one needs to know what a behavior is and the properties that exemplify it in an organism; then to endow a robot with those properties; and finally to see to it that they are deviated or frustrated so that the robotized object engages in misbehavior. The difficulty is that it is not easy to know, a priori, what a behavior is and what the properties are that demonstrate it. As Levitis et al. (2009) indicate, though the notion of behavior is intuitive, it is difficult to create a definition that does justice to the advances in behavioral biology over the last 50 years. We could say, somewhat laconically, that behavior is everything observable when external stimuli trigger responses from the organism. Certain authors do not go much further: "*behavior is the observable activity of an organism; anything that an organism does that involves action and/or response to stimulation*" (Wallace et al. 1991); or "*behavior is the externally visible activity of an animal, in which a coordinated pattern of sensory, motor and associated neural activity responds to changing external or internal conditions*." (Beck et al. 1991) Through these two definitions we see that the notion of behavior implies a certain level of integration of sensory information to produce a response. In addition, that response is something observable, something that can be noted, and it is most often identified as a motor response. Such a simple definition, however, excludes many organisms and activities about which it would be interesting to enquire if they show behavior. Like the notion of failure, of difficulty performing, of dysfunctioning, the concept of misbehavior seems to broaden the definition of behavior to borderline cases that could enrich it. Does the fact of an animal (to say nothing of plants) doing nothing constitute a behavior? Should actions that do not succeed be considered in the same way as those that do succeed? And what about misconduct, the fact of intentionally doing wrong?

The formal definition of behavior is dependant upon the mutations of the science that studies it, recording its advances and limitations, and is therefore constantly being adjusted, which could make using it difficult when it comes to bestowing a behavior upon a robotized object. Another approach is to take an interest in the intuitions of observers about what constitutes a behavior. In that case, behavior would be the ensemble of visible transformations that generate an impression of behavior in the observer. The apparent circularity of that definition can be avoided by targeting more precise attributions, asking, for example, if the object seems to be moving in relation to a goal it is pursuing, or to what extent it appears to control its actions. It is then possible to make connections between the parameters of transformation and their impact on the interpretations that they give rise to in the observer. This tactic corresponds to the study of the perception of action. That domain of the cognitive sciences studies the intuitions of human observers about the movement produced by a living creature (Scholl and Tremoulet 2000), attempting to define the systems of cognitive analysis that allow the human observer, on the basis of spontaneously produced inferences, to go beyond what is directly observable and to return to the source of visible behavior through the beliefs, intentions, and personality traits that the movement seems to demonstrate (Heider and Simmel 1944; Gergely et al. 1995; Luo and Baillargeon 2005).

8.4 Toward a Misbehavioral Objects Design Space

To empower objects, we need to explore the design of interactions from the object's point of view. We need to imagine objects with a certain autonomy, able to initiate interaction with the user and even to engage in misbehaviors in order to claim their own share of individuality. In order to develop a toolkit for designers, we have been exploring the different ways a (mis)behavioral object could promote interaction with humans, and how the little quirks in its behavior could nurture a relationship with the user. Ultimately, we have to address the sustainability of the perception of its misbehavior over time, rather than as a one-off experience.

The concept of misbehavior can have a weak meaning and a strong meaning. In the weak sense, it corresponds to what we don't expect, to what causes surprise. When a robot vacuum cleaner suddenly starts spinning in place, without managing to move forward, its behavior is not what we expect from it; it behaves badly in the sense that it is not accomplishing its function (which is to roam around the room to clean it), but also in the sense that this dysfunctioning, perhaps only temporary, creates an interruption of routine, of the normal course of things. In the strong sense, the misbehavior has to do with the social value of the behavior. In certain circumstances, the misbehavior corresponds to a desire to do wrong, to violate certain social rules. Our robot vacuum cleaner, that we are now presuming to be endowed with free will, takes pleasure in rolling between the legs of guests, throwing them off balance. Its behavior is dysfunctional, but unlike in the first example, that dysfunctioning is not accidental, it is the manifestation of a (bad) intention. We see here that the misbehavior has very different meanings depending on the more or less intentional value we attribute to it. Many nuances are possible depending on the agent's level of awareness of the social or moral rules it is violating, or the consequences of those actions. For example, someone can behave badly without intending to do harm; his action is voluntary, but the damage it causes is not.

