Chapter 6
Casual Interaction – Moving Between Peripheral and High Engagement Interactions

Henning Pohl

Abstract In what we call the focused-casual continuum, users pick how much control they want to have when interacting. Through offering several different ways for interaction, such interfaces can then be more appropriate for, e.g., use in some social situations, or use when exhausted. In a very basic example, an alarm clock could offer one interaction mode where an alarm can only be turned off, while in another, users can choose between different snooze responses. The first mode is more restrictive, but could be controlled with one coarse gestures. Only when the user wishes to pick between several responses, more controlled and fine interaction is needed. Low control, more casual interactions can take place in the background or the periphery of the user, while focused interactions move into the foreground.
Along the focused-casual continuum, a plethora of interaction techniques have their place. Currently, focused interaction techniques are often the default ones. In this chapter, we thus focus more closely on techniques for casual interaction, which offer ways to interact with lower levels of control. Presented use cases cover scenarios such as text entry, user recognition, tangibles, or steering tasks. Furthermore, in addition to potential benefits from applying casual interaction techniques during input, there is also a need for feedback which does not immediately grab our attention, but can scale from the periphery to the focus of our attention. Thus, we also cover several such feedback methods and show how the focused-casual continuum can encompass the whole interaction.

Key words: Casual interaction, engagement, control-change

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6.1 Introduction

Most systems around us are only designed for focused interactions (interaction with full attention and full control of the process), limiting us in how to interact with them. Consider something very basic such as going on a day trip. You decide to head to the sea and go to the station to catch some train going in that direction. However, once you stop to buy a ticket you encounter an obstacle. The ticket machine requires you to select a specific destination and a specific departure time. You might very well not care which destination to go to; after all you just wanted to go to any place next to the sea. But the machine forces you to make a selection, while it could easily access additional information to help you in your task. Which town is least crowded? Which train has the shortest wait time? Which beach has the best weather forecast for the day? Yet, the input from the user has to be exact and such a ticket machine does not allow for more relaxed selections. If this machine offered what we call casual interactions, you could, e.g., just pick *"I'd like to go to the sea"* and have the system assist you with the details. This requires yielding some control over the task, which is the defining characteristic in casual interactions.

Casual interaction touches on similar topics as peripheral interaction, but offers a different perspective on what characterizes the shift from foreground to background, from focused to casual. In peripheral interaction, *"interactions with technology could be designed to shift between center and periphery of the attention"* to *"enable digital technologies to better blend into our everyday lives"* [2]. This, e.g., results in *"objects that could drift between the focus and periphery of a user's attention according to the momentary demands of their activity"* [8]. Where peripheral interaction focuses on aspects of physical placement and attention, casual interaction builds on a user's desired level of control (also see Figure 6.1). An interaction is *casual* when control is yielded to the system, whereas it is *peripheral* if low attention is given to the interaction. Those two aspects can overlap, e.g., when yielding control means using coarser interactions at the side, but at other times those two views diverge. Users can, e.g., have an interaction in the center of their attention, yet choose to give up control (e.g., by providing ambiguous input, expecting the system to partly take over). The ticket machine mentioned above is such a system, where users are focused on the interaction, yet might wish to yield some control over the precise outcome to the machine in order to lower their interaction load.

The concept of casual interaction thus revolves around the notion of control—as an aspect of user engagement. Engagement, as defined by O'Brien and Toms [17], encompasses multiple attributes of an interaction, such as *attention*, *novelty*, or *challenge*. When focusing on engagement through *control*—a user is said to be more engaged in an interaction when she is asserting more control (e.g., by being precise), and vice versa. A central point in casual interaction then is that these are not just two choices to pick from. Instead, interaction with a system or device can happen at any point between those extremes. Users pick the interaction they find most appropriate for their chosen level of control. Thus users can pick between having tight control of a system (focused interactions) and giving up some control over the outcome (casual interactions).

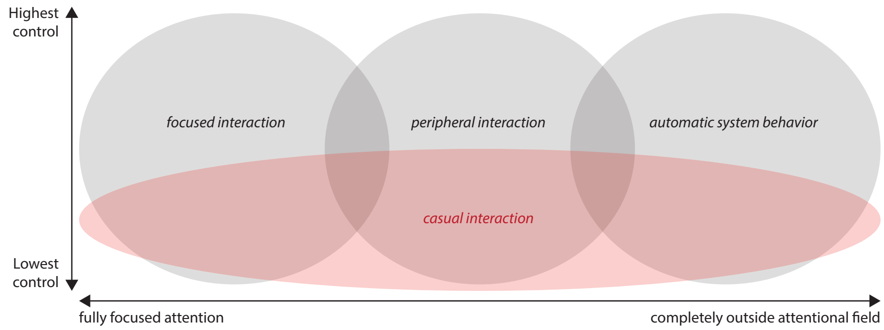


Fig. 6.1 Interactions become casual when users yield control to a system. Instead of requiring precise or focused input, they can then interact with more ambiguous or imprecise inputs.

