CS6750: Assignment P2

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1 DIRECT INTERACTION AND INVISIBLE INTERFACES

Over the weekend, my partner and I visited a resort in the Poconos. While we were there, we enjoyed a number of activities on premises, including fishing, archery, billiards (8 ball), minigolf (putt-putt), and golfing at a driving range.[1] This section will consider four of these tasks and discuss how direct the user interaction was with the task and how invisible the interfaces were.

Table 1—Saturday afternoon activites in the Poconos.

Task	Goal	Interface	Object
Fishing	Catch a fish, then release it	Fishing pole	Bait on hook
Practice archery	Land an arrow in the bullseye	Bow	Arrow
Play billiards (8 ball)	Sink my balls, then the 8 ball	Cue (stick)	Cue ball
Play minigolf	Sink the ball for each of the 9 holes	Putter	Golf ball
Practice golf driving	Hit the ball as far as I can	Driver	Golf ball

1.1 Fishing

The act of fishing involves a fishing pole and reel with line that leads to a bobble and a hook, where bait (e.g., earthworms) is attached; the purpose of the bait is to entice a hungry fish to take a bite and, hopefully, get attached to the hook. For the task of fishing and the goal to catch (and release) a fish, the object is the bait on the hook interfaced via the fishing pole. The interaction between the interface and the object is indirect via the fishing line that gets cast out into the water. This is accomplished by pulling the pole back over one's shoulder while holding down the release button, and throwing (casting) the pole forward while simultaneously releasing the button. If successful, the hook with bait travels far; if unsuccessful, the hook and bait travels very little or, in the worst-case, the whole fishing pole is tossed into the water! Once the hook is in the water, it is manipulated by reeling the fishing line in towards the user.

1 While the prompt suggested setting aside one hour, these activities spanned the course of about five hours.

The interface itself is quite visible to a novice user, there are many steps that a user must take in order to have a successful cast. That is, the user must actively think about the interaction (pull back, press and hold release, throw pole, release button, reel in). For sufficiently experienced anglers, the interface is made invisible by learning and the process of casting and retracting the hook is smooth and natural.[2]

1.2 Archery

Archery is a sport practiced for competition, for hunting, and for fun. The goal of any archer is to hit the target with an arrow in the desired spot; for competition and for fun, the desired spot to land the arrow is the center of the target, known as the "bullseye". The object, the arrow, is manipulated via the bow and bow string by knocking the arrow (setting it on the bow string), pulling back, aiming, and releasing. This interaction is fairly direct, where the user is holding the arrow at its tail as it is being pulled back and aimed. If pulled back sufficiently far and aimed true, the arrow will sail in a straight line to the target and, ideally, to the bullseye. A shot can still be considered successful if the arrow hits the target but does not hit the bullseye, but if the arrow misses the target or hits the target and bounces off, then the shot is unsuccessful.

To a novice user, the interface via the bow is visible as the steps needed to shoot well are deliberate. However, after a few minutes of practice, the interface begins to disappear and the act of knocking, pulling, aiming, and releasing becomes one smooth motion. A sufficiently experienced archer may not notice the bow at all, with all attention being placed at the point of aim and the position of their body relative to the desired spot on the target. Given the long history of archery, the property of invisibility is conferred onto the interface by a combination of learning and good design.[3]

1.3 Billiards (Eight-Ball)

Billiards, or pool, is an activity can be found at many bars in the United States. Eight-ball is perhaps the most common game to play on a pool table; the game consists of two players (or two teams) sinking their own pattern of ball (stripes or solids) into pockets on the table before sinking the eponymous 8 ball. While

2 Despite some initial clumsiness, both of us were able to each catch a fish (hers was bigger).

3 Both my partner and I (novices) did well shooting at about 15 yards.

there are many rules and variants of the game in professional play, the game we played was casual. The balls on the table are moved around by striking a solid white ball, the cue ball (object); the cue ball is struck by the user with a long, blunt-tipped stick, the cue (interface). The rules of billiards stipulate that the user cannot strike any of the numbered balls with the cue, and thus must strike the cue ball in such a way that it knocks the numbered balls into the pockets (holes) on the table.

The player in a game of billiards interacts with the cue ball directly via the cue by striking the cue against the cue ball. However, the goal of eight-ball is to sink all of your balls (stripes or solids) and then the 8 ball *without* landing the cue ball in any pocket; thus the interaction between the interface and the important objects in this task is indirect via the cue ball. The interface between the user and the interface is quite visible as the player must determine what angle to strike the cue ball, how hard to hit it, what angle to aim for, etc. This can quickly be overwhelming for novice players. Even expert players must consider their shots strategically, never truly losing sight of the role the cue plays in the overall game. While an expert player may wield the cue more adeptly than a novice, in both of their cases the interface remains central and visible.[4]

