Innovations Report

An investigation into the unique aesthetic qualities of Physical Effects as a valid part of a CG / VFX pipeline.

Neill Barrack • i7928064 • NCCA Bournemouth University • 8 March 2012

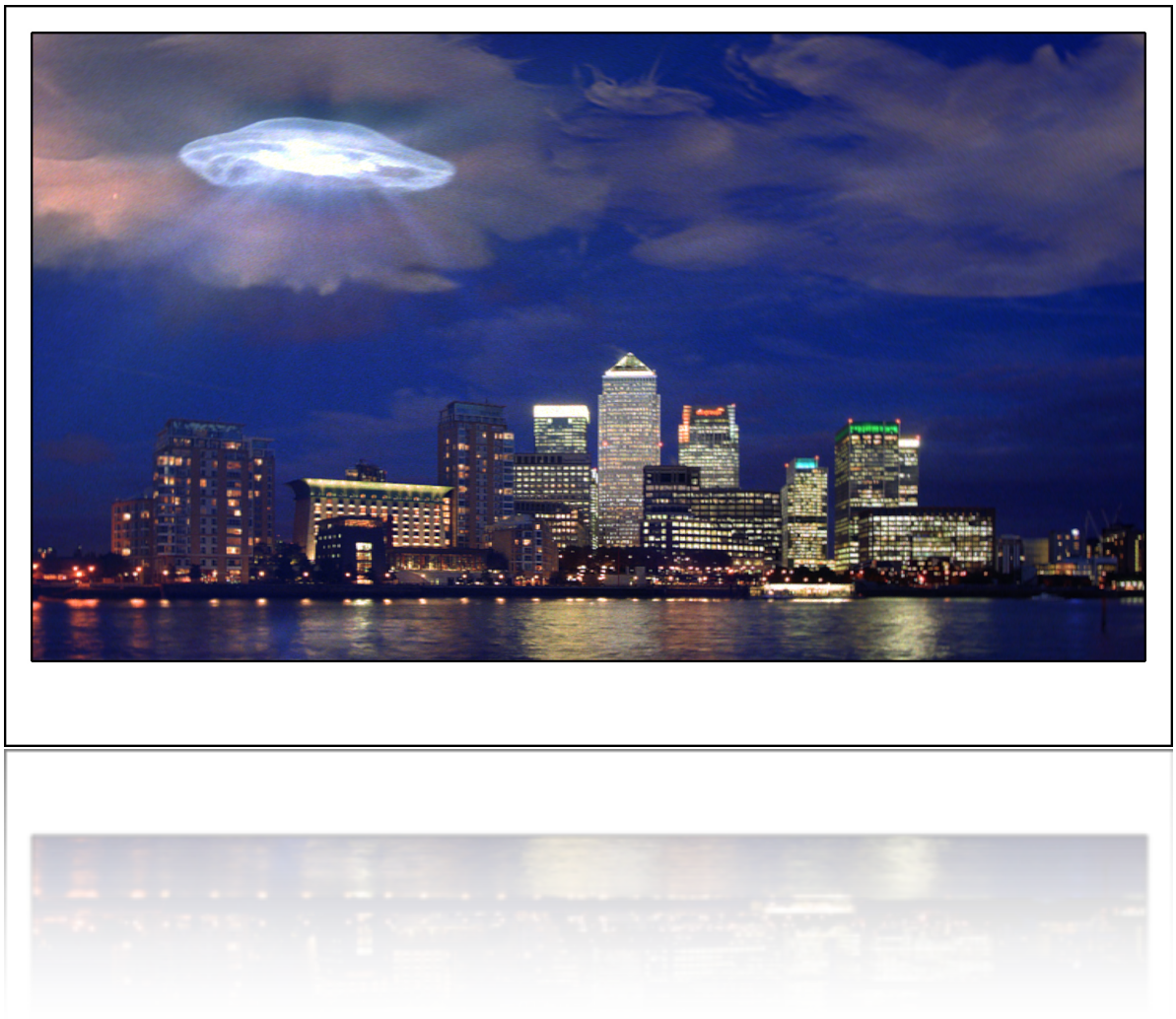

Table of Contents

Abstract

The purpose of this report was to investigate the aesthetic potential for physical effects footage to augment filmed or computer generated visual effects shots. Various methods of producing and interacting with smoke, fog and clouds have been explored. Much of the emphasis of the experiments and research is on cloud tank usage. The research and experiments culminate in three artefacts where physical effects have been composited over computer generated or filmed backplates.