To instill misbehavior in an object, we are proposing an initial design space including three features: character, intention, movement (Fig. 8.4).

To design an object that demonstrates personality through the way it behaves, we assume that the designer will begin by imagining a personality trait or mood, will wonder what intention or motivation reflects that character trait, and finally will

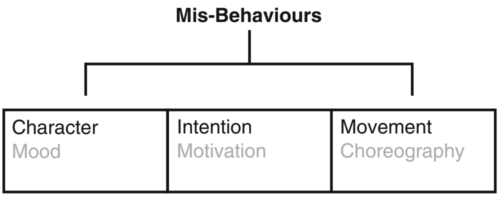

Fig. 8.4 Character, intention and movement: a part of our design space to develop misbehavioral objects

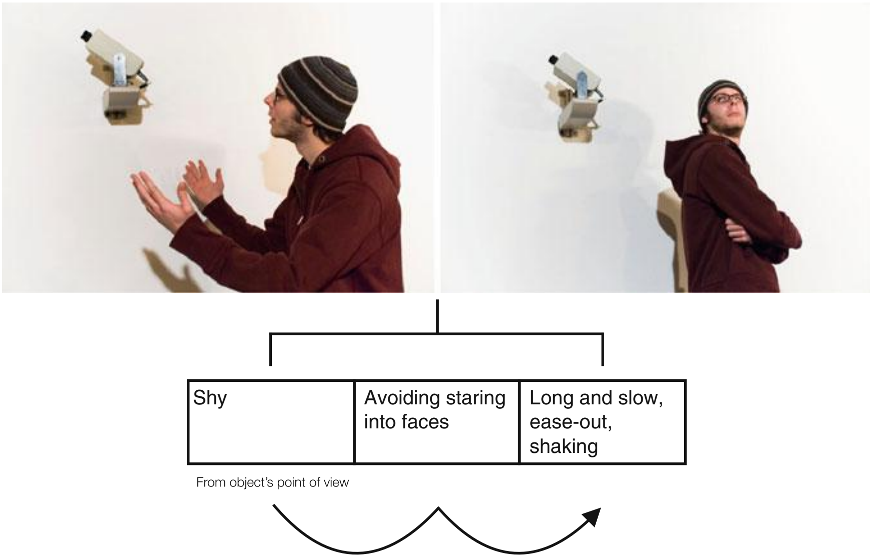

Fig. 8.5 From the object point of view, the trajectory from a personality trait to an intention that reflects this personality, which in turn defines some observable characteristics

define the observable characteristics of the behavior that best express that intention. From the observer's point of view, the path is reversed: the first observable element is the behavior, the way the object moves; from that behavior it will be possible to infer an intention, and then to construct a representation of the object's personality.

The work of Silvia Ruzanka, Ben Chang, and Dmitry Strakovsky (created in 2003) illustrates these three characteristics. The *Insecurity Camera*, instead of tracking visitors, systematically avoids their eyes when they approach it (Figs. 8.5 and 8.6). The behavior observable by the visitors is the action of always turning away when someone approaches, and based on that behavior, the visitor can deduce that the camera is trying to avoid the visitor's eyes, and in the end the personality trait that emerges is shyness.

This framework provides a design guide, but also serves to verify that the designer's intentions coincide with the way the object's behavior is perceived. To go more into detail about the psychological interpretations underlying the comprehension of the robotized object's behavior, it is possible to distinguish three levels of complexity. Those three levels represent the way we spontaneously interpret a perceived behavior and how much sophistication we are ready to ascribe to an object engaged in a behavior (Fig. 8.7).