1.4 Minigolf

Minigolf, also known as putt-putt[5], is a scaled-down version of golf that focuses entirely on the green phase, where the player uses a putter (interface) to sink their ball (object) into a target hole (goal) from relatively short distances. The interaction between the interface and the object is direct, where the player strikes the ball directly with the putter. The goal of a hole of minigolf is not dissimilar from the subgoal in billiards; also as in billiards, the interface is quite visible to both the novice and the expert. The game of minigolf and the structure of the holes is simplified such that even young children can play. The visibility of the interface can be reduced somewhat by selecting a putter appropriate for the body (height and reach) of the player, but most minigolf courses provide putters, and the selection may not be ideal for players of all sizes. There remains a sizable gap between the novice and the expert, but, unlike in billiards, the threshold for

4 My partner beat me when I accidently sunk the 8 ball on my shot before I was supposed to, which triggers an automatic loss in eight-ball.

5 To be pedantic: Putt-Putt refers to a game of minigolf where every hole has a par of two.

expertise in minigolf is lower. An expert minigolfer is not necessarily an expert golfer, but an expert golfer is certainly an expert minigolfer.

2 LEARNED INVISIBILITY

Humans are said to be creatures of habit, and I am no exception. Every morning after I've gotten out of bed, stretched, and brushed my teeth, I proceed downstairs to the kitchen to truly begin my day with a hearty breakfast. Invariably, my breakfast consists of peanut butter oatmeal (made the evening prior), two slices of toast with butter, and a cup of Earl Grey tea. While the microwave and toaster are appliances I have been familiar with for most of my life, the electric kettle was a somewhat recent addition and, surprisingly, had a somewhat significant learning curve. In this section, I will discuss the task of making myself a perfect cup of tea using an electric kettle to boil water and the microwave to monitor steeping time.

2.1 Learning to Make the Perfect Cup of Tea

After my previous, no-name kettle died, I replaced it with a Cuisinart®1.7 liter stainless steel electric kettle. I originally selected this particular kettle due to its multiple built-in temperature settings (for different types of tea or coffee) as well as for its standby/keep warm mode for when I wish to have multiple cups of tea in succession. While these extra features sounded like boons on paper, in practice I found there was a greater learning curve than expected.

After pouring in enough water, to actually begin the boiling process the user must have the kettle on its base, keep the lid closed, select the appropriate temperature setting using the "+" button, and finally press "START/OFF". If the user accidentally overshoots the desired temperature setting, they must continue to press the "+" button until the display indicates the desired temperature again. I quickly discovered a shortcut by way of the "BOIL" button, which sets the temperature to the maximum setting, which happens to be the setting for black tea. Once the appropriate temperature is selected, the "START/OFF" button is pressed to begin heating the water. When the kettle is boiling, all of the buttons are lit. At first I wasn't certain when the kettle was on, and I'd stand by patiently waiting to hear the sound of boiling water. Over time, I eventually learned the kettle's interface to a point where I no longer think about *how* to boil water; instead, I now focus on the high-level goal of making tea. The kettle provides

audio feedback when a button is pressed in the form of a short beep and alerts the user when the desired temperature is reached in the form of a consecutive series of short beeps. While learning the interface I paid attention to what buttons were pressed, what the display read the temperature as, what the audio feedback meant, and if the water level was sufficient. Now, I don't think about the kettle interface; I know that if I press the correct buttons, I will hear two beeps and shortly thereafter I will hear the water boiling within.

2.2 Redesigning for Rapid Understanding

While I initially expected the added granularity of temperature control to be a useful feature, I now realize that a much simpler interface would suffice for the purpose of boiling water at a given temperature. If I were to redesign the kettle's interface, I would focus on simplicity by removing the LED temperature display and replacing the buttons with the preset temperatures that automatically begin the heating process when pressed. In this design, the user need only press the button associated with the desired temperature and would not need to cycle through the settings nor press "START/OFF" to begin heating the water. With this paradigm, the user need only know which button corresponds to the appropriate temperature and can rapidly get to a point of expertise where the temperature value itself is not considered.

3 HUMAN PERCEPTION AND INTERFACE DESIGN

Most people who have stepped inside of a commercial gym before are familiar with cardiovascular exercise equipment, such as treadmills and stationary bikes. Oftentimes this equipment has advanced features, such as heart rate monitoring and adaptive difficulty (e.g., treadmill angle, pedal resistance). Effectively using the human capabilities of sight, hearing, and touch (haptics) can enhance the overall user experience with the interface. In the case of a stationary exercise bike, visual feedback is often presented via an LED display that informs the user about their exercise so far (elapsed time, distance, estimated calories burned, etc.) Audio feedback on an exercise bike is usually given as simple beeps to inform the user about the start or completion of an exercise routine. Finally, the sense of touch and pressure is used to inform the user about the pedal resistance for a given circuit. Additionally, these senses will indirectly inform the user about their posture when exercising, i.e., they have poor form if the seat is uncomfortable or the pedalling is asymmetric. This section will consider

design enhancements to stationary bicycles that use these senses in novel ways.

