Exploring the Relationships between Affective Character Design and Interactive Systems

THESIS

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Abstract

Emotional content facilitates human communication by adding depth and complexity to the information being transferred. By providing additional layers of meaning to the communicative process, affective display can reinforce, expedite, and clarify the messages being sent. Interactive systems can benefit from the same advantages that emotional communication provides by offering affective information channels. Consequently, affect and emotion can be important design considerations for creating interactive systems.

Affect and emotional content can be applied to such systems through the use of interactive virtual characters. Since we recognize, process, and interpret the emotional cues of other people, virtual characters can serve as familiar, intuitive interfaces for sharing affective content.

However, the design of these characters is highly dependent on the nature of the systems for which they are created. Without a fundamental understanding of the purpose and content of a particular system, it can be very difficult to determine which affective attributes to apply to a specific character. As such, designers need to understand the dynamic relationships between affect, interactive virtual characters, and the systems in which they reside.

The purpose of this thesis project was to explore these relationships by creating an interactive installation using a virtual character to communicate with users through
ffective display. By reflecting on the process of creating the installation and observing how various affective attributes influenced the delivery and impact of emotional narratives, it was hoped a clearer understanding would be gained of the benefits and limitations of affective character attributes for emotional communication.

The paper begins by introducing the fundamental concepts of affective systems, interactive characters, the primary goals of the thesis project, and the research questions it was intended to explore. After reviewing current research and theory on affective systems and interactive characters, the paper examines the conceptualization process of the installation that would ultimately be created. Titled *The Drinking Problem*, the installation is intended to provide the emotional experience of contending with the addictive behavior of an alcoholic.

The paper then describes the process of developing the installation, including rationale for design changes and general experiences with all aspects of production. The thesis concludes with a discussion of the project results, including various outcomes of *The Drinking Problem* and design insights gathered from the developmental process.
Dedication

To my family and parents,
for their endless love and support.

To my lovely daughter Zoey,
for the happiness and perspective
she gives with every smile.

And to my beautiful wife Amy,
for everything she is.
Acknowledgments

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Chapter 1: Introduction

The term affective may be defined as anything that is influenced by or results from emotion, which is the complex state of mind involving physiological arousal, expressive behavior, and conscious experience (Myers 2004, 807). While research suggests that human emotion has several roles to play, one of the most important seems to be its contribution to the interpersonal communication process (Darwin 1872; Gratch and Marsella 2005, 6).

Emotion allows people to add layers of contextual meaning to the direct information they exchange, thereby increasing the complexity and sophistication of those exchanges (Myers 2004). This allows them to convey additional information such as mood and intent that significantly shapes the nature of the dialogue.

Consider the example of the simple statement “I had an interesting day.” In the absence of emotional context or any additional information, this vague sentence could be interpreted in any number of ways. Without affective delivery cues such as vocal inflection or facial expressions, the statement has little meaning by itself. If we then consider the same statement in an emotional context, the meaning can change dramatically depending on the affective cues being displayed. If the speaker presents a somber expression, dejected posture, and a low-pitched tone during delivery, one could infer that the “interesting day” was not a pleasant one. On the other hand, if the speaker is smiling while talking and gesturing enthusiastically, the listener could assume that the
day’s events had culminated in a positive experience. In this instance, the emotional information expressed helps the listener understand the message.

This simple example underscores the idea that affect and emotional context can provide depth to the communication process. By augmenting information with the appropriate affective cues, people may deliver more content with fewer words and in shorter timeframes. Under optimal circumstances, this increases the speed and efficiency of communication while simultaneously increasing the fidelity of the information being delivered (Gratch and Marsella 2005, 6; Vinayagamoorthy et al. 2006, 7). With regard to incomplete, unclear, or ambiguous messages, emotional context can provide a backup communication channel that helps ensure a clearer understanding of the messages being sent. While emotional context does not preclude misunderstanding, it can facilitate the exchange of information, if used and interpreted properly.

This capacity to enhance human communication has helped make the delivery of emotional information a fundamental part of the human condition. Known as affective display, we outwardly present our emotions as a part of expressing ourselves when communicating with others (“Affective Display”). Affective features such as facial expression, gesture, and posture all serve to deliver emotional cues that extend more direct communication channels such as speech and text.

Not surprisingly, humans are innately predisposed to read and interpret these cues in others, however much they may be misinterpreted. We intuitively recognize elements of affective display and have the ability to process and interpret this information in order to facilitate comprehension.
Combined with the natural advantages of emotional communication, this inherent ability to express, detect, and process emotional information has inspired many interactive designers to integrate affective features into their work. Known as affective computing (Picard 2010), one of the primary goals of research and application in this area is to create systems capable of utilizing the functions of the emotional communication process. Since these systems may include a variety of potential applications in any number of fields, the term affective systems will be used throughout this paper as a general term that refers to any interactive system that employs analogs of one or more features of the human affective process. In turn, the phrase interactive systems is used to refer to computing applications that employ digital characters. While “interactive systems” is a broad term that can be applied to any number of things, for this paper it will be used to reference video games, training simulations, educational programs, and other forms of computing systems most commonly associated with the use of interactive digital characters.

Recognizing the potential advantages of such systems, scholars and practitioners in various disciplines have made similar efforts in recent years to make their own work more affective. Video game developers, simulation designers, and creators of instructional software are just some of the professionals who have been influenced by the benefits affective systems can provide. While these benefits offer considerable motivation to integrate affect into their work, many practitioners may have already decided to do so because their work involves the use of interactive characters.
1.1 Interactive Characters

Borrowing from traditional definitions used in literature, theater, and cinema, a character may be defined as that which “provides the illusion of a human person” (Pavis 1998, 47). By extension, interactive virtual characters may be considered representative digital agents that project the impression of a human persona. While virtual characters may be created using non-human representations such as animals or even inanimate objects, these characters are often endowed with anthropomorphic qualities that allow them to function in a more human-like manner. By doing so, designers give these characters increased capacity for communication and emotional expression, qualities very important to the success of affective systems.

Inherently, interactive virtual characters may function as intuitive interfaces for relating emotional information. Since they are potentially capable of displaying the same affective cues that a human being can, many interactive developers elect to use them when attempting to create affective computing systems. As humans have evolved to detect and process the emotions of other humans, it seems logical to design affective interfaces that use similar display features.

Developers already experienced with making interactive characters in fields like gaming and simulation have also been influenced by affective theory. Given that emotions are a natural part of the communication process, characters imbued with affective attributes could be given additional degrees of believability and expressiveness that non-affective characters may lack.
1.2 Additional Design Considerations

However, no matter how interactive or expressive virtual characters are designed to be, they rarely function in a vacuum. While they may serve as important focal points for interactive systems, they always function in concert with other system elements that must be taken into account. These additional considerations influence the development and functionality of the system as a whole and consequentially drive the character design in the process.

Video game characters provide a good example of this relationship. While sometimes it may appear as though games revolve around these digital personas, for the most part characters are designed to help achieve the goals of the game as a whole. Consequently, their visual appearance, functionality, and behavior are almost always predicated on the storyline and mechanics of the game in which they exist. Although designers may aspire to create emotionally compelling and engaging characters, they must do so through the filter of the game itself.

Of course, video games are not the only types of interactive systems that employ affect and interactive characters. Simulations, embodied conversational agents, and educational programs are just a few examples where affective character attributes can be used for greater emotional impact. Naturally, every project comes with its own set of considerations, constraints, and specifications that designers must take into account when developing an affective system. This can be a daunting task, especially if one is not well-versed in the particulars of affective design. Thus, interactive developers should seek to
understand the relationships between affect, characters, and the systems they are trying to create.

1.3 Affective Research

In an effort to understand these relationships, a great deal of research has been conducted on affective computing systems and interactive characters. These studies vary greatly and span a number of disciplines that include fields such as robotics, computer science, games, psychology, product design, cognitive science, animation, artificial intelligence, and interactive simulation.

Much of the research regarding interactive characters deals with the identification and development of specific features, functions, and technologies that can be incorporated to enhance affective characteristics. This can range from topics as specific as procedural expressive eye movement (Brockmeyer et al. 2013) to more general subjects such as the anthropomorphic characteristics of digital characters (Fink 2012). Authors attempting to survey one or more fields will often compile detailed lists of attributes they believe are representative of the most important aspects of affective systems (Norman 2004; Schmitz 2011; D'Mello and Calvo 2013). (These attributes are discussed in greater detail in the second chapter of this paper.)

Despite these efforts, there seems to be a lack of detailed information on how context and other aspects of emotional systems shape the development of affective interactive characters and vice-versa. While general guidelines are sometimes offered that touch on these relationships, these concepts tend to be fairly general and non-specific.
This deficiency is compounded by the fact that importance values are rarely assigned to affective attributes. While authors may identify characteristics like “physiological sounds” or “reactionary behavior” as valuable features of affective characters, they seldom indicate which attributes should be given more or less consideration in a given set of conditions.

The existing body of research also seems to focus on idealized versions of characters and systems that can be difficult or undesirable to create. While it’s understood that design guidelines are generally intended to provide various methods for improving existing products and workflows, the reality is that most interactive systems have limitations that make perfect realizations of affect unfeasible. Without clear indications of which affective attributes may or may not be important in particular circumstances, designers may find it difficult to distinguish between essential and non-essential elements on any given project.

Furthermore, perfectly realized systems and characters may not be a designer’s primary goal. Resource limitations notwithstanding, some designers may wish to integrate affective “flaws” into a particular system in order to produce specific results. These flaws may include emotional limitations implemented either by design or necessity. Examples of such limitations can be found in structural or behavioral characteristics that reduce expressiveness, such as a lack of traditional facial features or expressive mannerisms.
1.4 Project Focus and Research Goals

When one considers the many combinations of character and system features that are theoretically possible, it’s understandable why experts sometimes fail to offer more specific affective design guidelines. The number of variables that must be accounted for, considering all the possible permutations of affective interactive systems, can be difficult to address with sweeping, universal design strategies. Combined with the fact that affective computing and its related disciplines are relatively new fields of research, it’s logical that gaps should exist in our understanding of these relationships.

Nonetheless, deficiencies in applied knowledge can cause problems for interactive designers attempting to enhance character affect. Without a clearer understanding of how certain attributes should be used, developers will continue to approach affective character systems with a fair degree of uncertainty.

In an effort to make a contribution to this understanding, this project explored how affective character attributes are developed in accordance with the primary goals, purpose, and content of an interactive system. For the purpose of the research thesis, the specific question to be answered was:

“With the knowledge and understanding of important attributes that contribute to designing affective interactive virtual characters, what are the important design decisions to be made when informed by the purpose or content of the system in which they are a part?”

To explore possible answers to this question, the goal of this thesis project was to create an installation using an affective virtual character to provide an interactive
emotional experience. By reflecting on the process of creating the installation and observing how various affective attributes influenced the delivery and impact of emotional narratives, it was hoped a clearer understanding of those attributes would be gained. This understanding would include the benefits and limitations of affective character attributes for emotional communication as well as the relationships between affective interactive systems and the characters they use.