To determine whether a behavioral artifact possesses certain psychological characteristics, we can ask the following three questions: Is it alive? Does it have intentions? Can it interact socially with other agents? Seeing an object as alive suggests that its behavior cannot be reduced to external causes and that we perceive the object as having a certain autonomy with respect to its environment. Adding an

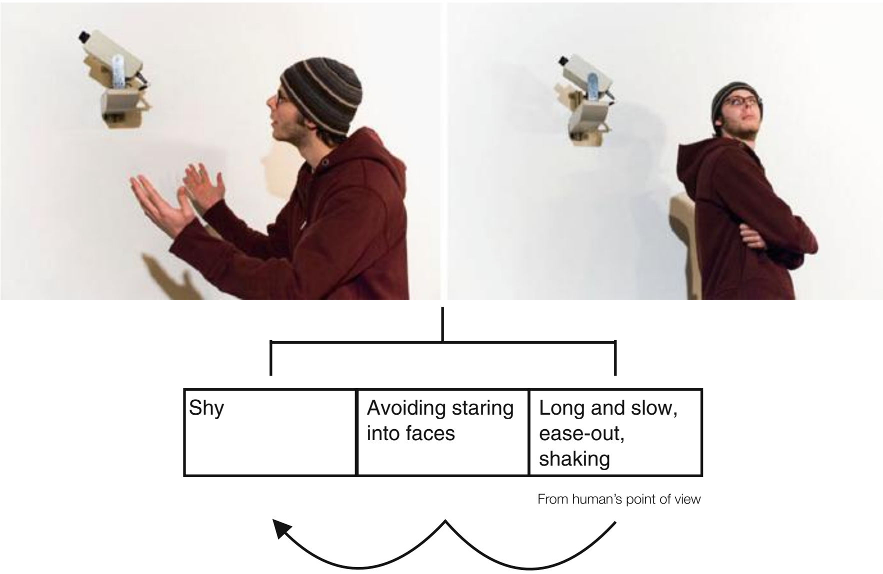

Fig. 8.6 From the human point of view, the observed behavior gives some insights about the object's intention, which may lead to infer a stable personality trait

Agent's psychological categories	Agent's personality traits
Social Agency / Can the agent socially interact? > behaves in coordination with other agents' behaviour. > diplays attitude with respect to other agents it may try to communicate with.	aloof, mischievous, authoritative …
Agency / Does the agent have an intention? > adjusts its behavior with respect to a goal and environmental constraints. > has a certain level of flexibility and may organise its behaviour rationally.	curious, shy, awkward …
Alive / Is the agent alive? > has a certain propensity to initiate and change its movement spontaneously. > is either attracted or tends to avoid certain properties of the environment.	???

complexity

Fig. 8.7 How much complexity are you ready to ascribe to a behavioral object? We describe here the properties associated to three different levels of complexity, as well as some examples of personality traits that might be attributed to an object based on the way it behaves

intentional component to its behavior implies that we perceive the behavior as directed toward the realization of some specific actions that we can evaluate based on our own naive psychology. Finally, an object identified as having intentional properties may also be able to engage in social interactions. At this level, an agent is not only seen as related to the properties of the environment it can perceive, but also to the values of a social context.

Certain personality traits corresponding to those three categories will emerge depending on the behavioral cues we can gather from the way the object moves and interacts with its surroundings. While it may be difficult to ascribe personality traits to an object that is merely seen as alive, some psychological dimensions are automatically related to the way an object behaves intentionally, how motivated it looks or how effective it is in the accomplishment of an action. At the social level, additional psychological components emerge related to the proficiency with which an agent interacts socially, or to its propensity to engage in positively or negatively valued behaviors.

Whether an object is perceived as engaged in misbehavior will depend on the level at which the observer locates the object in terms of psychological complexity. This is why, in order to elicit the proper interpretation and emotion, the designer has to keep in mind how elaborate the object's behavior should seem, and which behavioral cues are most relevant to achieving that.

