Visualizing Emotional Requirements

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Abstract

Emotional requirements capture the game designer's vision for the player's emotional experience and are used to facilitate communication between pre-production and production teams. However, production-phase deficiencies in emotional requirements have been identified. In this work, we extend the definition of emotional requirements to include emotion prototypes and emotion markers and present improved techniques for eliciting, capturing and visualizing emotional requirements. A detailed investigation of one gameplay scenario is presented, with a focus on evaluating visualization techniques for emotional requirements. The solutions developed in this work met the needs of all development team members and appear to be general solutions for the domain.

Keywords: Requirements visualization, non-functional requirements, emotion, emotional requirements, video game.

1. Introduction

Our research program is motivated by a desire to reduce the risks in video game development. Our evaluation of development processes in the video game industry [2] identified communicating the game designer's vision across the transition between the pre-production and production phases of game development as a source of development risk. We developed emotional requirements and emotional intensity maps [3] to capture the intended emotional experience for this vision and showed how they can alleviate some of the communication challenges that occur between pre-production and production teams.

An emotional requirement captures the emotional state that the designer intends to induce in the player, and the artistic context (the look and feel) within which the emotional experience is to occur. An emotional intensity map is a lightweight visualization technique that allows the game designer to situate the intended emotional experience within the virtual world (see Figure 3 for an example). Emoticons are used to identify the player's intended emotional state within simplified representations of the virtual world and grayscale shading is used to describe the changes in the player's emotional state within different parts of the virtual world.

Emotional requirements were introduced into the development process for the game *Run the Gauntlet* by Far Vista Studios for further evaluation within an industrial setting. During a follow-up interview with the lead game designer at Far Vista Studios, we learned that the adoption of emotional requirements at the studio had been lower than expected. The game designer self-identified the principal reason for the reduced usage as "they [emotional requirements] did not provide the expected benefits". When queried further, he noted that the combination of emotional requirements and emotional intensity maps were useful in his role as a game designer but that the media production team did not find them sufficiently useful to trigger adoption. Followup with the production team identified two weaknesses: the emotional intensity maps did not identify *how* the target emotion was to be induced in the player nor did the map identify *where* the inducing elements were located. In this work we show how how we have augmented the definition of emotional requirements with emotion prototypes and emotion markers to address these shortcomings and report on our investigations into visualizing these emotional requirements.

We used an action research approach [4] for our investigation so that we could collaborate closely with the team members to critically study how they used emotional requirements. While this is not a strict action-research study due to resource constraints, we followed the guidelines for this approach as much as possible for our work. We observed the issues hindering greater adoption by the production team and actively engaged both the game designer and members of the production

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team in the refinement of the proposed solution. This study was limited to a single development team and the results met all of their needs. The proposed solution appears to be general and has support from prior work in other fields but has not yet been validated with other teams.

The study focused on a single scenario used in the game *Run the Gauntlet* by Far Vista Studios, from conception through to virtual world implementation and the initial stages of gameplay testing and balancing. The requirements portion of this study was performed over a two week period. There were two in-person sessions of approximately six hours each and numerous telephone conversations of more than 10 hours total length. Ongoing media production lasted approximately three more weeks.

In the remainder of this work, we present a review of related work and the context for the study[1]. We report upon the extensions made to emotional requirements as a result of the study and techniques for visualizing the augmented emotional requirements. We review the results of a design effort that utilized the revised emotional requirements and propose mechanisms for integrating emotional requirements into the development workflow. Finally, we present a revised definition for an emotional requirement then present our conclusions and make recommendations for future work.

2. Related Work

2.1. Storyboards

Storyboards are a well-recognized prototyping tool, originally developed for the movie industry where they are used for planning and communication as a film is prepared for production. These prototypes, quick sketches that draw heavily from comic strip techniques to convey the sense of the planned shots and their sequence, are also in common use in the game industry. Storyboards have also been used in requirements engineering, Andriole [1] introduced them to the domain over 20 years ago as a tool for requirements verification during customer sessions. More recently, Thronesbery [9] proposed the use of storyboards during requirements elicitation to also capture design knowledge from the domain experts. Reeder [7] showed how the requirements engineering phase of an industrial design process can be enhanced by the application of storyboarding techniques based on photographic images rather than the work of a sketch artist.

Extending storyboard tools such that they support emotional requirements could assist game designers that utilize storyboards in their work. For example, the image captured within the storyboard could be the emotional intensity map. The accompanying textual information could capture the specific instructions of the game designer as to how to induce the desired emotional state in the player and provide further guidance regarding the artistic context.