To achieve these goals, the project would involve the creation of an installation using emotionally-compelling subject matter expressed through interaction and the affective attributes of a digital character. This would call for a character design with the ability to project those attributes along with an interactive system that would facilitate the delivery of the chosen narratives.

From a research perspective, the potential insights gained from this project could be useful in other attempts to create affective interactive characters. By observing how various attributes contribute to meaningful emotional dialogue, designers may be better prepared to make their own choices regarding character design. This could be especially useful when resource limitations require designers to make hard decisions about the scope and scale of their own projects.

Similar insights could be gained from the standpoint of interactive systems alone. Should the results of this project provide a clearer understanding of affective character-system relationships, it stands to reason that designers would learn how to design better systems as well as better characters. This knowledge could potentially be useful in the
design of any affective computing system, regardless of whether or not virtual characters were used.

1.5 Design Problems and Challenges

A significant challenge for this project would be assessing the impact of specific affective attributes. While it could be relatively easy to determine if the installation communicated with users on an emotional level, it would be more difficult to identify particular attributes responsible for emotional stimulation. This would be particularly true if multiple affective attributes simultaneously influenced the same user emotions. Conversely, it would also be difficult to isolate cause if separate attributes produced several emotional responses that users were unable to distinguish from one another. To deal with these challenges, observation of user interaction would be required to isolate various cause-and-effect relationships.

Another challenge facing this project was the practical necessity of quickly establishing emotional connections with users. While strong interpersonal connections between humans can take years to establish, artists in media such as film, theater, and literature have much smaller windows of opportunity in which to connect to their audiences.

The same holds true interactive media designers, who often have even shorter timeframes in which to make these interpersonal connections. When designers attempt to create affective interactive experiences, the challenge becomes even more formidable if a major goal is establishing emotional rapport. Unlike simpler types of interactions,
affective experiences must connect with users on a deeper, more personal level. This can be difficult to achieve when users are expected to interact with installations for only minutes at a time.

It would be important to address this problem because the installation was intended to function as a gallery installation. In that context, most users would have limited amounts of time with which to explore the project, especially when other works in the gallery ultimately commanded their attention. For this reason, it was important to design the installation in such a way that was both immediately compelling and functionally expedient.

1.6 Paper Structure

The remainder of this thesis consists of four chapters detailing the development of the thesis project and to elaborate on various discussion points presented in the introduction. Specific emphasis is placed on various rationale for making certain design decisions and the ways in which those decisions influenced the outcome of the final project.

Chapter 2 reviews relevant research involving affect, virtual characters, and interactive systems. This section provides context for the affective design decisions involving the interactive character that would be created for this project. Chapter 3 details the original vision for the project, including preliminary rationale for the themes, structure, and function of installation and the interactive character it uses.
Chapter 4 reviews the overall process of developing the installation and the logic for making changes to the original design of the project. The paper concludes with a general assessment of the creative research, project results, and conclusions in Chapter 5.
Chapter 2: Background

The following chapter details knowledge and information obtained from the examination of research that has informed and influenced the development of this thesis project. Specifically, it reviews affective attributes of interactive systems and virtual characters that have been identified in various fields of study. For the purpose of this thesis, “affective attributes” may be defined as qualities or features of interactive systems that enhance emotional communication. These attributes were used to guide the design of the interactive character serving as the focal point of the thesis project.

Since a comprehensive review of all affective attributes is beyond the scope of this paper, the following sections focus on those that are featured most prominently in the literature. Additionally, most of the content is limited to attributes related to interactive virtual character design, with special emphasis placed on those essential to the development of the thesis character.

Because various forms of behavior determine the affective impact of interactive characters, the chapter largely centers on action patterns and associated display features that contribute to emotional communication. While the visual appearance of interactive characters has some influence on their ability to communicate affectively, verbal and non-verbal behaviors represent the majority of factors shaping the affective process. Section 2.1 briefly touches on visual appearance and its role in the affective process. Section 2.2 constitutes the bulk of the chapter, divided into seven subsections that
include intrinsic behavior patterns (2.2.1), extrinsic behavior patterns (2.2.2), facial expressions (2.2.3), gaze (2.2.4), gestures and movement (2.2.5), posture (2.2.6), and verbal behavior (2.2.7). A brief summary and final thoughts on affective attributes are provided in Section 2.3.

2.1 Visual Appearance

Since interactive virtual characters largely exist as visual representations, designers must naturally take their appearance into consideration. Many researchers deem appearance to be an important quality for enhancing affect in interactive systems (Norman 2004, 65) and creating social, lifelike characters (Schmitz 2011, 158, Vinayagamoorthy et al. 2006).

Because visual appearance is critical for establishing first impressions, a psychological event that refers to the immediate and intuitive response individuals have when first encountering a person, place, or thing ("Impression"). Just as people form preliminary mental models of others when they first meet, the same process occurs when people first encounter artificial characters (Bergmann, Eyssel and Kopp 2012, 1).

Social psychology studies have demonstrated that visual appearance and nonverbal behavior are the primary factors in forming first impressions (Bergmann, Eyssel and Kopp 2012, 2). These impressions can influence the affective process because all subsequent communication must be processed through the filter of those first impressions (Bergmann, Eyssel and Kopp 2012, 1). While the effect of this event may diminish with time and experience, first impressions can be a significant factor for
interacting with virtual characters since contact time with users is largely variable. When designing characters that people may interact with for only minutes at a time, first impressions can be critical for the emotional impact of those characters. Therefore, designers might wish to consider these initial impressions when designing the appearance of their characters. They may think about the emotional “statements’ they wish to make when the character is first introduced, and how those statements will influence the emotional dialogue from that point forward.

2.1.1 Realism and Visual Style

In theory, the visual appearance of interactive characters is limited only by the imagination of the designer. While the realities of interactive development usually impose practical limitations involving time, money, and resources, most designers still have a great deal of flexibility in creating their characters. Even when saddled with a variety of real-world constraints, designers using modern CGI and interactive development technologies are still capable of pushing the limits of their aesthetic creativity.

This fact has helped produce an interactive landscape filled with characters representing a variety of shapes, styles, and designs. Some are more realistic and representative of beings that exist in the physical world, while others are more stylized and suggestive of a particular aesthetic. Given this potential variation in visual appearance, some interactive developers have questioned whether or not it is important to make characters appear more realistic (Bergmann, Eyssel and Kopp 2012, 3).
While there are certain conditions where more realistic characters can be useful for achieving certain goals (ex. medical and scientific simulations), realism doesn’t guarantee more affective, lifelike, or communicative characters (Vinayagamoorthy et al. 2006, 4). Studies have shown that characters with primitive, cartoonish, or other types of non-realistic appearances can communicate just as effectively as realistic characters (McDonnell 2012, 7). In context-appropriate cases such as children’s games and educational applications, stylized characters may be even more effective at delivering content and emotional information.

Consequently, designers may wish to consider the potential benefits of using stylized or minimized versions of artificial characters. Unless project specifications require the use of realistic characters, non-traditional designs may provide certain advantages in terms of user engagement, emotional impact, and communication.

2.1.2 The Importance of Visual Appearance

While visual appearance is a significant and unavoidable consideration for designing interactive virtual characters, the current literature suggests it is not nearly as vital for relaying emotion as other attributes are (Vinayagamoorthy et al. 2006, 4). Other than establishing first impressions, the only other major concern regarding character appearance seems to be that it should represent behavior (Vinayagamoorthy et al. 2006, 3, Bergmann, Eyssel and Kopp 2012, 3). When appearance does not support behavior (and vice-versa), users become notably and negatively affected in their interactive experiences.
For the most part, verbal and non-verbal behaviors appear to be much more important for influencing affect than visual appearance. A 2008 study applying identical motion capture takes to digital characters with fundamentally different appearances demonstrated that changes in user emotional impact between characters was insignificant (McDonnell et al. 2008). While the study was limited to body motion and did not include other affective attributes such as facial expressions, it still provided compelling evidence regarding the relationship between appearance and affect. Studies like this seem to suggest that the influence of appearance on emotional communication is somewhat limited.

2.2 Affective Behavior

Behavior may be defined as the range of actions and mannerisms made by an individual in conjunction with their environment ("Behavior"). For the most part, human communication is dependent on behavior since our actions determine how, when, and why we transmit and receive various types of information. This communication includes affective information, the exchange of which is dependent on various verbal and non-verbal cues.

Since human interaction is the model on which most interactive character behavior is typically based, theorists and practitioners have concluded that affective behaviors can be applied to digital characters as well. With this in mind, it is important for designers to understand behavioral patterns and display features that stimulate emotional interaction in human communication.
For the purpose of this paper, behavior can divided into two sub-categories that include intrinsic and extrinsic forms. Within the context of this thesis project, intrinsic behavior refers to character actions that are influenced by and pertinent only to the characters themselves. Such behavior includes autonomous actions that don’t require user input or stimuli from the virtual environment in which a character resides. Examples of intrinsic behavior include various types of postures, facial expressions, and gestures that are spontaneously initiated.

Conversely, “extrinsic behavior” refers to actions that are stimulated by and act upon only that which is external to the character. External influences include user input or environmental stimuli that elicit some type of reactive behavior. Examples of extrinsic behavior would include characters avoiding environmental obstacles and moving through a virtual environment based on guidance from user input.

The concepts of intrinsic and extrinsic actions have been adopted for this thesis because they serve as a simple means of describing fundamental forms of interactive character behavior. As discussed in the following sections, distinguishing between the two types of actions is important for understanding, designing, and applying such behavior to interactive characters.

2.2.1 Intrinsic Behavior Patterns

Intrinsic behaviors are important for affective systems because they provide the impression that characters are capable of functioning independently. This creates the illusion of a lifelike persona capable of independent thought and will. As several studies
have shown, enhancing believability and lifelike behavior in digital characters strongly promotes affective communication (White, 1995; Persson, Laaksolahti and Lönnqvist, 2000).

There are many types of intrinsic behavior designers should consider when developing their characters. In addition to specific categories of spontaneously generated facial expressions, motions, and gestures, there are general patterns of intrinsic behavior that designers may wish to emulate.

**Stereotypical behavior** refers to actions that elicit simplified and conventional mental models of the emotional state of humans and interactive characters (Schmitz 2011, 159). This includes any set of emotional actions that are easily recognizable and interpreted through a relatively small number of affective display cues. Examples of such behavior include shyness, curiosity, frustration, and confusion.

Stereotypical behaviors are excellent tools for enhancing character affect because they a) rely on a small number of cues and b) are easily identifiable. Consequently, they can be implemented relatively quickly and easily with a certain degree of confidence that they will be identified by users. For example, consider a situation in which a character needs to display “shyness.” While real human shyness is a complex behavior involving many subtle factors and display cues, interactive characters need only project the primary cues to relate this affective state. If a character’s head turns down and away from the camera while displaying a sheepish grin (see fig. 1), there is a good chance these actions may be interpreted as “shyness.”
Personality is another concept related to the intrinsic behavior of affective characters (Prendinger and Ishizuka 2004, 7; Schmitz 2011, 160) that may be defined as the inherent patterns of collective character, behavioral, temperamental, emotional, and mental traits of a person ("Personality"). An idea related to moods and emotions, personality describes characteristic patterns of behavior that generally have a) no time limit and b) are not focused on any particular stimulus. These qualities distinguish personality from emotion or moods, which tend to be temporary in nature.