8.5 New Criteria for Enriching Our Methods of Observation and Our Design Space

Starting from the idea that, to bring about a misbehavior, an observer must be able to recognize the traces of a behavior in the transformations manifested by the robotized object, we have elaborated behavioral criteria. Those criteria can both guide the implementation of movements significant in terms of a robot's action and to provide objective elements for evaluating the implemented behavior. We have therefore created eight evaluation scales (Fig. 8.8) to capture certain attributes critical in the psychological elaboration of a behavior. We are seeking to evaluate to what extent the movement of the robot appears controlled and to what extent it is in

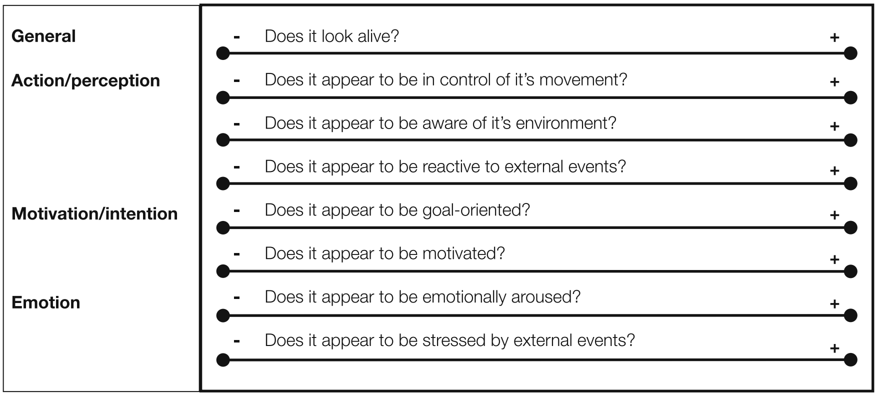

Fig. 8.8 The eight evaluation scales we devised to evaluate and guide the process of behavior interpretation

reaction to its environment (Action/Perception). We want to know if the robot's movement gives the impression of being directed by goals, by the intention of completing an action (Intention/Motivation). Finally, we want to determine if the perceived behavior of the robot has emotional valence (Emotion). These parameters do not in themselves define a misbehavior, but they allow for sufficient structuration of the transformations manifested by the robot so that these can be considered to be misbehavior. So, for example, to give the impression that a robot is reluctant to perform a task, the robot must have already demonstrated the ability to perform the task, whatever it may be, and its behavior must be sufficiently organized and directed for the observer to recognize the specific intention not to perform an action.

Here is a detailed description of the various criteria used to guide the implementation of the behavior and to evaluate its interpretation:

Does it look alive?
This very general parameter is used to verify if the movements and/or transformations manifested by the artifact give the impression of a living entity or of a mechanical entity.

***Action/Perception**

Does it appear to be in control of its movements?

This parameter may be the simplest to the extent that it can be evaluated independently of the context in which the robot may be found. It is related to the general appearance of the robot's movements. Do changes in its movement occur completely randomly, or are they organized in time and space? Maintaining a trajectory and a given speed over a significant period of time gives the impression of control over movement, whereas erratic movement leaves one to believe that the robot cannot withstand certain impulses.

Does it appear to be aware of its environment?

This parameter relates both to the characteristics of movement and to the possibilities of relating movement to elements in the robot's immediate environment. Does the robot take certain environmental limitations into account as it adjusts its behavior? For example, is it able to avoid certain obstacles? A positive answer indicates that the robot possesses some perceptual abilities, whereas a negative answer implies that the robot is not sensitive to its environment, or in any case that it does not possess the capacity to translate the sensory stimulation it receives into coordinated movements.

Does it appear to be reactive to external events?

Compared to the previous parameter, this one indicates the quality of the reaction to specific events in the environment. Does the robot react rapidly to a change in its environment, or is it slow to produce an appropriate response? Depending on the speed and intensity of the response to an event, the robot will seem lively, quick to react to the slightest signal, or on the contrary will seem indifferent to what is happening around it.

***Intention/Motivation**

Does it appear to be goal-oriented?

In relation to the previous parameters, this one introduces the targeted dimension of the behavior. Do the robot's movements appear to be organized in relationship to a goal? Does it give the impression of accomplishing a goal? Based on the degree of organization of the movements, we will see a robot that seems to know more or less where it is going, what it is supposed to do, and for what purpose.

Does it appear to be motivated?