2.2. Film Studies and Cognitive Psychology

In their collection of film studies essays written from a cognitive psychology perspective, Plantinga and Smith (Eds.) [6] note that cognitive psychology practitioners tend to "discuss emotion states in terms of goals, objects, characteristics, behaviors, judgments, and motivations." Smith further notes in a later essay in the same work that the "concepts such as pleasure, and displeasure, and desire used in film studies are too broad to provide specific insight into how a particular film makes its emotional appeal at any given moment", motivating his work toward gaining the desired precision.

These perspectives have strong parallels with our work and we are able to use Smith's work as the exemplar for the application of cognitive psychology to film studies and, by extension, to our work. Much of Smith's work that is referenced herein is aimed at performing critical analysis of the emotions in film in a *post hoc* manner – one of our goals is to use the same or similar concepts *a priori*, in the requirements and design phase.

In games, we are limited by a lack of controlled dialog between players, particularly in Player *versus* Player (PvP) games. Typically, the only player to player communication is unmoderated, via some form of textual or vocal chat channel. Therefore, the artistic context is relatively more important in games than in film and Smith's perspective has greater immediate relevance than the work of the other researchers.

Smith posits that cognitivists believe that we recognize emotions by pattern matching against *emotion prototypes* [6, 8]. Emotion prototypes have three characteristics. They have an object orientation; the emotion is cued, or triggered, by an object or the action taken by an object. They demonstrate an action tendency; the emotion spurs us to take some action. Finally, they demonstrate a goal orientation; there is some purpose to the action that we take.

Smith identifies an *emotion marker* as something that will engender a brief burst of emotion but probably does not affect the narrative or underlying story. Emotion markers can take any form; they may be sounds, scenes, or even dialogue. There may be more than one emotion marker in a given scene and it is expected that

[1] A poster version of related elements of the same study is available in the Proceedings of Requirements Engineering 2009

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one or more of the emotion markers is the cue or trigger in the emotion prototype[2].

Emotion prototypes and emotion markers, as described by by Smith , illustrate how the questions raised by the production team have been addressed in other fields.

3. Emotion Prototypes and Markers

The three characteristics of the emotion prototype are useful refinements upon the emotional requirement; explicitly providing this information could provide some of the guidance requested by the production team as to *how* the emotion is to be induced. The characteristics can also be used in formulating metrics for evaluating the quality of the emotional requirements: Does the emotional requirement sufficiently exhibit these characteristics such that the requirement provides appropriate guidance for the production team?

While our earlier work [3] proposed the use of emoticons as a lightweight mechanism for identifying the intended emotion, the concept of the emotion marker augments the emoticon by providing specific information that we had generally identified as belonging to the artistic context. The addition of a direct link between the emoticon (target emotion) and the emotion marker (emotion-inducing element) meets the guidance needs of the production team.

The emotion prototype and the related emotion marker do cause some issues with representation - the extra information is not part of the emoticon, it is not necessarily co-located with the emoticon, and does not appear to have a suitable visualization. It may be that integration with the storyboard, as discussed earlier, is most appropriate and this issue remains under investigation.

Despite the additional complexity that was introduced, we decided to address the identified weaknesses in the prior definition of emotional requirements by extending their definition to include Smith's emotion markers and enhancing their internal documentation using the three characteristics (cue, action, and goal) of the emotion prototype.

While we gain insight from Smith's work, we must also remember that games are less narrative than film; the game designer is unable to absolutely control the narrative journey in the same manner as a writer/director for film. This lack of narrative control is replaced by interaction with a set of designed experiences that are used by the game designer to emotionally manipulate the player into the path of the desired emotional and narrative journeys.

[2]For the remainder of this work, we shall refer to the emotion marker as singular, understanding that the plural is also supported

4. Scenario Concept

Run The Gauntlet is a player *vs.* player combat game. One of the most important scenarios in this genre is the sniper scenario: There are two players, the Sniper and the Runner, and they embody the classic antagonist *v.s.* protagonist narrative model. The fundamental goal of the Runner (protagonist) is to survive contact with the Sniper (antagonist) while the fundamental goal of the Sniper is to prevent the Runner from achieving their goal. Both of the players also share the goals of surviving the scenario, maximizing their gains, and minimizing their losses.

