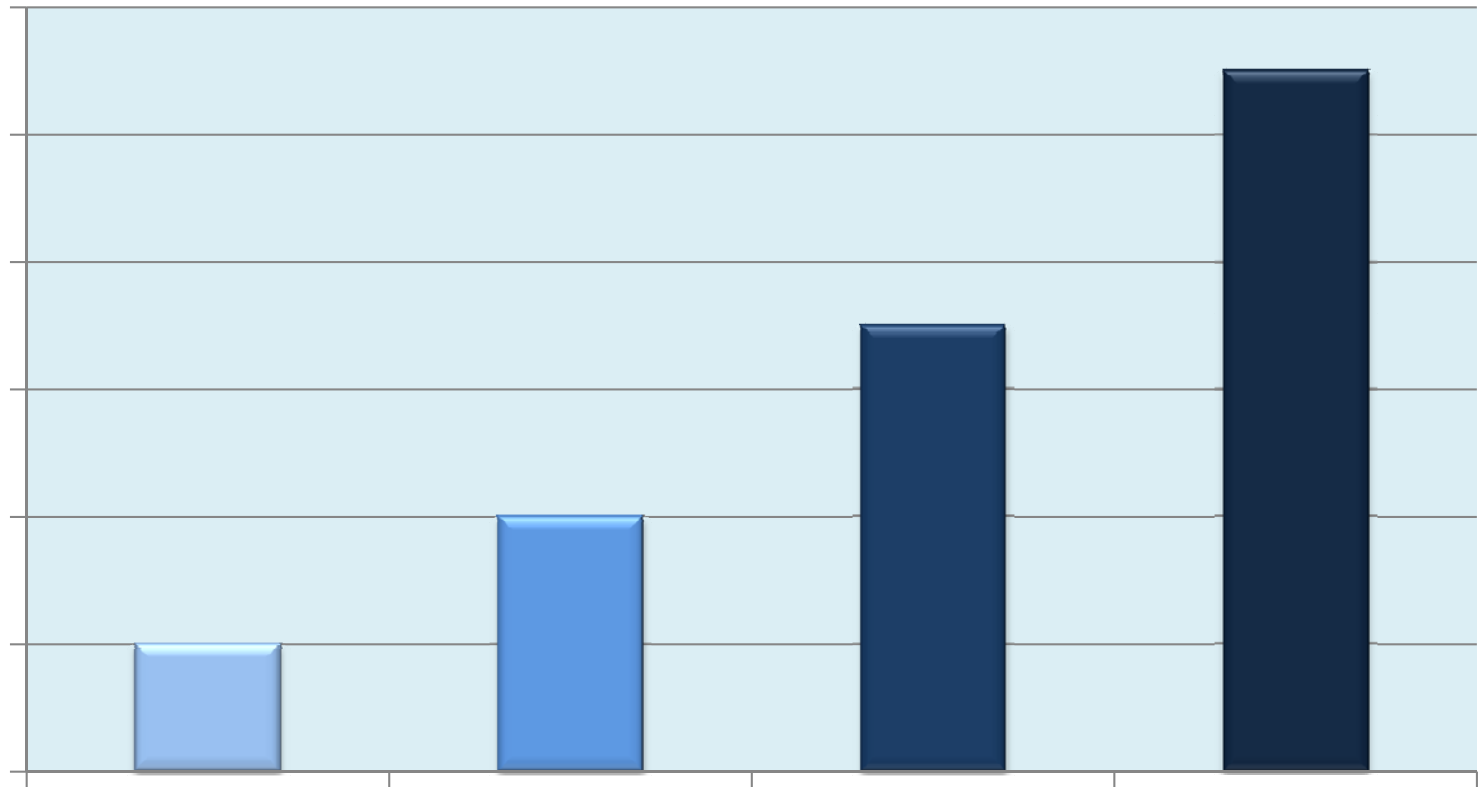# nVISION 08

THE WORLD OF VISUAL COMPUTING

Easy immersion with NVIDIA 3D Stereo

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3D Stereoscopic Has Gone Mainstream

3D Enabled Cinemas are Growing

For Consumers Looking for an Immersive Gaming Experience at home, PCs are the only choice!

