

# Color Enhancement for Videogames

Naty Hoffman  
Activision



# Color Grading and LUTs

- Last two talks
  - LUTs can emulate film emulsions in games
- Lou Levinson's talk
  - DI color grading enables creative control over look
- This talk will tie both threads together
  - In-game looks can be authored with color grading-like flexibility and applied as LUTs



# Color Enhancement: Film & Game Similarities

- Same primary goal; creative control over look to:
  - Manipulate the mood of the viewer
  - Call attention to important visual elements
  - Etc. (recall Lou Levinson's talk)
- Similar advantages: easy to art direct, allows for changes late in production, etc.



# Color Enhancement: Film & Game Differences

- In games, can't tweak with same precision since scene content changes in unpredictable ways
- In games, desirable for dynamic game state (such as player's health) to also affect color



# Traditional Game Color Enhancement

- Applied in a full-screen pass after rendering the scene geometry and effects (“post pass”)
- Using shader math driven by variables like saturate / desaturate, RGB tint, contrast
- These settings keyed to game location, game events, script triggers etc.



# Game Color Enhancement with 3D LUTs

- Graphics hardware can access a small 3D texture ( $16^3$  or  $32^3$ ) as fast or faster than the typical color enhancement shader math
- Use input RGB as coordinates, lookup new color
- Opens up many possibilities for color operations
- But how to author?



# Two Techniques for Game LUT Authoring

1. Use a custom app which ties into the game engine (or actually runs in game)
2. Author 3D LUTs in an external application



