A note on these slides:

- This presentation was created in OpenOffice 2.0 Impress and later converted to Powerpoint format. Some slides and fonts may look slightly funky as a result. You can download the original .odp file on my webpage, or watch the presentation in one of the other formats (PDF, Flash) to get the original experience.

- Videos of the workflow presented in this talk are available for download. I recommend you watch the videos to get the most from this presentation.

- The finished textures can be downloaded on my page.

SO, NORMAL MAPS...

Are they...like, cool and stuff?

(Do we need a session like this one in 2007?)

NORMAL MAP USE IN 2007

- Large parts of the industry have adopted pixel shaders

- Every team has artists that have worked with the technique

- There's nothing more to talk about, right?

- Right?

NORMAL MAP USE IN 2007 (CONTINUED)

- If we are all using normal maps on a daily basis, why are there so many bad-looking surfaces in various games?

NORMAL MAP USE IN 2007 (CONTINUED)

- In other words, why do we often see stuff like this even in the visually most impressive games?

That's actually a decent representative of the "bad normal map" faction – but you get the drift. Every game has that one surface that pulls you out of the game.

TALK OUTLINE

Part 1: Normal Map Basics

Part 2: Efficient Normal Map Creation
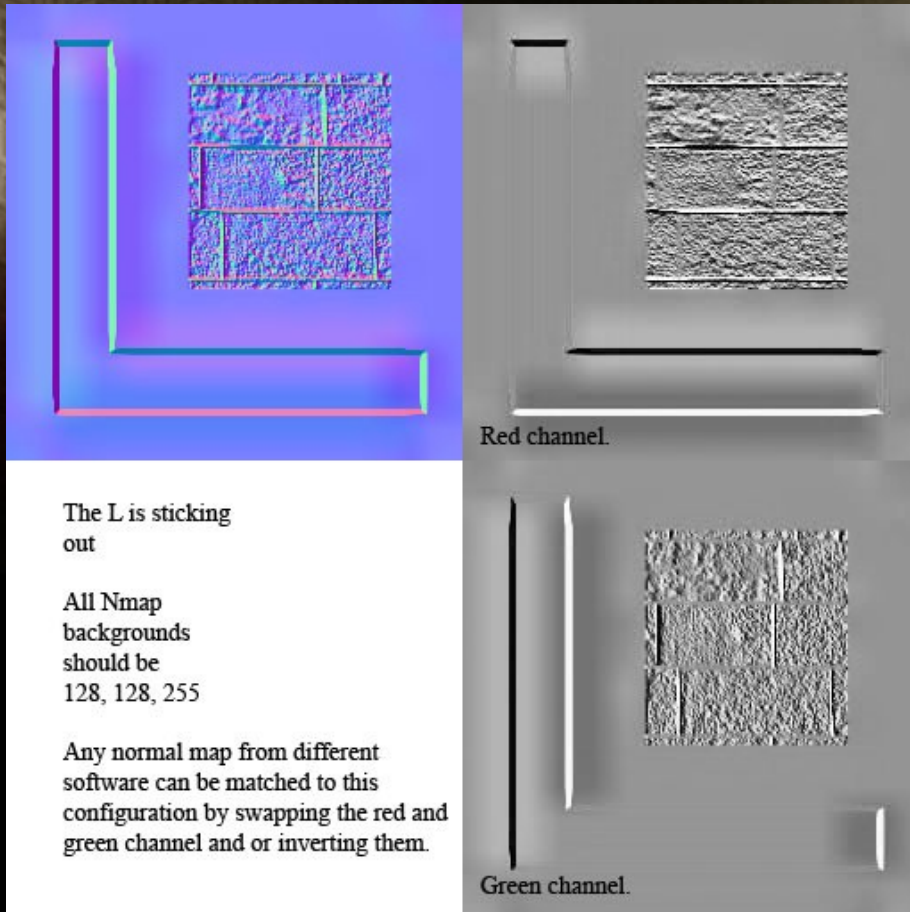
Part 3: Q&A

PART 1:

NORMAL MAP BASICS

NORMAL MAP DIRECTIONS

- The three color channels of the RGB image correspond to the directions in a 3D Cartesian coordinate system:

    - Red = left/right

    - Green = up/down

    - Blue = in/out

- Handedness* of Red and Green not standardized (in some engines, the Red and Green colors are even swapped!)