Agenda

- Basics of 3D Stereo on a PC

- NVIDIA GeForce 3D Stereo drivers

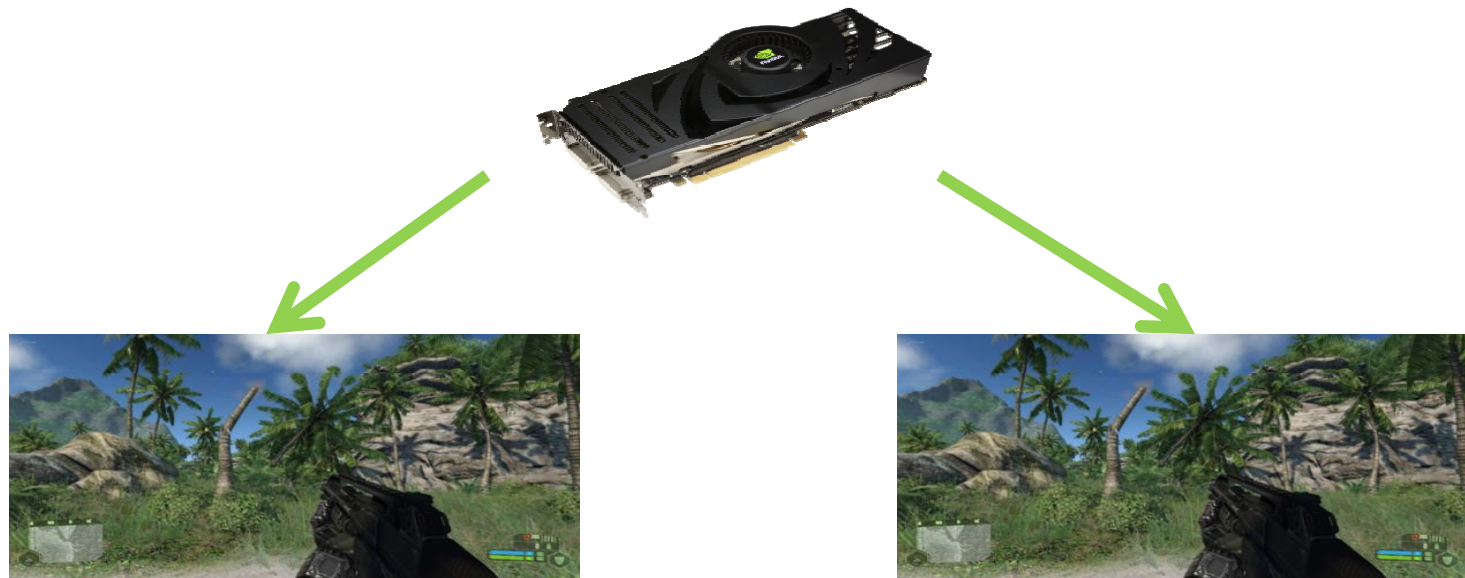- Maximizing 3D Stereo in Your Game

- How We Can Help

Basics of 3D stereo on a PC

- **Step 1**: GPU receives data from an application and starts the rendering process.

Basics of 3D stereo on a PC

- Step 2: The GPU and driver uses W coordinate data to create two different images which are offset from each other and stores them in the frame buffer.

Basics of 3D stereo on a PC

- **Step 3**: The GPU then renders both offset frames on a display. The viewing device is what determines how the images are processed for the viewer.

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3D Stereo Displays

- Two different techniques for viewing:
  - Active shutter glasses
  - Passive glasses and LCDs with polarized filters

- Three types of displays for active shutter glasses:
  - 3D Ready DLP TV
  - 3D Ready LCD
  - Analog CRT

3D Ready DLP TV

- Checkerboard pattern generated by GPU
- Converted by display into page-flipping format

3D Ready LCD

- 120 Hz
- Full resolution per eye

NVIDIA GeForce 3D Stereo Drivers

- Windows Vista 32-bit only

- Download from www.NVIDIA.com/drivers
  or www.nvidia.com/object/3dstereo_drivers.html

- Detailed instructions for enabling stereo are included in the appendix.

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GeForce 3D Stereo Settings End Users Can Configure

- **Depth Amount setting** represents the *maximum stereo separation*, which is applied to far objects.