One might assume that users always would desire high control. However, control comes at a cost: to provide very precise and accurate input to a system (and thus exert high control), users need to do the same: give precise and accurate input. However, this is not always possible or desirable. For example, users might be tired or have their hands full, precluding them from fully controlling a device. Thus there is a tradeoff between how much they engage with a device (the level of control of their input) and the resulting control they thus receive over the device. In casual interactions, we closely investigate this tension. One might wonder, why a user would choose one or the other. And what are the tradeoffs to be considered here then? We will explore this further in this chapter and will also have a look at several example of casual interaction systems.

In the following sections, we will first take a look back at a scenario similar to this book's introduction and examine *light control* from a casual interaction perspective. After a brief overview of related previous concepts, we will then investigate individual aspects of casual interaction more in depth. This covers basic aspects of why casual interaction is desirable, a closer look at the design space (how to yield control, and how to design for multiple levels of control). Over the span of the chapter, we will look at concrete examples of systems that were designed for casual interactions, allowing users to scale back and assert less control during their interaction.

6.2 Light Control from a Casual Interaction Perspective

As in the introductory example from this book, we can envision a scenario where casual interaction supports controlling the lights in a smart home environment. To support casual interactions, multiple ways to affect the lighting are available, each with varying levels of control. This is in line with Offermans et al., who report that for users *"depending on the particular situation/context, both a high degree of control and low effort can be considered important"* [18]. In this example, those different interaction options are all integrated into one device—-a bracelet controller. The user in our scenario then picks the one option she deems most fitting for her currently desired level of control:

Catherine comes home from work. Once she enters her house, the lights turn on and provide a neutral ambience. However, Catherine is tired after a long day at work and would like to change the lighting to a more calm and relaxing setting. She wears a bracelet that allows for multiple different ways to control the lighting. To switch to a different lighting preset, she quickly rotates her wrist outwards and back and then performs a waving gesture in the air. This is detected by the bracelet and the lighting changes to the desired mood. After a short nap, she sits down on her sofa and decides to read. For reading, Catherine would like to increase the ambient light slightly. She grasps around the bracelet to activate the brightness mode. While holding the bracelet, she now turns her arm to increase the brightness to the desired level. She does not care much about the light color at this point and just desires an overall brightness increase. Now a game of her favorite hockey team is about to be shown in TV. For the game, Catherine would like to change her living room lighting to her team's color. She is an avid fan and thus is much pickier in the exact lighting color. Thus, she uses the exact color control mode of the bracelet. She uses the embedded capacitive slider to pick just the right values for hue, saturation, and lightness that she wants. She can toggle between the different slider modes with light taps on the bracelet.

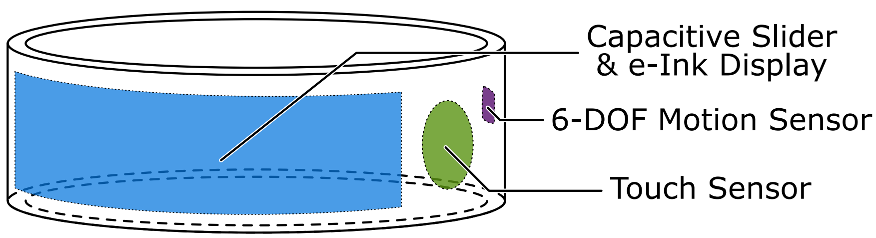


Fig. 6.2 In our envisioned mood lighting scenario, Catherine uses a bracelet that supports a range of interactions. She can directly control color values with a capacitive slider or perform arm gestures which are picked up by the built-in motion sensor.

In this scenario, we encountered multiple ways to control the lighting. In their effect they are all the same: the lights change to a different setting. However, they differ in the amount of control the user has and how much precision and focus they require. They also each make use of a different combination of sensing in the bracelet (as illustrated in Figure 6.2). Catherine used three different interaction modes:

Casual interaction By gesturing, she switched to some preset lighting pattern. This allows for large changes in lighting mood, but restricts user freedom to the available presets. The gestural interaction for this change can vary in complexity. Conventionally, users would pick simpler gestures for common presets and only move to more complex gestures for more rarely used mood settings. Catherine does not need to observe the bracelet while making preset changes, potentially allowing her to perform such interaction peripherally.