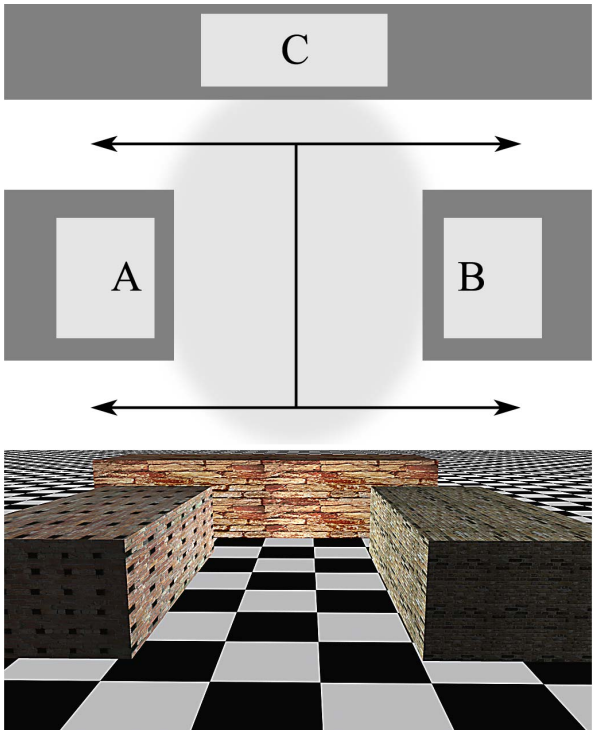

Figure 1. Sniper scenario pre-visualizations. The upper image is a plan view of the scene, the lower image is a minimum cost 3D rendering.

In the study scenario, the Sniper can take a position in one of the buildings marked A, B or C in the top half of Figure 1, a plan view of the relevant portion of the game world. The Runner is free to move about on the streets below and must successfully transit the shaded danger zone, while under attack from the Sniper, to continue onward to other gameplay regions and other gameplay experiences. The bottom half of Figure 1 is a

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low-fidelity 3D prototype of the same scene, typical of those used at the beginning of what is referred to as the "pre-visualization phase" of game design.

Capturing an intended emotional experience in the form of requirements is challenging. For example, the intended emotional experience for the Runner can be described in narrative form as follows.

> I approach the area with nervousness because I expect to be surprised in some way. When the attacks begin, I am afraid but I am optimistic that I can survive and I am excited by the challenge. I recognize a puzzle that I have to solve and when I do survive, I feel relieved and satisfied. When I fail, I am disappointed and if I fail too often then my annoyance can turn to frustration and anger.

Mechanisms for performing this conversion are part of our current research effort. Compared to functional requirements, a significant challenge with emotional requirements is precision: what emotions exist within the game design, what do we call them, and do the labels for the emotions mean the same thing to all members of the development team? Another challenge is to convert this description of an emotional experience to emotional requirements that are situated within the game world, under the assumption that doing so will reduce the chance of miscommunication between the team members. Finally, are there elements of emotional requirements that can and should be visually expressed and some that are more appropriately expressed via another mechanism?

5. Designing the Player Experience

For practical reasons, we need to standardize emotion-specific terminology – at least on a per-project basis. Emotions and their categorization have been intensively studied and there are many results available. In this study, we used the (primary, secondary, tertiary) categorization developed by Parrott [5]. We note that we employ this categorization as a language reference and ontology without making judgment as to its absolute accuracy since it's role is to facilitate communication within a team and it is not used to perform comparative analyses between teams.

In Parrott's classification, the primary emotions are the primitive emotion states. Secondary emotions are those generated by some form of deliberation upon the primary emotion and the generating stimuli. Tertiary emotions are similar to secondary emotions but there is also an element of loss of control or attention. . . to some degree, an involuntary response.

The game designer was presented with this categorization and asked to identify the intended emotions for this scenario. The chosen emotions included (among others) elation, satisfaction, joy, excitement, exhilaration, relief, surprise, disappointment, nervousness, sadness, and fear. A review of the chosen emotions identified a pairing between emotions such as nervousness and surprise and also between joy and anger/sadness. While not truly opposites, these pairings are strongly contrasting and we feel that there is an underlying principle at work: Satisfactory player experiences for this genre appear to be derived from enforced shifts between strongly contrasting emotional states. In this scenario, as the player becomes aware of the obstacle, they become nervous. When the threat is finally exposed, they are surprised. If the player overcomes the obstacle, their mood is directed toward an emotion in the joy category. If they fail to overcome the obstacle, they experience one of the emotions identified in the anger or sadness categories and they tend in that direction.

5.1. Emotions and Emoticons

A visual representation for emotions is necessary to meet the goal of situating the requirements within the game world. Further, given the traditional business requirement for archival storage of production documentation, we would prefer a mechanism that survives the transition from interactive query or inspection within the game world to print media. Emoticons can act as useful placeholders but they do not necessarily provide the resolution required to support the designer's choices – we found ourselves searching through the font looking for an expression that was "just right".

In Figure 2 we see two examples of abstraction. In the top half of the Figure, we see a selection of emoticons from a font freely available on the Internet. In general, there is insufficient information in these images to be able to readily discern the difference between any but the primary emotions. In the bottom half of the image, we see a selection of sketch artist cartoon faces. If sketches of this quality were converted to a font, then there would be less opportunity for misunderstanding (there were some issues associated with members of the production team relating the emoticon to the underlying emotion across all aspects of the production process). Detailed and expressive emoticons, implemented as a font, would greatly facilitate inclusion or adoption within standard production tools used in the production process, at little or no cost.

