Understanding the Pushbutton Revisited: From on and off to Input and Output

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Abstract. The button is a familiar technology that is used to control and regulate things and machines in our everyday lives. With the digitalization of the button, many possibilities for novel and innovative functions have been invented and implemented. The use of digital buttons comes with some challenges that are explored in this paper. We describe the transition between the mechanical switch to the digital switch, and specifically use the concept of familiarity to find out more about the use of digital switches in a case study of indoor lighting. The contribution of the paper is to open for the transition between mechanical buttons and digital buttons and point to some challenges that arise in everyday use.

Keywords: Interface · Understanding · Pushbuttons

1 Introduction

The concept of the button is familiar to users of technology. Over the last decades, however, the button has developed from mechanical buttons to digital buttons, adding complex programmable possibilities to their application and use. We therefore ask how users make sense of the familiar buttons featuring new possibilities for interaction.

Rachel Plotnick [1] shows that the understanding of pushbuttons was already a subject to societal concern at its introduction in the late 19th century. Advertisers, producers, journalists, and educators participated in a debate encompassing many different perspectives on how users, or consumers, could best understand the pushbutton in the time from 1880 to 1915. Perspectives ranged from those who believed that creative interrogations of pushbuttons should serve as an introduction to a broader electrical education, to those who argued for the ability of the pushbutton to make use effortless [1]. From 1915, however, the consumers familiarity with the pushbutton led to the interface design to stabilize and the pushbutton became "black boxes", resulting in less need for understanding the workings of the pushbutton [1].

While users' familiarity with the button was established more than a century ago, the added possibilities offered by programming of buttons now make electrical and digital buttons more complex to both use and understand [2]. We therefore revisit the discussion on how users understand buttons in the context of interaction design and HCI.

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To illuminate changes and new challenges in designing for interactions with new and emergent technologies such as autonomous technologies.

The Guiding Question. That we address in this paper is comprised of two parts. First, we ask what the transition between the mechanical button to the digital button entail? What exactly is it that have changed as the mechanical pushbutton has developed to digital buttons? Secondly, we ask what challenges that evolve with the transition and how this affects users understanding of buttons.

Layout and Objectives. The rest of the poster is organized in the following way. We first describe the development of the pushbutton to examine the transition from the mechanical to the digital button. We apply a model to illustrate an important new feature of the digital button as input to a system. Then we describe the concept of familiarity to discuss the implications of emerging challenges. After this, we examine a case of the basic operations of switching lights on and off with digital buttons to explore the challenges and opportunities that buttons introduce in use situations. Finally, we discuss our findings and conclude by identify implications and areas of concern for further research into the understanding of technology in design and use.

2 The Development of the Pushbutton

The pushbutton as a switch for electricity was developed in the last twenty years of the nineteenth century. They were increasingly built into household items like lamps and doorbells from the beginning of the 20th century and developed to represent instantaneous control of electrical devices [1]. We will name these early electrical buttons as "mechanical" buttons, in that they are mechanical devises that works by breaking or closing an electrical circuit [2]. They usually represent their own state by their position, for example by latching in a lowered position and then released, or a knob turning to a horizontal or vertical position [2]. The possible states of mechanical buttons are thereby limited, and their states are observable by human users. The button typically offers two states, that is "on" and "off".

A century later buttons still come in many different sorts and shapes, as examined elegantly by [2]. Where mechanical buttons worked by closing or breaking an electrical circuit, new digital buttons can be in the form of physical buttons or graphic buttons on screens and work by submitting a signal as input to a computer for processing. Still, they often utilize the same feedback mechanisms which are inherent consequences of the construction of the mechanical button, such as clicks and latched positions [2].

A Model of Input and Output. To illustrate the new functionality of digital buttons, we apply a model of interactive artefacts that has been applied in robotics, electronics DIY communities [3], and in interaction design materiality studies [4]. This model describes the structure or anatomy of a digital artefact as consisting of three main components: sensors, processing unit and actuators (Fig. 1). Sensors are components that take in information about its surroundings, or "read" the environment. The button is such a sensor that senses the push from its environment, for example embedded in the mouse and keyboard of a PC. The signals are processed and transformed by a processing unit, like the processor of a PC. Actuators are components that actuate the signals from the processing unit, they can "act" or "write" on its surroundings, like computer screens and light bulbs.