Following the previous parameter, this one measures the degree of the robot's commitment to a task that it is perceived to be accomplishing. A high score on this scale could be associated with the impression that the robot is persistent in performing a task, while a lower value could be associated with the impression that the robot is capricious.

***Emotion**

Does it appear to be emotionally aroused?

This parameter is used to assess the extent to which the behavior expresses emotional values. It is a question of whether the overall behavior of the robot indicates a given level of excitement. A robot could, for example, give the impression that it is in a hurry, that it is rushing to finish a task, or that it is moving in an irrational way, as if overcome by anger. Or the robot could appear self-controlled and moderate as it performs an action.

Does it appear to be stressed by external events?

Here we seek to highlight the quality of the robot's responses to external stimuli. Does the robot react emotionally, does it seem frightened, for example, or excited by something it has noticed in its environment? A low score on this scale could indicate that the robot seems apathetic, devoid of emotional reaction.

8.6 *MisB* Toolkit: A Prototyping Toolkit to Experiment with Behavioral Objects

If we want to put our projects to the test of reality, and to do so rapidly, so as not to be dependent on a form of linearity that would lead us from theory to action, from design to production, it is important to engage in a practical—and therefore technical—exploratory phase, to build our tools and define the most suitable experimental conditions.

We have to produce testing objects for our project in order to progressively adjust design and building methods. To organize and stimulate that approach, we have identified existing techniques that might best meet our needs. To animate objects independently, the relevant technique is primarily robotics, and more specifically modular robotics, which can be adapted to various forms and movements.

Fig. 8.9 The *MisB* KIT realized by EnsadLab to prototype behavioral objects

We identified four possibly suitable modular robotics products: Lego Mindstorms, Cubelets, Arcbotics, Bioloid. To select the technology or technologies with which to work, we decided upon a few criteria: modularity, sturdiness, hardware and software openness (open source or offering the possibility of interfacing with open source software and hardware components), ease of use, quality of components, and cost. Cubelets and Arcbotics soon proved to be inadequate: the first is very closed, and the other very fragile, ineffective, and presents major challenges for supply and support. Lego Mindstorms is very interesting, but is too closed and rooted in the toy sector, lacking the power and sturdiness needed for our projects. Bioloid, from the Korean brand Robotis, is the technology we selected because it meets most of our criteria, with one additional advantage: it allows for a change of scale, moving from playful or service robotics to industrial robotics in the same software environment. Indeed, a wide range of motors is available, all drivable with the same control board and the same software environment. From the Bioloid technology we have primarily maintained the motorization and control system: robust, precise, Dynamixel motors, easily controllable with the CM09 control board, which is powerful, open, and built like an Arduino board, perfectly compatible with auteur-oriented open-source software environments like *Processing*. In addition, the control board (CM09) is based on an open-source LeafLabs board under an MIT license, a board that Robotis modified to support its Dynamixels motors (Fig. 8.9).

Fig. 8.10 Interface of the *MisB* KIT software, developped by EnsadLab

We then combined that system with a set of building blocks we created: solid pieces and structural elements entirely covered in Velcro, making it possible to assemble models and modify the assemblages very quickly, like a kind of "high-definition" Lego. This principle is as simple as it is powerful, since it makes it possible to create prototypes in a few minutes with great freedom of action, and other materials can be associated with the base as long as they also contain Velcro. For instance, structural units taken directly from K'Nex building sets have been added to the toolkit, as has a set of shells and skins for covering our robots, dissociating them from their technical condition (motorized mechanics) and allowing them to be seen simply as objects.

Along with those choices of materials, we have developed software that provides simple but open possibilities for the design and production of behaviors. We were able to develop the software in a technical framework familiar to and mastered by our community (Art and Design), basing ourselves on the *Processing* software environment. Our software makes it possible to drive—in real time, via a basic interface (MIDI console)—the objects we have built, to record the movements, to publish them and create a library that is itself programmable. Movements prepared in that way are assigned to motors in order to be played, in a linear mode as well as in conditions relative to the data from sensors onboard the created object, which is to say interactively (Fig. 8.10).