Introduction

When being asked to innovate something it is necessary to first understand what innovation means to the individual concerned. To me an innovation is something useful, something new or a new way of using something old. When planning this project it was important to me that I undertake something that had the potential to be useful to others.

There are unique aesthetic qualities present in physical effects that have been neglected in favour of art direct-able computer generated visual effects (CG VFX) simulations. In my investigation I intend to explore various physical effects techniques in order to discover if these methods have the potential to augment a CG VFX pipeline.

Various methods of producing smoke, fog and cloud effects will be attempted in a studio. The emphasis of this report will be on cloud tank preparation and use, but experiments with other physical effects and their aesthetic use in a CG pipeline will also be investigated.

I aim to prove that physical effects have a place in the current CGI pipeline process. Particularly with student and small budget projects physical effects are a way to produce fast and realistic effects with little or no budget.

This report will provide a method of setting up a cloud tank; I will be investigating different levels of salinity to discover what affect if any that has. I will also be investigating the aesthetic effect of different fluids.

The challenge is in making these physical effects art-directable. For my project the challenge will be to interact somehow with the effects created to allow the footage to be utilised in a digital compositing workflow.

Method

Cloud tank equipment required;

Aquarium or other water tight glass container

Pressurised fluid delivery system

White fluid

Salt

Water

Polythene sheeting

Continuous lighting equipment

Camera capable of shooting video

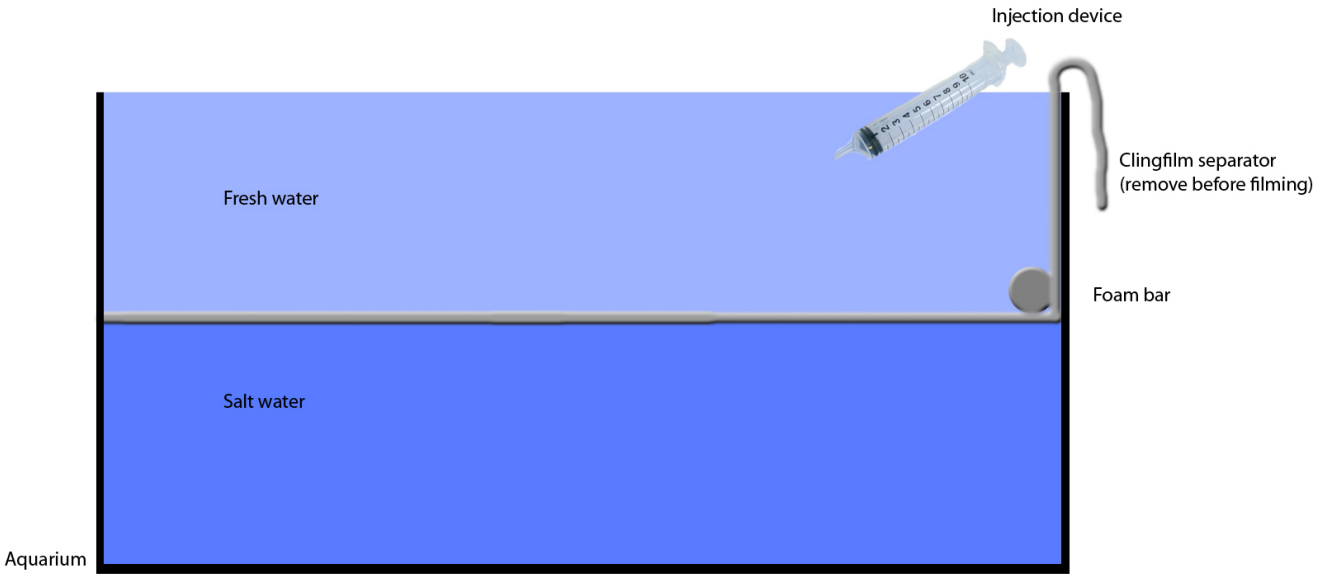

Figure 1. Basic cloud tank setup (Squires, 2009).

