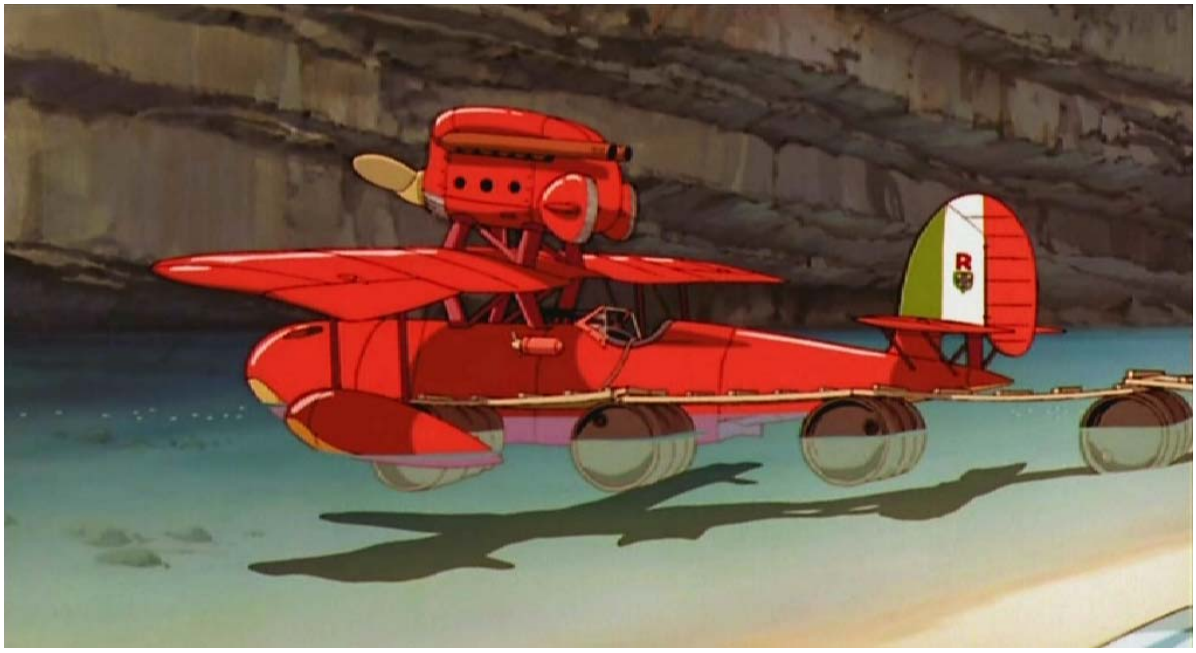
ANIMATION DESIGN 3

INNOVATIONS REPORT

NON PHOTOREALISTIC RENDERING OF WATER IN HAYAO MIYAZAKI STYLE



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INTRODUCTION

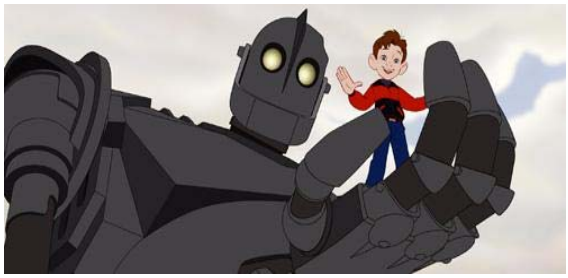
The object of this project is to introduce a drawn animation style and to replicate it in computer graphics using the available software tools, in order to produce a similar result as that used as inspiration. The state of contemporary animation is reviewed in an attempt to justify the chosen topic, and a solution to the proposed task is presented, as well as a description of the paths taken to arrive at the result.

CONTEMPORARY ANIMATION

In the last twenty years we have seen the advent of what is called computer generated imagery. Since *Tron* marked the beginning of a new age, computers have increasingly been used to create films and animations, gradually replacing the traditional hand-drawn cells. The animation industry, once led by Disney and Warner Brothers, has been undergoing a metamorphosis over the last decades. Long-established methods are being complemented with increasingly popular new technologies, which relieve animators from daunting tasks such as drawing geometrically accurate and complex objects over many frames or calculating perspective changes in camera movements. Of course technology isn't adopted to ease animators' work, but to produce fantastic new images, previously particularly difficult to draw, for example images that resemble reality much closer than cell shading ever could. Even so, the old and established cartoon style of imagery is still popular and a whole field of scientific study has emerged to arrive at computer generated images that resemble drawings or paintings. This is known as non photorealism. Today, many animated films are fully generated by artists who work in front of computers in 3D software, doing away with hand drawn animation completely.