We recommend that each team develop their own emoticons, or equivalent images, for their use so that all team members instantly recognize the intended emo-

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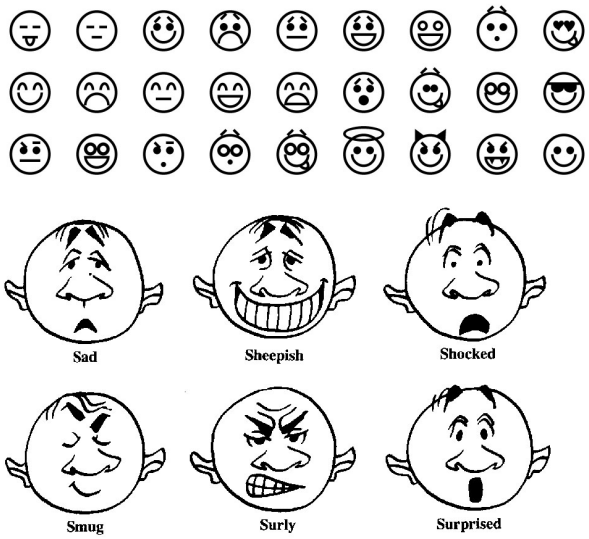

Figure 2. Top: A selection of typical emoticons from the EmotRG font. Bottom: Sketch artist cartoon face samples. Authors unknown.

tions. If this proves impractical, a simple text label could be used but a text-based approach suffers when images are significantly reduced in size.

Our experience has shown that we can capture and represent the primary emotions, and some secondary emotions, with a well-designed set of emoticons. However, tertiary emotions require significant context for proper interpretation and may not be amenable to this technique. If game design progresses to the point where designers are actively identifying tertiary emotions, we expect that the emoticon would be used somewhat like the actor symbol in a use-case diagram – as a placeholder that indicates the presence of further information, such as our earlier suggestion [3] to bind the emotion timeline (a graph that illustrates the relationship between emotional intensity and time) to the emoticon. Given that we are now extending the emotional requirement to include the characteristics drawn from the emotion prototype (a *cue* that identifies the relevant emotion marker(s), an *action* describing the expected player response, and a *goal* that captures the interactions with the world), this information should also be bound to the emoticon.

Once the desired emotions were identified from the categorization, the corresponding emotional intensity map (Figure 3) was generated for this scenario using standard graphics tools on the same plan-view template used in the upper image of Figure 1. The dark zones represent relatively safe areas (HAPPY, RELIEF) for the Runner while the white zones are the zones of highest danger (FEAR). The game designer's intended player emotion is identified by an embedded emoticon within each zone.

6. Generating the Emotional Intensity Map

In Figure 3, the game designer has specified that there is a large Y-shaped region where the Runner is in greatest danger and two smaller regions near the corners of buildings A and B that are almost as dangerous. The designer has also specified that there is a region of safety within the Y-shaped zone. This safe zone implies that there is something in the virtual world that makes this zone safe – most likely a physical construct.

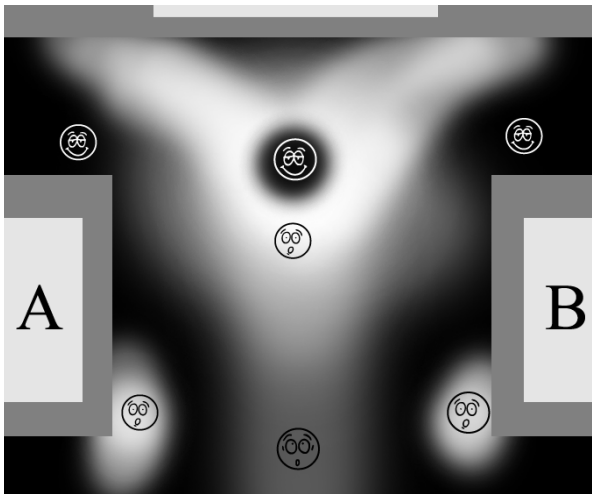

Figure 3. Sniper scenario emotional intensity map. Black denotes safety, white denotes danger.

Grayscale shading is used to characterize transitions between two emotional states such as FEAR and RELIEF. The luminosity indicates the relative strengths of the states and the background mood is assumed (externally documented). However, this model breaks down if we want to indicate transitions between more than two states. For example, a transition between FEAR and a combination of RELIEF and RESENTMENT (*e.g.* I made it, but curse the game designer for making it so hard!) is not supported for we have no way to allocate the respective contribution of RELIEF and RESENTMENT.