(*) which way the coordinate system is pointing

NORMAL MAP DIRECTIONS (CONTINUED)

The Factor 5 normal map chart

Correct ZMapper settings for F5 normal maps

- Provide a artist chart identifying all directions and correct settings for extraction

NORMAL MAP DIRECTIONS (CONTINUED)

- Start looking at the individual color channels of your normal maps!

- Correlate the colors to the three axis

- Think about how you can use the information in each channel in related maps (see the workflow demo for an example)

FACTOR 5

NORMAL MAP DIRECTIONS (CONTINUED)

- If your normal map does not match the chart, do not regenerate the entire map!

- Instead, identify and select the incorrect color channel and invert that channel in Photoshop

- Inverting a color channel can also me used to change the embossing (in or out) of details like ornaments

NORMAL MAP COMPRESSION

- DXT compression was created to make maps look good to the human eye!

- Normal maps are not supposed to be pretty, they're supposed to be mathematically correct

- Have you ever looked at the color channels of your DXT compressed normal maps?

- It's not pretty...

NORMAL MAP COMPRESSION (CONTINUED)

- In DXT compression, the Red and Blue channels suffer more than the Green channel

- DXT1 compression means 5-6-5bit depth for the RGB channels, stored in a 4x4 2bit lookup table

- In normal maps, this leads to blocky artifacts (lookup table) and a loss of Red "up/down" information

- The alpha channel in a DXT5 texture is preserved better than the Red channel

NORMAL MAP COMPRESSION (CONTINUED)

- Solution: Copy the Red channel of the normal map to the Alpha channel before compression

- Compress as DXT5

- Swizzle the Alpha into the Red channel

- Drawback: DXT5 takes additional texture memory

COMBINING NORMAL MAPS

- Normal maps can be combined in Photoshop to bake high frequency detail onto big surfaces

- For example, you can bake a tiling rust normal map onto a full suit of armor without painting the entire surface with rust inside Zbrush

- Be careful with rotated UV shells, the tiling detail map will assume different directions!

COMBINING NORMAL MAPS (CONTINUED)

Add big gashes, dents etc. in Zbrush.

Overlay a tiling rust map.

Result

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FACTOR 5

COMBINING NORMAL MAPS (CONTINUED)

- We can't simply combine the two normal maps in one go!

- We need to combine each color channel (direction) separately, then reassemble the map:

  - *Overlay* the Red and Green channels individually

  - *Multiply* the Blue channels

- Copy all three channels into a new normal map

FACTOR 5

NORMAL MAP CONCLUSIONS

- Normal maps are mathematically correct, but that doesn't mean that we can't fudge them

- DXT1 compression can decrease normal map quality, use DXT5 + swizzling for better results

- Think about each color channel as a X/Y/Z direction and learn what to do with them