# Example of in-engine Authoring: Valve's Source Engine

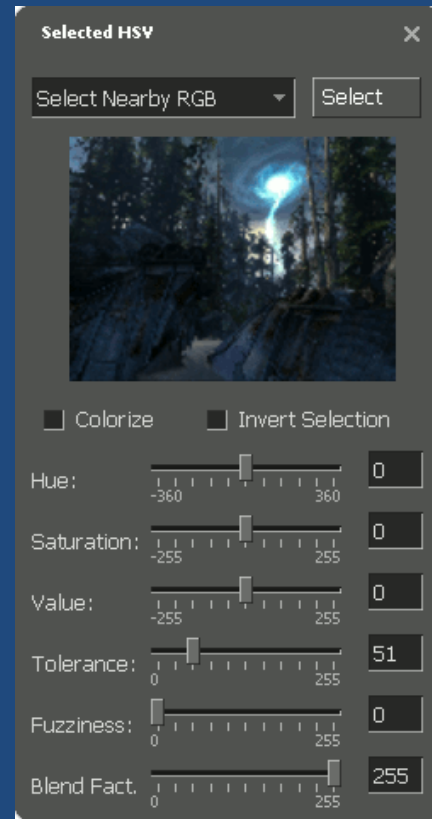
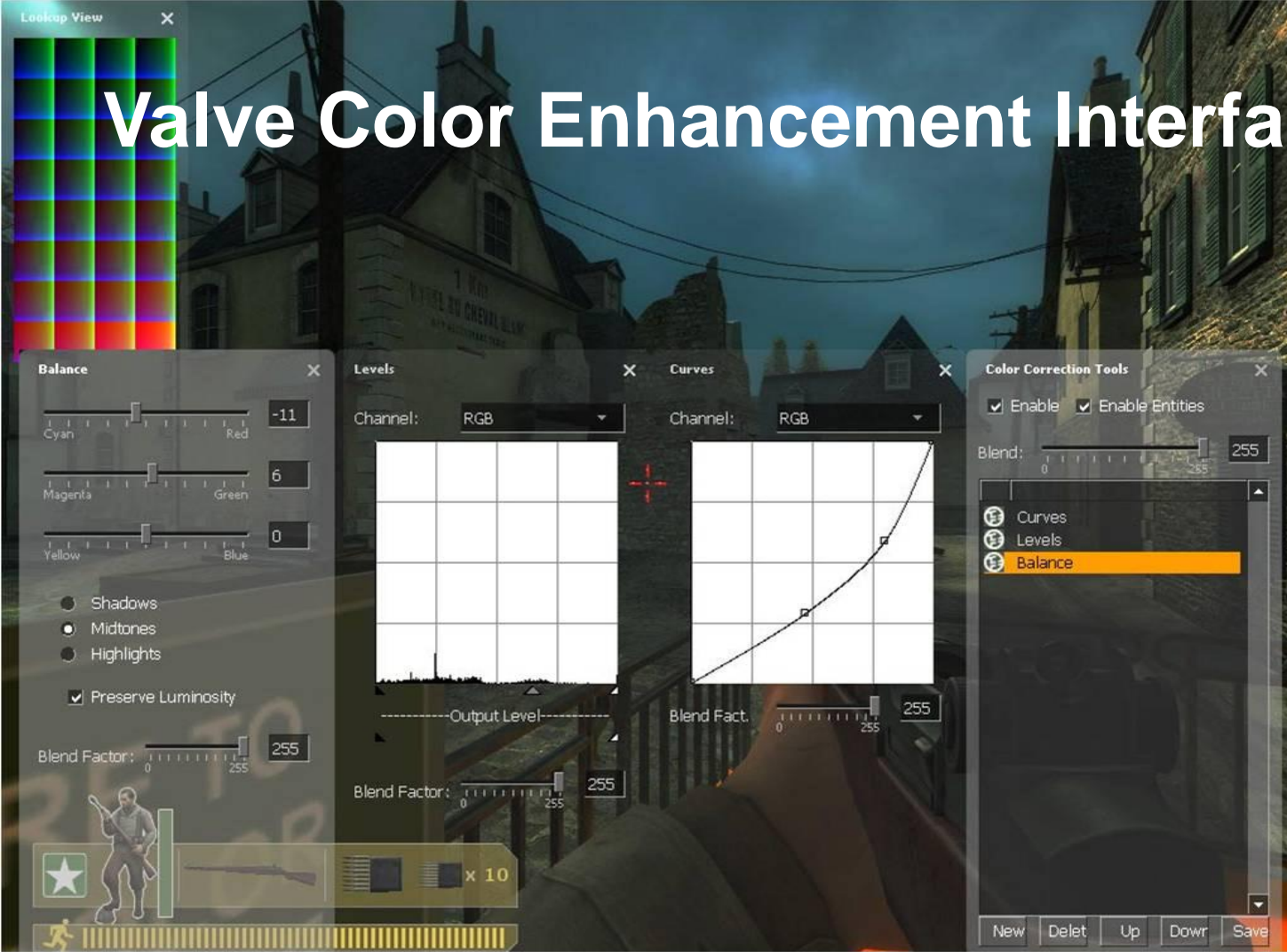
- Valve pioneered this technique (and the use of 3D LUTs in videogames)
- Their interface includes
  - Common Photoshop operations such as curves, levels and color balance
  - Basic selective (secondary) color enhancement
  - Can apply multiple layers of operations





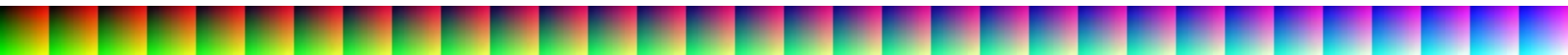
# Valve Color Enhancement Interface

Images used with Valve's permission



# Authoring LUTs Out-of-Engine

- Take “identity LUT” (result same as input RGB)
- Slice (e.g.) 32x32x32 cube into 1024x32 strip:



- Grab (uncorrected) screenshot from the game, paste “identity LUT strip” on it
- Give screenshot + LUT strip to artist to perform color manipulations in external app
- Convert strip back to 3D LUT, import into engine

# Authoring LUTs Out-of-Engine

- History of this technique in the course notes
- Not ubiquitous yet, but becoming mainstream
- Natively supported by major middleware engines
  - Unreal Engine, CryEngine
- Also implemented into homegrown engines
  - At EA, Activision Blizzard, others



# Pros / Cons of In-Engine LUT Creation

- Pros:
  - Immediate feedback
  - Artist sees color exactly as it appears on target
- Cons:
  - Need to implement custom tool
  - Every new operator and interface needs to be implemented separately