It is important to introduce the fresh water layer slowly to minimise the amount of mixing between the layers. The best way to achieve this is to use a plastic sheet between layers whilst filling the fresh water part of the tank (Squires, 2009). This separation layer needs to be very carefully removed before filming.

Report

Cloud Tank Definition; A glass tank filled with saline solutions of various densities, used to film billowing cloud formations (Rickitt, n.d.).

Although the basic method of cloud tank creation is published (Squires, 2009) the specifics of how to create and operate it are not well documented. The salinity of the lower layer of water has not been mentioned other than to say that nine tonnes of salt were used in the production of cloud tank shots on Raiders of the Lost Arc (Bjerre, 2010). This paper seeks to fill this gap in knowledge and allow the reader to recreate a cloud tank without the need for lengthy initial experimentation.

The movie industry has seamlessly integrated cloud tank physical effects into blockbuster movies such as Poltergeist, Raiders of the Lost Arc, Flash Gordon, Star Trek and Independence Day to name but a few. Independence Day (1996) was the latest film to utilise this technique and was the first film to benefit from digital compositing software (figure 2). The effects that they created were extremely effective and stand up even today as believable effects.

Figure 2. Cloud Tank Physical Effects footage from Independence Day (1996).

When compared to a similar shot from the Battle of Los Angeles (2011) (figure 3) it is clear that the CG effect is far less believable than the physical effect from fifteen years previously. Perhaps this is an unfair example given the budgetary difference between the two movies but it is the best example discovered of similar effects being attempted.

Figure 3. CG VFX from Battle of Los Angeles (2011).

Since Independence Day however, the cloud tank technique has fallen out of favour with studios instead opting for CG effects.

The reason for this change is hypothesised by this paper to be due to the increased capability and speed of computer simulation. These simulations can be extremely accurate and aesthetically art direct-able.

This paper does not propose that physical effects are superior to CG VFX, merely that under certain circumstances physical effects can produce an result that is more aesthetically believable than poorly executed or low budget CGI.

To decide whether a physical effect is viable for a production it is necessary to make the effect art direct-able. For the cloud effect that I wanted to create it would be necessary to interact with the cloud fluid. The cloud tank footage for Independence Day had a miniature space ship pushed through the cloud layer (Netzley 1999).

For this production a polystyrene shape attached to a wire was used to push though the cloud layer. The wire was not stiff enough to hold the polystyrene under water so another model was made this time attached to a car aerial. This second model was painted a bright blue to give the ability to pull a chroma key in Nuke. This ability proved extremely useful in the generation of volume rays emanating from the collision object. However the polystyrene was still proving difficult to control under water due to its high buoyancy. Therefore a third collision object was made this time out of Plastiline. This worked much better; however, it was still hard to control the movement smoothly and consistently. With the plastiline model it was possible to use plastic headed pins allowing a track to be made of the object in Nuke.

Typical Cumulus clouds form with fluffy tops and flat bottoms. The flat bottom is the region where the temperature of the air is too warm for water vapour to form (Anderson, 2003). For a physical effect to mimic this dew point region it will be necessary to create a density differential in the tank. Thus creating a divide that the cloud fluid can collide with. The most common way that this is achieved is in the creation of a halocline (Squires, 2009). A halocline is a density differential in water, most commonly formed as pressure increases in seawater at depth. I will simulate this by creating a high salinity brine solution that is denser than fresh water and therefore the two liquids will not mix.