- **Stereo separation** is the distance between left and right eye images of the same object.
  - Maximum stereo separation should be equal to the distance between the pupils of a persons' eyes (about 2.5 inches).
  - Some people may feel uncomfortable with a high stereo separation, so it's default is 15% of the maximum.
  - Most users will raise it to higher value after adjusting their eyes to using 3D stereo

Stereo Separation
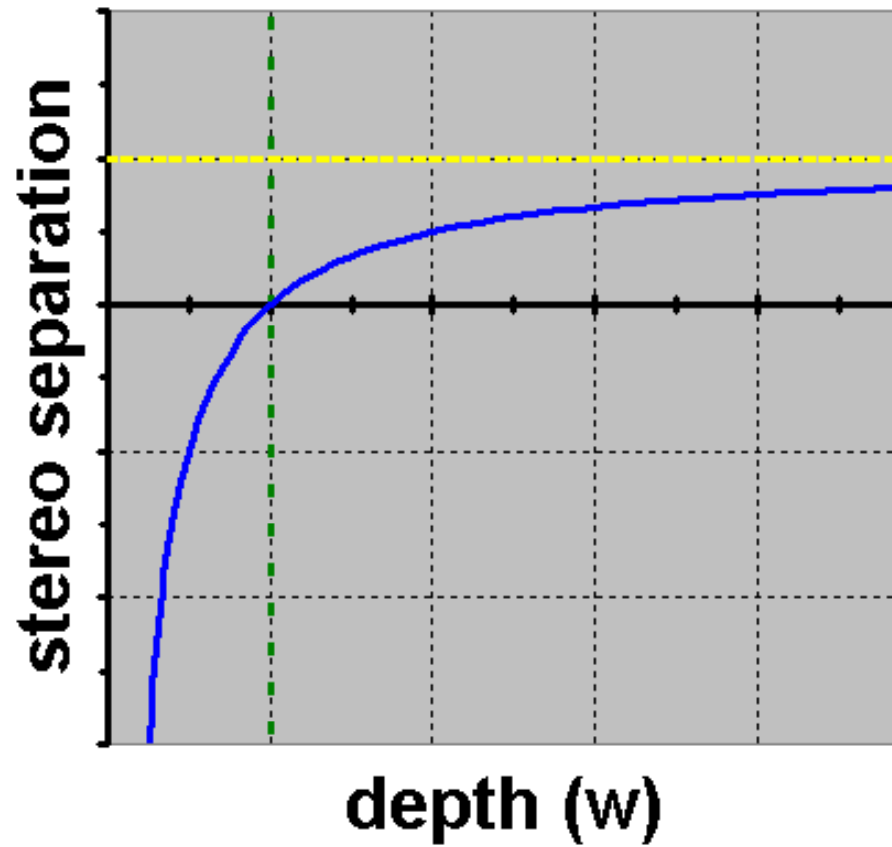
Stereo Separation
(continued)

- If stereo separation = 0,
  an object appears at screen depth.

- Distant objects have separation
  quickly approaching maximum,
  as a function of 1/W.

- Maximum separation is the distance
  between the pupils of a persons' eyes
  (appx. 2.5 inches).

Zero separation depth

- Zero separation depth (screen depth) is controlled via **Convergence adjustment** hotkeys.

- Keys can be set at
  - 3D Stereo CPL -> Set Keyboard Shortcuts -> advanced in-game settings

- Officially supported games have optimal Convergence values pre-configured in profiles shipped with our drivers.

Getting ready to test your game

- To test a new game in stereo, a game specific profile needs to be created.
- Detailed instructions are included in the appendix.

NVIDIA GeForce 3D Stereo driver from a programmer's point of view…

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GeForce 3D Stereo implementation in driver

- Swapchain and certain textures are created with left and right eye representations.
- Draw calls are executed twice, once rendering into the left and once into the right eye representation.
- Vertex shaders passed by the application are modified by NVIDIA driver to apply the stereo effect:
  – Stereo separation is computed from W coordinate (depth).
  – It is then either added or subtracted from X coordinate.

Projection matrices and depth
(where does W come from)

- ## Perspective projection matrix:
  - Copies incoming Z coordinate into W.
  - Z is adjusted to maximize the use of depth buffer precision.

- ## Orthogonal projection matrix:
  - Sets W to 1.0
  - Z is adjusted to maximize the use of depth buffer precision.