Semi-casual interaction When using the whole bracelet as a brightness slider, freedom of lighting choice is rather restricted. Instead of switching to a precise color setting, users in this mode can only enact a more general mood shift. However, the interaction needed for this is minimal and can be performed in the periphery of attention. The complexity is lower than in gesturing as no memorization of presets is required. While the user here does give away some control (after all, not all colors are reachable with just brightness changes) there is only minimal required interaction with the device. This also makes this kind of interaction more appropriate when guests are present. While they might not appreciate Catherine to fiddle with color sliders, a quick dimming action on the bracelet is less disruptive.

Focused interaction Toggling between different slider modes and then using the precise built-in sliders allows Catherine to pick any color in the available space. However, this freedom comes at a significant interaction cost. Switching between and manipulating three different sliders is a complex task that required precision and thus cannot easily be relegated to the periphery. Thus, a user will likely only resort to this mode when other input modes are too restrictive.

We can see that each mode sits at a different point of the control space. Catherine in each situation picked the mode that provided her the needed level of control (i.e., precision when specifying the lighting change) while minimizing the put in effort. Note that this choice is not made by some system, but she retained control in picking the desired level of control.

In the given example, three different modes were available. However, this discretization is a design choice and for each system complexity and freedom have to be carefully weighted. With an increasing number of modes, users gain flexibility but the risk of a mode error increases as well. Catherine could have instead chosen a bracelet with only one casual interaction mode (e.g., only using it for dimming). Here she would use her phone for more precise interaction and switch between those two devices depending on how much control she desires. We will revisit this choice between integration and separation of interactions later in the chapter.

6.3 Related Work

There has been interest in concepts of interaction where users are less engaged or give up control for a long time. Buxton in 1995 already described the space between foreground and background interaction [6] using the example of a video chat system. He notes that foreground interaction uses higher bandwidth than background interaction but also happens intermittently while background interaction allows for longer running, persistent interactions. While he specifically relates this to video chatting and relaying presence, this relation holds true for a more general interaction channel as well. In Buxton's model, though, these modes are discrete and, while users can move between fore- and background, he does not address how gradual change in ground would be addressed.

Interaction in the background has been taken a step further towards incidental [7] or implicit [14] interactions. In Dix's incidental interaction [7], users might not even be aware of the interaction itself (they retain no conscious control in this instance). Once users become aware of the interaction, however, interactions become expected or even intended (users regain control through awareness). Here a user's experience with a system drives how much control they can have. Ju et al.'s implicit interaction [14] extends the foreground/background model with an additional *initiative* dimension. Hence, a system, during foreground interaction, could be *reactive* and have the user in control, or act *proactively* on its own. They specifically explore proximity as a way to transition between these different modes.

A larger range of work has investigated concrete scenarios for foreground and background interactions. Hinckley et al., e.g., build on Buxton's work and explore how sensors in mobile devices can support both grounds [12]. Along the same line, Hudson et al. detect *"whack gestures"* to enable interaction with mobiles without taking them out of a pocket [13]. Olivera et al. instead look at tangibles and find that those can support background interactions by being less distracting and more fitting for concurrent interaction [19]. In peripheral interaction the background is described as the *periphery of attention* and designs hence focus on aspects such as awareness (e.g., in the *CawClock* [3]), or input in the periphery (e.g., using tangibles without looking at them).

In the presented concepts, the choice of ground is commonly based on attention and the grounds themselves are discrete or even binary. In contrast, casual interaction is concerned with users' level of control in an interaction. Casual interaction systems also can offer continuous change in ground, dependent on a user's changing level of control. The concept of yielding control builds upon the H-Metaphor by Flemish et al., which proposes a varying control system for automated vehicles where drivers can yield and take control as they choose:

> You can let your vehicle go without being completely out-of-the-loop, or you can reassert a more direct command, for example, by taking a tighter grip on your haptic interface. [9]

One example they use to describe this change is riding a horse. A rider can *"loosen or tighten the reins"* to change how much control to exert on the horse. Tightening the reins can, e.g., mean making more deliberate and decisive movements or interacting with the horse more frequently. When the reins are loose, the horse is given more freedom to decide where to go. By tightening the reins, a rider can take back control and steer the horse more closely. The horse itself contributes to the task. It can, e.g., see a path ahead and follow it even under loose reins. External cues thus inform the behavior of the horse. However, the rider retains the option to tighten the reins and steer off the path if so desired. Similarly, casual interaction systems are designed to allow looser reins when using a device—yielding some control to it as desired to offload some of the effort of the interaction.