A multi-layer compositing technique, using controls for translucency and visibility could be used to simultaneously support multiple emotions. However, such a technique may only be feasible in the interactive medium of the computer and does not readily support the transition to print media, especially grayscale print-

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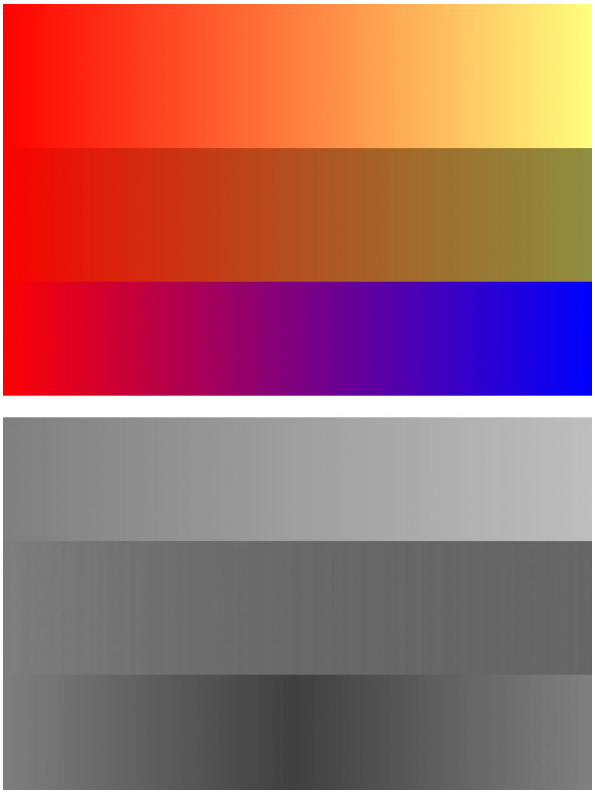

Figure 4. Color in emotional intensity maps

ing.

Even with interactive support, multiple color encoding for requirements is problematic. Figure 4 illustrates some of the issues. In the color portion of Figure 4, red denotes FEAR, yellow denotes RESENTMENT and blue denotes RELIEF. The saturation of each color denotes the intensity of the emotion: red and blue are at 100%, yellow is at 50%. In words, the goal is to transition the player's emotions from very afraid to very relieved while deliberately engendering a mid-level feeling of resentment toward the game designer - possibly to create a feeling of competition between the player and the designer.

The top color bar is for the transition from FEAR to RESENTMENT. The bottom color bar is for the transition for FEAR to RELIEF. The middle color bar is the luminance blend of the two transitions. For the color blend to act as an effective media for requirements capture and representation, all users of the representation must be capable of recognizing that the blended color at the right hand side of the middle bar of the image is a composite of 50% yellow and 100% blue. While this may be possible given that we have deliberately chosen primary colors for illustration, what happens when other colors are used?

It is reasonable to expect that, if every emotion is assigned a unique color, the team could come to recognize those colors – in isolation. However, given that there are only three primary and three secondary colors, we are less comfortable in believing that the combinations of the colors will be easy to recognize and translate to appropriately precise specifications.

The grayscale portion of Figure 4 shows the same transitions between emotions after they have have been converted to luminance. It may be dangerous to assume that the typical asset developer could successfully reason from the grayscale image back to the information contained within the color image. Further complications are illustrated in the bottom band of the grayscale image – there is a significantly darker band at approximately the midpoint in the transition. This occurs because we are collapsing three degrees of freedom (Red, Green, Blue (RGB)) down to one (Luminance, L). As a result, there is no longer a one-one mapping between the visual representation and the information it is meant to convey; many combinations of (RGB) map to the same value of L. Further, there is more than one algorithm for the conversion of color images to grayscale images which can also lead to problems with interpretation.

7. From Requirements to Design and Implementation

Prior to this study, our focus was on capturing the regions and on the emotions themselves. However, we now understand that it is the boundaries between regions that are of greatest import for the media production process. It is at the boundaries that some form of emotion marker must be placed to act as a trigger to induce the desired emotion state. The safe zones of Figure 3 imply that there are aspects of the virtual world that make these zones safe – most likely physical constructs that act as emotion markers. In Figure 5, a luminosity thresholding algorithm was used to identify possible locations for these emotion marker(s), identified here with a pattern fill, thereby providing the appropriate guidance for the media production team.