There have also been successful efforts of blending both drawn art and CGI seamlessly. For example, in last year's "Belleville Rendez-Vous" computer animation was used to a great extends to create vehicles, train tracks, an ocean scene and many camera movements, which would be vary daunting to draw manually. The frames were rendered and drawn on top of to produce the final cells. In 1999, Warner Bros.' "The Iron Giant" made use of a combination of 2D and 3D to produce a nice blend between one of the main characters, an adequately geometrical iron robot and most of his surrounding environments and characters, which were gracefully hand drawn. One thing that can be noticed when comparing these films under scrutiny is that as time goes by and knowledge and technological resources advance, the integration of the two arts is gradually more perfect.

Belleville Rendez-Vous 2003, Sylvain Chomet



The Iron Giant 1999, Warner Brothers

Nevertheless, not the whole world has been caught up in the computer graphics craze yet. A small but indomitable Japanese studio still holds true to the old tried and tested methods of excellent drawing and story telling. But, for how long?

Studio Ghibli is one of Japan's premier animation production houses, considered by many as the *Disney* of the East. It has produced dozens of animated films since it was founded in 1983, most of them by the hand of animator, director and living legend Hayao Miyazaki. For more than forty years this creative *auteur* has inspired generations of children and adults alike with fantastic stories, compelling characters and above all, his distinctive drawing skills and style. Miyazaki's repertoire includes films which have recently been mass exposed to western audiences, such as "Princess Mononoke", "Spirited Away" and "Porco Rosso", the latter of which served as inspiration for this project.

Studio Ghibli is not very big, and it predominantly produces films rather than TV series, as these are usually very constrained to schedules and low production costs, so as to ensure its reputation for high quality animations. A computer animation department has recently been formed for the production of a fully CG film, "My Neighbours the Yamadas", but the studio is mainly renown for its traditional animation. It takes years to complete an animated film and a single failure could seriously damage the reputation and finances of the studio. However, so far the Ghibli formula has worked very well.

Miyazaki (left) is not a typical director. First and foremost an animator, he personally checks almost all key animation and draws up to seventy percent of the cells, assuring that the style he intends is preserved throughout the feature film. His work method is also quite unusual; he will always start drawing without a pre-established plan, setting himself in the mind of the characters and seeing where that takes him next. Such a system is unthinkable in large western studios, where good planning is a key to success and every aspect of production is part of an optimized pipeline which is very troublesome to alter. Miyazaki is able to do this because he works for himself, trusting his skills and the fact that if he gives his best the film will be successful. For anyone else it is a dangerous game to play, but Miyazaki has the extraordinary experience and skill that never disappoint. As an auteur, he focuses primarily on his Japanese target audience, making little effort to appeal to audiences abroad. In Japan, Studio Ghibli's releases consistently fare better in terms of box office revenues and critical acclaim when compared to western releases. Indeed, distribution abroad was minute and until recently, when ironically Disney Buena Vista recognized high profitability in distributing the Japanese studio's films in the western market,

as their films were mostly unknown to western audiences, except for a select demographic who had rare exposure to Miyazaki's art. Ghibli audiences have been increasing, and many people have now heard of "Princess Mononoke" and "Spirited Away". In London, Cinemas such as the Barbican have in the last couple of years helped this trend along by actively promoting Japanese animation.

I was first exposed to Miyazaki at the age of 5 or 6, long before Studio Ghibli was founded, when the first TV series he directed, "Conan, the kid from the future", aired in Portugal. Miyazaki's style has been with me ever since, as things we are exposed to as children tend to remain and have impact us our whole lives.