- Use the color channels of your normal map in other textures to match up all maps!
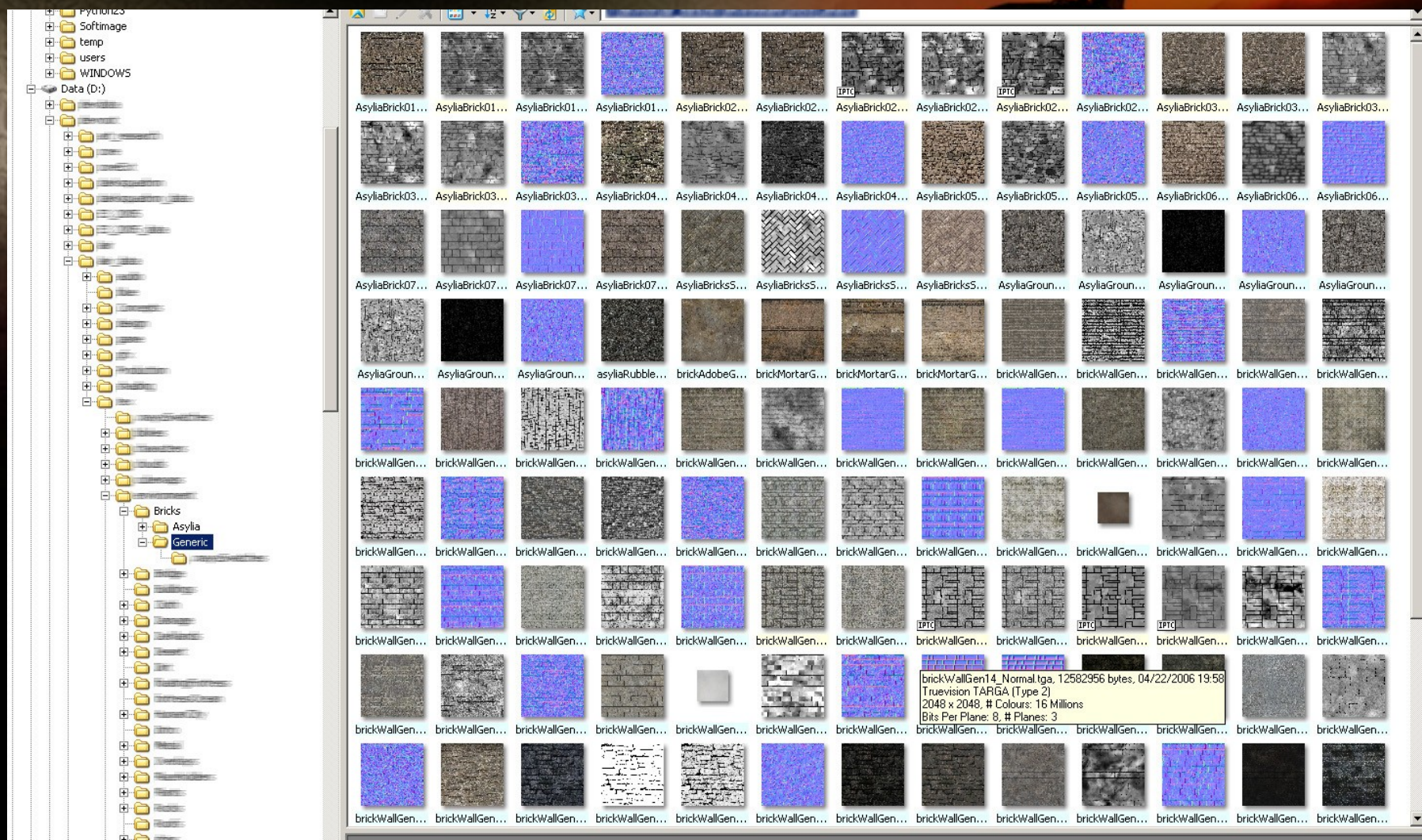
PART 2:

EFFICIENT NORMAL MAP CREATION

TEXTURE LIBRARIES

♦ Every game, be it sci-fi, urban or medieval, needs a library of reusable materials to texture the environment

TEXTURE LIBRARIES (CONTINUED)

As an example, this is a partial view of the brick directory for Lair

TEXTURE LIBRARIES (CONTINUED)

- Bad library surfaces usually creep in because of volume and time constraints

- As a solution, we need to introduce workflows that quickly create good-looking surfaces

- To do so, we might have to change the way artists go about creating texture libraries

THE CHALLENGE

- Create a library of real world surfaces (in this case brick) in a short amount of time

- Create good-looking assets that hold up to close scrutiny

- Keep the process fast enough to be feasible in production

ARTIST'S INSTINCTS

- Dig into reference library and pick visually pleasing source art

- Create the color map

- Convert photo to grayscale to get displacement map

- Create normal map based on the grayscale image

WHY THE APPROACH WON'T WORK

- Color images never contain correct height information

- There's always some directional light/shadow information

- Converted grayscale images usually come out too busy

THE SOLUTION

- Create light-neutral color map

- *Rebuild* all height information from good displacement (scan) data

- Match up the color map to the new height information

- Keep the process fast enough to work in production

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FACTOR 5

LAIR PRODUCTION CHALLENGES

- We can see for miles, and the dragon can fly anywhere within a heart beat and get an up-close look at something

- Even though mission based, need to author like open world game because the world is so big