The game designer would typically explicitly identify the emotion markers, and their locations, during the requirements phase to ensure that the desired control over the artistic context is maintained. As a consequence of this specification effort, appropriate guidance is provided for media production from the beginning of the development process, potentially reducing the number of development iterations. However, the exact mechanism for implementing the emotion marker could be left to the production team – thereby allowing

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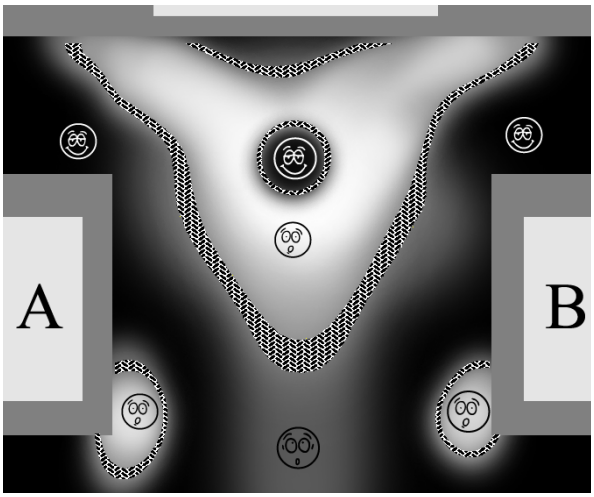

Figure 5. Sniper scenario emotional intensity map. Pattern fill indicates possible locations for emotion markers.

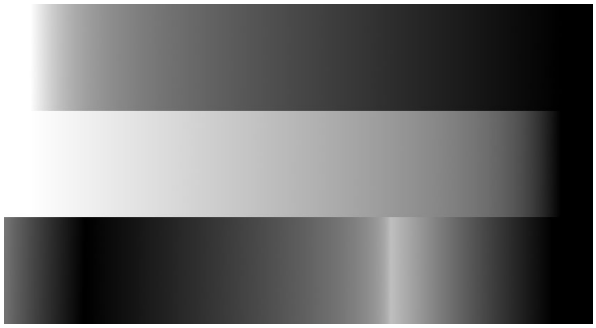

Figure 6. Gameplay difficulty in the emotional intensity map. White denotes danger, black denotes safety. From the top, an easy path, a difficult path, and a complex path.

them to make their own creative contribution, within the constraints of the production budget and the artistic context.

7.1. Difficulty and Emotional State

While *difficulty* is actually a gameplay requirement, the difficulty level has strong emotional interactions, engendering emotions such as FRUSTRATION and ACCOMPLISHMENT. Figure 6 illustrates how the game designer could, if there is a one-one mapping between emotion and difficulty, also indicate relative difficulty using an emotional intensity map. There are three gradients shown; in each case white denotes FEAR, black denotes RELIEF, and the player experience starts from the left and proceeds to the right within each gradient. This overloading allows the emotional intensity map to serve a dual purpose. The top gradient represents an easy path – the luminance of much of the path is closer to black than to white. The middle gradient is a relatively difficult path; only near the end of the path does the intended emotion substantially move from fear to relief. The bottom gradient represents a relatively complex, yet safe, path; a path with some obstacles and one point of greater perceived danger, but without significant elements of fear over most of the path. The bottom path might represent, for example, the emotions of a player as they traverse a maze-like scenario.

Difficulty can also be controlled, to some degree, via the threshold setting for the technique of Figure 5. In this example, increasing the threshold value would move the potential locations for the emotion markers closer to the central safety zone. As a result, the Runner would remain exposed to the Sniper for more of the playing area and the Runner player would perceive this as increased difficulty.

7.2. Constraints on Emotional Requirements

A noteworthy characteristic of the sniper scenario is the lack of face-to-face, personal contact between the players (or rather, their avatars). While traditional cognitive psychology draws heavily upon the concept of facial feedback (the presentation of facial cues indicating the internal emotional state of an individual), video games do not always have this option. The low resolution of the player avatars and the lack of feedback paths between the players and their avatars in the world make facial feedback difficult; the game designer is deprived of this most-familiar interaction mechanism. In addition, there are many scenarios, such as the one studied in detail in this work, where one player cannot necessarily see or perceive the location of the other player. Finally, interactivity allows the game designer to introduce the faceless opponent – the rules embedded in the game engine can act as the replacement for a visible character, further complicating matters.

Therefore, constructing emotional requirements that include facial cues may be inappropriate, if not impossible. It may be better for the game designer to assume that they must design the emotional experience within the constraints of employing only environmental visuals, sounds, and observable actions within the virtual world.

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8. The Final Product

The sketches used for the layout of the virtual world during the requirements process acted more as inspiration to the art department than as hard requirements and practitioners should be prepared to accept this behavior pattern. Figure 7 is a plan view of the final prototype from the artists and modelers, prior to the placement of the emotion markers, and is an innovative interpretation of the requirements created during the study. The black arrow in the image points to the danger zone for the Runner and the white arrows point to the Sniper positions in the three buildings.