6.4 Why Would We Want to Have Less Control?

As described earlier, there can be many reasons users might choose to yield control to a system. Here, we further explore why this might be the case. We group reasons for asserting low control into three categories: (1) mental reasons, (2) physical reasons, and (3) social reasons. These three categories respectively cover (1) internal, cognitive aspects, (2) those regarding a user's presence in the world, and (3) those arising from interactions with other people.

Mental reasons often relate to notions of distraction, exhaustion, or focus. This is often the case when a user is engaged in a different task primarily. In such situations, a secondary task in the periphery might only receive a small amount of attention. Focus in such a scenario can move back and forth numerous times [2]. If we design interactions to work at lower levels of focus, we might reduce the cost of such switching. Avoiding effort, however, is not necessarily bound to restriction by another task. In fact, just being exhausted after a long day can lead to active-choice avoiding behavior due to ego depletion [4]—a concept that postulates that willpower is finite and self-control decreases over time, leading us to avoid making active choices.

Physical reasons for choosing low control include scenarios such as wearing gloves, carrying bags, or the hands being busy with another task (e.g., driving). A user encumbered in such a way is not able to engage as much with her devices as an unimpaired user [20]. For example, consider carrying home several grocery bags —- the hand holding them cannot hold the phone as well. While having our hands full might mean that we cannot closely control our devices, in casual interaction there should be ways of interaction left for us to give commands even when thusly encumbered. An example of such interactions—performed while the hands are already busy—are microgestures [28]. As described in Chapter 5, such gestures make use of remaining degrees of freedom, not yet involved in the primary task (e.g., fingertip movements).

Social reasons for low control are often related to how we would like to be perceived when interacting [10], but also include questions of acceptable behavior. In situations such as meetings or dates, it is seen as rude to take out a phone and interact with it. We use attention to signal to others that we value our time with them. Engaged use of our devices can then negatively influence our relationships. Low-engagement interactions (possible without shifting focus a lot) can still be ok though. Imagine the mood lighting device from earlier: sitting on a couch next to your date, taking out the phone to dim the lights could be seen as disruptive while the proposed dimming interaction is much more subtle and can be performed less visibly. Interacting casually not only allows signaling attention to others, but also gives users a general way to signal to observers how little engaged they are. A public image of being in control, yet not putting in too much effort for this, can be quite desirable [26]. Appearing to others as if one is trying too hard can have negative connotations.

6.5 Are Users Willing to Exert Less Control?

One key question in casual interaction is whether giving users a way to trade control for comfort is something they actually appreciate. It might well be that users want to have full control all the time and shy away from relinquishing some of it. However, we found that, when given a choice, users are willing to do just that if they felt they could retain an appropriate level of control to achieve their task. We tested this with a very simple setup: a steering task, where users had to control the movement of a ball and maneuver it to a goal area [23].

To complete this simple steering task, we gave them three different means of control, each at a different point in the focused-casual range. They could use (1) touch interaction to directly control the ball, (2) hover interaction to rate-control the ball (similar to a joystick), or (3) in-air swipe gestures to move the ball in a general direction. From (1) to (3) control degrades, while less and less focused interaction with the device is needed. When interacting in the most casual way, users could lean back, wave their hand over the device once and be done. Compare this to touch interaction, where users had to move their finger over the screen multiple times to move the ball around. While this gives very precise control of the trajectory, it also requires much more work from the users. Note that the *"level of control"* for those three modes is not defined on an interval, but on an ordinal scale.

Participants completed multiple levels, where the difficulty of each level is determined by Accot and Zhai's steering law [1]. We found that users indeed scale back their interaction if the task is sufficiently easy and they do not require full control—control correlates with task difficulty. In fact, users were very attracted to the more casual control modes and would try those first before resorting to more controlled interactions. Imagine we had built a system only allowing for focused and precise interaction. Those users would have had no way to scale back their control. So even when they would not have required a high level of control, they would have been forced to provide this input anyway. We feel forcing users to do more when they could get away with doing less is somewhat cruel. If we can design our devices in a way that allows users to lower their control when appropriate and push the interaction to the periphery, we should do so.

6.6 Integrated and Separated Casual Interaction Systems

When designing for casual interactions, there are two approaches: (1) try to design one device so it offers multiple ways to interact across the range of control, or (2) design for multiple devices where each device covers just a subset of the control range. Both options can be good choices, but offer distinct advantages and disadvantages.