For example, a character responding with anger to some environmental stimuli (ex. an anvil falling on his head) would clearly be a case of expressive emotion. However, if the same character projected a general tone of anger throughout the entire interactive experience (regardless of external influences), the character could be described as having an “angry personality.”
Designers wishing to impart an additional sense of emotional believability may want to consider the overall personalities of their characters. While emotional reaction to individual stimuli is important for creating the illusion of affect, personality helps relate inherent narratives along with a pattern of emotional behavior that helps define the affective nature of a character.

Other forms of intrinsic behavior include a variety of motions, gestures, and display features that appear spontaneously and autonomously. While a comprehensive discussion of these behaviors is beyond the scope of this paper, examples include: *facial tics, shoulder shrugs, head nods/bobs, rocking, leaning, finger/toe tapping, and expressive arm, hand, and finger gestures.* (For more detail on these behaviors, refer to the listed references.)

2.2.2 Extrinsic Behavior Patterns

Extrinsic behaviors are essential elements of all interactive characters because they provide a means for responding to their external environment. By definition, characters must be able to respond to stimuli to be considered interactive. Since interaction is also a fundamental requirement for living, social, and intelligent beings, it stands to reason that enhancing interaction tends to augment the perception of characters as life-like digital personas. As the sophistication and complexity of this interaction increases, so does the resemblance to living, intelligent creatures. As previously noted, digital characters with increasingly life-like behaviors are more capable of emotional
projection. As a result, enhancing the quality of interactive behavior generally tends to promote affective communication.

Most reactive character behaviors could be considered extrinsic, since they involve a response to some external stimulus. This includes reactive gestures such as “flinching” and “wincing” along with larger body movements like “ducking” or “blocking.” However, while these relatively simple behaviors are suggestive of life-like responses, they lack the subtle nuances of sophisticated intelligent behavior. To provide the illusion of thoughtful, human intelligence required of anthropomorphic characters, designers should seek to employ more complex forms of extrinsic behaviors.

As with intrinsic behavior, there are many general patterns of extrinsic behavior that designers may wish to consider when designing interactive characters. These include various forms of social dialogue (ex. small talk), social protocol (introductions, hand-shaking, etc.), and other behavioral concepts inherent to social computing (Schmitz 2011, 161). Examples of forms of complex intrinsic behavior include empathy and humor (Schmitz 2011, 162). When applied correctly, these behaviors can give interactive characters much higher potential for affective communication.

However, these behaviors can be difficult to implement because they require the system to sense and respond to various forms of input. This is especially true when interacting with humans, as traditional input devices such as mice, keyboards, and control pads are unnatural extensions of the human communication process. When attempting to incorporate more sophisticated user input methods such as cameras, gesture sensing devices, and haptic technologies, the effort needed to incorporate acceptable interaction
tends to increase. With this in mind, designers should carefully consider the affective requirements of their characters before deciding to integrate complex extrinsic behavior. If the effort involved in implementing such behavior outweighs the potential affective benefits, designers may wish to find alternative methods for integrating extrinsic behavior.

2.2.3 Facial Expressions

*Facial expressions* provide extremely important affective visual cues, and some researchers would contend they are the most important (Ekman and Friesen 1975). As with other affective attributes, they have unique communicative advantages such as providing emotional feedback, highlighting mood, and reflecting attitude. Because of these advantages, humans pay particularly close attention to the face when communicating with others (Knapp 2012).

The importance of facial expressions in the communication process has prompted many character developers to devote significant time and resources to enhancing these important attributes. This may result from the notion that characters with more expressive faces are generally thought to have greater capacities for acceptance, communication, and engagement. This would explain numerous efforts to develop various technologies intended to capture the subtleties of the human face. These efforts include any number of procedural or motion capture technologies focusing on facial expression.

**Procedural methods** rely on algorithmic generation, blending, and timing of facial expressions, whereas traditional animation and motion capture techniques rely on
expressions generated by animators or actors. When more open-ended and flexible interactive solutions are required, designers may elect to use procedural approaches. Where emotional expressiveness outweighs the need for adaptable interaction, animated or motion capture techniques may be employed.

Of course, the ability of facial expressions to deliver emotional content is dependent upon how visible they are to the user. In circumstances where the face is partially or completely hidden from view, facial expressions may be poor vehicles for conveying emotion. Under these circumstances, other forms of affective display such as gesture and posture be may be used to greater effect (Vinayagamoorthy et al. 2006, 24).

While scholars generally consider speech and facial expressions to be more effective than gesture and posture cues in human communication, this may be less true for interactive characters. Due to factors such as small screen sizes, less-expressive facial features, and variations in the fidelity of digital speech, gesture and posture cues can sometimes be more effective than other emotional display features.

2.2.4 Expressive Gaze

Expressive gaze is an important attribute that can conduct a great deal of emotional information. Generally speaking, gaze indicates the degree of involvement and attention a virtual character is investing in a particular interaction, which is reflective of the character’s emotional state. Thus, gaze can suggest emotional conditions that correspond to various degrees of character attention. Feelings such as anger, sadness, happiness, and fear are just a few of the emotions expressive gaze can help to relate.
Consider an interactive character staring deeply and intently in the direction of a user. Combined with one or two additional cues such as a forward-leaning posture and a discernible frown, the intense gaze could easily suggest anger. Of course, other attributes such as facial expressions are needed to refine perceptions of gaze, but it can be a powerful cue in and of itself. Gaze can serve as an indicator that interactive characters are about to initiate user interaction. If a character that was previously staring in another direction suddenly shifts his gaze towards the user, it’s reasonable to expect that the character is about to initiate some form of interaction.

Once interaction is underway, gaze can provide expressive feedback when users complete a turn in the interactive process (Vinayagamoorthy et al. 2006, 22). Turn-taking is an important process for creating believable and life-like interaction between users and digital characters.

In many applications, attentive character gaze is most focused on users at the beginning and end of a given interaction or conversation. However, it’s important to note that gaze must be diverted at various times during a particular interaction to prevent users from becoming uncomfortable or intimidated.

Generally speaking, designers must consider gaze when designing interactive characters regardless of whether they have eyes or even a face. As the orientation of characters towards the user is generally suggestive of “body” gaze, even the most primitive of characters are capable of using gaze for emotional and communicative expression.
2.2.5 Gestures and Motion

**Gestures** may be defined as *movements of various parts of the body to express an idea or meaning* ("Gestures"). They can be intrinsic or extrinsic actions depending on why they are initiated, and like other types of behavior can be quite useful for expressing emotion. In most situations, gestures can replace or augment other forms of communication such as speech and facial expressions. Although there are several different models for classifying gestures, they can generally be divided into three basic categories of *emblems, illustrators*, and *regulators* (Vinayagamoorthy et al. 2006, 6).

**Emblems** consist of standardized, highly recognizable gestures that are often used intentionally when other forms of communication are unavailable. Examples of emblems include waving hello from a distance or communicating a “stop” action by putting both hands palms-up in front of the body. **Illustrators** are voluntary but spontaneous gestures used to enhance other forms of communication such as speech. One example of an illustrator would be the use of hands to describe the shape of an object while verbally describing it. **Regulators** are the third type of expressive gesture and refer to actions that help direct conversation and other forms of dialogue. The open-handed wrist rolls suggestive of a cranking movement is an example of a regulator used to tell someone else to speed up a conversation.

While emblems, illustrators, and regulators primarily assist with directing communication, the manner in which gestures are displayed determines how emotional content is projected. For example, short and frantic gestures are often indicative of extreme emotions such as anger, frustration, or fear. Gestures using broad, slow-moving
actions often represent more subdued emotional states such as sadness or tranquility. So while gestures serve as a means of non-verbal expression, it is the specific nature of their motion that helps facilitate emotional communication.

Gestures and other forms of character motion can provide very affective emotional cues. This is particularly true when interactive characters are seen from a distance, where features such as facial expressions can be difficult to discern. When creating characters that spend large amounts of time at considerable distances from the virtual camera, designers would do well to take gestures into account. Practical examples of such situations include many action-adventure games in which a third-person camera system is often used.

Of course, camera distance and the visibility of facial expressions are not the only factors that should influence the use of gesture. Generally speaking, any interactive environment where primary communication channels are limited should be considered. Applications intended to function in loud environments where ambient noise may interfere with speech and sound may be one such example.

2.2.6 Posture

In the context of this paper, posture refers to the position and orientation of the body of a human or interactive character. Postures could be considered transitory states separating one bodily movement from another or starting positions from which all subsequent movements are made until the next posture is reached. Regardless of one's perspective on postures, research shows that they are highly effective at
communicating emotion (James 1932, Rossberg-Gempton 1993, Mignault, 2003). Postures are especially effective for conveying established, long-term patterns of emotional behavior such as personality and mood.

However, it appears that not all body parts are equally effective at expressing emotion, even when they are part of the same posture. For example, established research suggests that the head and torso are more expressive features than arms, legs, or other body parts ((Vinayagamoorthy et al.) 2006, 25). Other affective qualities of posture include a) their ability to help others distinguish between similar forms of emotions, b) the capacity to direct the visual flow of conversation, and c) the ability to establish an emotional context based on proximity to users (De Silva, 2005).

In reference to other forms of affective attributes, postures serve much in the way that gestures and motions do. By providing an alternative to more direct cues such as speech and facial expressions, postures can be used when other avenues of emotional expression are limited.

2.2.7 Speech, Voice, and Physiological Sounds

*Speech* and the human voice can be very strong emotional triggers (Persson et al. 2000). In various fields of affective computing, many efforts have been devoted to the development of natural-sounding artificial speech. Also known as *speech synthesis*, the major goal of this area is to generate artificial speech that is indistinguishable from the human equivalent. While there appears to be several evaluation techniques for assessing the quality of synthetic speech (Picart, Drugman and Dutoit, 2012), most of them focus
Challenges to creating artificial speech include various issues with text conversion, natural language processing, and prosody, the particulars of which are beyond the scope of this paper. The concept of prosody refers to the rhythm, stress, and intonation of speech and is the primary means of emotional communication in the human voice (“prosody”, 2013). While developers of artificial speech often attempt to address prosody, it remains an element of synthetic voices that is still lacking in terms of emotional delivery. For this reason, many interactive character developers opt to use recordings of human voices in place of speech synthesizers when emotional impact is an important requirement of their work.

While speech and voice are certainly important audial elements of interactive characters, they are not the only affective sounds in a designer’s arsenal. Characters can also emit various physiological sounds such as grunts, groans, and sighs that can impart lifelike qualities and emotional content when used properly (Norman 2004, 120, (Schmitz) 2011, 159). While obviously related to speech and voice, physiological sounds represent a distinct category of affective sounds that deserves special consideration.

