

Making of *The Superpunch*

Presented at Imagina'04 by
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Introduction

The Superpunch is the final punch Neo that delivers to Agent Smith in the final installment of *The Matrix* trilogy during the film's last face-off. It was the first shot that the directors Larry and Andy Wachowski and their conceptual designer storyboarded for the sequels. (The shot's storyboards were also the first storyboards to leak out on the Internet back in Spring 2000). *The Superpunch* was meant to show, in familiar Bullet Time, the event of Neo's super-powerful last punch that occurs over a fraction of a second and lands on Smith's face deforming it in a surreal, anime-like fashion. As a Bullet Time shot, it was to feature an impossible virtual camera yet it had to look real. The nature of the push-in camera move and the requirement of punching someone with an inhumanly strong force meant that the original multiple still camera rig approach could not be deployed. The shot went through many different stages of visualizations, breakdowns, and considerations. *The Superpunch* became even more challenging when we learned that it had to happen under heavy rain. We explored creating the shot based on live action elements and augmenting it with CG elements. Tests revealed that this approach would compromise the required fluid camera. The camera was meant to glide through space showing us an exciting event from previously unseen perspectives. Around the Spring of 2003 when we had gained confidence that our 3 year-long R&D effort in realistic human face rendering technology could pull off a full-frame, slow-motion close up of a familiar actor such as Hugo Weaving, we decided to create the shot entirely in the CG world.

Study of Target Facial Deformation

One of the main points of discussion and study was what Agent Smith's face was supposed to look like during the impact. The storyboards depicted a surreal, exaggerated, caricature-like extreme facial deformation. Our team collaborated with the directors to study the desired target shape by "abusing" Hugo Weaving's face – pushing fists into it, blowing high speed air-nozzle streams at it, etc. These studies resulted in the construction of a practical maquette representing the directors' desired extreme facial deformation. This shape was well more distorted than a real actor's face could get even under the most extreme punch.

Facial Animation

We briefly considered doing a blend-shape like approach to go from a pre-punch pose to the maquette extreme, but we felt that this would not give us realistic results. We had spent 3 years developing a powerful and successful image-based facial animation technique called Universal Capture. This technique allowed us to process a marker-less multiple angle HD footage of an actor's performance and produce a 3-D recording which could be displayed from different angles and in new lighting conditions. By re-projecting the original images, the process allowed us to vary the color texture on the face over time which was critical for the realism of our results. In the case of *The Superpunch* we felt that although we couldn't capture directly what we wanted, we could still make use of a powerful performance from Hugo Weaving and manipulate it to resemble the maquette. We selected a performance, processed it and then had an incredibly gifted artist create the additional facial deformations by hand using a set of cluster, wire and proprietary deformer in Maya. It was the ultimate marriage of technology and artistry. The directors were closely involved in the process of layering the additional facial deformations and ripples. In the end, they slightly revised their vision of the target expression to be less surreal.

Water Elements

The creation of water elements was a very challenging task due to the large amount of water and its required interaction with the virtual actors. We deployed a variety of techniques to construct the various elements. For the static rod-like water drops suspended in the air during the shot (inspired by the storyboards and having no basis in physical reality) we used a set of 30 hand-modeled basic shapes randomly instanced throughout space. After the fists impact in the beginning of the shot, the water splashes out creating a barn door like effect. This effect was achieved with a combination of hand modeled, placed, and animated shapes and instanced raindrop-like objects with motion derived from particle simulations. For the water on and around Neo's fist and sleeve, we used particle simulations and a custom implicit blobby surface plug-in to construct meshes from the particles. The same approach was also used for the water on Smith's face that flies off at fist impact. The spit coming out of Smith's mouth was modeled and animated by hand. Once again the simulation (movement and timing) of these elements was not physically correct, but rather entirely driven by artistic vision and direction.

Realistic Appearance and Rendering

Even though the shot's animation was not based on physics, the appearance had to be - the shot didn't have to feel real, but needed to look real! This required us to rely on a full ray-tracing solution for shadows, reflections, refractions, caustics, including accurate simulation of 3-D depth of field. For the realistic skin surface detail, we had access to 100 micron scans of plaster casts of the actors' faces and fists. We converted this information into displacement and bump maps. For the realistic skin appearance, we relied on modifying our image-based skin reflectance estimation by adding a wet layer in the shaders. We also had an efficient and realistic subsurface-scattering approximation without which the skin would have looked like granite. For the clothing, we added a wet layer on top of the reflectance data measured from dry costume samples. We also extended our in-house hair tools to support wet hair styling and appearance which were matched to live-action reference. For added realism of the skin around the impact areas, we created animated vein and knuckle imprint maps that allowed us to manipulate the color and normals of the skin surfaces. The beauty lighting was reconstructed from high dynamic range chrome ball images of the on-stage lighting set-up for the surrounding live action shots. The lightning timing and direction was designed and tweaked to highlight and complement important moments within the shot. The background, which responds to the lighting and is also being reflected and refracted by all water elements, was constructed using our image-based virtual background pipeline from a lidar scan and photographs of the actual crater built on-stage for live action photography. For photorealism and physically accurate appearance, all elements were rendered together in mental ray with full ray-tracing including proper 3-D depth of field simulation.

Conclusion

The Superpunch was considered the most difficult shot in *The Matrix* sequels for many reasons, most notably because of the challenge of showing a full frame computer-generated face of a known human actor. We believe that we met this challenge and also had an wonderful experience putting the shot together with an approach that combined state-of-the-art technology with exceptionally fine artistry and attention to detail. Most importantly, we felt that were able to realize the directors' fantastic vision and assert the storytelling power of visual effects.

Credits

George Borshukov - Shot Supervisor / Technology Supervisor
Kody Sabourin - Shot Design/Animation Lead, Facial Deformation
Masuo Suzuki - Wet Appearance and Water Look Development
Oystein Larsen - Water Effects Animation
Tadao Mihashi - Rendering Lead
Ken Faiman - Universal Capture Performance Processing
Scot Schinderman - Water Effects Software
Oliver James - 3-D Depth of Field Shader
Rene Garcia - Texture Paint
Christina Tempelaar-Lietz - Wet Hair Software
Matt McDonald - Compositing
Carina Ohlund - Virtual Background Construction
Tristan Ikuta, Nathan Fok - Cloth Simulation and Modeling
Brian Freisinger - Head Model Surfacing
John Jack - Producer
Kim Libreri - VFX Supervisor
John Gaeta - Senior VFX Supervisor
Geofrey Darrow, Steve Skroce – Conceptual Design
Larry & Andy Wachowski – Directors

Results

See next page.