Cloud fluid experiment:

Tempura paint (powdered paint) was used by Foerester and Timme on Independence Day (Rogers, 1999). In the experiments undertaken for this project paint did produce some of the most aesthetically interesting / believable effects but requires such high pressure that the cloud travelled from one side of the tank to the other in a fraction of a second. This is not suitable for use in a small tank and also adds the variable of concentration to the equation. If the concentration of the paint varied by even a small amount it would either sink immediately to the bottom of the tank (figure 4) or would disperse into the water too rapidly.

Figure 4. paint test

The fluid that appears to work the best in a small tank is whole milk (figure 5). Whole milk is at a standard concentration, removing this variable from the equation and was utilised for all of the cloud tank effects in my demonstration movie.

Figure 5. Whole milk test

Evaporated milk was also tested as a cloud making fluid as it slightly thicker than milk. It works well, however, it is slightly yellow in colour (which could conceivable cause a problem in post) the aesthetic difference between evaporated and whole milk was not sufficient to make this a viable cloud liquid.

With regard to the salinity level of the water various small scale tests were carried out. Providing a differential has been created the salt concentration of the lower layer has no effect on the aesthetic of the footage recorded. The salinity level established by this research is approximately 20 grams of salt per litre of brine required. If more was used the salt would not dissolve in the water decreasing its optical clarity. If less were used the halocline would mix too rapidly with fresh water upon removal of the separator sheet.

One factor that has a major affect on the halocline is the temperature of the water. Warm water will have a convection effect that will cause the brine and the fresh water to quickly mix. The separation layer that I used was made of cling film, was not heavy enough to remain submerged as the fresh water was added on the top of the brine layer. This separation layer served only to divert the fresh water supply preventing

rapid mixing of the layers. In my opinion if the separation layer had remained suspended on the halocline the resulting turbulence upon removal would have caused the layers to mix rapidly.

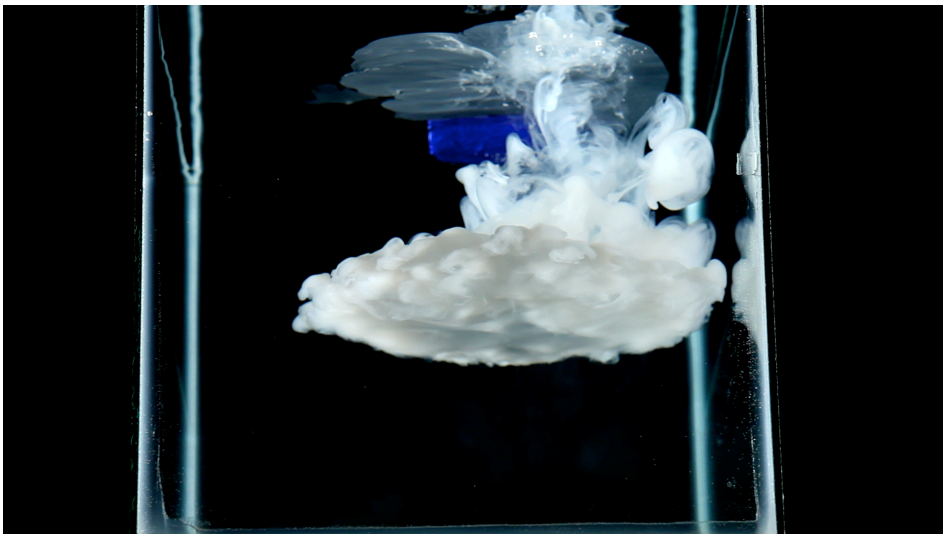

Figure 6. Cloud tank footage.

The majority of the problems with the footage captured come from the size of the tank. The effect spreads so rapidly that it interacts with the sides of the tank causing problems in Nuke with creating travelling mattes. As demonstrated in figure 6 the cloud generated whilst aesthetically viable for this project is unusable due to the collision with the side of the tank and because too much of the source of the injection would need to be manually rotoscoped out in Nuke.