In order to adjust the movements, they are saved as sound files (WAV), tracing the dynamics of their motorization, and are therefore publishable as such, in any existing audio software—Audacity, for example (Fig. 8.11). Once published and saved, always in the same WAV format, they can be returned to the movement library, thereby enriching it.

Like our original approach, these various levels and stages of work allow for rapid and progressive access, from the simplest (direct manipulation, the object being remote-controlled) to the most complex (programming, to allow the object to interact directly with its environment). The open-source software environment is geared to the broadest audience, making workshops possible for very different groups, from accompanied beginners to experts.

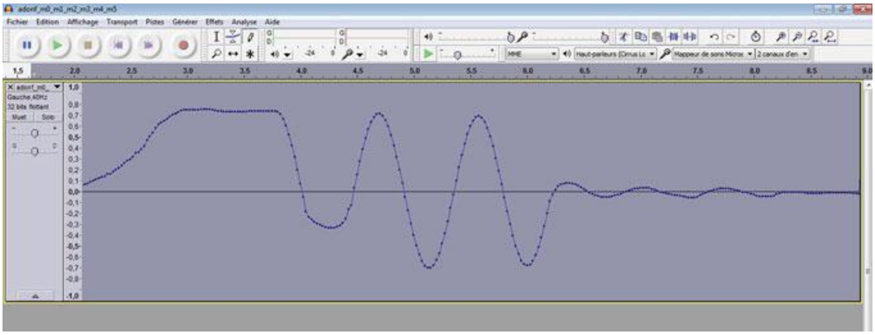

Fig. 8.11 How to edit a behavior as a sound inside the framework of the *MisB* KIT

8.7 Workshops: The Example of the Misbehavior of Animated Objects at TEI 2014

Experimentation is at the heart of our project, and it is through experimentation that we can move forward practically as well as theoretically: it allows us to test our ideas in an uncontrolled environment and with participants exterior to the project. To experiment the construction and evaluation of behavioral—and even misbehavioral—objects collectively, we are developing a series of workshops (Fig. 8.12), inaugurated by "The Misbehavior of Animated Objects"[4] at TEI 2014 (8th International Conference on Tangible, Embedded and Embodied Interaction) in February 2014, in Munich.

As at TEI, our workshops can currently be organized for a maximum of 18 participants, divided into teams of 2–3 individuals, experts and beginners. They can last from one to several days.

At TEI, seating charts had been planned ahead of time, allocating participants for a maximum of complementarity among engineers, designers, artists, and specialists in other disciplines, as well as for institutional diversity, to avoid having "colleagues" at the same table.

[4] The workshop "The Misbehavior of Animated Objects", for TEI 2014, was developed as part of the collaboration between the *Reflective Interaction* team (directed by Samuel Bianchini) and the *Sociable Media* team (directed by Rémy Bourganel), with support from Labex Arts-H2H and the Bettencourt Schueller Foundation and its Chair for Innovation & Expertise, in dialogue with the Tangible Media Group of the MIT Medialab (group founded and directed by Hiroshi Ishii) and with the participation of Jean-Baptiste Labrune and Nicolas Nova. See, URLs, July 9, 2014: http://www.tei-conf.org/14/studios.php#s9; http://misbehaviour.ensadlab.fr; http://diip.ensadlab.fr/en/article/axe-5-the-behavior-of-things.

Fig. 8.12 Workshop "The misbehavior of animated objects" organized by EnsadLab at the 8th international conference on tangible, embedded and embodied interaction, February 2014, Munich

The workshops are organized into five stages:

1. Overview of historical and relevant productions for inspiration.
2. Presentation of the creative issues at hand: how to design and make misbehavioral objects? Presentation of our design space in relation to those issues, to stimulate and compel. Introduction to our toolkit via a "live demo".
3. Begin handling the toolkit, experimenting and creating animated objects with misbehaviors in relationship to their context, including the people present. Materials to dress-up the object are also offered. Facilitators and technology experts are available for support.
4. Halfway through, each group presents its first experiments, with its results and questions as well as its process. During this phase, we invite participants to simplify, even radicalize their initial idea, then to use different materials to dress up the objects in order to distance them from their mechanical systems.
5. The last half hour is dedicated to a 3-min demo for each group, in front of all the other participants. Each demo is filmed and followed by interaction with the audience (Fig. 8.13).