Frames from the introduction of Conan, the Kid from the Future

THE PROPOSED TOPIC

Miyazaki's style is evidently an expression of his artistic susceptibilities, but as for any animator who has to draw innumerable frames, simplicity and streamlining are also important factors. Water, which is the topic of this report, is drawn in a very particular way: mostly without reflections, merely distorting what lies within and behind it, in a simulation of refraction. Objects that intercept the surface are simply distorted and change colour in the submerged area. Reflections are represented by occasional jagged white lines. This creates a pleasant a sense of very clear and pure water but also saves much effort of drawing a semitransparent surface and keeping that surface correct in perspective.

Example of hydroplane floating in clear water from Porco Rosso
1992 Hayao Miyazaki

Refractions of the light are visible when its rays traverse a medium of a different density from that through which it had previously been in. Light from the sun illuminates objects under the water; that light bounces back from those objects, out of the water and into our eyes.

The subject of this project emerged from the wish to gain knowledge of computer image generation techniques, applied to a visually appealing theme. The aim in mind was to generate a similar result as Miyazaki's representations of water, using software based tools.

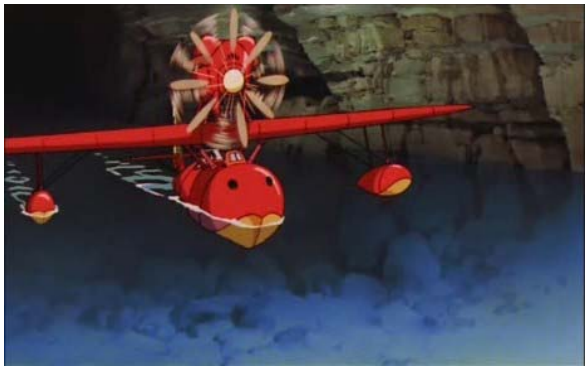
Even though Miyzaki himself sees little use for computer generated imagery as a means of alleviating workload, and although it can be argued that it might be prejudicial to the style to replicate it, potentially making it banal, this project is inspired by Miyazaky and intended as homage to the Japanese animator.

IMAGE ANALYSIS AND BREAKDOWN

The scenario chosen to replicate was one of calm ocean waves on a secluded bay, (right) where Porco Rosso, the lead character in a film of the same name, seeks refuge from the world. Because this mass of water is connected to the Adriatic Sea through a canal, waves are calm in frequency and ample in height, unlike a lake in which there are few waves at all, or a pool in which there are frequent and shallow waves.

Water representation has everything to do with how the surface that separates it from the air looks and behaves. Reflections and refractions as well as surface wave motion play a big role in the description of the surface. The principal characteristics that were identified in this particular case were that when seen far away, masses of water are influenced by the atmospheres luminosity, creating an opaque ramp between a dark and a bright blue, sprinkled with white highlights. Close up, water is usually crystal clear, with rare reflections, shown as random whitish lines, and refractions, i.e. bent and softly jagged distortions. Additionally, colour change of submerged objects is apparent.

Below are images taken from the film Porco Rosso, which served as inspiration for this project.

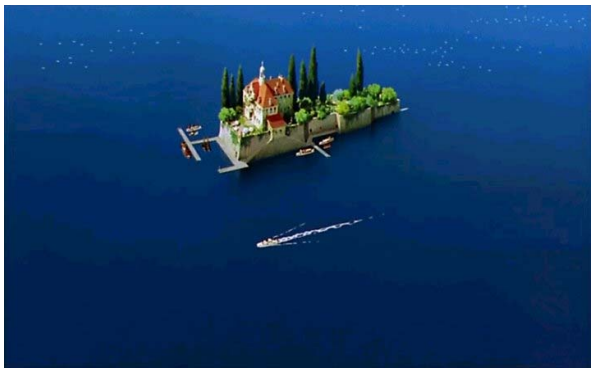


^ Example of water transparency and white turbulence lines

^ Example of shadow distortion and no surface reflections

^ Example of colour change and distortion

^ Example of colour change, distortion and white lines



< Example of ocean seen in the distance. A blue gradient sprinkled with white reflection dots.