For example, consider a character that emits a long, drawn out sigh. Even in the absence of speech, movement, or any other significant behavior, this simple sound could suggest a variety of emotional states including sadness or frustration. When used in conjunction with other affective display attributes such as posture and facial expression, these types of sounds carry even greater emotional weight with users. A character
presenting a sad facial expression and a sloped, dejected posture to complement the sigh could project unhappiness or depression without uttering a single word.

Physiological sounds such as these can be useful and subtle tools for interactive character designers since they are relatively easy to implement. As speech synthesizers and extended recordings of voices can be difficult to apply to interactive characters, physiological sounds represent an efficient means of imparting affective expressions. When combined with other audio elements of an interactive environment such as music tracks and sound effects, physiological sounds can be used to deliver a great deal of emotional content.

2.3 Summary

Many attributes of affective interactive characters have been highlighted in this chapter, along with several suggestions for implementing them. With this in mind, this chapter only serves as a brief introduction that barely scratches the surface of the complex topic of affective character attributes. Those wishing to explore these concepts in greater detail are encouraged to investigate the references listed at this conclusion of this paper.

However, it’s important to remember that interactive characters must function within the constraints of the system for which they are designed. While an understanding of affective attributes can be helpful when designing such characters, they must still be applied in such ways that they contribute to the purpose for which the system is intended.
Also important to remember is the degree to which user variability can affect how affective attributes are perceived. Differences in age, culture, education, and experience are just some of the factors that influence user perception, so care must be taken to account for these factors as much as possible. Physiological and psychological differences between users must also be considered as these conditions affect perception, processing, and response to various interactive stimuli. Consequently, designers would do well to consider the potential diversity of users who may interact with their characters as well the context and environments in which those characters reside.
Chapter 3: Concept Development

The following chapter details the initial conceptualization of the installation presented in the introduction and the manner in which the project would help explore the research questions the thesis was intended to answer.

Section 3.1 provides a brief overview of the project as it was originally conceived in order to provide context for the remainder of the chapter. Section 3.2 details the logic and rationale for designing the project within the framework of answering the research questions. Section 3.3 discusses the choice of themes, subject matter, and narratives, along with the reasoning behind their selection. This is immediately followed by an overview of the works that influenced these selections in Section 3.4, which primarily discusses cinematic and animated works.

Section 3.5 reviews the interaction and mechanics of the installation as it they were first envisioned. The chapter concludes with a discussion of interactive works that influenced this interaction in Section 3.6.

3.1 Summary Description of the Project

The project that would eventually be created for this thesis is an interactive installation designed to convey the feelings experienced when trying to help a hopeless addict. Titled The Drinking Problem, the installation uses an affectively-designed interactive character to relate emotional narratives and behavior consistent with addictive
behavior. For the purpose of clarity, this character will be referred to as the “Alcoholic” for the remainder of this paper.

*The Drinking Problem* is intended to provide users with an emotional experience from two perspectives, the first of which is the Alcoholic himself. By giving the character the ability to display affective behavior, users are given a window to the character’s emotional state. As this state changes in response to user interaction, an emotional narrative emerges.

The second perspective is that of the user interacting with the character. This view is representative of the primary purpose of *The Drinking Problem*, which is to recreate part of the emotional experience of interacting with a hopeless addict. As users first engage the installation, they will experience a brief sense of hope and control that they can bring about a satisfactory conclusion to the interaction. As the installation progresses, the user ultimately comes to the realization that they have no ability to affect the behavior of the character. Hopefully, this realization will be accompanied by feelings of frustration and futility representative of the real-life experience of dealing with the addictive behavior of others.

This brief project description is intended to provide context for the remainder of this chapter, which will focus on specific details of the conceptualization process.

### 3.2 Early Concept Development

Before *The Drinking Problem* was conceived, the primary goal of the research was to explore design considerations for integrating affective virtual characters with
interactive systems. To permit this exploration, a suitable interactive environment was needed to serve as a practical test bed to develop an affective character. Therefore, it was determined that the practical goal of the project was to develop a creatively expressive interactive installation that used an affective virtual character to relate select emotional narratives to users.

While works of artistic expression are certainly not a requirement for exploring affective systems and interactive characters, it was decided that such a vehicle would be very suitable for relating emotional content. Since the nature of artistic expression can be conducive for delivering emotional narratives, an installation of this type seemed preferable to interactive systems of a more conventional nature (games, simulations, etc.). The process of creating *The Drinking Problem* would provide practical opportunities to explore the design decisions involved when balancing affective character attributes with the intended purpose of an interactive system. These decisions and their effects on the outcomes of the installation were intended to provide useful insights on the future development of affective characters. Outcomes of particular interest would include 1) the emotional impact of the installation on users, 2) how affective attributes of the character influenced that impact, and 3) how those attributes had been crafted during development to better align with the purpose and content of *The Drinking Problem*.

### 3.3 Themes, Narratives, and Subject Matter

Before the interactive environment and character of the installation could be designed, it was necessary to select the themes, narratives, and subject matter of the
installation. Early in the process it was decided that the project would focus on the topics of addiction and alcoholism.

Using such emotionally-charged subject matter could benefit the project in several ways. First, it would provide a recognizable theme many users could relate to. As alcoholism affects millions of people around the world, most users could connect to this subject in some way. Secondly, the narratives could allow for dramatic, expressive, even stereotypical character behavior more easily recognized by users.

Since The Drinking Problem was intended to be a work of creative expression, certain license could be taken with those behaviors to make them even more recognizable and expressive. As noted in the literature review, stereotypical behavior is an important quality for enhancing affect (see Section 2.2.1). The fact that substance addiction is a familiar, relatable, and emotionally-charged theme could also help address the need for an installation that quickly and effectively reaches users on an emotional level.

### 3.4 Influences on Theme, Narrative, and Style

Several works in film, animation, and interactive media would influence the delivery of themes and narratives for this installation. Movies including Less Than Zero (1987), Leaving Las Vegas (1995), and Requiem for a Dream (2000) provided excellent dramatic references of substance abusers that would affect the design of the Alcoholic character. These were especially useful since the Alcoholic was intended to deliver a dramatic, stereotypical performance of addictive behavior.
The 2004 film *Ryan* was particularly influential for this installation, both from the standpoint of subject matter and character development. Chris Landreth’s animated documentary was an expressive depiction of an interview with Canadian animator Ryan Larkin. A talented and inspiring artist, Larkin was beset by substance abuse problems that cut short his promising career.

Figure 2: An example of Chris Landreth’s “psychorealistic” visual style from the 2004 animated film *Ryan*. (Image retrieved from http://undergroundanimation.com/wp-content/uploads/2012/04/ryan.jpg)

In addition to similarities in character and topic to the proposed installation, *Ryan* was influential in that it depicted a visual style of character design that Landreth would
later call “psychorealism.” In designs of this type, the visual appearance of a character is metaphorically representative of their internal selves (see fig. 2). In the case of the Ryan Larkin character, the film presented a distorted, surreal, and broken vision of a man filled with inner demons and emotional problems.

While the literature review suggested that character appearance is not a major factor influencing affect, it did suggest that appearance was important for establishing first impressions and relating narrative. Along with a personal preference for unconventional aesthetics in 3D works such as Ryan, this fact led to the decision to apply a non-photorealistic visual style to The Drinking Problem. (Specific details regarding the development of this style can be found in Section 4.1 of this paper.)

3.5 Interaction and Mechanics

Set in a digital environment resembling a kitchen, the user will engage the Alcoholic from a first-person perspective. Specifically, the orientation of the virtual camera gives the impression that the user is standing or sitting across the table (see fig. 3). Users interact with the Alcoholic by manipulating objects in his immediate environment to produce various types of behavioral responses. As The Drinking Problem would be installed on a touch-screen computer, user interaction is limited to objects that can be clicked on, dragged, and released.

Users have the ability to manipulate objects in the environment, although not the Alcoholic himself. This is intended to mirror the real-world concept that one cannot make an addict do anything directly. The primary objects users are able to manipulate are the
alcohol bottles found throughout the environment, which can be moved and placed around the kitchen.

Figure 3: View of *The Drinking Problem* from a user’s perspective.

For all practical purposes, users can do one of only two things with these bottles; place them inside or outside the Alcoholic’s reach. Placing them within reach allows the character to grasp the nearest bottle and drink its contents. Moving the bottles out of reach will temporarily delay his ability to drink. If the user breaks the bottles or keeps them out of the character’s reach for too long, new bottles will spawn that the Alcoholic will be able to retrieve.
This represents the primary goal of the Alcoholic, which is to find the next bottle and drink it. Once he is finished drinking he will discard the current bottle, then locate and retrieve the next one to continue the addictive cycle. As the Alcoholic drinks more over a certain period of time he exhibits increasing levels of drunken behavior. This behavior is projected through gestures, postures, and facial expressions characteristic of intoxication.

If users manage to keep the Alcoholic from drinking for an extended period of time, the character becomes more sober and slowly reverts to his normal behavior. However, unless users maintain vigilant action in keeping the bottles out of reach, the character quickly finds another bottle to drink. In the end, it’s impossible to keep the Alcoholic from drinking indefinitely as users can only hinder the process. If users cease their efforts to keep bottles out of reach, the character will immediately resume his drinking. This is intended to reflect the reality that removing the source of addiction is ultimately an exercise in futility, since addicts will always find a way to acquire more. Thus, the installation is designed to provide the Alcoholic with an endless supply of bottles.

Left to his own devices, the Alcoholic will drink himself almost to the point of death. At this point the character stops drinking and slowly begins to recover. When the character reaches his maximum level of intoxication, the program resets itself by increasing the rate of recovery and temporarily suspending the drinking behavior. Once the Alcoholic has reached full sobriety, the bottles begin to spawn again and the character resumes drinking.
The Alcoholic will not be able to speak, as one of the goals of *The Drinking Problem* is to convey a narrative primarily through visual affective display. If the Alcoholic communicated through verbal dialogue, it would be difficult to determine the degree to which affective display was used to relate emotional narratives.

3.6 Interactive Influences

While films and animation provided excellent references for character behavior, narratives, and emotional content in *The Drinking Problem*, interactive works offered inspiration in the form of both content and interaction. Particularly helpful were video games containing serious subject matter attempting to relay emotional narratives. Of these games, one of the most notable was the 2012 independent game *Papo y Yo*.

3.6.1 *Papo y Yo*

In this fantasy-adventure game users play the role of Quico, a young boy who explores a virtual favela with his pet “Monster.” Designed by creator Vander Cabellero, the game serves as an interactive allegory for the author’s personal childhood experiences with his abusive, alcoholic father. In an interesting take on interactive narrative, the relationship between Quico and Monster is intended to reflect the emotional relationship Cabellero had with his father as a child.

Most of the time, Monster is a gentle, playful giant (see fig. 4). However, eating frogs throws Monster into fits of violent rage, whereby he chases Quico until the boy can find a piece of fruit with which to calm the creature. This dynamic continues throughout
the game as players experience tension from the fact that Monster may lose control at any moment.