Earlier we already looked at one example of a device that incorporates different interaction modes: the light-control bracelet. With more casual interactions often using around-device space or coarser movements, such coexistence of different modes is feasible. However, this approach does make devices more complex. Instead of learning one way to use them, users now have to learn multiple techniques. Users might get confused when accidentally activating the wrong mode or might be overwhelmed when functionality is overloaded (e.g., when slider movements are interpreted differently depending on the active device mode). There is a fine line between a device that empowers users to do less and a device that frustrates users because they cannot figure out how to use it in a given moment. It will be up to system designers to pick the right number and kind of modes to combine for every specific instance.

In current systems an incremental learning approach is often used to lessen the impact of required initial effort/complexity somewhat. Instead of learning all different modes at once, users take up the general mode first. Over time, as they use the system, they then discover additional commands or modes (e.g., the keyboard shortcuts for often used menu items) slowly increasing their skills and capabilities. Similarly, users of integrated casual interaction systems could start with the focused mode first and then add more casual interactions as they see fit. This process can be supported by casual interaction systems pointing out more casual ways to achieve the same effect after a user interaction.

Instead of integrating several interaction techniques into one device, users could be given different devices for different levels of control. Most people already carry one device for focused interactions: their phone. Thus, there is little need to introduce additional focused interaction devices. Instead, wearables (such as watches or bracelets) are an example of a device class that supplements phones and could be utilized to support casual interactions complementary to the focused interactions of the phone. This could be a simplified form of the light-control bracelet, e.g., only allowing dimming of the lights. Similarly, we can envision such modes being integrated into clothing, furniture, or tools. For example, some lamps such as the *TaoTronics TT-DL05*[1], already come with integrated touch sliders for dimming. Such integrated dimmers allow for a way to change the lighting with less effort than taking out a phone, opening the lighting app, selecting the specific light and then using on-screen sliders to do the same. Instead, users can just touch and hold the lamp or drag along the base or stand.

One scenario where we specifically explored custom low-control devices is user recognition. For this we modified a light switch and embedded a distance sensor (see Figure 6.3). By observing how users press the button, small groups of users can be reliably distinguished [22]. While this does not offer the same level of security as, e.g., keycards, this setup allows performing user recognition in the periphery. Users are recognized as they enter the room and switch on the lights. Should they require a higher level of authorization, they can still switch to a traditional authentication method. The button, however, enables them to put less effort in and devote less attention to the task should they not require such a high level.

Instead of having objects in the environment imbued with interaction capabilities, we have also explored the concept of making use of any object for casual interactions [24]. Imagine your whole living room being tracked (e.g., by your phone or

[1] `http://www.taotronics.com/taotronics-tt-dl05-led-portable-eye-care-lamp.html`

Fig. 6.3 This button enables a low-effort way of user recognition by observing button pressing behavior. For small groups of users, establishing who, e.g., entered a room can then be as easy as pressing a button. In addition to conflating the action with the recognition, this allows for recognition in the periphery as the button can, e.g., be pressed while entering the room.

a stationary setup) and thus any touch or other interaction with objects in the room being available as a means for input (as illustrated in Figure 6.4). Instead of, e.g., having a dimmer control embedded into a device, you could repurpose any nearby object to temporarily fulfill the same role. Objects repurposed in this way can offer good affordances for many tasks (e.g., round objects invite turning and squishy objects invite pressing). While this makes them well suited as interactors, this also means less attention has to be paid when interacting with them. Turning a mug around can be done in the periphery, while modifying an on-screen dial requires at least visual focus on the interface.

Which one of those options is more appropriate when designing a casual interaction system is not a clear-cut decision. Integrating everything into one device increases portability but comes at the price of added complexity. On the other hand, one would not want a large number of specialized objects lying around everywhere. This would lead to clutter, making it hard to find a currently required one. A balance could be struck via a mixture of both models: having one centralized device for all focused and some casual interactions, in combination with a small number of casual interaction wearables and any number of casual interfaces integrated into objects. A lamp with an integrated dimmer (as described earlier) provides an additional casual interaction path that is fixed to one specific location. When next to the lamp, users then have the option of interacting with it casually. When away, they can use their phone to select and then dim the lamp. Should this level of control (remote) be required, having to resort to focused interaction is acceptable.