As examples, we will briefly present three projects from the TEI workshop. The first is a hemisphere (Fig. 8.14), initially positioned on its rounded side, where it rocks, picks up speed, seems to want to move, even to turn over, which it succeeds in doing after a time. So then it finds itself on its flat side, unable to move, though it still tries. The flipping over was described by the young researchers as a radical

Fig. 8.13 Workshop "The misbehavior of animated objects" organized by EnsadLab at the 8th international conference on tangible, embedded and embodied interaction, February 2014, Munich

Fig. 8.14 Demo of behavioral objects at the end of the Workshop "The misbehavior of animated objects" organized by EnsadLab at the 8th international conference on tangible, embedded and embodied interaction, February 2014, Munich

action (suicide was even mentioned), aiming at a violent change in the ability to move and therefore in behavior, and aiming also at provoking a kind of empathy among those watching it and who are able to help it.

A second project uses an object from daily life, a small reusable fabric bag (Fig. 8.14), like those given away during eco-themed promotions. But the bag is upside down, it is full, and it moves. When we move towards it, perhaps to pick it up, it tries to catch us, and closes in on itself. In its form, this object eludes our initial restrictions (neither anthropomorphism nor zoomorphism), as did several ideas, by giving it an amplified zoomorphic appearance via a behavior that implies a mouth when the bag closes.

The third object reproduces an everyday object: a garbage can (Fig. 8.14). As soon as we move closer to take off its cover, it turns around, blocking any access to its opening and therefore keeping us from putting anything in it. The participants presented it as an eco garbage can that questions the very act of throwing away.

In addition to the work stages outlined above, we asked participants at the beginning and at the end of the TEI workshop to write down their definition of misbehavior in an object. Definitions seem to settle on four dimensions: 'unexpected behavior', 'socially unacceptable behavior', 'surprising/poetic' (only one vote), 'doing differently, intentionally, with an unexpected goal', aiming specifically (as in the garbage can example) at changing the behavior of the audience.

The first case presented above (the hemisphere) is a good illustration of that last definition since the ambition is to provoke empathy in the viewer for the object in difficulty. The same is true for the last example (the garbage can) that attempts to question us about our consumerist behavior. The example of the bag that becomes an aggressive animal responds to the first definition more directly, and the second one in part. The 4 definitions are of interest, but "doing differently with a goal" is particularly promising due to its aptitude to transform the public when it is confronted with an object having adopted such a way of being. An experiment like that one also seems more reproducible, capable of maintaining a sustainable relationship by being both coherent and unpredictable, displaying autonomy, motivation, and a form of irrationality.

Based on these first experiments and analyses, we think misbehavior can be explored along two main axes, each offering an alternative to a purely utilitarian relationship: (1) objects whose behavior (possibly moralizing) tends to question users about their own behavior and thus induce a change of attitude, thereby creating a new form of empowerment for users; (2) imperfect, clumsy, perhaps handicapped objects that arouse empathy, able thereby to create a stimulating affect and to hold our interest. These two approaches point to an answer, from a design point of view, about how the misbehavior of objects could stimulate a renewed form of habitability in the world: the empowerment of the object can bring about a favorable subject-subject relationship from either a moral or an empathic point of view.

That workshop provided an opportunity to test an initial framework for structuring our design space (character/intention/movement). While it proves robust when output is evaluated, some participants did not follow the model, starting rather from an exploration of movement, trying it out and then rationalizing it afterwards, a posteriori, in line with our model. The model nonetheless made it possible to quickly test if the project's conception is structured and consistent with our expectations. The 3-level organization of our first design space—from the most basic form (the demonstration that the object appears to be alive) towards agency and then social agency—made it possible to profitably limit the expectations of the workshop by focusing on the first level: trying to "give life" by simulating misbehavior. In light of the results, that first design space provides a foundation that encourages us to continue. The second and, even more so, the third level of our design space presents a complexity that seemed difficult to address in the context of such a workshop with the toolkit as it was then. But the fact of having defined the three levels, and, more broadly, of offering a first design space for our toolkit allowed us to raise several essential questions that encourage us to conclude with new perspectives for research and creation.