Smoke:

To make the candle shot, footage of matches being blown out was captured against a black background with a simple three point lighting setup (figure 7). This was retimed in Nuke before being comped over a simple scene from Maya. The effect created, whilst simple gives a very realistic result to a basic scene.

Figure 7. Smoke footage.

Pond mister:

Tests were also done using an ultrasonic pond mister (figure 8). The device was submerged in a small amount of water in a bucket and activated. When activated the device creates water vapour which being heavier than air can be poured out of the bucket and filmed against a black background. The device creates a very interesting effect that could be utilised as a creeping ground mist or as I used it; inverted to create the illusion of smoke rising.

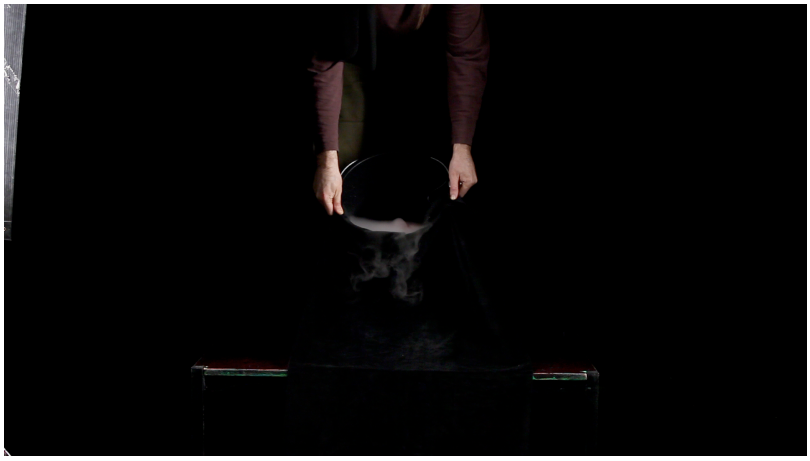

Figure 8. Pond mister footage

Rubbing alcohol experiment:

Late on in my research I discovered that rubbing alcohol could be used to create a density differential in a tank of water (figure 9). This method allows for much faster resetting of the tank due to rubbing alcohol being far less miscible than saline, allowing it to be poured quickly onto a freshwater layer without the need for a plastic separating layer.

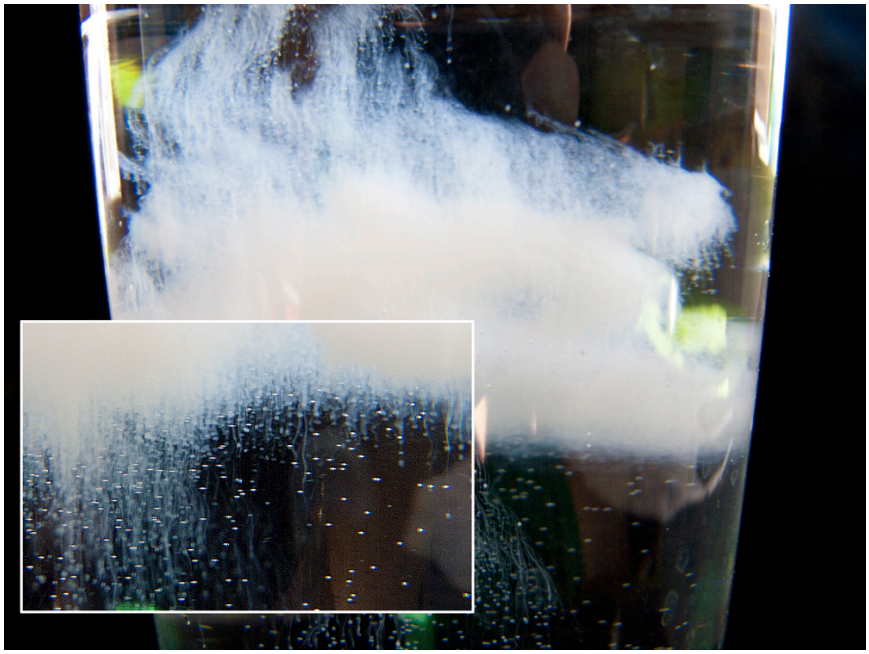

Figure 9. Density differential created using rubbing alcohol.