Stereo in intermediate textures

- In StereoTextureEnable=1 mode a texture will have left and right eye representation if the following two conditions are met:
  - Not square (width != height)
  - Are of the same size as backbuffer or larger.
- This is result of the following considerations:
  - Stereo needs to be applied also to offscreen buffers, so at least some textures should get stereo effect.
  - However, not all textures should have it. For example, shadowmaps (shadows fall the same regardless of whether you look at them from left or right eye POV).

Stereo in intermediate textures
(continued)

- When developing an app, follow these rules:
  - If rendering from POV of a camera/player, render to backbuffer or a texture of the same size as backbuffer.
  - If doing postprocessing step(s), make sure subsequent destination textures are also of the same size.
  - If rendering from POV of a lightsource or other situation which needs stereo effect turned off for the whole scene, and does not need separate left and right eye representation, render to a square texture.

Rendering 2D objects

- 2D objects are typically HUDs, menus, or text messages which should ideally be at screen depth with no stereo effect.
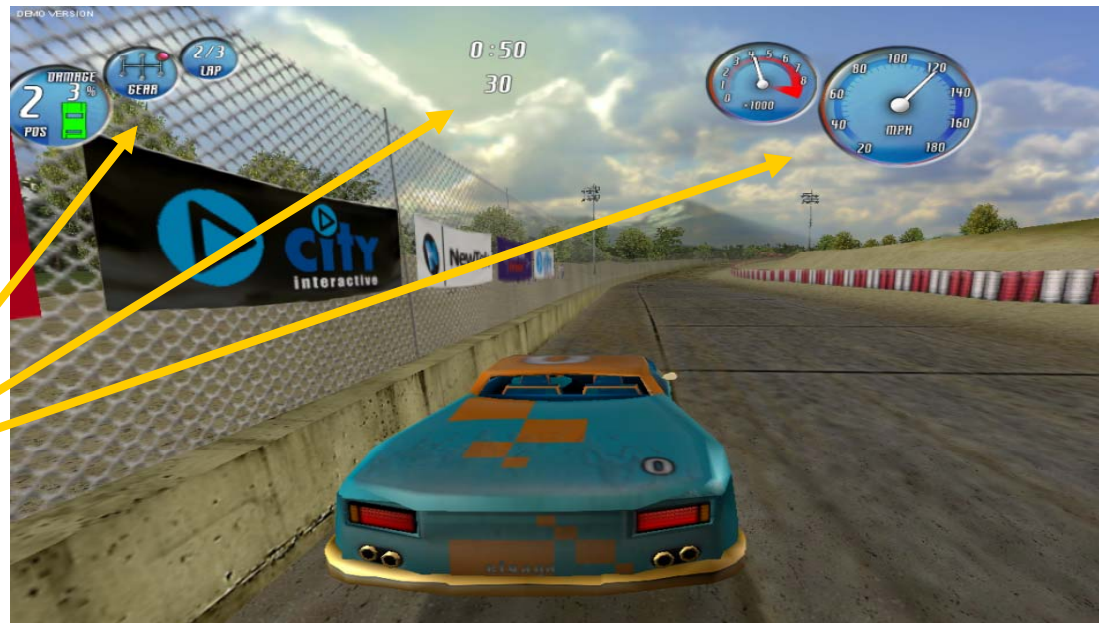
- To render a 2D object, with no stereo effect, set W coordinate to 1.0

Example: postprocessing

- Scene is rendered to a texture, and has stereo effect applied at that time.
- Make sure destination texture has the same size as backbuffer so that it has left and right eye representations.
- Then you render a full screen quad from that texture, either to a backbuffer, or another texture.
- If both source and destination textures have left and right eye representations, then 2 rendering operations will occur: left->left and right->right.
- To make sure that no additional stereo separation is added when rendering a full screen quad, set W=1 on all vertices.

Maximizing 3D Stereo in your Game

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Placing objects at correct depth

- Our eyes use multiple cues to determine distance to an object.

- Stereo separation is only one of them.

- If object A is obscured by object B, it is a strong hint that object A is further away.

- When stereo separation contradicts with other depth cues, eyestrain and headache will result.

Examples of incorrect rendering

- Skybox rendered at the beginning of the scene, with Z write disabled, and some random W value, unrelated to the rest of the scene.

Enter the Sphinx and clear all resistance.

Stereo tip

When rendering skybox or other background objects, use W value larger than the rest of the scene!

More examples of incorrect rendering

- Object/NPC highlights, hit-point bars, etc. rendered not at the same depth(W) as the object being highlighted.