- Thus, our process should be applicable to many other genres, i.e. first-person shooters and RPGs
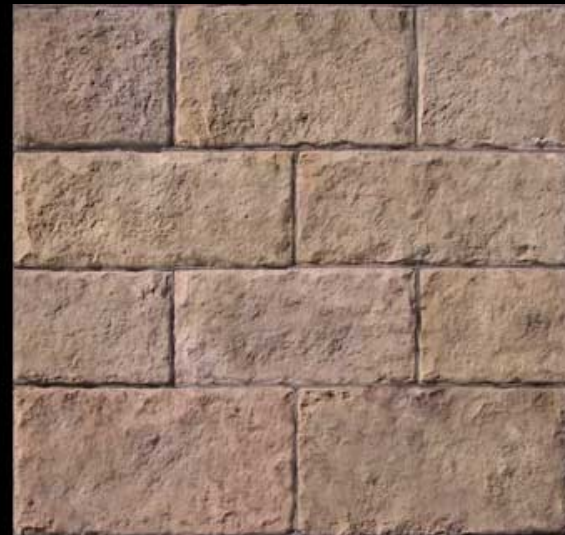
We need to fill an environment like this with bricks

WORKFLOW DEMO

Please download and watch the workflow videos for much more detail on the following slides.
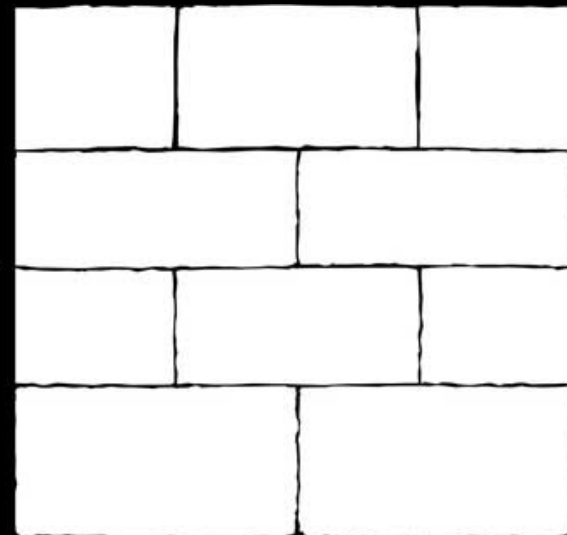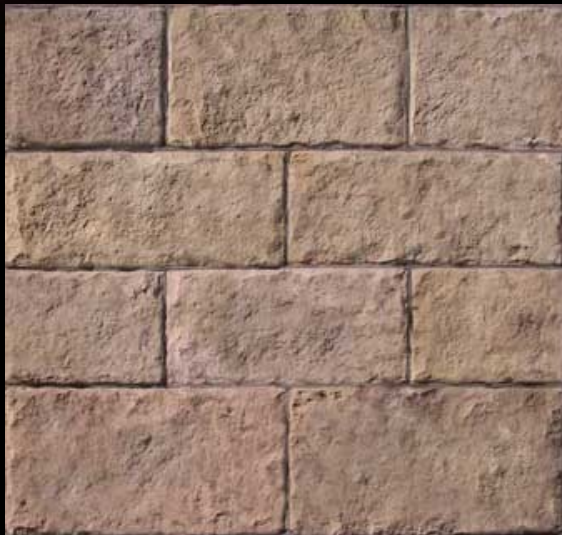
WORKFLOW DEMO (CONTINUED)

- Remove all directional light information (which in turn describes the height information of the surface)

WORKFLOW DEMO (CONTINUED)

- Mask out the cracks between the bricks to start the displacement map

FACTOR 5

DISPLACEMENT DATA

- Use real height data of rocks to rebuild the displacement information of the bricks

- Height data can come from various sources:

  - Using an in house scanner to scan real-world rocks (Factor 5 uses a Polhemus Fastscan for this)

  - Purchasing scan data: Visit XYZRGB.com for samples. You can also email matthias@factor5.com if interested.