Upon beginning trials it was quickly apparent that due to rubbing alcohol being solvent based the cloud fluid would split when it hit the differential. This effect maybe appropriate for some situations but further tests would be required to establish how viable this method would be on a larger scale.

Lighting:

Tests were carried out on lighting the clouds from within, using bundles of fibre optic lights. Although they created an interesting effect they were not bright enough to produce something usable in comp in for this project.

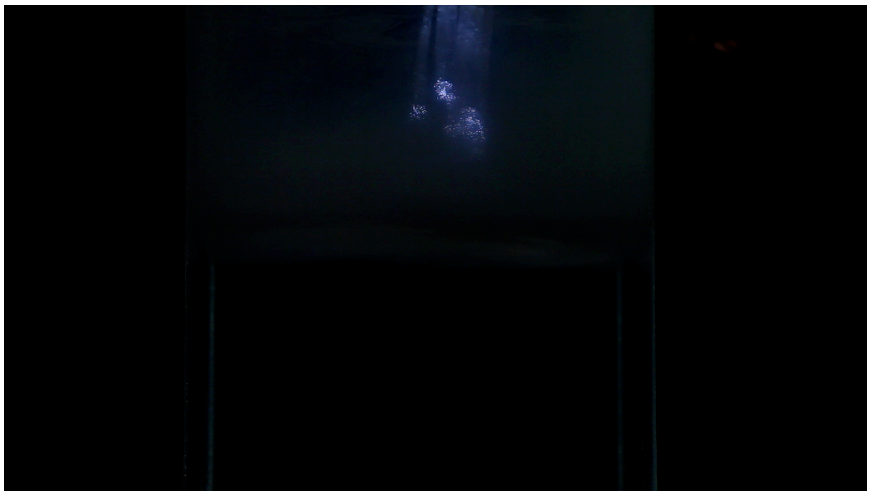

Figure 10. Bundles of fibre optic lights in the cloud tank.

The lighting is key to obtaining usable footage. I used a four point lighting setup that lit the tank almost entirely from the sides. It is best to light from the sides as this keeps reflections on the glass to a minimum. Black baffles were also used to cut down on lens flare. Using a telephoto lens allows the camera to be placed far enough away from the tank to prevent it from reflecting in the tank glass.

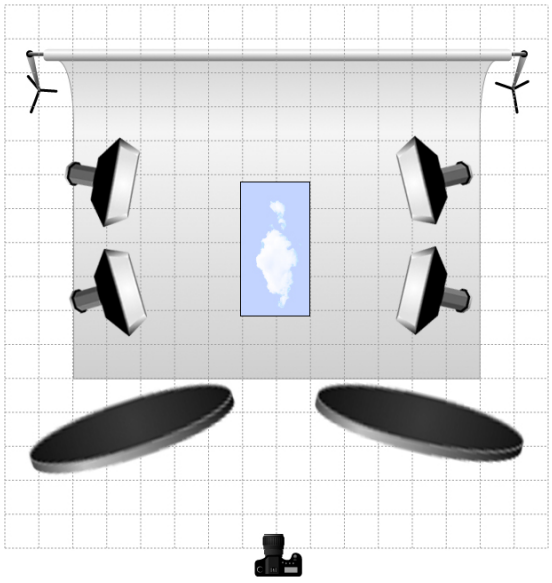

Figure 11. Four point lighting setup with black baffles to cut down on spill.

The disadvantage to physical effects aside from the only very basic ability to art direct the shot comes from the need to generate an alpha map for use in compositing. To attempt to overcome this all the footage for these experiments was recorded against a black background, with the cloud/smoke/fog being white it can be used with some re-grading and garbage mattes as an alpha.