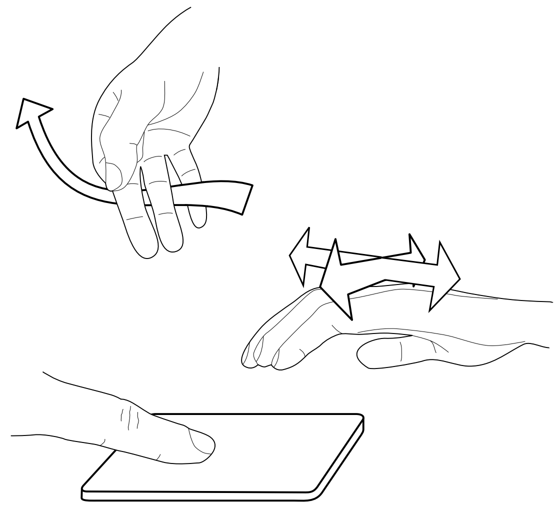
Fig. 6.4 Instead of embedding input capabilities into objects around us, we can leave them as-is and track them externally. Manipulations of such objects or touches on them can then be used as a means of input. We can, for example, temporarily make a nearby coffee mug a volume slider or press down on a hacky sack to use it as a transient button. Such appropriation of objects can be limited to a given interaction window (e.g., the hacky sack is only a button when a call is coming in), or persist over longer durations (when objects are explicitly set aside for specific interactions).

6.7 How to Design for Low Control

While we have already seen some examples of low-control systems, here we will take a closer look at what can be done when building low-control interfaces. Examples of casual interactions are interactions that (1) happen further away from a device, (2) use low-fidelity proxies, (3) are performed less accurately, (4) use a more restricted input repertoire, or (5) require less concentration or thought. By definition, an interaction is casual when control is given up. What that entails specifically then is dependent on the actual device and how one can interact with it.

As shown in Figure 6.5, distance to the device can be one way to delineate casual interactions [15, 16]). If we imagine a phone lying on a table, then picking it up and using touch interactions requires more effort and precision than waving in the general direction of the device. With increased distance feedback from the device becomes harder to receive and often sensing fidelity will decrease as well. Thus the bandwidth in the interaction goes down accordingly. Touch interaction allows users to provide more complex and rapid command sequences compared to gestures away from the device. This natural regression of input in around-device interactions can be used to either separate the around-device space into distinct zones of casualness or continuously change the control level.

Fig. 6.5 When designing for different input options in one device, distance from the device can be used to switch between them. Here focused interaction happens on the device when using touch. In the above-device space, users can perform rough or precise gestures. In this example, close space is used for more complex gesturing, while the space far away from the device is used for more casual waving gestures. With increased distance the level of control decreases, but interactions become more casual.



As shown previously, repurposing nearby objects for interaction allows creating temporary control proxies. For example, when your phone rings, you can dismiss that call using any nearby object with some marker property (e.g., anything colored red and *pressable*). Not having to take out your phone for this results in an interaction where less attention is diverted. By using physical objects as proxies, we enable eyes-free interaction and allow users to move this interaction to their periphery.

While distance to a sensing device naturally results in input regression, the coarseness of input can also be adapted independently. For example, in interaction with a touch screen, users can do both: precisely select small targets or use swipe gestures over the whole screen. One example of this is available in many current phones as *swipe to delete*. In the inbox view of their email app, users can either delete messages by touching them and then selecting a delete action from a menu bar or they can swipe over the message to directly delete it. The first action allows for more elaborate actions (selecting multiple messages, archiving instead of deleting, moving messages, . . .), but also requires more precise input and thus more attention from the user. Another example are on-screen gestures, which can scale from very simple and easy to perform (e.g., horizontal swipes) to much more complex and harder to perform (e.g., drawing Chinese characters). In the framework of casual interactions, we can regard coarse input as more casual and precise input as more focused.

Similarly to making input coarser, we can also just restrict the number of available inputs. Instead of showing twenty buttons on a screen, we might reduce this to three more general buttons. Here the interaction stays the same (touch on a screen) but as the number of choices goes down we decrease the mental load for selection and, by increasing target size, can also make acquiring targets easier. One example of this approach can be found in some smartwatches. Displaying a full keyboard on a smartwatch necessitates very small key sizes. Instead, messaging apps such as the one in the *Apple Watch* only display a smaller number of predefined replies (e.g., *"I'll call you back"*). The small number of available messages severely limits control of the user in what she can reply, but does enable replying fast and without much effort. By making shown information glanceable, users can take it in with less effort (and presumably better maintain focus elsewhere). This can tie in closely with a reduced number of input choices (showing less overall), but can also mean keeping the same number of controls but restricting the information shown per control (e.g., only displaying emoji abbreviations on message template buttons instead of full message texts). Reduced visual complexity and increased size of visual features already allows users to interact with their device at a distance by allowing them to perceive feedback without requiring them to pick up the device.

Overall, the more casual an interaction is, the more constrained, coarser, and distanced from the device the input can be. This is counter to the kind of interaction we are used to: focused on our devices and in a tight control loop where we quickly alternate perceiving output and providing new input. Note that none of the markers of casualness presented here are absolutes. For example, reducing the number of choices does not mean reducing them down to one (such as in *Amazon's Dash Button*[2]—an attachable physical button one can press to, e.g., order new detergent) or even zero (as in agent systems). Instead, there is a continuum where we can make things more casual in several degrees. We can also combine two or more aspects. Further away from the device we might use coarse and large gestures for input but at the same time also reduce the number of available options.