TECHNICAL SOLUTIONS

The initial efforts were directed towards learning to use a tool which was designed specifically to deal with visual issues, Pixar RenderMan. RenderMan is a standard interface between modelling and rendering software, originally intended to aid anyone model in the software that best suited their needs and render the geometric information in any renderer that conformed to the standard. It is a sort of postscript language directed at 3D graphics. Pixar is best known for an extraordinary body of computer animation work produced over the last eight or nine years. They are the creators of the two Toy Story films, A Bug's Life, Monsters Inc. and Finding Nemo, but in the late 1980's they chiefly concerned with the development of the renderMan standard and the rendering tools compliant with the interface, which were made commercially available. Pixar uses its in house developed renderer PhotoRealistic RenderMan, also known as PRMan, on all its work and given that we had academic access to the software, it was thought that it would be appropriate to use it on this project as well. This assumption however turned out to be untrue. Early on in the project, Alias Wavefront Maya was used to test the intended

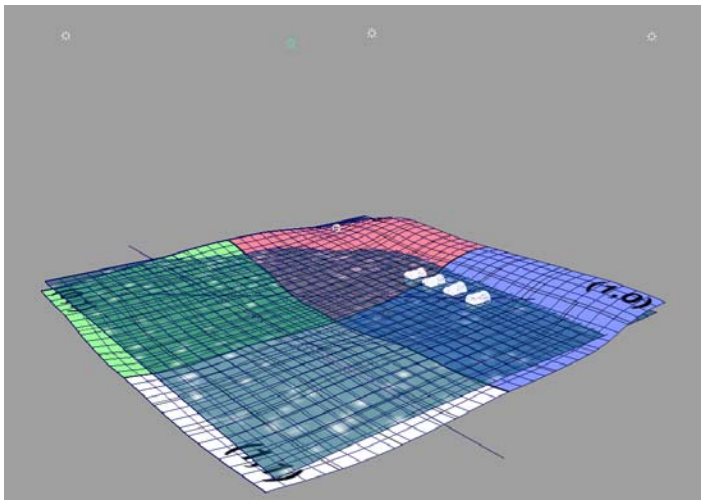
results, as it was very simple to use, and natively supported features such as raytracing, modelling and texturing which were evidently part of the task. What became clear during the progress of the project was that there was no real need to implement the water shading in RenderMan. Never the less, the initial efforts are outlined further on in the report.

Raytracing allows for calculations of refraction and reflection of light to be executed on objects. Technically, a ray of light is traced in a backwards direction. That is, it starts from the eye or camera and traces the ray through each pixel in the image plane into the scene and determines what objects it hits. The pixel is then set to the colour values returned by the ray.

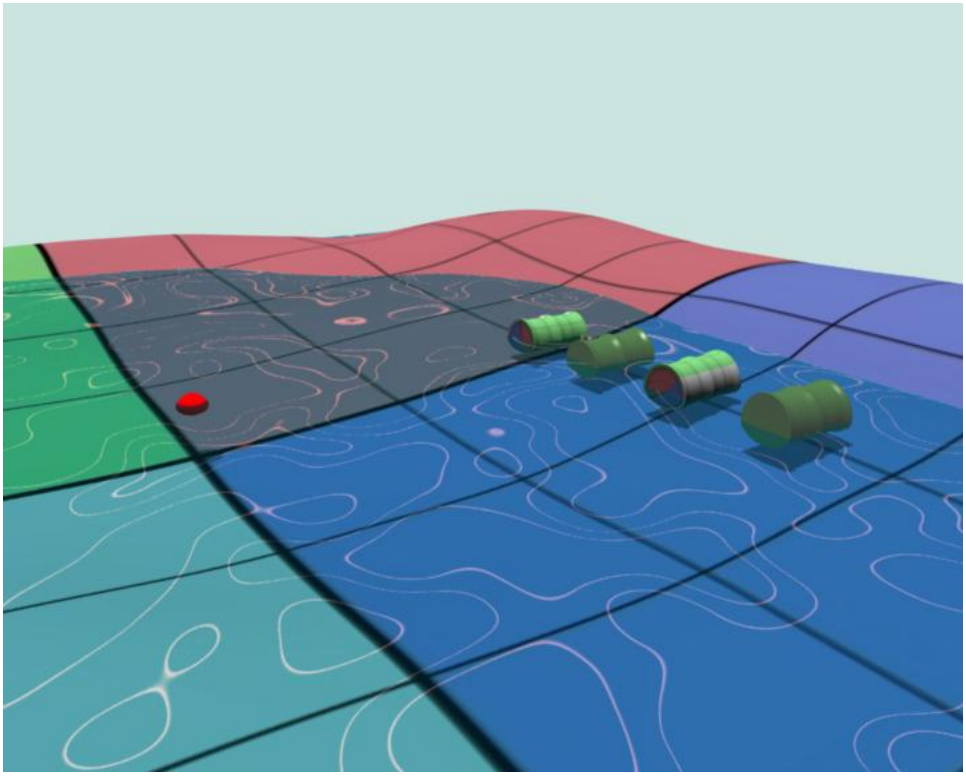
Ray tracing is a time consuming technique because it's computationally expensive, but it yields very accurate results. This is an intended outcome, as Miyazaki's skill is such that his drawings seem perfectly true to refractions.