Quico’s companions (Alejandra and Lula) face constant peril from Monsters outbursts, as does Quico himself. Even though their intention is to help the creature, they cannot escape his murderous rages. As the characters continue their journey with the goal of curing Monster, they face difficult challenges that put their welfare and that of the creatures’ at odds. At the game’s conclusion, Quico sadly discovers that he never had the power to cure Monster/ his father at all, and must abandon him to his fate.

While *Papo y Yo* is larger in scale, scope, and complexity than *The Drinking Problem*, they share similar content and elements of interaction. Aside from obvious similarities regarding the theme of alcoholism, a shared goal of both works is that they
attempt to relate the experience of dealing with addictive behavior in others. In order to achieve this goal, interactive mechanics and character behaviors are simplified, compartmentalized, and exaggerated to better translate the interpersonal dynamics between addicts and people close to them.

Behavioral similarities between Monster and the Alcoholic are evident, particularly in the cyclical nature of their addictive behavior. Both characters have calm, sober states they express when not under the influence of frogs/ alcohol. When either character ingests the source of their addictions, their behavior toward the user becomes decidedly negative. Both characters return to their calm, sober states eventually, underscoring the “Jekyll and Hyde” nature indicative of substance abuse.

Despite the similarities between the two characters, there are significant differences in behavior and interactive mechanics. When Monster eats a frog he instantly transforms into a murderous beast, but can be instantly calmed when players get him to eat a piece of fruit. In contrast, the Alcoholic becomes intoxicated slowly over the course of drinking several bottles, with his behavior becoming detached and less functional rather than violent. Unlike Monster, the Alcoholic also cannot be instantly converted to his sober state. Users engaged in The Drinking Problem must slowly wait for the effects of the alcohol to wear off, a condition more representative of the realities of alcohol consumption.

These interactive and behavioral differences between the two characters are reflective of the purpose and nature of the respective systems they were designed for. As Papo y Yo is an adventure game of considerable complexity, players are given greater
control over Monster with options to calm or lead him with a piece of fruit. Progress through the game levels is facilitated by this control, level progression being an inherent feature of this kind of game.

Since *The Drinking Problem* is a more simple experience not intended to function as a game, the interactive dynamics and behavioral displays can be significantly different. Without extended narratives, multiple levels, and complex mechanics with which to contend, users of *The Drinking Problem* can focus on the Alcoholic’s behavior. Consequently, this behavior can be more subtle, extended, and nuanced.

These differences in behavior and mechanics highlight the considerable influence interactive systems have on the design of affective character features. Even when two characters like Monster and the Alcoholic have very similar roles to play, the type and purpose of the systems in which they function require markedly different mechanics and affective behaviors.

3.6.2 Tartarus

*Tartarus* is an interactive installation that strongly influenced the concept of this thesis project. Created by Alan Price in 2006, *Tartarus* makes reference to the legendary dungeon from ancient Greek mythology. A hellish region located beneath Hades, the original Tartarus was a mythical prison where the Titans and other wicked creatures resided in eternal punishment.

A modern-day take on this theme, the digital *Tartarus* features an interactive character residing in a virtual environment comprised of a series of small, dark rooms and
staircases (see fig. 5). Designed as an infinite space, users can guide the character up and
down the stairs indefinitely, always ended up in the same room. Users guide the character
through the environment by clicking on a mounted touch screen display. After clicking
on a specific location, the character navigates to the selected point in virtual space.

Figure 5: Screen captures from Tartarus (Alan Price, 2006). (Images retrieved from http://accad.osu.edu/~aprice/works/tartarus/index.html)

The only other object in the Tartarus environment consists of an unassuming
wooden chair. As part of the interaction, users can direct the character to move the chair
at various locations throughout the environment. Just as Sisyphus was condemned to
push an immense boulder up and down a hill for eternity (“Sisyphus”, 2013), the
Tartarus character is destined to carry the burden of this chair over and over again. As
the character moves through the environment the wooden chairs begin to replicate,
eventually surrounding and trapping him. At this point, the chairs disappear and the cycle of futility begins again.

This project was extremely influential given the themes of addiction and alcoholism that were selected for this thesis project. In many ways, the life of an addict resembles the hell of Tartarus as their addiction compels them to engage in an endless, repetitive pattern of self-defeating behavior. The wooden chairs of Tartarus and the boulder of Sisyphus immediately conjured images of endless alcohol bottles that dominate the life of an alcoholic. After viewing Tartarus, the notion of an unending, self-imposed hell seemed like the perfect metaphor for The Drinking Problem.

Conceptually, the biggest distinction between Tartarus and The Drinking Problem would be the specific implementation of an expressive, affectively-designed character. While the Tartarus character delivered an emotionally-compelling narrative, the thesis project would require a character capable of relating emotional narratives through affective display. While the character of Tartarus employed some affective display attributes such as attentional gaze, it didn’t seem to incorporate other affective features such as facial expressions, emotional gestures, etc. In contrast, The Drinking Problem will employ affective display as well as other forms of behavior to relay the intended narratives.
Chapter 4: Process

The following chapter details the process of developing the thesis installation after the preliminary conceptualization was complete. These sections describe the relevant details of this process, including the rationale for procedures and design changes made during development.

Throughout this chapter, I refer to affective concepts detailed in Chapter 2 and the preliminary ideas for the Alcoholic and The Drinking Problem in Chapter 3. Section 4.1 provides a generic overview of the development process to provide context for the remainder of the chapter. Section 4.2 details the design decisions involved in the construction of 3D assets, while Section 4.3 reviews the animation process involved in creating the movements and gestures of the character.

Section 4.4 discusses interactive elements of the installation, including user interaction and interactive character behavior. Section 4.5 concludes the chapter by reviewing major changes made to the installation from initial conceptualization through final implementation.

4.1 Summary Description of the Development Process

After the initial concept of The Drinking Problem was finalized, the first step in production involved creating the necessary 3D assets, which included modeling and
texturing all objects in Autodesk Maya. Once these assets were created, animation of the primary gestures and movements of the character began. Traditional key framing methods were employed at first, but were later replaced with motion-capture techniques. Thirty-two different animation clips were created for the movements and gestures that would be used by the final character. Although the bulk of the animation was produced via motion capture, the final animation clips were refined using key framing techniques in Autodesk MotionBuilder and Maya.

Models and animation clips were imported into the Unity game development environment where interactivity would be integrated. Smaller functional components (finding bottles, spawning bottles, etc.) were completed separately before consolidating all functionality with the refined models and animation clips.

User feedback and comments were collected throughout the development process and were used to guide the development of The Drinking Problem. Users were asked to comment on the appearance and functionality of the installation, as well as overall system goals and objectives. This included the underlying narratives regarding alcoholism and any emotional effects users may have experienced. User feedback is discussed more thoroughly in the sections below, while a summary of user feedback is provided in the Chapter 5.

4.2 Asset Building

Several 3D assets were created for The Drinking Problem including the Alcoholic character, a kitchen environment, and associated props and furniture (alcohol bottles,
All models were self-created using Autodesk Maya except for the mesh of the Alcoholic, which was obtained online from mixamo.com.

The decision to use a pre-built mesh from an online vendor was made for several reasons. First, the character design didn’t call for any unusual geometric features that would require the creation of a new, distinctive mesh. In fact the intention was that the general shape of the character would be somewhat generic to suggest a universal quality that more users could identify with. Secondly, using a prebuilt mesh would save considerable amounts of time and effort. As it was originally conceived, the only functional requirements for the model were that it represented a human form and used a skeletal rig capable of displaying the gestures, postures, and facial expressions characteristic of addictive behavior.

Figure 6: Color maps and screen captures of the Alcoholic character from *The Drinking Problem*.

Although research from the contextual review indicated that visual appearance was not a vital component of affect, it did suggest that it was important for establishing first impressions and certain elements of story. This is particularly true in the absence of
speech, the normal communication channel for relating narrative. Therefore, I decided that the surface of the character would resemble an expressionistic style of painting or sketching reflecting the character’s emotional turmoil. This was similar in concept to the “psychorealistic” style employed by Chris Landreth in the 2004 animated film Ryan. This style was also intended to attract user attention, a beneficial feature for a gallery installation.

The character’s unusual appearance would be created by modifying the surface materials rather than the geometry. Like many parts of the installation, these materials and their associated texture maps were gradually refined over the entire course of production. Preliminary versions of the surface materials resembled painted, gesturally applied brush strokes, an effect created by digitally painting layers of strokes onto texture maps (see fig. 6). Later versions incorporated higher levels of detail in the surface features, making the strokes thinner, sharper, and more similar to inked cross-hatching. These refinements were intended to enhance the visibility of the character’s affective display cues.

Both the character and the environment are entirely devoid of color save for the external environment visible outside the windows. Combined with the unique look of the surface materials, this tended to impart the feel of a somber, lonely, and withdrawn environment. Low-intensity lights and pronounced shadows were used to enhance this effect.

User comments were mixed regarding the rendering materials. Some preferred less defined paint strokes while others favored the higher definition and sharper features
used in later designs (see fig. 7). While users generally commented that they enjoyed the overall appearance of the installation, they indicated that it was difficult to make out certain features such as facial expressions. Additionally, users commented that the character tended to blend in with the environment, which used surface materials similar to those of the character. Although lighting and depth-of-field effects were used to increase contrast between the character and the environment, users still found the materials distracting.

Figure 7: Side-by-side comparisons of two different versions of the Alcoholic character with different materials.

Contributing to this problem was the fact that color maps used alpha channels to make parts of the character transparent (an attempt to create a visual metaphor suggesting the hollow spirit of the character). While users said they generally liked the effect, it still created additional problems with visibility.
Visibility issues raised certain questions regarding the relationship between visual appearance and affect. While appearance is generally not as important for affective display (see Section 2.1.2) character designs that reduce the fidelity of display features also inhibit the perceptibility of those features. Consequently, appearance influences affect, albeit indirectly.

4.3 Animation

Once the major 3D assets were created, the process of animating the character began. This entailed creating a library of movements that would later be applied to the interactive version of the character using the Unity game engine. These movements included conventional actions and gestures (walking, sitting, reaching, etc.) as well as behavioral movements associated with various emotional states (anger, sadness, frustration, etc.) Scripts would later be used to initiate and direct these behaviors during interaction.

Since the installation required the Alcoholic to display varying degrees of intoxication, it was necessary to create “sober” and “drunk” animation states for all movements and gestures. After doing so, scripts were used to procedurally blend between these states depending on how intoxicated the character was supposed to be. While creating two states for every movement required additional effort, it was necessary to provide procedural control of the intoxication effect. Otherwise, it would be impossible to make the Alcoholic appear as if he were gradually becoming drunk (or sober.) Similar
methods for animation blending would be used later in the manipulation of facial expressions and posture.

At the beginning of the animation process, traditional animation techniques were used to create the character’s movements. This involved setting keys on joint rotations, a somewhat time-consuming process. For the most part, these methods were sufficient for simple motions such as grasping, walking, and drinking. But as the project progressed, it became clear that these techniques would be somewhat inadequate, particularly for the expressive behaviors of the character. Early attempts to create subtle and nuanced expressions, movements, and gestures resulted in animation that felt artificial, awkward, and ungainly. This was probably a function of my limited animation skills, as a more experienced animator could likely have produced better results. However, since fluid, refined motion was considered an important element for creating lifelike and expressive characters, I considered other animation techniques. After some deliberation, I decided to use motion capture technology to obtain the primary gestures and movements of the Alcoholic character.