- Height data is very versatile, try different sources for seemingly unrelated materials

DISPLACEMENT DATA (CONTINUED)

- Building a displacement library benefits the company for many years and multiple projects

- The same displacement data can be reused in different textures without being easily noticeable

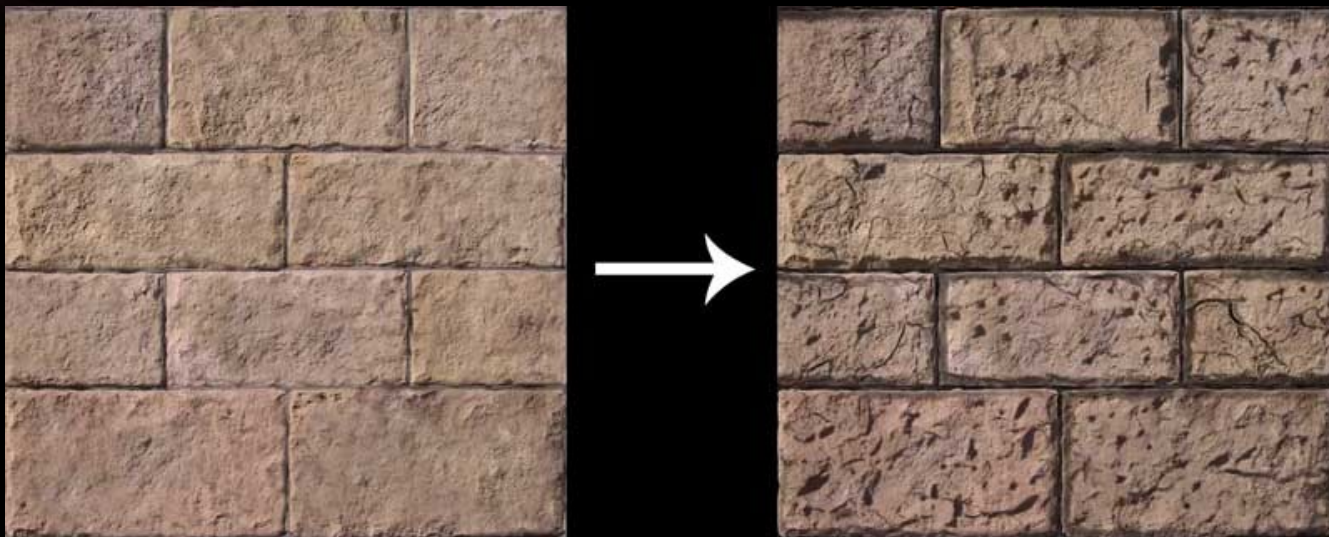- In our example, we will use scanned sheet rock from a home improvement store:

WORKFLOW DEMO (CONTINUED)