Object hit points/name/etc

Object

Even more examples of incorrect rendering

- A gun rendered at the end of the scene, after Z buffer from the main scene rendering has been cleared, and using W range significantly overlapping with the main scene.

Stereo tip

Try to make sure it renders fine with Z buffer remaining from the main scene, using the same matrices.

Make sure your projection matrices are consistent across the whole scene!

Crosshairs

- 2D crosshair does not work in 3D stereo.
- Lasersight works in stereo.

Stereo tip

Draw the crosshair and lasersight at the right depth of the object.

Maximizing stereo effect

- Maximum stereo separation is about 2.5", and represents 100-200 pixels.

- Stereo separation quickly approaches maximum, as a function of 1/W:

  For example, if you start at W=10 being your screen depth (zero stereo separation), then at W=1000 stereo separation will be within 1 or 2 pixels of the maximum.
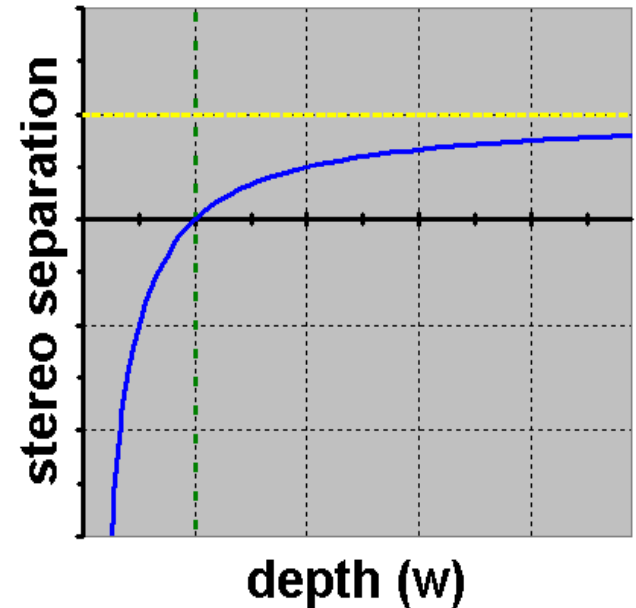
depth (w)

Maximizing stereo effect
(continued)

- Try to fit as much of your scene as possible within W range between screen_depth and screen_depth*100.

- Set screen_depth to the maximum possible value (using "convergence adjustment" hotkeys).

    But make sure objects do not come out of the screen and get clipped by screen sides.

Maximizing stereo effect
(continued)

- Different scenes may require different screen_depth:
  - If a scene requires significantly different screen_depth setting than the rest of the game, consider applying uniform scaling transform.
  - In the future, NVIDIA will make available StereoAPI functions to change screen_depth ("convergence") dynamically.

Out of the screen effects

right eye image
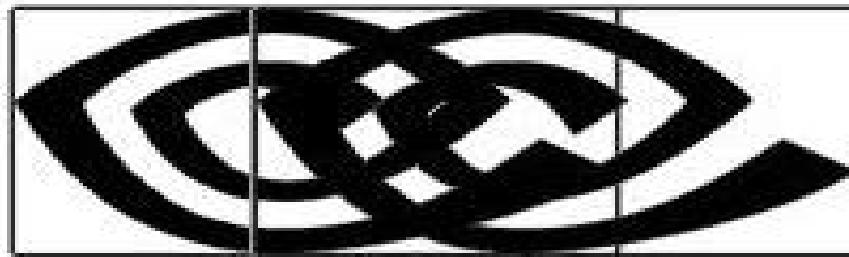
left eye image

left eye

right eye

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Out of the screen effects
(continued)

- Object appears out of the screen if it has negative stereo separation (right eye image is to the left of the left eye image).

- Cannot get clipped by the sides of the screen.

Out of the screen effects
(continued)

- A mind may refuse to believe that something is hovering outsize of the screen (you will see double image), so some additional convincing may be needed:

  – Highly realistic rendering helps.
  – Move object slowly from inside the screen to the outside area to give eyes time to adapt.

Games not written for stereo are unlikely to have good out of the screen effects

- This is an opportunity to differentiate your game!
- We are looking for 3D Stereo showcase titles and promotions

Other issues

- Some displays support stereo only in specific resolutions, and they may not be standard. Make sure your application supports all resolutions and refresh rates reported by the driver.