It quickly became apparent at the compositing stage that the footage was all much too fast at the recorded speed of 30 frames per second (FPS). An investigation into this lead to the following formula being discovered;

$$(\sqrt{m})*(r)=f$$

m= miniature's scale

r = base frame rate

f= new frame rate (Okun and Zwerman, 2010)

The formulae would be useful if the equipment utilised could operate at high frame rates, however, the Canon 5D MKii that I used to capture the footage is limited to 30FPS. Therefore it was necessary to manually retime the footage in post. For some of the shots I was retiming as much as 50% slower to get realistic movement.

Conclusions

Is it still viable process?

Physical effects are very much a viable part of a movie production pipeline. My research has shown me that physical effects are used all the time in modern movies from small effects like breath vapour in a cold room being generated using compressed gas (Children of Men, 2006). To larger effects like smoke and explosions (Battle: Los Angeles, 2011 (not to be confused with Battle of Los Angeles)).

So whilst physical effects are used in the movie industry they are being neglected as a resource at a student level. If a student is seeking a career as a CG simulation artist then it makes sense for them to attempt to produce simulations. However a high proportion of students at the NCCA do not want to produce simulations as a career. These people may need smoke or clouds or flames in their project but do not necessarily have the time to spend learning how to simulate them and then spend days rendering the final result (that may or not be of production quality).

There is no doubt that effects like cloud tank filming are time consuming to setup with only a small team. The tank must be spotlessly clean and the fresh water filling process needs to be done very slowly to minimise mixing with the salt water layer. The research and experimenting has taken a large proportion of the time allocated to this project and the findings laid out in this report would allow for immediate filming of future projects. Hopefully the techniques described in this paper will be of use to other students at the NCCA should cloud effects / physical effects be required for their projects.

Is there an aesthetic benefit to using physical effects over CG? This is a difficult question, with current CG imagery at the level it is, given a skilful VFX artist and sufficient time almost any physical effect can be replicated in a CG simulation. However the fact remains that it is not always preferable or necessary to produce a

complex simulation. Physical effects offer a fast and cheap method of producing production quality footage.

With digital capture media the expense of film has been removed from the equation, making this effect cheap and comparatively fast. The ability to immediately play back the captured footage means that it is instantly known if a shot was successful or not removing the need to repeatedly retake.

The halocline created by the suggested ratio of salt to water is far more robust than I thought it would be, the two layers are very reluctant to mix and can take more interaction than my initial research led me to believe.

The separation layer is only useful to divert the water flow minimising mixing of the two layers. A halocline could conceivably be constructed without this layer if the fresh water could be added in a method that did not disturb the lower layer.

The effects created are 2D effects they work well with a static camera or a camera move that is dollying or zooming in but should there be any camera rotation the illusion would be spoiled.

Critical analysis

Why is this innovative?

Technology moves at such a pace that sometimes things fall by the wayside before they have been fully explored. Cloud tank effects have rarely been coupled with digital compositing to my knowledge. The effects created as part of this project demonstrate how quickly and efficiently physical effects can add a sense of realism to CG renders or 2D backplates.

How successful was the project?

Although the footage has been successfully composited and has produced an aesthetically pleasing result, the technique utilising a small tank and manually injecting the cloud generating fluid is somewhat crude and unpredictable. The methods outlined by Scott Squires (Effect Corner, 2009) coupled with a rig to control the interaction objects movement and a larger tank would produce far more consistent predictable results.

The size of the tank has a large impact on the effect created. With a larger tank the fluid can be injected at a higher pressure, creating more realistic billows of fluid. The concentration of the fluid can also be increased, this has the effect of slowing down the dispersal of the fluid into the water and allowing for longer duration shots of slower moving cloud.

Footage from this project is being utilised in three fellow students major projects, reducing their need to produce simulations, therefore the project has had some success in proving that these techniques are viable.