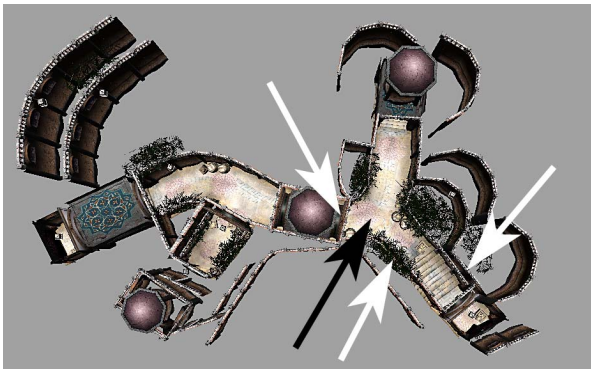

Figure 7. Late prototype, plan view. Black arrow indicates Runner danger zone, white arrows indicate possible Sniper positions.

In Figure 8 we see, from three perspectives, a late-stage prototype of the region of interest that is almost ready for play testing. The top row of images is the scene rendered with full illumination and no special effects. The bottom row of images is what the players perceive in-game, under low illumination and with active fog effects, a significantly different experience.

There are numerous emotion markers in the scene. The brightly lit windows are cues and clues for the Runner, used to draw their attention to the source(s) of danger, while drawing their attention away from the barrels and boxes scattered about the street that promise a refuge, however brief, to the Runner as they attempt to escape attack from the Sniper positions. Column (a) is a view of the scene from an arbitrarily placed camera. Column (b) is the scene from the Sniper perspective in building C while column (c) is the Runner's perspective as they (carefully) look back toward the Sniper position of column (b).

9. Elicitation and Capture

In earlier work with emotional requirements, we were including the scenario concept information (a summary of the scene) within the emotional requirement. However, we found it useful to extract this information since it was shared by all emotional requirements within a given scene. The final form of the process is as follows.

1. Create the scenario concept. Capture a textual summary and a few sketches of the virtual world.
2. Iterate as necessary:
   (a) Define the gameplay experience. What actions can each player take, what assets can the players utilize, how can the players interact?
   (b) Define the artistic context, the virtual world, in sufficient detail that the definition can be given to the media department for implementation.
   (c) Define the emotional requirements using the suggested techniques.
   (d) Iterate as necessary, within the context of (cue, action, goal), to ensure that the desired player experience will be created:
      i. Evaluate interactions with the artistic context.
      ii. Evaluate interactions with the defined gameplay experience.

When evaluating the interactions with gameplay and artistic elements, we found that we were often presented with opportunities to define new interactions – in essence, inventing new requirements. After exploring the possibilities, we abstracted the following interaction patterns.

- Spatial: The location of the element within the virtual world. For example, spatial interaction patterns were typically based upon the relative position between players or between a player and an artifact in the virtual world.
- Temporal: The interaction pattern is dependent only on time, or on a (readily) discernible or deducible function that includes time.
- Engine attributes: Engine services such as collision detection and visibility calculation – the *physics* of the virtual world can be defined and manipulated.
- Game attributes: Those things that are unique or defining elements of the game; for example, the slow-motion effect now known as *bullet-time*, popularized in the *Matrix* movie series.

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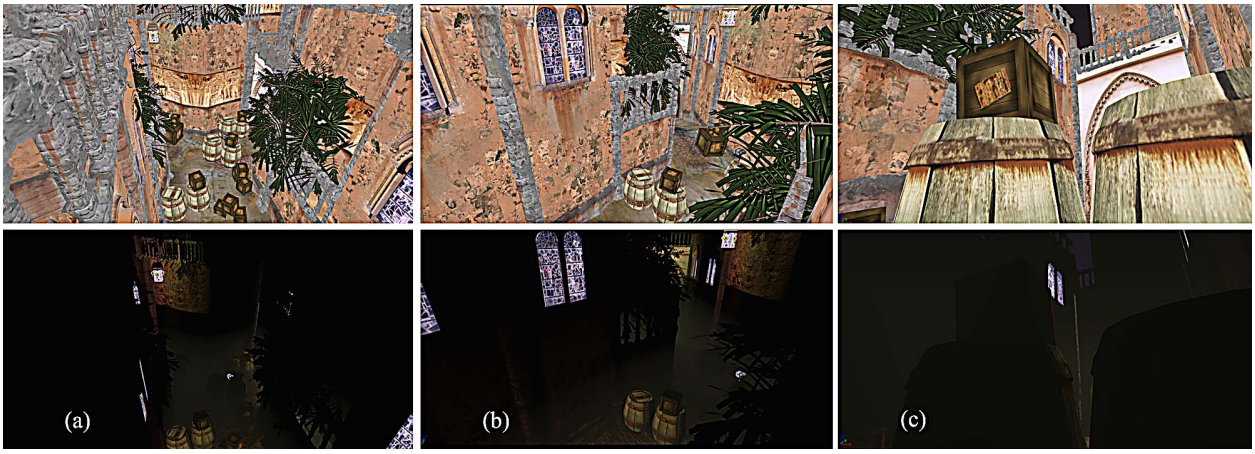

Figure 8. Three perspectives: (a)Isometric View, (b) Sniper View, (c) Runner View

Spatial and temporal interactions can probably be captured by static visuals in the requirements process but engine and game attributes are more likely to require additional textual information.