6.8 What Does Yielding Control to a System Require?

So far, we have described the general approach of yielding control and examined one scenario where this occurs when changing lighting mood. However, we should dive deeper into what it means from a system's perspective when we yield control to it. After all, while we have seen that users are willing to have less control and give some power to the system (see Section 6.5), this requires systems to actually do something sensible with this power. Asking your lighting system to change the mood to something a bit cozier and that system then playing back a wild light show would not match up with our intentions. Thus, yielding control usually requires a conceptual model of the space a system operates in. This often requires system designers to think about the problem space on a higher than usual level. For example, designing a lighting system that only exposes one color slider to users (leaving the choice of color completely up to them) can be done without much understanding of color theory. On the other hand, allowing users to manipulate mood requires dedicating design resources to that aspect as well.

Models used in casual interaction systems can come in many different forms. They can, for example, be based on some notion of *error* (e.g., in text entry), *like-*

[2] https://www.amazon.com/oc/dash-button

lihood (e.g., in music retrieval such as in [5]), or on a *designer's intuition* of important feature points (e.g., when limiting selection of lighting color to a list of known *"good"* colors). One difference in such models is thus whether they are more strongly based on a describable algorithmic principle or whether they encode a more human understanding of importance. The very extreme example of a model-based system are agents—here users completely delegate tasks. Based on a model the agent system then makes all choices on behalf of the user. The model is typically informed by a set of sensor inputs (say, time of day and door status) and infers some action (e.g., sounding an alarm). As such, agents provide system behavior to the user with no required effort, but also take away all control. In casual interactions, we similarly make use of models to inform what to do once some control is ceased, but have the user stay in the loop. System behavior is not fully automated but instead steered to varying degrees by the user. As users are kept in the loop, they receive feedback and can correct or adapt system behavior as they choose.

One example of casual interaction using an error-centric model is adaptive autocorrection [27]. As text entry on touchscreen phones is more error-prone than on a physical keyboard, autocorrection algorithms are used to change an entered sequence with typos to the one most likely intended. There are actually two models at play here: (1) a touch model, and (2) a language model. The touch model describes how we might not hit the center of a key on a touchscreen keyboard but instead deviate to some degree. The language model on the other hand knows about likely character sequences and thus can, e.g., determine that a user probably did not want to enter *"hellp"*, but instead might have meant to enter *"hello"*. Together, these models help correcting for off-target touches and typos in the resulting text.

While this system behavior is generally very useful, it can get in the way the moment one tries to enter a word not known to the system. Then autocorrection corrects something we did not want to have corrected at all. This is commonly problematic when mixing languages, using slang, or entering abbreviations. However, currently there is no way to take back some degree of control from the autocorrection system to override the behavior. If we think back to the horse riding example, this would be similar to a horse that always stays on the path. If you would like to ride out into the open field you would be out of luck. Instead, we have explored using typing pressure to allow users to override autocorrection (as illustrated in Figure 6.6). When they want to enter a word and have it not changed, they can do so by pressing down a bit harder. Note that this is a gradual shift between high and low control. There are no distinct control levels. When typing softly users allow autocorrect to jump in and *"fix"* what they entered. Only for parts where autocorrection is not desired, control is taken. This combines both: casual interaction when assistive behavior is welcome and focused interaction when tight control over the system behavior is needed.

We already encountered one example of a designed model earlier: predefined answers in a smartwatch messaging app. Because typing on a smartwatch is cumbersome, the Apple Watch allows users to reply using a number of predefined messages. Thus, one can send back a quick *"ok"* without typing. The watch also generates contextual reply options to choose from (e.g., enabling *"sushi"* and *"pizza"* as replies when the previous message was *"should we get sushi or pizza?"*). In this

Fig. 6.6 In a touchscreen keyboard a language model provides a probability for the next letter (shown here as key color) and a touch model gives a measure of certainty for a user's touch (here shown as a gradient around the touch position indicated by a cross). The combination of both models determines the most likely next letter. We vary how much influence the language model has by changing the size of the touch area. When users press harder it shrinks and keys closer to the touch are much more likely to be chosen. As users relax and only press lightly, the area increases and many more keys are potentially chosen—increasing the influence of the language model.

way the watch actually combines both algorithmic and designed models. With the Apple Watch, users also retain the option to dictate a reply. So while the default reply interface is more casual, a focused interaction is available if more control is needed. Another example of a designed model can be seen when looking back at the lighting change system described in the beginning. Programming the system to make sense of what it means to change the mood of the lighting (e.g., to make it more calm or cozy) comes down to hand-tuning mood-color mappings.