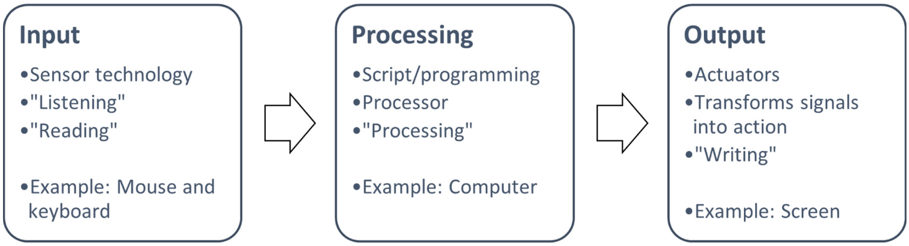

Fig. 1. The model of Interactive Things

3 Familiarity – A Way to Understand the Use of Buttons

What does it mean to understand buttons, use or technology? We will approach understanding as a part of the concept of familiarity, a concept that has previously been applied within HCI. Phil Turner makes references to philosophy, and especially the early Heidegger to explore the phenomenon familiarity [5, 6]. Heidegger claims that the basis for understanding our being-in-the-world lies in the everyday lives that we all live [7, 8]. He discusses three underlying concepts that are based upon our familiarity with the world. First, the idea of involvement or engagement, which Heidegger simply expresses as "being-in-the-world". Second, we relate to our world based upon understanding. This understanding is based or embedded in our activities and this understanding shows up in the activities we are engaged in. Understanding is essentially a skill, or a capacity to do something, according to Heidegger. Third, self and world are not primordially two distinct entities, like a subject relating with an object, but a unity of person-world. This unity is based upon the involvement and understanding in the world, as described for example in [8].

Within HCI, there are also various other lines of thoughts and analytic concepts that have evolved from our understanding of the everyday world. Norman [9] has been advocating using our everyday world, doorknobs, and light switches for example, as inspiration and sources for guiding how interaction and interfaces to computers can be designed. Ehn [10], referring Wittgenstein, introduced family resemblance, to promote the involvement of the user in the design of interfaces for new typesetting systems. This concept has been further developed by Mørch [11], in the context of tailorable systems and adaptive evolutionary systems. From the perspective of Tangible and embodied Interaction, Dourish points out that while familiarity is subjective, outcomes of interaction, such as i.e., easiness, success, or performance can be understood observable signs of familiarity [12].

4 A Case of Programmable Light Switches

Method. Our case is a system providing automated lights, blinds, and heating in a 10 000 m^2 office building that is ten years old. We have conducted two in-depth interviews with employees working in the building about their relationship with the lights switches in their offices. The recordings of the interviews were auto transcribed the with the Whisper software from OpenAI. Their answers have been analyzed in the perspective of familiarity. We present two vignettes based on the interviews to show how the buttons can be perceived of daily users.

In the Office – Disabling the Manual Light Button. It is pitch dark outside with temperatures of minus 5C this December morning at 0730. Harold is entering his office, and the light there is switched on as he opens the office door and move to his desk. A passive infrared motion sensor (PIR) that is mounted in the ceiling detect the movement in the room, and signals to the system that the light is to be switched on.

Fig. 2. Left: Motion sensor mounted in the ceiling of the offices. Right: Button disabled with gaffe tape.

During an ordinary office day, many people pop into Harold's office to get advice, and to pick up parcels. He noticed that some colleagues pressed the button at the door when they went out from his office, especially when he was not there. Harold have noted that when the light is switched off manually, information from the PIR sensor is disabled for 30 min (Fig. 2). Since this was frustrating, he decided to disable the button at the door. This he did by a strip of gaffe tape that simply locked the button to one position (Fig. 2). By this, he can always enjoy a fully lit office.

In the Office – Disabling the PIR Motion Sensor. Hanna likes indirect lighting in her office. She has two light sources that lights up the desk, and the shelves in the office. She works better when the light sources are this way as compared to a fully lit office from the standard ceiling light. When moving into the office, Hanna used to turn the light off manually by pressing the button at the side of the door. However, the ceiling light turned on after approximately 45 min in the room because of her movements. She then had to walk over to the button to press the button again. After a few weeks with this routine, she decided to cover the PIR sensor in the ceiling by attaching an A4 sheet of paper in the ceiling with two pushpins. This worked fine for Hanna, as the sensor was disabled and did not register any movement in the room.