10. Specifying Emotional Requirements

The complexity of an emotional requirement is greater than we realized during our prior work. An emotional requirement that provides sufficient information about the relationship between the emotional requirement and the virtual world, such that the needs of the game designer and the media production team are met, is specified as follows.

1. The intended emotion. Use of a reference list, standardized for the project or organization, is recommended (Section 5.1). The emotion can be situated within the virtual wold using an emoticon or other abstraction.

2. The artistic context (discussed further below).

3. The emotion prototype.

   (a) The cue (trigger), the emotion marker. The objects, animations, sounds, lighting changes, or other elements of the virtual world that are used to trigger the player's emotional response.

   (b) The action that the player is expected to take. This action is specified relative to the cue.

   (c) The purpose or goal of the player's response. The goal integrates the emotional requirement with the gameplay requirements and design.

4. A means, such as an emotion intensity map, to situate the emotion within the virtual world and to provide guidance as to the spatial relationships between the emotion and the virtual world.

5. A means, such as an emotion timeline, to provide guidance as to the temporal relationships between the emotion and the virtual world.

The original designation of the "artistic context" proved to be too vague for production purposes. While the artistic context describes the look and feel for a given setting (including such information as the period, genre, architectural style, the color palette used, the lighting conditions, and descriptions of the ambient sounds), this information was already available within the general artistic guidelines used by the media production team for each scene. Including the same information within the emotional requirement, rather than simply referencing the relevant artistic guidelines, may lead to greater specification maintenance costs as document versions must remain synchronized.

As in the current scenario, there may be multiple cues. If there are multiple cues, there may also be multiple goals. Further, some of the cues may be intended for emotional requirements and some of the cues may be intended for gameplay requirements. The requirements must clearly identify whether a given cue is related to an emotional requirement or to a gameplay requirement.

The game designer must be careful to avoid creating too many trigger requirements. The player may not recognize the triggers as *triggers*, which can lead to player frustration. If there are too many simultaneous triggers, the player may not be able to respond to them in a timely manner, leading to a far different experience than expected. Finally, triggers that are unused or mal-

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formed waste development and testing effort.

11. Conclusions

The study identified weaknesses in the prior definition of emotional requirements and emotional intensity maps that were impediments to adoption at the development studio participant. The addition of emotion prototype (cue, action, goal) information to the emotional requirements, and the explicit identification of potential locations for the cues (emotion markers), have addressed the known issues and the study participants expressed satisfaction with the results. Independent corroboration of the principles underlying our work was also identified in the work of Smith and other members of the cognitive psychology and film studies communities.

The use of color in emotional intensity maps was investigated. Techniques that support interactive queries show some promise but there is significant potential for misinterpretation by the user. Further, the need for archival storage in black and white print media is a significant barrier to the adoption of color in emotional intensity maps.

The study has elaborated an enhanced elicitation and capture process that better meets the needs of the production team. Additionally, four interaction patterns were derived then used to identify new opportunities for enhancing the player experience.

The action research methodology was well-suited to this problem. Engaging the game designer and media production team as an integral part of the research program helped to ensure that proposed solutions received timely critical feedback and progress was very rapid. Unfortunately, this rapid progress came with reduced control over the research agenda. While we feel that we effectively addressed the immediate issues with emotional requirements, we did not explicitly answer all of our motivating questions and the study would have been strengthened with more participants.

12. Future Work

A stronger understanding of emotion prototypes and emotion markers has the potential to further reduce risk in the production process. If we can identify libraries of emotion prototypes and emotion markers that are known to induce the desired emotional response, effectively identifying *emotion patterns*, then we can reduce the associated risks. However, such a library can quickly become recognizable by the target audience and, therefore, useless. In addition, any form of risk reduction must not impair the creative process or it will do more harm than good.

We have shown that we can readily identify the desired emotions from a reference categorization. However, we do not feel that we have sufficient control to discriminate between these emotions beyond some instances of the secondary emotions. Further work is necessary to identify techniques that will allow us to craft experiences that are defined in terms of all of the secondary emotions and even the tertiary emotions. Increasing the number of emotions simultaneously supported in an emotional intensity map would allow us to remain with a relatively simple, graphical representation for emotional requirements. Techniques that survive the transition between the virtual world and print media are most desired.

Developing extensions to one or more artists tools, level-editing tools, or storyboarding tools such that they provide integrated support for emotional requirements would allow us to broaden our research base and enhance adoption of the research outcomes.

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