Assisted by other faculty and students, the motion capture process required several attempts over a two-month period in which I served as the primary source of the motion data. This involved several sessions in which I donned a motion capture suit to obtain the necessary movements and gestures that would be used by the character. While free-standing movements (walking, stumbling, etc.) required nothing other than delivering the performances, physical props were needed to capture movements where the character was seated (see fig. 8). These props included a chair and a PVC frame
constructed to resemble the outline of the digital table the Alcoholic would interact with in virtual space. Rather than using a real table for the performance, a frame was necessary to avoid interference with sensors on the motion capture suit.

Figure 8: (Left) Motion capture performances were used to obtain the movements for the Alcoholic. (Right) The PVC frame used to represent the virtual table for motion capture performances.

While the decision to use motion capture would eventually result in more fluid character motion, it significantly increased the time and effort for the animation process. This increase in workload could be attributed to several factors, not the least of which was my lack of skills regarding motion capture technology. Motion capture data usually requires a significant amount of post-capture manipulation to “clean” and refine this data, a very time-consuming process.

Since the motion capture system employed was relatively new at the time these first capture sessions were conducted, the results were somewhat problematic. The first two sessions resulted in capture data laced with various artifacts that produced popping
movements and awkwardly bent joints. These artifacts were the result of unforeseen bugs and workflow problems inherent to the new motion capture system. While extended efforts were made to correct and refine the data in the post-capture process, ultimately they were considered too unmanageable and therefore discarded. As a result, a return to traditional key framing techniques was briefly considered. Fortunately, faculty and students assisting with the motion capture technology made significant workflow adjustments that permitted much cleaner takes to be obtained. As a result, work with the motion capture process continued.

In retrospect, the decision to use motion capture technology may have been an error in judgment. While the process provided relatively fluid motion for the Alcoholic character, it’s questionable whether the affective gains made with these motions were worth the considerable time and effort required. Even after the animation clips were created, blending these clips in the development environment was challenging. This resulted from alignment issues that were difficult to foresee when performing motion capture takes in the studio. Such issues caused the Alcoholic character to move in unpredictable ways when motions were blended. Examples of these unintended movements included instances where the character partially passes through objects like chairs and tables when in intermediate phases of the blending process (see fig. 9).
Figure 9: Blending problems cause parts of the character to pass through the table and other objects.

My future projects involving affective character animation may be less reliant on motion capture techniques. While animation created from this process can be incredibly lifelike and expressive, it’s unclear whether the affective benefits obtained were worth the developmental energy required. Users mentioned that they enjoyed the natural movements associated with the animation clips, but for the most part they seemed unsure as to whether those movements directly contributed to emotional affect.
As most emotional information is perceived by observing the face, head, and upper torso of a character, full body motion capture may be a bit unnecessary when the character is seated, as it is in much of *The Drinking Problem*. As such, other individuals more proficient with this technology may be in a better position to maximize its potential. Interactive applications that emphasize full body movement may have more need for motion capture techniques, thus justifying its use.

4.4 Interaction Development

After most of the character animation was completed, the process of integrating functionality began. Although preliminary experimentation permitted some of the simpler functions (walking, grabbing, etc.) to be developed prior to this stage, most of the interaction was created after the animation process was complete.

Functions in *The Drinking Problem* may be divided into **user** and **character** functionality, the first of which was designed to be exceedingly simple. User interaction was limited to moving, dragging, and clicking on objects in the digital environment using a touch-screen display (see fig. 10). This uncomplicated form of interaction was implemented for several reasons.
Figure 10: *The Drinking Problem* is intended to be displayed on a mounted touch-screen for user interaction.

First, it was intended to enhance usability. As a gallery piece, ease-of-use can be an important quality that allows users to interact with the installation quickly and intuitively. As they do so, users are more likely to establish certain emotional connections. By allowing users to forget about *how* they interact with a program, they may be in a better position to reflect on character behavior, narratives, and the inherent themes of the installation. From the standpoint of affect, users are more likely to absorb the emotional communication imparted by affective behavior and emotional display cues.

Secondly, the simple interaction of *The Drinking Problem* was intended to provide a functional metaphor for the inability to influence an addict’s behavior. In
severe cases of addiction, it is difficult (if not impossible) to make an addict do something they don’t want to do. This can be very frustrating for those close to the addict, as they feel powerless to change their behavior. These feelings of frustration, futility, and powerlessness were exactly the sort of emotions this installation was intended to relate.

In an effort to simulate the relationship that elicits these emotions in the physical world, the system was designed to restrict user control. Consequentially, the only way users can manipulate the Alcoholic is by moving the bottles that produce various reactions from the character. This interaction was intended to reflect the real-world dynamic in which people often attempt to help an addict by removing the source of their addiction. Since they are unable to motivate the addict directly, they try to do so indirectly by manipulating the only thing addicts seem to care about (in this case, alcohol.)

Ultimately, this control proves to be an illusion in the installation just as it is in real life. No matter what users do to keep the bottles away from the Alcoholic, the system responds by spawning more bottles within reach of the character. Again, this is representative of life situations where alcoholics always seem to find their way back to the bottle.

While moving bottles is the primary form of user input, other types of interaction were considered at various points during production. Specifically, I considered giving users the ability to control other things in the environment such as the television, refrigerator, etc. Like the bottles, users would have limited ability to control these
objects due to the nature of the touch-screen interface. For example, users might be able to turn the TV on or open the refrigerator door.

As conceived, such actions would be used to temporarily distract the Alcoholic from his drinking behavior; an interactive feature that could promote user engagement. However, time constraints prevented these features from being implemented at the time of this writing. Future versions of the installation are likely to incorporate these functions.

4.4.1 Getting Into Character

Since user interaction was generally limited, most of the functionality in The Drinking Problem would consist of the intrinsic and extrinsic behaviors of the Alcoholic. As the installation’s intended purpose was to relate an emotional narrative via the affective display of the character, it was important to consider both functional and emotional qualities of these behaviors.

As with most characters, the goal of creating the Alcoholic was not to replicate the exact behavior of a human being. To do so would extend this project into disciplines like artificial intelligence and cognitive computing, areas far beyond the needs of this project. Instead, the goal of developing this character was to create the impression of a person, one with the appropriate number of features and behaviors to achieve the intended goals of the installation. Although a much more obtainable objective, achieving it would still require the careful selection and development of functions, behaviors, and personality.
traits needed to create this digital persona. Before this was possible, it was necessary to determine the essence of the character that was the Alcoholic.

To facilitate this process, the question I asked myself was, ”How would addiction behave if it took human form?” Almost immediately, certain adjectives came to mind evoking the core of addictive behavior. After a period of additional reflection, I compiled a list of words that I felt most accurately depicted the concept of substance addiction. These words were: “self-destructive“, “repetitive“, “obsessive”, “indifferent“, “impulsive”, “isolated”, “detached”, “broken”

It is important to note that these terms were not meant to be textbook adjectives used to describe substance addiction. Rather, they represent concepts that I personally associated with addictive behavior; concepts that carried both meaning and feeling. Since The Drinking Problem was intended to serve as a work of expressive creativity, I decided to use these descriptors as the foundation for crafting the behavior, personality, and affective qualities of the Alcoholic character.

4.4.2 The Nature of the Alcoholic

Also important to the development of the character was the nature and severity of alcoholism the installation was supposed to depict. As he was conceived, the Alcoholic was not intended to represent a functional addict who simply has a drinking problem. Individuals such as these tend to be fairly capable in terms of expression, interaction, and other forms of outgoing behavior. Although such a character would likely be more dynamic and animated, this wasn’t the type of addict needed for The Drinking Problem.
The character depicted in this installation was an attempt to represent an alcoholic deeply trapped in a cycle of addiction and self-destructive behavior (see fig. 11). Typically, people like this have serious difficulties with even the most basic types of human interaction. In a sense, they represent “broken” human beings trapped in their own self-imposed hell. While maudlin, this was exactly the type of character *The Drinking Problem* was intended to portray. It was also one I felt would be more likely to relate the intended emotional experience to users. Such a character presented a significant challenge for this project, both in terms of creating the installation and achieving the research goals of the thesis itself.

![Image](http://www.treklens.com/gallery/photo644471.htm)

Figure 11: The character in *The Drinking Problem* is intended to reflect the worst case scenario of a non-functional alcoholic. (Image retrieved from [http://www.treklens.com/gallery/photo644471.htm](http://www.treklens.com/gallery/photo644471.htm))
This challenge would be significant because typically, the purpose of adding personality and affective behavior to characters is to make them \textit{more} engaging, not less. As most interactive systems try to encourage user participation, the idea of creating an installation that used a fundamentally un-engaging character seemed counter-intuitive.

Of course the primary goal of \textit{The Drinking Problem} was not to engage users, at least not in the conventional sense. In a way, the real goal of the installation is to be \textit{un-engaging} at some point because it represents the same emotional experience people have when trying to help a hopeless addict (frustration, powerlessness, futility, etc.) Rather than give people a sense of enjoyment or pleasure as they might find in a video game or some other form of interactive application, the true goal of \textit{The Drinking Problem} is to communicate an idea.

Still, with any interactive system some user engagement is necessary. Otherwise people abandon a system before its goals can be achieved. Should the Alcoholic be too distasteful, users would likely give up on the installation before the message had a chance to sink in. As such, one of the challenges of this project would lie in striking the appropriate balance of affective character behaviors. Ideally this balance would allow the integrity of the character as a broken human being to be maintained while still making him appealing enough to encourage user interaction.
4.4.3 Personality and Patterns of Affective Behavior

In terms of the character’s personality, most behavior was developed through the lens of three basic emotional states that included *indifference*, *anger*, and *sadness*. While these states represented a very simple pattern of emotional behavior, they seemed appropriate for depicting the stereotypical emotions of a withdrawn, emotionally and socially stunted alcoholic.

Many of the affective cues in these states would be delivered through the movements and gestures obtained from the motion capture process. Since multiple motion capture performances were recorded to reflect different emotional conditions, there were several variations of each animation clip corresponding to particular emotional states. For example, the action of discarding a bottle can be depicted using one of three animation clips that included “angry”, “sad”, and “neutral”. When the installation runs, scripting is used to retrieve the appropriate clip depending on which emotional state the character is currently expressing.

Most of the time, the character resides in the *indifferent* state (see fig. 12). This reflects the “default” condition of the character where his alcoholic needs are currently being met. In this state, the character projects affective cues suggestive of a person who is distant, detached, and unresponsive. Facial features were relaxed to project a blank, uncaring expression, while gestures and movement are slower and less deliberate. Visual gaze was unfocused to give the impression that the character wasn’t paying attention to the user or anything else. Generally speaking, expressive behavior was reduced to a minimum in order to create the sense of a character who is detached from the rest of the
world. However, finding the appropriate balance of affective conditions was challenging as I had to learn through trial-and-error that *reducing* expression doesn’t equate to *removing* expression.