I will be utilising the techniques that I have learnt during this study to augment CG footage with physical effects as a part of my major project. Whilst the effects that I have produced appear to be very simple they are effective. The smoke and pond mister

footage have integrated seamlessly into CG footage and the pond mister particularly will prove useful in creating effects for my major project. This has been demonstrated with the shot of the statue holding the smoking fire bowl.

I also hope to be able to film cloud tank effects again to layer alongside cloud simulations for my major project. With what I have learnt during this investigation I believe I will be able to generate some unique looking shots.

If possible I would also like to look at methods of creating tornadoes and mushrooms clouds in the tank utilising what I have learnt.

Recommendations

How would I do it differently?
I would certainly attempt to access bigger tank, for the reasons outlined in the conclusion of this report.

If I was able to access a bigger tank I would then build a pressurised rig to deliver the milk or paint for the reasons outlined in the conclusion of this report. I would also recommend building a rig to more accurately control the passage of the model spaceship through the cloud.

I would recommend working with a bigger team. There were only two of us filming these effects and the reset time between shots was somewhat prohibitive.

It would be better to art direct the shot from behind the camera rather than operating the delivery system and proxy spaceship directly. Working from in front of the tank directing a team would allow this to work. If working in a small team attempting a cloud tank effect again, I would setup an external monitor linked to the camera that would allow me to better direct the shot whilst operating the collision object.

It is essential to remember that the tank is part of the optical system of your setup. Any dirt / debris / scratches on the glass will deteriorate the quality of your footage.

Some tutorial style videos online (Indy Mogul, n.d.) recommend taping the seams of the tank with black tape to cut down on lens flare in the shot. Ultimately this doesn't work efficiently, it has the effect of casting strong shadows through the tank making the footage unusable. A much better way of reducing lens flare is to arrange lighting and camera positions more efficiently to ensure that no light falls on the cameras lens or the front of the tank.

There are no hard and fast rules regarding the salinity level of the brine layer. Providing a differential has been created the salt concentration of the lower layer has no effect on the aesthetic of the footage recorded. I found that a good ratio is 20grams of salt per litre of brine. This gives the best trade off between halocline resilience and optical clarity of the tank water.

The best type of collision object to use in a cloud tank is non buoyant painted a chroma colour and has tracking markers applied to it.

The effects generated with pond mister and match smoke were fast cheap and realistic. They would greatly enhance any CG project where these effects were required.

Safety considerations:

When shooting with a large quantity of water and multiple mains powered lights it is very important to familiarise yourself with the correct safety precautions. Recommended reading on this matter: Production safety for film, television, and video (Small, 2000).

BIBLIOGRAPHY

Anderson, F (2003). Flying the Mountains: A Training Manual for Flying Single-Engine Aircraft. New York: McGraw-Hill. p75.

Bjerre, D. (2010). Old School Effects: The Cloud Tank. Available: http://singlemindedmovieblog.blogspot.com/2010/04/old-school-effects-cloud-tank.html. Last accessed 20th Jan 2012.

Indy Mogul. (N.D.). Cloud Tank. Available: http://www.indymogul.com/tag/cloud%20tank. Last accessed 6th Jan 2012.

Netzley, P (1999). Encyclopedia of Movie Special Effects. Westport: Greenwood Press. p45-46, p105-106.

Okun, J. Zwerman, S (2010). VES Handbook of Visual Effects. Oxford: Focal Press. 315.

Rickitt, R (unknown). Special Effects - The History and Techniques . unknown: Billboard Books. p112-113,p305,p309.

Rogers, P (1999). The Art of Visual Effects: Interviews on the Tools of the Trade. Oxford: Butterworth-Heinemann. p151.

Squires, S. (2009). Cloud Tank Effect. Available: http://effectscorner.blogspot.com/2009/02/cloud-tank-effect.html. Last accessed 28th Feb 2012.

Small, R (2000). Production Safety for Film, Television and Video. Oxford: Focal Press.