- Some stereo output modes degrade resolution compared to the original, such as line interleaved stereo. Make sure that text is rendered using large fonts, and do not use line primitives.

Other issues
(continued)

- Most of the current stereo output devices do not have a 100% cancellation of right eye image in the left eye and vice versa. This results in "ghosting". Highly contrast scenes will be more likely to suffer from this issue.

- Polarized glasses reduce overall brightness of the scene, so monitor brightness may need to be increased for viewing in stereo mode.

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How NVIDIA Can Help

- Work with our devtech engineers to get us early access to titles for 3D stereo evaluation and feedback

- Get your development environment "3D stereo ready" for on-site testing
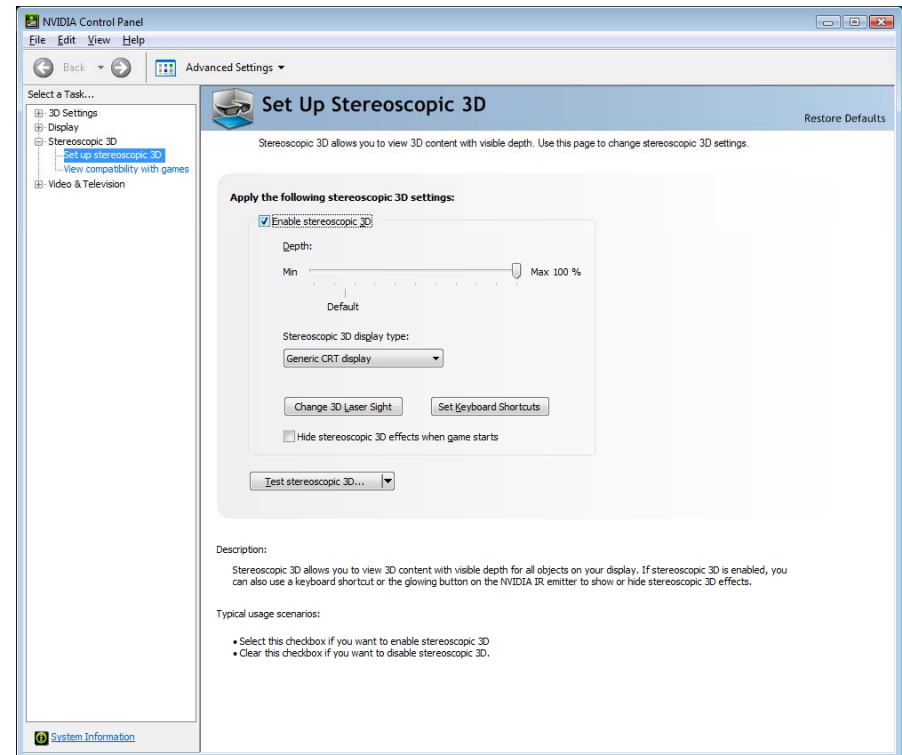
- Game promotions/bundles

Thank you!

- Questions?

- Demo

- Discussion board:

  forums.nvidia.com
  Hardware->3D Stereo

APPENDIX

How to Install and Enable

1. Install standard GeForce driver and reboot.

2. Install GeForce 3D Stereo driver (no reboot)

3. Go to 3D Stereoscopic page on NVIDIA Control Panel and enable stereo.

4. Run the test app, to make sure stereo works.

Configuring 3D Stereo Game Profile

- Check "Enable 3D stereoscopic" box on
  3D Stereoscopic page of NVIDIA Control Panel
  - Note if "Hide 3D stereoscopic effects when game starts" option is enabled. If it is off, you will need to use the hotkey, *Ctrl-T* by default, or a button on IR emitter, when the game starts.
  - Open "Set Keyboard Shortcuts" dialog, and check "Enable advanced in-game settings" box.

- Run the game, and enable stereo mode. It may not be correct at this point.

- Hit "Save Configuration" hotkey *Ctrl-F7*

Configuring 3D Stereo Game Profile *(cont.)*

- Configuration is saved to HKLM\Software\NVIDIA Corporation\Global\Stereo3D\GameConfigs\<game exe name>
    - Add DWORD entry StereoTextureEnable: 1
    - Add DWORD entry StereoCutoff: 1

- These are optimal values for games that do not render directly into backbuffer. We will likely make them default in the future.

- Try running your game again after setting these values.