PROCESS OF REPLICATION THROUGH MAYA

Within Maya it was fairly simple to arrive at the pretender results. A scene was created with a couple of NURBS surfaces, one modelled to represent the ground plane, and another to represent the water surface. The ground was textured with a simple grid image, which helps visualize distortion rendered in the water. The water had two linear deformers applied to it, blended to imitate the animation of calm ocean waves; a wave deformer and a sine curve deformer were used. The texture used for was a simple *Lambert* shader which has no reflections or highlights, tinted slightly blue for colour. Transparency was turned on for low opacity. In Order to create random white lines on the surface, a ramp was applied to the colour node of the shader; a noise functions was used on the coordinates of the ramp with a high frequency value to create the random curves. As for refractions, raytracing simply had to be switched *on* in the rendering preferences, setting the default values to 0 in Reflections and 1 in Refractions.



The settings of the main light which illuminates the scene were also important. A *directional* light was used to imitate that of the Sun, which being so far away from our scene sends out practically parallel light beams. The settings which matter the most are the raytrace shadow attributes. In order to get the shadows to actually project on the ground plane below the surface plane, *Ray Depth Limit* must be set to 2. If light needs to traverse more than two geometry planes, than this parameter must be set as high as there are planes. *Light Angle* is set to one, to soften the shadow slightly, otherwise it remains very hard. Finally, *Shadow Rays* are also set to one as it suffices for the desired result, and to decrease rendering time. Higher values were experimented, but yielded no difference except for increased render times. After that a few barrels were modelled and animated floating on the surface, as well as a red ball, which was animated falling into the water and then bobbing back to the surface. A rendering of the final result is shown below. The results were found to be very acceptable. In a real production scene all that needed to be done would be to adjust minor details to match the desired results, such as texturing and lighting.



The resulting Maya rendering

PROPOSED RENDERMAN APPROACH

There are a couple of ways to go about working with RenderMan. One is to describe geometry in renderMan's native file format, RIB (which stands for RenderMan Interface Byte stream) in a text editor, linking shader files to the described geometry. Shader files describe the way the geometry is to be rendered and are written separately from the main RIB file in a language called SL (Shader Language). Once compiled, the shaders are called and used when rendering the RIB file. A very comprehensive description of how renderMan works is available in Ian Stephenson's RenderMan Fast book.

Another way is to write the shader files and apply them to geometry in Maya using the Slim graphical user interface, a part or Pixar's RenderMan Artist Tools software suit to which we had academic access. Slim has many standard shaders already built in which can be used, however, when a very specific look is intended, it is best to code the shaders by hand, so that every parameter is known and controlled. Subsequently one can import them to Slim.

The procedure to arrive at the pretended water aspect with render man would be to white a displacement map to create waves in the water surface, another shader which coloured the surface to some shade of blue and turned it's opacity down. Another shader should be written that applied a texture to the ground beneath the water, so that a refraction function *refract* could be used to calculate distortions on the texture, a procedure called environment map look up, which accelerates rendering times, as it does not rely on true raytracing to do arrive at the refraction values. Refract is a function that performs a simple geometric calculation based on the position of the camera and the orientation of the surfaces. Once these shaders were written and applied to the scene, raytracing would be used to track the refractions on the displaced surface of animated objects.

CONCLUSION

A method of generating images in computer software that emulate the style of animator Hayao Miyazaki has been presented. This method does not make use of advanced rendering techniques other than raytracing, and is simple to reproduce. A rendered animation has been produced which illustrates the result achieved.

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