When first crafting the indifferent state of the character, I believed what needed to be done was nothing at all. In other words, I decided to leave most of the affective features completely neutral, with very little manipulation or modification. In the end, this decision was very ineffectual because the resulting character felt more like a blank automaton than a broken human being. Even with the “neutral” animation clip obtained from the motion capture performance animating the body, the character still felt lifeless. At the time, I didn’t realize my mistake until I thought about the fundamental nature of human beings a little more carefully.
Humans are designed to be expressive, even when they don’t intend to be. We can see this quite clearly when watching people who are resting or even unconscious. While they may not be intentionally expressive, their eyes move, muscles twitch, and blood circulates under the skin. Animators have been aware of this for decades, which is why they impart subtle motion to characters that aren’t doing anything in particular. After thinking about this, I realized that the same paradigm might apply to affective display.

This does not mean that affective character features should always be in a state of constant motion. Rather, it means the affective display of characters must always be representative of living human beings who are constantly in states of affective transition. This is true even if the changes in affective display are so minute that they largely go unnoticed.
When affective character attributes are left untouched, characters can appear truly lifeless (even if they are moving.) Consequentially, my initial efforts to create an “indifferent” state by leaving the affective features completely unchanged resulted in no state at all. Since I had abandoned the idea of the character as a living, expressive being (albeit a broken one), I created a character state that was animated, but lifeless.

After this realization, I made slight adjustments to various affective features of the character. This included altering the facial expression to carry the slightest of frowns, changing the tilt of the head, and tweaking the posture of his spine and arms. When finished, I was relatively satisfied with the results of the “indifferent” state. Although the changes made would likely be unnoticed by the vast majority of users, I was confident I had imparted a subtle but vital quality that had been lacking before.

The character’s anger state is triggered when he has gone too long without alcohol (see fig. 13). This is determined by a scripted timer that resets every time the character takes a drink. Referencing behavior found in real addicts, this reaction was intended to reflect the idea that sometimes the only thing capable of bringing an alcoholic out of their indifferent state is withdrawal symptoms. When alcoholics go too long without a drink, they can become very angry, agitated, and irritable.
To reflect this, certain behaviors are triggered once the “lastDrink” timer has reached a certain threshold. An angry expression becomes more prominent as time passes, which is achieved by animation blending the facial features to conform to the appropriate expression. Fits of expressive rage are also exhibited by triggering certain motion clips at random intervals. These clips include the character engaging in a number of expressive gestures such as banging his fists on the table or waving his arms in disgust. Once the character is able to have a drink again, he returns to his initial state of indifference.

Behaviors in the sadness state are triggered in a similar way except that sadness was scripted as a function of intoxication. As the character becomes more and more drunk, he correspondingly becomes sadder (see fig. 14). While the character maintains a

Figure 13: The Alcoholic in his “angry” state.
slight expression of sadness throughout the interaction, this becomes more significantly pronounced as he becomes more intoxicated. Once the character sobers up his sadness disappears, returning him to his indifferent state and regular pattern of addictive behavior.

Figure 14: The Alcoholic in his “sad/drunken” state.

Rather than an accurate reflection of addictive behavior, this condition was intended to serve as a commentary of sorts. Real alcoholics express any number of emotions when drunk, including anger, joy, etc. In this case, the decision to imbue the character with sadness was a creative choice I made to reflect the personality of this particular character and my perspective of his condition.
All told, the emotion pattern of behavior displayed by the Alcoholic is understood to be simplistic and perhaps even unrealistic to some degree. While it mirrors certain realities of addictive behavior, it is by no means an accurate model of formally established or universally recognized patterns of alcoholic behavior. For the purpose of this installation, it is simply the choice I made that reflects the type of character I envisioned for the project. While simple and somewhat stereotypical, the hope was that this uncomplicated pattern of emotional display would be effective, impactful, and relatable.

4.5 Design Changes

While much of the original design was integrated into the final version of The Drinking Problem, the sophistication and complexity of the installation was somewhat
reduced. This reduction was primarily due to time restrictions, technical difficulties, and other limitations of the development process. For example, while the final character was capable of expressing several emotional states, the character could have been theoretically capable of expressing other emotions such as joy, embarrassment, and contempt. Additionally, the character’s behavior could have been expanded to include other personality characteristics such as humor and sarcasm.

However, none of these emotional or behavioral elements were part of the original design as it was conceived, nor were they considered critical to the success of the installation. While they may have ultimately enhanced or enriched certain aspects of the project, they were not believed to be essential components of The Drinking Problem.

In retrospect, the most significant design change came from the decision to remove the Alcoholic’s ability to rise from the table and walk around the room. This behavior was originally intended to allow him to retrieve more bottles when his supply at the table ran out.

It was also meant to give his functional and emotional performances an additional dimension by allowing him to engage in behavior that wasn’t possible while seated at the table. For example, while walking around the kitchen the Alcoholic could conceivably stumble around the room and bump into objects such as countertops, trash baskets, etc. This could have provided elements of humor and interest that helped maintain user interest and engagement.

These behaviors had always been intended to be included in The Drinking Problem, as evidenced by the various animation clips of walking, stumbling, etc…that
were produced. Unfortunately, technical difficulties with collision detection and navigation in the interactive development phase resulted in the elimination of these behaviors until such time that these difficulties could be resolved.
Chapter 5: Evaluation

The research objective for this thesis project was to explore how the purpose and content of interactive systems inform and influence the affective attributes of interactive characters. As such, the primary question to be answered was, “When balancing knowledge of affective interactive characters with the purpose and content of the systems of which they are a part, what important design decisions must be made?”

*The Drinking Problem* was created in an attempt to explore answers to this question. In the process of aligning the affective design of the Alcoholic character with the purpose and content of the installation, it was intended that important aspects of the affective decision-making process would be revealed. These revelations would be drawn from observing how and why affective attributes were crafted and the impact they would have on the final installation.

Section 5.1 discusses the overall outcomes of *The Drinking Problem*, including successful aspects of the project and areas where improvement may be needed. Suggestions for these improvements are discussed along with user feedback collected during the assessment process. Section 5.2 reviews the research insights acquired through the development of this project along with considerations that interactive developers should take into account with affective interactive character design. The paper concludes in Section 5.3 with a summary of the points made in this chapter and the general outcomes of this thesis project.
5.1 Analysis of the Installation

Functionally, *The Drinking Problem* worked very much as it was originally intended to. Although the installation’s scale was reduced in complexity over the course of development, it still achieved most of the practical goals the concept initially called for.

The Alcoholic was capable of performing the necessary functions I considered important to express addictive behavior. This consisted of the self-destructive drinking cycle and various reactions to user manipulation of the alcohol bottles. These reactions included his ability to locate, acquire, drink, and discard the bottles. The character was also capable of exhibiting patterns of drunken behavior, becoming visibly intoxicated or sober depending on how often he was permitted to drink. These actions were important for establishing stereotypical behavior many experts deem important for relating affect (see 2.2.1). Furthermore, the Alcoholic was capable of displaying emotional behavior patterns consistent with the simple personality designed for the character (see 2.2.1).

That being said, there are several aspects of the installation that would benefit from additional refinement and adjustment. At times, motion blending between animation clips appears awkward and out of sync, suggesting further modifications to these clips are needed. Physics problems can arise when the character grabs and releases bottles, and occasionally parts of the character pass through other objects in the environment. While none of these issues are insurmountable, they still need to be addressed before the installation is stable enough to function as a gallery display.
In addition to these technical issues, additional features may help improve *The Drinking Problem*. While lack of speech remains a firm design parameter, use of sound might be appropriate for reinforcing emotional behaviors without resorting to language or text. As established in Section 2.2.7, many sounds other than speech can serve to convey emotional qualities. This would include physiological sounds coming from the character (grunts, groans, etc.) as well as ambient sounds from the environment. Additional audio elements such as music tracks or sound effects may also be suitable for enhancing the installation.

In terms of interaction, allowing the Alcoholic to walk around the kitchen may be the most impactful adjustment for enhancing the installation. This would potentially provide a more interesting perspective and allow users to manipulate more than just the bottles. Walking around the kitchen would also create opportunities for full-body gestures and movements, giving the character an added dimension of expression. As stated in Section 2.2.5, gestures and movements can be important affective attributes, especially when other attributes such as facial expressions are obscured.

An issue that requires additional attention is the need to make more users aware that the installation is interactive. When preliminary versions of *The Drinking Problem* were informally displayed, many people believed they were viewing an animation rather than an interactive work. Consequently, some form of prompting from the installation may be necessary, such as the Alcoholic gesturing in a way that invites users to join him. A more simple type of prompt could be employed by using visual icons that occasionally appear over the bottles, thus encouraging users to click on them.
Giving the Alcoholic a more diverse range of expressive behaviors may also be helpful. While the current behaviors seem adequate to convey basic emotions, additional behaviors could help reinforce and refine the projection of his emotional states (anger, sadness, indifference). For example, while the character currently pounds the table to express anger, other actions such as throwing bottles at the user or pointing fingers could emphasize this emotion.

Expanding his personality to include positive emotional states such as happiness or amusement could facilitate user engagement and bonding. While it’s important to maintain the character’s integrity as a depressed non-functional alcoholic, slight personality adjustments may be necessary compromises for establishing stronger emotional connections.

Regarding the goal of emotional bonding with users, the results of the installation appear somewhat mixed. Many users commented that they experienced feelings of frustration and futility when they were unable to change the behavior of the Alcoholic. Since this was the intended outcome of the installation, these comments could be viewed in a positive light.

Unfortunately, some users wondered if these frustrations were due to design flaws of the installation rather than a deliberate effect the system was designed to produce. In other words, users were frustrated they could not “win the game,” but rarely considered that they were facing an intentional no-win scenario. Rather than viewing The Drinking Problem as an expressive installation designed to relate the frustrations of futility, some users viewed it in the context of a poorly designed game.
Once the concept of *The Drinking Problem* was explained (after users interacted with the installation), reaction tended to be fairly positive. They indicated that installation produced “interesting” and “thought-provoking” ideas, but only after the concept had been explained to them. While this was not true of all users, many people experienced *The Drinking Problem* this way.

While I certainly felt a degree of disappointment that many people didn’t receive the underlying message of *The Drinking Problem*, I would hesitate to make drastic changes based on this reaction. While I have no doubt that adjustments could be made that would help deliver the themes and narratives more clearly, I fear something might be lost in the process of doing so. In an attempt to make this “futility experience” more obvious, the concern would be that some of the impact and subtlety of the message would be lost.

Another unresolved problem pertaining to the emotional delivery of *The Drinking Problem* lay with the emotional “hook” required to draw users back to the installation. As stated earlier, an important characteristic of people who continuously try to help addicted individuals is the emotional bond that compels them to keep trying. Without this bond, most people have little motivation to help anyone, let alone an unfamiliar digital character. Without similar connections for users of *The Drinking Problem*, the compelling emotional factor is significantly decreased.