- Fill in the shapes, round off the edges to get a natural, chiseled look
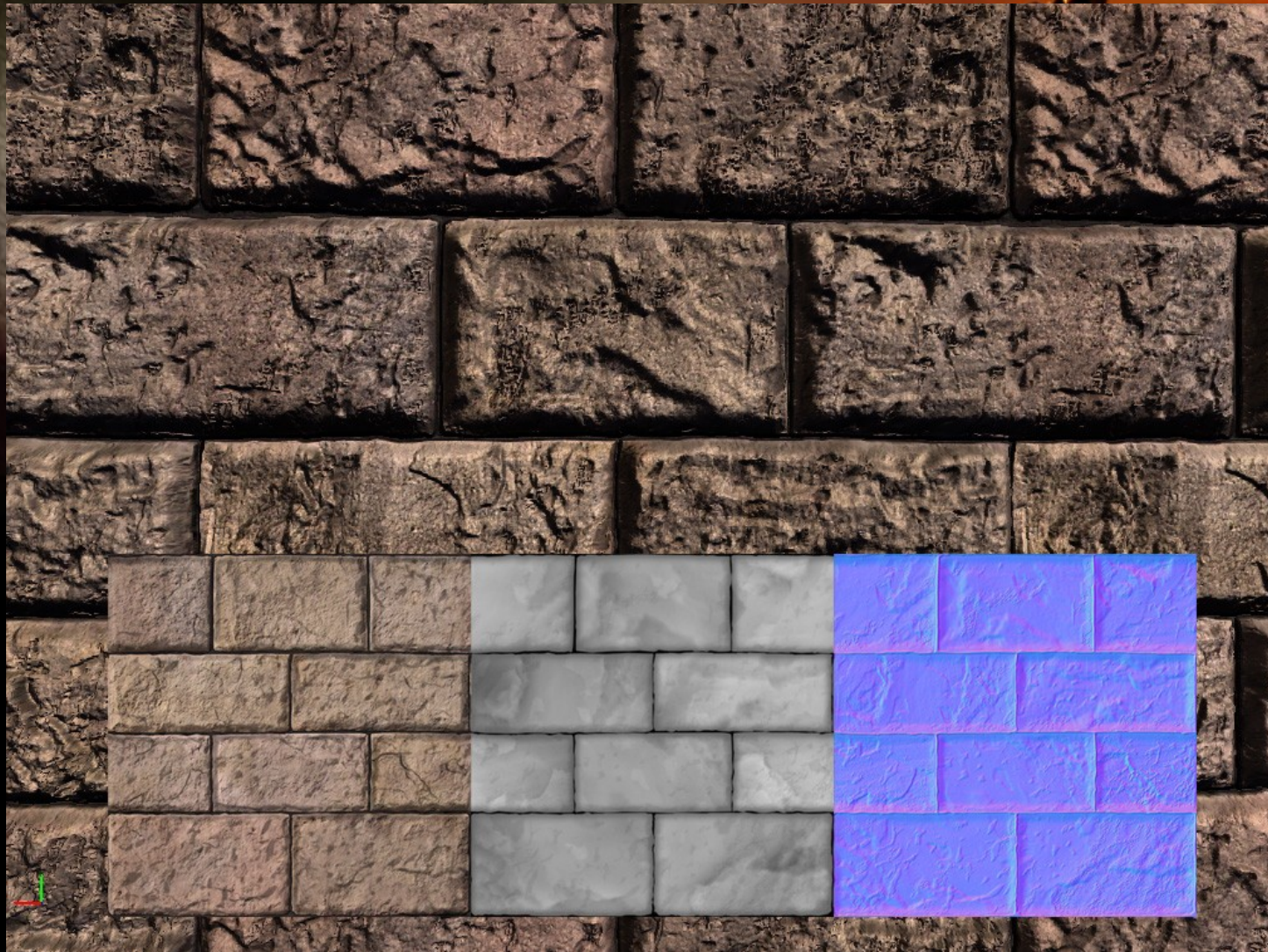
- Extract your normal map based on the height map
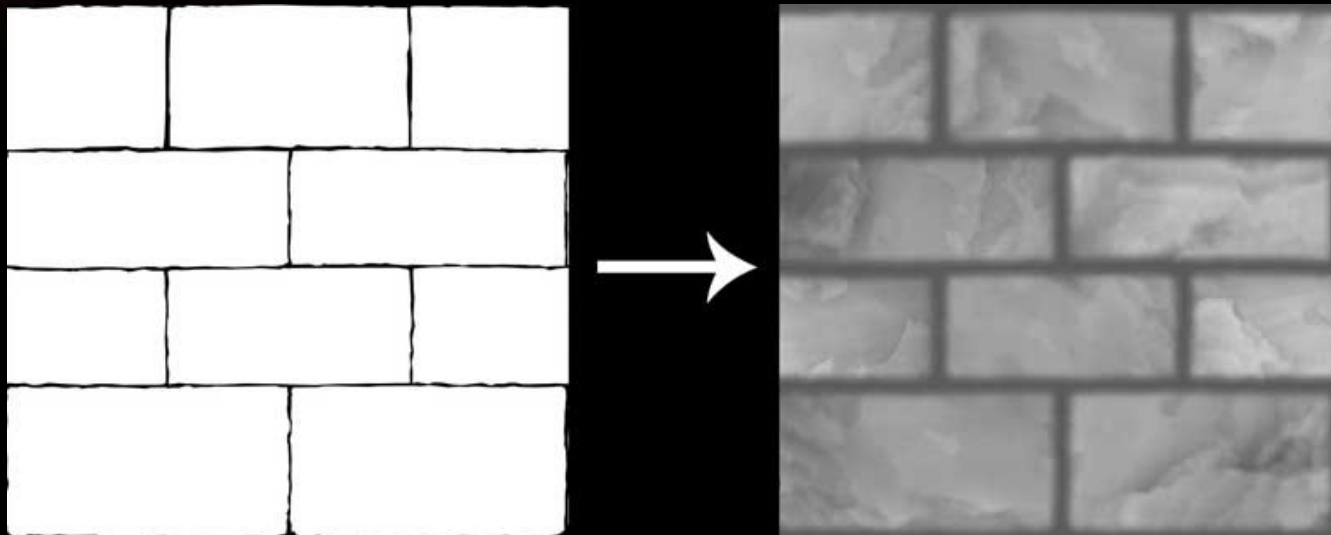
WORKFLOW DEMO (CONTINUED)