# Pros / Cons of External LUT Creation

- Pros:
  - Use any app, from Photoshop to pro grading tools
  - Much more power and flexibility, no need to implement custom tool
- Cons:
  - Iteration time
  - Matching color to target platform difficult, can use techniques similar to film DI to solve



# Example: Left 4 Dead (Valve)

- Horror game
  - Dark, scary cinematic environment
- “Filmic” Effects used communicate player state and enhance dark setting



# Example: Left 4 Dead

- Unify/simplify the palette
  - Call out specific colors that are important for navigation/gameplay
- Some game entities, particularly the protagonists, are designed with this color correction operator in mind and retain their saturation relative to the more desaturated environment





# Example: Left 4 Dead (No Effects)



Image used with Valve's permission





# Example: Left 4 Dead (Color LUT)



Image used with Valve's permission





# Example: Left 4 Dead (All Effects)



Image used with Valve's permission



# Example: DJ Hero 2 (Freestyle)

- Music rhythm game
- Dance clubs, complex lightshows and pyrotechnics
  - The color enhancement adds additional stylized, over-the-top effects synchronized to the music
- Use Photoshop (including color grading plugins)





# Example: DJ Hero 2



no LUT

Image used with Activision's permission

**DJ  
HERO 2**



# Example: DJ Hero 2

green scale

Image used with Activision's permission

**DJ  
HERO 2**



# Example: DJ Hero 2



sepia

Image used with Activision's permission

**DJ  
HERO 2**



# Example: DJ Hero 2

only green

Image used with Activision's permission

**DJ  
HERO 2**





# Example: DJ Hero 2

posterize

Image used with Activision's permission

**DJ  
HERO 2**



# Example: DJ Hero 2

threshold 75

Image used with Activision's permission

**DJ  
HERO 2**

# Example: DJ Hero 2

threshold 25

Image used with Activision's permission

**DJ  
HERO 2**



# Example: DJ Hero 2

invert RGB

Image used with Activision's permission

**DJ  
HERO 2**



# Example: DJ Hero 2

lightness invert

Image used with Activision's permission

**DJ  
HERO 2**

# Example: Guitar Hero 5 (Neversoft)

- Similar game genre to DJ Hero
- But goals of color enhancement are different
  - Help establish mood the mood of the scene
  - Reinforce a particular style for each venue
  - Less extreme color transformations



# Example: Guitar Hero 5

- Use Sony Vegas
  - Load a variety of screenshots and scrub back and forth to make sure LUT works in different situations
  - Use a variety of color operations
  - Curves, levels, hue adjustments, brightness / contrast, color balance, three-way color correction (primary & secondary), gradient map, HSL adjustments, invert, etc.







# Example: Guitar Hero 5

Image used with  
Activision's  
permission





Image used with  
Activision's  
permission





The screenshot displays the Vegas Pro 9.0 software interface. The main video preview window shows a scene from the game Guitar Hero 5, featuring a character playing a guitar in front of a large, illuminated structure. Overlaid on the left is the 'Video Track 1' properties window, specifically the 'HSL Adjust' tab. This window contains sliders for 'Add to hue' (0.00), 'Saturation' (0.75), and 'Luminance' (1.00). Below the sliders is a color bar. The bottom of the interface shows the 'Project' window with a timeline at 00:00:52:02, a preview window, and a list of video clips. The status bar at the bottom indicates the frame number (1,562) and display resolution (1138x640x32).