6.9 How to Adapt Output in Casual Interaction Systems?

So far we have mostly focused on casual interaction as a way to scale back control of a system. However, to allow for true casual interaction, there also need to be corresponding feedback techniques. Such casual feedback is designed for low attention capture and for use in the periphery. If we look at feedback used in current phones then this is currently not considered. Vibration feedback, for example, is very disruptive and not suitable for casual feedback at all [11]. Current fidelity of screen design also does not work well for peripheral and casual interaction. One approach is to have different visualization modes for levels of focused or casual interaction. Stock Lamp is one example of such a system specifically designed to adapt differently to focused (actively and passively) or peripheral use [25].

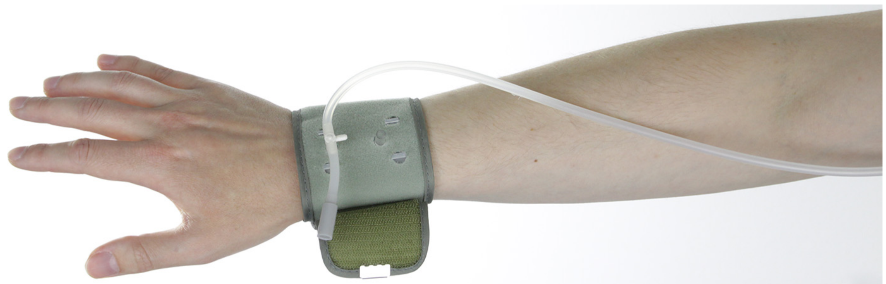


Fig. 6.7 We are experimenting with pneumatics in cuffs around the wrist to apply compression feedback as a modality for low-disruption background notifications.

We have begun to investigate pressure as a feedback modality that can support the kind of peripheral feedback unsupported by vibration feedback [21] (see also Figure 6.7). In such compression feedback devices, pneumatic actuation is used to tighten a strap around, e.g., a user's wrist. We found that at low pressures, feedback can be sustained over long periods, while not disrupting the user yet being perceivable. Such background feedback can help alleviate some of the disruption of notifications. Instead of sounding an alarm with every new incoming message (independent of urgency), casual feedback systems can notify users in the background that something is available for them to look at. By increasing the pressure in the strap, attention capture of the feedback can be increased to levels exceeding those of vibration feedback. Thus, this kind of feedback supports the whole range from casual to focused interaction. We can have it persist in the background (barely perceivable but readily noticeable when concentrating on it), but move it to the foreground when necessary.

Some current devices already try to incorporate their own version of more casual feedback. Some *Microsoft Lumia* phones come with *Glance screen* functionality and show basic notifications while the main screen's backlight is off. Phones can be configured to only display this low-fidelity feedback for a short while after a hover interaction. Such glance screens try to provide some feedback at lower levels of interaction than unlocking the phone or activating a notification center. The Samsung Galaxy Note Edge takes another route and extends the screen over one of the outer edges. This allows displaying notifications at the side, allowing easier viewing when the phone is lying, e.g., more than arm's length away on a table. Ideally, this would be combined with a way for the phone to sense hands in the space in front of the phone. Users could then use casual interactions to, e.g., check active notifications and send quick replies, without even picking up the phone.

6.10 Conclusion

In this chapter, we have outlined the concept of casual interactions. Casual interactions try to provide options for lower control interaction to users. We feel that there is already a pressing need to be able to interact with less effort, which will only increase in the next couple of years. Our phones are focused interaction devices, which are with us at all times. It currently looks like, in addition, we might be carrying around several wearables as well (which will all want some of our attention). At the end of the day we come back to our smart home full of internet-of-things devices (again wanting us to engage with them). Casual interaction is one approach to keep the assault of attention grabbing at bay. Casual interaction allows us to relegate some control back to a system, while keeping us in the loop and enabling us to take back control as we see fit. This is different from agent-based systems that try to automate things and move the user out of the loop.

Fundamentally, casual interactions built onto the assumption that completely modeling user state is unfeasible. Instead of trying to predict when a user is tired, encumbered, or in a demanding social situation, we relegate that to the users themselves. They are the ones able to pick how much control to give away, not a system on their behalf. With current system design ingrained with the assumption of focused interaction, we should try to investigate more how to do things with less. This will require specific models for each use case, but once we find underlying concepts we can reduce complexity where appropriate, yet retain a way back to interaction with said complexity where users demand so.

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