- Use the blue normal map channel to add non-directional color information for the slopes back onto the diffuse map

- Copy small detail from the original color map

WORKFLOW RESULTS

You can download a video of the finished surface as well as the maps!

WORKFLOW RESULTS (CONTINUED)

- Don't judge the individual maps by prettiness – make sure that the combined result looks good in the pixel shader!

- We usually over crank our maps (depth etc.) to look good in our (flight) games

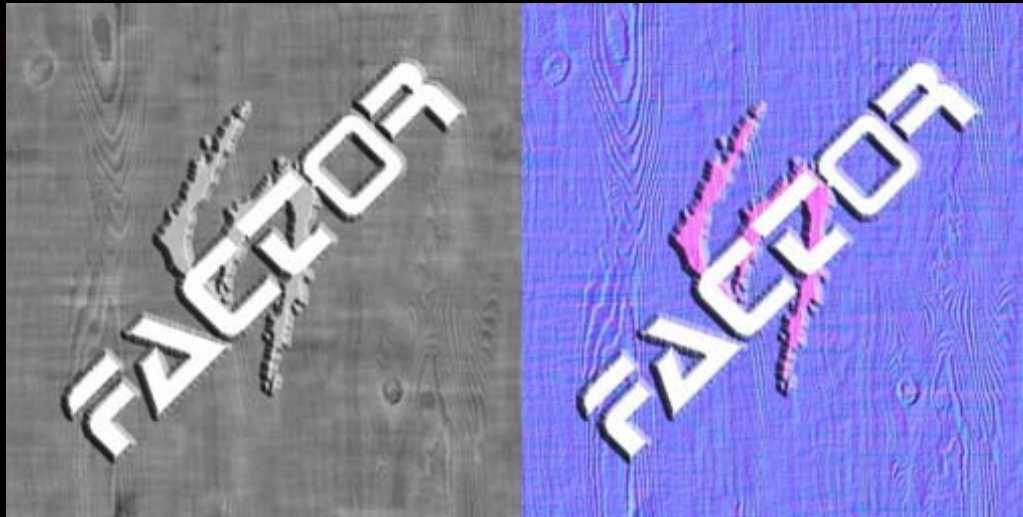- For added up-close detail use a second, tiling normal map as detail map

WORKFLOW RESULTS (CONTINUED)

- For anything but hero surfaces, we don't need to treat every brick individually

- We can overlay the mask of the cracks on top of a tiling displacement map and get good results

WORKFLOW RESULTS (CONTINUED)

- The same basic idea also works for other surface types (i.e. wood)

WORKFLOW DEMO

Workflow videos end here.

LAIR DEMO

L·A·I·R

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FACTOR 5

FINAL THOUGHTS

- Please fill out the feedback forms! Thanks!

- Theses slides, as well as workflow videos and the final texture will be available at http://www.worch.com/gdc

FINAL THOUGHTS (CONTINUED)

- Other talks that might interest you:

    - "Cross Application Asset Creation for LAIR: From Characters to Clouds"
      (Mark Teare)
      Friday, 9:00am-10:00am – *Room 135, North Hall*

    - "RSX Best Practices"
      (Mark Cerny, Jon Olick and David Simpson)
      Thursday, 2:30pm-3:30pm - *Room 3001, West Hall*

AND NOW IS THE TIME ON SPROCKETS WHEN WE DANCE!

(Alternatively, we can take some time for a Q&A.)

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