# Example: Guitar Hero 5

Image used with  
Activision's  
permission





# Example: Guitar Hero 5

Image used with  
Activision's  
permission



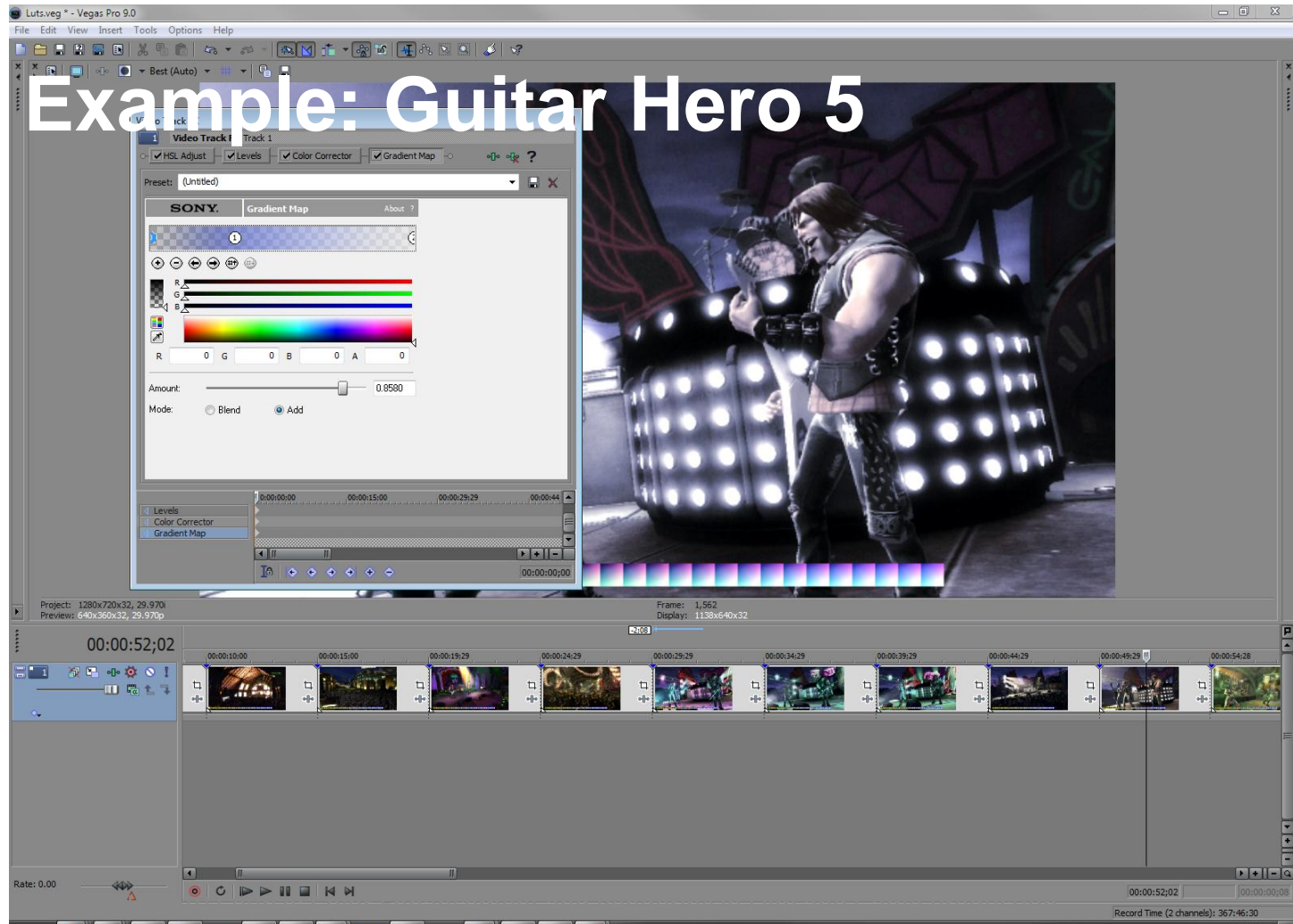


Image used with  
Activision's  
permission

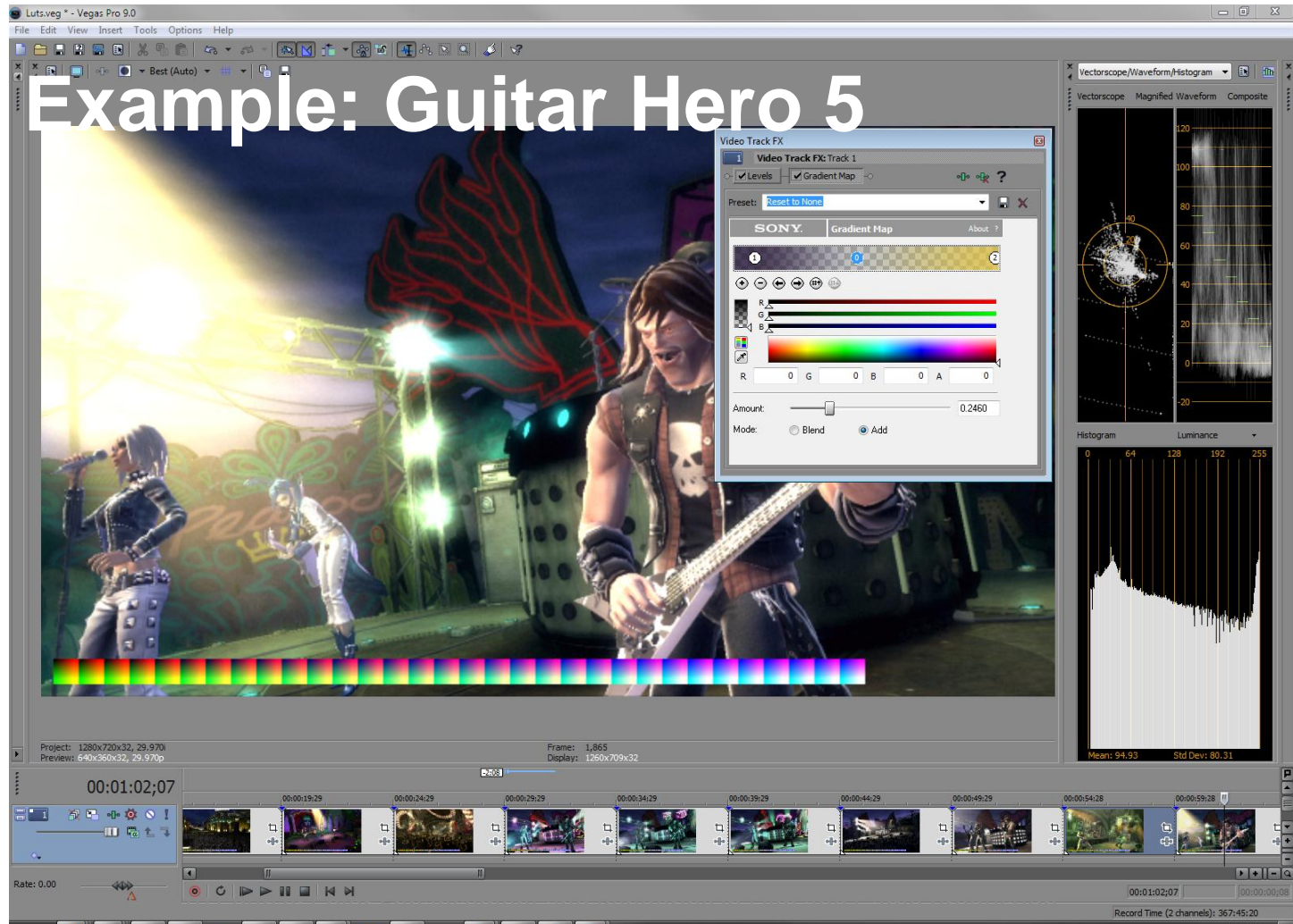






Image used with  
Activision's  
permission





# Example: Guitar Hero 5

Image used with  
Activision's  
permission





# Example: Guitar Hero 5

Image used with  
Activision's  
permission







# Example: Guitar Hero 5

Image used with  
Activision's  
permission





# Calibration

- However the LUTs are authored, it's important for the artists to have properly calibrated TVs and viewing environments
- Similar to setups for mastering home video (eg Blu-ray) editions of feature films
- Need to also test on “typical consumer setup”



# Acknowledgements

- Kyle McKisic for Guitar Hero 5 info and screens
- Jason Mitchell for Left 4 Dead info and screens
- Phil Bale for DJ Hero 2 info and screens
- Other course speakers for discussions and ideas