8.8 Conclusion

The goal of our project is to address the subject of (mis)behavioral objects by bringing together several points of view and methods, in order to balance reflection and practical engagement. Our historical approach, taking the current situation into account, therefore aims to position us and to clarify our subject in relation to what already exists. The contribution of the cognitive sciences takes advantage of those existing elements by studying the most convincing cases.[5] At the same time, based on the analysis of those cases, of our practical intentions, and of their testing through experimentation, researchers in the cognitive sciences can propose models to guide our analysis and design, as for our first attempts at the design space.

From the very first implementations, models are tested in experiments, and then give rise—after observation and analysis using an iterative methodology—to adjustments and to new implementations. Starting this way from the first models, we will progressively adjust our design space as well as our toolkit. However, we are aware that this attempt at modeling must primarily constitute a foundation for design, but definitely not a simplistic grid that would only validate projects able to conform to it.

It is clear that the tools developed (the design space and the toolkit) are conceived generatively, in the sense that their vocation is to inspire creation through practice. If reflection and hands-on participation are to be combined, it is above all to stimulate creativity and not at all to restrict or inhibit it.

After these first steps through which we developed the project using different approaches, we are confronted with many questions that should have an impact on the way we adjust our research in practice and in theory. Among these, we retain one that took form during our exchanges with Hiroshi Ishii during preparation for our TEI workshop: if an object could include the ability to demonstrate

[5] We recently organized an in situ study, meaning in the exhibition itself, of Céleste Boursier-Mougenot's work *Off Road* (2013), when it was shown in the spring of 2014 at the Abattoirs, musée d'art contemporain de Toulouse. The study aiming to establish the "psychological profile" of this behavioral work, based on the perceptions of the public, is being carried out by Florent Levillain, under the direction of Elisabetta Zibetti in the context of the research project *The Behavior of Things*, and in collaboration with sociologist Naoko Abe (as part of his post-doc with the Gepetto Team at the LAAS-CNRS, Toulouse).

misbehaviors, how to make certain that these remain unexpected, since once we understand their motivations, and the way they are manifested, those behaviors no longer seem unexpected and provocative? How to preserve an unpredictable character that would qualify the misbehaviors over time? Several strategies are possible; the main one is certainly to be found in the programming of robotized objects, thereby joining in the pursuit of "artificial intelligence" and its many endeavors that consist of providing adaptive—and perhaps emergent—abilities to objects controlled by programs.

If we must inevitably have recourse to some of the results of that research, we do not wish to—and cannot—set ourselves up in competition with it. Instead, we want to try to find other solutions more in line with the "DIY" spirit present in the development of our toolkit. So rather than contributing the indeterminate through a software angle, it is to the materials side that we are now looking. How to integrate materials that produce actions, reactions, and unpredictable movements? Because as soon as one adds materials to variable physical "behaviors" (including ordinary materials such as rubber, for example), then the whole of the object's movement will be transformed if the material is skillfully employed. Incorporating that form of open-ended plasticity, the object will necessarily react with movements as unexpected as they are uncontrollable. Of course, beyond the implementation of that plasticity, we could consider—once again from a more technological point of view—integrating materials with open but reactive behaviors, meaning whose reactions are partially controlled, or at least their activation and perhaps their movement—so-called "intelligent" materials. This consideration of the plasticity of materials may allow for the combining of the "psychological" and the "material" behavioral dimensions. That will be a next stage in our work.

Finally, to continue and to our broaden reflection on the attribution of behaviors to objects, we might look into behaviors from a "moral" approach. In that case, behavioral objects would no longer be understood only in terms of how people ascribe intentions, beliefs, or goals to them, but in how values specific to objects, by virtue of their autonomy and their inherent capacity for affirmation and action, might emerge in the human world.

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