5 Results and Discussion

Our findings from the case highlight some of the changes of the button from its introduction in the 1890's. The light switches in the building have kept their two-state form, while they are performing more complex temporal light control and dimming.

In each office, the button has become distributed and now consist of minimum two entry points; the light switch in its traditional form in the form of a two-state switch, and an added PIR sensor mounted in the ceiling that measures movement in the lighted area. The introduction of emerging interaction mechanisms like movement control is also introduced in addition to physical button control may challenge the understanding of the user interface. Further, the temporal programming that controls lights overrides the input that the user has given to the system in form of pressing buttons. This may pose challenges to the user's understanding of the system. It may also indicate that the end user is not the intended user. The owner of the building and the environment may benefit from timing lights and making sure someone is present to enjoy the light. This points to a new and emerging challenge raised by programmable, autonomous systems like in our case study.

Hanna and Harold demonstrate that they have become familiar with the workings of these buttons and their added points of input in their offices and understands how they function by countering and partly disabling them through applying appropriations. Other people visiting Harold, however, demonstrate unfamiliarity with the button. They may assume that the light switch button is an analogue button and make sure to turn the light off as they leave. But it has a programmed delay of 45 min programmed into it that is unfamiliar to the visitor, an *invisible and temporal* feature. This can be understood as an example of the familiar acting in unfamiliar ways. When the digital button looks and feels like an analogue button, users expect it to work as an analogue button. We use our familiarity with the old to understand the new. When the feedback to the user from digital buttons is different from that of analogue buttons, challenges with understanding feedback may arise.

Even if Hanna and Harold demonstrate familiarity and understanding of the buttons, they can't control and adapt the mechanisms to their needs. We found that both have created appropriations to their light switches. While originally being introduced as a means of instant control over electrical devices, the functionality of the light switch button is outside of their control and partly inaccessible due to the added motion sensor that will detect movement regardless of their need for light, and the programmed timer. The effect is that they have effectively broken their relationship with the buttons by disabling them.

6 Conclusion and Future Work

This study contributes by unpacking some issues with the use of digital buttons today. From our examination of the transition from the mechanical to the digital button, we understand the main difference to be that whereas the mechanical button is giving a causal, direct impact of the thing that is switched on or off, a digital button is an input to a computer system. The signals that are sent into the computer can be used to do countless different things, challenging the users understanding of the interaction on several levels. Our preliminary findings indicate that areas of concern include insufficient control for end users, challenges to users understanding of the interface and of the wider system because of the complexity introduced by the programming of digital buttons.

Implications for Further Research. We round off this poster by identifying a few implications and areas of concern for our further research into the understanding of technology in design and use of new and emerging technologies.

Understanding as a Skill. Approaching understanding as an ability that builds on existing competence points to the importance of drawing on designers and users existing competence. However, in many use cases, the familiarity many users have with mechanical buttons cannot be successfully invoked with digital buttons. The button therefore lends itself as a good example technology for further experiments to illuminate some of the challenges with understanding design and use of new and emerging technologies through building on the familiar.

From Off and On to Input and Output. Users who are familiar with mechanical buttons are used to see the status of the system by observing the button. This however is not always the case with digital buttons and might be challenging users understanding of the interface and the consequences of their actions in the system. However, our case suggests that challenges to understanding are not confined to the surface of the interface but concern the understanding of systems as well. Inspired by the long tradition of creative interrogations of the pushbutton as educational for understanding electrical devices, conceptualizing the digital pushbutton as input in the digital artefact model could serve as foundation for engaging users with digital pushbuttons to provide insights on autonomous systems through the interactive things model.

From Single Point of Control to Distributed Control. When digital buttons are used in concert with sensors in the environment of the users, user control are challenged. We would like to investigate how users can regain the control in such distributed systems.

Local and Remote. When digital switches can be programmed and reprogrammed without changes to the hardware, control and overview are removed from the end user, who is not necessarily the intended user.

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