Segmented Control of A Closeup Chemical Reaction Effect

Alex Frenklakh[*]
alexf@blueskystudios.com
Blue Sky Studios

Julia Correnti
juliac@blueskystudios.com
Blue Sky Studios

Chris Rydalch
chrisryd@blueskystudios.com
Blue Sky Studios

Figure 1: Foam (left), "Magic" Bubbles (center), "Fail" Goo (right) © 2020 Twentieth Century Fox Film Corporation.

ABSTRACT

A key "Spies in Disguise" plot point was when Walter, a spy agency technician creates a potion that can transform humans into pigeons. The Effects Department was tasked with creating two distinct chemical reaction looks: "Success"– a pleasant foam-based effect used for when Walter creates the formula, and "Failure" – a disgusting, slimy effect showing Walter's failed attempt at synthesizing an antidote. Because the effect is so close to the camera, director notes on the performance of each hero element were very specific and evolving over time. To achieve the directors' vision, we developed new ways to segment the many procedural and simulated elements into smaller problem domains and combined procedural, simulation and rendering/compositing techniques for maximum flexibility.

CCS CONCEPTS

• **Computing methodologies → Computer graphics**.

KEYWORDS

procedural animation, simulation, closeup, effects direction, fluids, particles, chemical, foam, Blue Sky Studios, Spies In Disguise, compositing, rendering

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[*]All authors contributed equally to this research.

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1 FLUFFY FOAM: THREE SIMS BETTER THAN ONE

We realized that the foam was the major visual element, and should be addressed first. The callout for this effect was: quickly rising and slowly receding foam that is fluffy and pleasant to look at, emphasizing "success". Instead of using a single simulation to create the effect, we identified four foam performance domains. Addressing each domain separately allowed us maximal timing and shaping control (Figure 2).

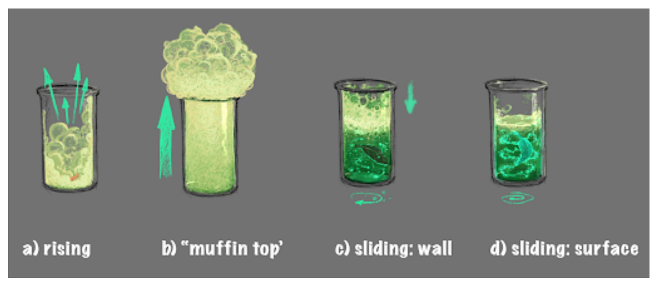

Figure 2: Foam Performance Domains. © 2020 Twentieth Century Fox Film Corporation.

For controlling major shapes in areas (a) and (b) we took timing cues from the animation department mockup, but created our own procedural geometry that allowed us to alter the shapes to evolving director needs. We used iterative relaxation methods in a custom solver to populate foam points onto the blend shapes, and tweaked them to have overlaps, so that the transition of bubbles from within the beaker glass to outside of it is virtually seamless. Rising foam element a) was run for a much longer frame range (around 1000 frames). This technique enabled us to speed up or slow down this critical area as needed. The roiling liquid surface was created with geometric noise on planar geometry, thus its position could easily be tweaked to match foam blendshapes, which would not be the case if we employed FLIP. Particle simulation of foam sliding down walls and onto the water surface was run as a single sim (Figure 2 (c) (d)). However, we applied different forces, noises, and scale reduction rates based on whether particle is sliding on the wall or over the procedural liquid surface.

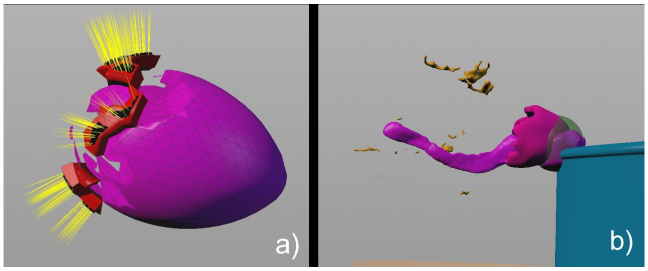

Figure 3: Egghell rig. a)voronoi fly-away bits and initial velocities b) automatic flip sim instancing. © 2020 Twentieth Century Fox Film Corporation.

2 AIR BUBBLES: FLIPPED METHODS

As the beaker begins to fill up with liquid, swirling bubbles create visual interest under the surface. We knew that a naturalistic motion of bubbles in agitated liquid would be very important. As opposed to using our standard approach for bubbles (particle simulation), we decided to run two full-beaker FLIP simulations: one for bubbles sourced throughout the liquid volume, and two for air bubbles sourced at the bottom of the beaker that rose to just under the surface and swirled around there to tie these visually to the "magic" bubbles. In both simulations, the air bubbles were assigned low-density values, while the liquid bubbles were assigned high-density values. This gave the bubbles very appealing rising and swirling motion, which was further enhanced with velocity fields in case of (b) to push the bubbles around the central axis of the beaker. Only the air bubbles were rendered to create the final composite.

3 MAGIC SPIRAL: POST SIM EDITING

The pigeon feather dropped into the empty beaker reacts with a couple of drops of the transformation formula. As the reaction progresses, a spiral of "magic" bubbles form inside the liquid. The spiral was generated using noisy vortex fields and post sim rotation. We designed an approach to make the spiral look sharper and more "graphic" in some areas without the need to re-simulate. This was done by advecting a curve through a rough geometrical middle of the spiral, and then using UV-space deformation to adjust how wide the particles dispersed from the curve post-sim. Additional bubbles emitted from spiral plused the effect.

4 BURSTING GOO: SIM-MING ON EGGSHELLS

Walter tries unsuccessfully to create an antidote formula, to turn Lance back from a pigeon into his human form. The story point was to echo the earlier "successful" formula creation effect until the point of failure where an "ugly" quickly crustifying mass we called "muffin top" suddenly forms and ejects out gooey and stringy blobs. Goopy Muffin-Top was created out of noised-up spheres driven by blend-shapes with some added procedural jiggle. For stringy ejecta we tried running a single flip sim, but when that approach proved hard to direct, we created a "bursting eggshell" rig. We would pick any muffin-top sphere, start frame, direction and ejection velocity/duration. The rig would take care of instancing a flip sim within the "egg", shattering egg surface with voronoi fracture to create "flyaway bits" a collision surface, and projecting goo in any direction (Figure 3).

It was flexible enough to be used for the very viscous bits dripping down the sides of the glass at the end. The Materials team further enhanced the feeling of a coherent drying mass, with some truly "disgusting" surfacing work. (They were proud to turn a few stomachs!). Materials were applied at rest and then deformed with the whole effect. This prevented "material sliding". Effects provided a curvature-based drying mask (0->1 value) to create the feeling of various parts drying organically.

5 INTEGRATION: ASSEMBLING THE ELEMENTS

Since the desired look of the end result was intricately specific, all the elements needed to be rendered separately, treated individually in comp, and integrated together and with the scene. Additional elements were created in comp to enhance the shots even further, such as electrical zaps, foam residue, dust, feather effects, and transitional frames into the failed "ugly" foam. In order to make the spiral effect look as magical as possible, variation in the bubbles was key. Several signal passes generated from the sim were provided to achieve this, including a bubble age pass, helix ID, proximity to main spiral, and a one-third split of all the bubbles.

6 TAKE-AWAYS: DIVIDE & CONQUER!

By careful planning and subdividing the effect into manageable pieces with natural-looking overlaps, relying heavily on procedural approaches in combination with simulation, and collaborating with materials and compositing departments, we were able to achieve the desired highly art-directable close-up chemical reaction effect.

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