Although I considered this problem from the onset of the project, I feel the solution has eluded me (at least for this iteration of the installation). While design elements such as the Alcoholic’s appearance might be enough to attract initial user
attention, I believe they are insufficient to compel most users to return to the installation in continued efforts to help the character. While informal showings of the installation suggested that people might return in an effort to “win the game,” this does not suggest strong emotional connections with the character had been established.

That being said, simulating these emotional bonds remains a goal of *The Drinking Problem*. In the future, more sophisticated versions of the installation may achieve this goal. By expanding the personality and expressive behaviors of the Alcoholic, and by integrating more complex forms of interaction, it is possible *The Drinking Problem* may reach users on a substantially deeper emotional level.

5.2 *Research Insights*

The primary research goal of this project was to determine the important design decisions to be made when balancing knowledge of affective characters with the purpose and content of the interactive systems of which they are a part. After reflecting on the development of *The Drinking Problem*, I believe these decisions pertain to selecting and applying affective character attributes in such ways that certain goals are realized. To this end, I believe affective character attributes should:

1. *Efficiently and effectively convey the emotional profile of the character.*

2. *Be flexible enough to be easily modified as both the character and interactive system evolve during development.*

3. *Impart emotional benefits worth the time, energy, and resources needed to implement them.*
The following sections (5.2.1 – 5.2.3) explain the rationale for these goals while providing specific examples of their applicability in the development of *The Drinking Problem*. For a condensed summary of these goals and rationale as well as additional examples, refer to Appendix A: Important Goals of Affective Interactive Character Attributes.

5.2.1 Convey the Emotional Profile of the Character

Once the purpose and content of an interactive system is understood, the first step in selecting affective attributes should be to develop an *emotional profile* for the character. For the purpose of this thesis project, an emotional profile may be defined as a *description of the affective considerations inherent to an interactive character including motivation, personality, moods, behaviors, and emotions*.

Just as writers, animators, and other artists often create *character profiles* to assist them in developing various personas, interactive character designers seeking to enhance affect may wish to create detailed *emotional profiles*. While general character profiles usually contain emotional qualities as well as other character demographics, affective developers may wish to expand the emotional parts of these profiles. By doing so, they may gain a far better understanding of how their characters should behave emotionally. Subsequently, they may be in a better position to know when and how various affective attributes should be employed to deliver such behaviors.

A deeper understanding of emotional characteristics is especially important for interactive characters. Unlike their counterparts in film, animation or literature,
interactive characters must be able to react to their environments. In order to create believable emotional responses, designers must know precisely how, when, and why these reactions must be initiated. This can be especially difficult given the fact that all emotional attributes (facial expressions, gesture, gaze, etc.) must work in concert to convey a particular behavior. When one considers that life-like emotional communication consists of many such behaviors seamlessly functioning together, the challenge of creating affective interactive characters becomes apparent. As such, detailed emotional profiles can be critical tools for helping developers understand precisely how their characters should behave.

Parts of an emotional profile will originate from the purpose and content of the interactive system, while others may be fabricated through the creativity of the designer. In the case of the character in *The Drinking Problem*, the profile created was fairly extensive. Descriptors such as “self-destructive” and “repetitive” were used to capture the essence of the Alcoholic, while the personality of a depressed, withdrawn, and non-functional addict was used to determine his emotional states (indifference, anger, sadness). These and other aspects of the Alcoholic’s emotional profile would ultimately contribute to the selection and application of various attributes (gestures, postures, facial expressions, etc.) that would be used to convey emotional information.

Of course, the depth and complexity of an emotional profile should vary with the character it represents. Consequently, the complexity of these profiles should reflect the sophistication, purpose, and intended use of the characters they describe, as well as the purpose and content of the interactive systems for which they are designed.
Application of affective attributes that do not align with a character’s emotional profile can be detrimental to the effectiveness of both the character and the interactive system. The successful application of attributes in one application does not guarantee success in another, especially if the manner of application is similar.

For example, consider the affective attribute of attentional gaze. In many educational programs designed for children, characters regularly and consistently focus their attention on the user to assist with engagement. As children often have short attention spans, designers must do whatever they can to maintain user interest. This often involves characters spending a great deal of time addressing the virtual camera and maintaining fairly persistent attentional gaze in the process. This behavior is reflective of the emotional profile of many characters designed for children’s applications, who tend to be cheerful, outgoing, and attentive.

Even though attentional gaze is often recommended by experts to enhance affect, the manner of application should be considered for each interactive scenario. If attentional gaze were applied in the same way for character like the Alcoholic in *The Drinking Problem*, the results would be antithetical to the emotional profile that described the character as a withdrawn person. If the Alcoholic were constantly staring at the camera while the rest of his behaviors and body language suggested otherwise, users would probably be confused regarding the emotional messages being delivered. People might feel the character is expressing worry or anticipation; emotions very different from the default emotion of indifference the character is normally supposed to project.
This example serves to highlight the idea that specific applications of affective attributes should not be considered universal design solutions that work in every context. Rather, designers should carefully consider the emotional profile of each character in a given system to determine precisely when and how certain attributes should be applied.

5.2.2 Flexibility

Affective attributes should also be selected, created, and applied in ways that make them relatively easy to change. As both characters and the interactive systems they were created for tend to evolve throughout development, easily modifiable attributes can be a tremendous advantage during the creative process. As the design or interpretation of the interactive system changes, flexible attributes allow developers to align their character behaviors accordingly.

Flexibility was a problem when changing some of the character behaviors for The Drinking Problem. While the motion-capture process provided a means of delivering more fluid and lifelike movements, it restricted the behavioral range of the Alcoholic somewhat. Any movements or gestures not obtained in the original motion-capture performance sessions either needed to be acquired in new sessions or created through other means (keyframing, procedural methods, etc.).

In terms of flexibility, it would have been helpful to capture a more diverse collection of behaviors that could be employed later if and when needed. Alternatively, I might have chosen to be less reliant on motion capture techniques to begin with, pursuing other animation methods that would have made adjusting character behaviors easier.
While there was no guarantee that procedural or keyframing methods would require less effort, the fact that they could be developed without the use of a motion-capture studio and the assistance of others would have provided a degree of flexibility that may have expedited subsequent changes.

Of course, flexible features are advantageous in any sort of interactive endeavor, regardless of whether they concern affective attributes or not. However, given the fact that implementing character affect tends to be a highly developmental process involving a great deal of trial-and-error, flexibility of affective attributes may be an especially imperative goal.

5.2.3 Attributes Worth the Effort

In addition to being easily modifiable, affective attributes should be worth the effort to implement. Although designers may wish to employ any number of affective features, they should consider whether the emotional benefits they provide outweigh the time, energy, and resources needed to apply them.

Referencing the example of motion capture in *The Drinking Problem* once again, using this method to obtain the necessary movements and gestures for the Alcoholic was a challenging endeavor. As described in Chapter 4, it was difficult to assess how beneficial the process was given the problems in determining how much the captured movements enhanced emotional communication. From this perspective, the time needed to acquire, clean, and refine motion capture performances may have been better spent developing other affective attributes such as facial expressivity and/or attentional gaze.
With this example in mind, interactive designers should carefully weigh the benefits of employing certain affective attributes against the required effort needed to implement them. While such benefits may assist with achieving certain goals of the interactive system, the effort required may negate such benefits due to increased production time and expenditure of other resources. Of course, this consideration is dependent on several factors, including the expertise of the designer and the availability of resources at their disposal.

As with the recommendation of maximizing attribute flexibility, weighing developmental cost/benefit ratios is a process that could generally be applied to many aspects of interactive design. Be that as it may, the complexity of affective characters and the significant effort required to create emotional interaction may make such considerations particularly important.

5.3 Thesis Summary

I generally considered the results of this thesis project to be successful, both in terms of *The Drinking Problem* and the research questions it was created to answer. While this project makes a relatively small contribution to the field of affective research, the insights gathered during the course of development may be helpful to others experimenting with affective character design.

*The Drinking Problem* seems to have accomplished its fundamental goal of providing an interactive narrative conveying feelings of frustration, futility, and powerlessness experienced through interactions with a hopeless addict. Moreover, it
appears to have accomplished this goal using affective display attributes and behaviors without resorting to the use of speech or text.

However, since several users had difficulty interpreting the emotional experience as an intentional outcome rather than a product of faulty design, more work on the project may be needed. Subsequent adjustments to interaction, functionality, and various aspects of affective character behavior may enhance the installation so these interpretational problems are not as pronounced.

Regarding the research objectives of the project, creating The Drinking Problem allowed me to reflect on the inherent processes involved in developing an affective interactive character. With the research objective of determining the important design decisions necessary to make such a character, I’ve proposed several goals for implementing affective attributes that I believe are important to the character design process. Although in hindsight these goals appear to be somewhat derivative of current design objectives found in animation and other forms of interactive development, I believe they are no less valid. Given that affective interactive character design has conceptual roots in both animation and interactive design, perhaps it is reasonable to expect overlap regarding design objectives.

The development of this thesis project has been extremely challenging but simultaneously rewarding journey. Exploring the emotional capabilities of interactive characters has greatly expanded my understanding and appreciation of this incredibly complex area. It has altered my perception of the nature of interactive characters and what they can be used to achieve. Rather than viewing them as simple collections of
functions and behaviors, I now look at digital characters as emotional constructs that have a great deal in common with living, expressive beings. More importantly, I see them as extensions of ourselves. Where before I considered only the puppet and its strings, I now appreciate the artistry, skill, and part of himself the puppeteer imparts.
Works Cited


## Appendix A: Important Goals of Affective Interactive Character Attributes

<table>
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<tr>
<th>Goal: Efficiently and effectively convey the emotional profile of the character.</th>
<th>Thesis Project Example: The Alcoholic character was designed to be a depressed, withdrawn, non-functional alcoholic existing in three emotional states (indifference, anger, sadness.) Given the withdrawn nature of the character and the system goal of not employing speech, natural movements and expressive gestures were deemed to be extremely important for conveying the emotional nature of the character.</th>
<th>Rationale/ General Example: Affective attributes should be selected and applied in ways that best reflect the emotional profile of the character. This may involve emphasizing some attributes while de-emphasizing or even completely omitting others.</th>
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<tr>
<td>Goal: Flexibility/ Ease of Modification</td>
<td>Thesis Project Example: Facial expressions of the Alcoholic were procedurally generated to allow for adjustments in emotional intensity. When certain needs of the installation where not being met (engagement, emotional conveyance, etc.) these expressions could be adjusted simply by changing the appropriate variables.</td>
<td>Rationale/ General Example: Any application of affective attributes that can be easily modified can be aligned with the interactive system for which they serve. This is especially useful when changes to system are required or some need of the system is perceived as not being met.</td>
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<td>Goal: Impart emotional benefits worth the time, energy, and resources to needed to implement.</td>
<td>Thesis Project Example: Affective benefits of using motion-capture to create more fluid/ realistic character animations may not have been worth the considerable time and effort. Using some combination of key-framed or procedurally-generated movements may have been more efficient.</td>
<td>Rationale/ General Example: Affective attributes can be difficult to implement. Before attempting to do so, designers should be reasonable certain a particular attribute conveys benefits worth the effort of integrating it.</td>
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