3.1 Enhancing the Exercise Experience

While stationary bikes are an effective means of cardiovascular exercise, they lack sophisticated stimulus to keep the user fully engaged. It's not uncommon to see people using stationary bikes also performing a secondary task for pleasure, such as reading, watching a video on their phones, or listening to music. In order to improve user engagement with the exercise, more stimulus can be provided.

Consider a hypothetical virtual reality (VR) interface that comes as part of the stationary bike. This VR interface could keep users more engaged with the task of exercising by displaying a simulated first-person view of a route or trail. The user would be able to turn their head and see all elements of the environment, including the trail ahead, the scenery, and even the simulated bike below them. Perhaps if the user is training for a particular bike marathon, the simulated reality may have other (potentially live) participants biking on the trail with them. This VR interface could optionally be fitted with headphones that provide audio feedback about the simulated environment, such as the sound of a cheering crowd in the case of the marathon trainer, or simply the sound of birds and rushing wind in the case of a more casual bike enthusiast. These enhancements would improve the overall experience for the serious and casual rider alike, motivating them to stay on the bike longer and push their limits further.

As anyone who has ridden a bicycle and a stationary bike can attest, the physical sensation between the two is quite different. On a real bike ride, the rider can feel the contact between the wheels and the ground beneath them, and how they ride is dictated by the surface they're riding on (street riding versus mountain biking). In the case of the stationary bike, there is significantly less variability. One way to enhance immersion and improve user experience on a stationary bike is to provide more haptic variability to the rider. Combined with the aforementioned VR system, the bike could shake when moving over rough terrain, or lean and tilt when a sharp turn is taken. Additionally, pedal resistance could dynamically change as the simulated bike moves up or down hills.

Another sense that is rarely leveraged in the context of exercise is that of smell. The hypothetical VR system could be augmented with an optional scent dispersal subsystem that provides additional input based on the user's environment, e.g., the smell of fresh air on a simulated mountain ride, or the smell of ex-

haust and rubber on a simulated city circuit. While these enhancements may not necessarily be pleasant for the user, it would undoubtably impact the user's immersion with their exercise.

4 ON REDUCING COGNITIVE LOAD

In the lecture unit on Human Abilities (2.4), designers are presented with five tips for reducing the cognitive load of the user interacting with the interface: (1) use multiple modalities; (2) allow the modalities to complement one another; (3) give the user control of the interaction pace; (4) emphasize essential content while minimizing clutter; (5) offload takes from the user to the interface. This section will consider tips (4) and (5) and will examine two everyday interfaces for violations.

4.1 Cluttered TV Remotes

Television remote controls are infamous for being difficult to use due to the sheer number of buttons and functions presented to the user at a time. A typical remote control has separate controls volume and channel selection, a numpad (0-9) for entering channels directly, buttons for controlling DVR or pay-per-view content (rewind, pause, play, forward), arrow keys for navigating menus, multiple power buttons (for the TV or the receiver box), buttons to access various menus, and even buttons to access streaming content (e.g., Netflix) on "smart" TVs. Additionally, some home entertainment setups require multiple remotes for controlling the various devices (e.g., surround sound). Essential content, volume controls and menu navigation, are sometimes lost in the sea of controls. For even an expert user, a new TV remote can be incredibly confusing. This is a significant violation of the fourth tip for reducing cognitive load.

A redesign of this interface could reduce the overall number of buttons and would emphasize only the essential controls: power, volume, and menu navigation. Functions such as channel navigation, recorded content control, and access to streaming services can, and should, be offloaded to the TV screen itself. This radical reduction of buttons and consolidation of controls would help bridge the gulf of execution for both novice and expert users.

4.2 Not so Smart Watches

In the past few years, smart watches have become ubiquitous, but have some drawbacks compared to "regular" watches, such as battery life. Regular watches are most often used as fashion accessories with a limited degree of utility for telling the time and date. While there is significantly less functionality in these devices (i.e., presenting the date and time), they suffer drawbacks that smart watches do not: it is often a difficult process to change the time and date accurately (e.g., due to time zone changes or a month with fewer than 31 days). Typically, the onus is strictly on the user to remember to alter the time and date when appropriate, violating the fifth tip for reducing cognitive load.

A redesign of this interface would be minor from the user's perspective, but would require additional hardware. The "SET" button on digital watches or the adjustment dial on analog watches could be removed entirely and replaced with an embedded radio antenna and GPS chip such that the watch automatically sets the time and date based on the user's location. While this may not be feasible for budget watches, the cost of embedded hardware is much lower than it used to be (chip shortage of 2021 not withstanding), this enhancement is feasible in many watch designs. By reducing the number of buttons/dials on the watch and enabling wireless time and date synchronization, the interface between the user and the task (telling the time) becomes effectively invisible.