Ocean Summits and Virtual Fish: Games for a Sustainable Future [07.15.08]

- Aerlyn Weissman

Most virtual worlds show us the terrestrial view of things, but a recent collaboration between the University of British Columbia (UBC) Fisheries Centre and a team of students from the Masters of Digital Media (MDM) Program of Great Northern Way Campus in Vancouver created a virtual underwater view of the Gulf of Mexico.

It's the first phase in a project to create 3D models of marine ecosystems all over the world and use them in a series of Ocean Summits; real time, player controlled scenarios that will show the impact of policy decisions on the world's fisheries.

The project is also developing new ways of visualizing scientific information, using the Blender game engine to display scientific data.

It's all part of an effort to provide a new computer-based awareness tool for fisheries stakeholders who will meet in the UBC Fisheries Centre Scenario Lab, a specially designed room and testing ground for finding sustainable solutions in a cooperative game environment.

For the MDM students, this project provided a unique opportunity to collaborate with experts at the Fisheries Centre, using professional tools in project management, 3D modeling, and programming. The expectations were at a professional level, as well -- deliverables, scope, communication, and of course, on time, on budget, performance.

State of the Oceans

It's no secret in scientific circles that the world's oceans and what's left of the fish in them, are in crisis.

A daunting list of problems -- over-harvesting, habitat destruction (much of which is from bottom trawling), invasive species, pollution, and climate change -- is most affecting the 10 to 15 percent of the oceans where today's most important fishing grounds are concentrated. Add in the current spike in fuel costs and it's easy to see why intelligent policy decisions will make all the difference to a sustainable future for our ocean resources.

Collaborative Data Visualization

Good decisions rely on having a clear picture of what's actually happening in the world's oceans, and the scientists at the Fisheries Centre realized that the ways they communicate with each other -- in the form of complex graphs and statistical tables -- didn't always translate into information that public officials or managerial people found pertinent. The challenge was to visualize their data, collected over the last 50 years, in a way that non-scientists could understand and use to determine marine resource policies.

The solution is data visualization. After many iterations, a team of students in the Masters of Digital Media Program at Great Northern Way Campus has built a proof of concept prototype which will allow the Fisheries Centre to display eight species of fish native to the Gulf of Mexico, with the numbers of fish on screen responding to the output of the EcoPath software. This data drives a dynamic 3D environment, which can instantaneously represent impacts on fish populations based on "what if" scenarios. Instead of committing decisions which may not result in the desired outcomes, policymakers can test different approaches to fisheries management and actually see the results first hand.

The Centre believes that, backed by the best available science, this kind of interactive process can be powerful and effective in creating more than a merely analytical response and will encourage Ocean Summits participants to adopt new options for fisheries management.

EcoPath with EcoSim (EwE)

The visualization layer we created receives output from EcoPath with EcoSim (EwE) software that has revolutionized scientists' ability worldwide to understand complex marine ecosystems. Primarily developed at the Fisheries Centre over the past 20 years, it is used by more than 6,000 scientists and researchers in 155 countries and provides important information to governments, commercial fisheries, coastal communities, NGOs and consumers. EcoPath incorporates foraging arena theory, and using global databases on fish stocks to directly parameterize the model, can reproduce the known history of many marine ecosystems.

The Scenario Lab

The Scenario Lab at the Fisheries Centre on the UBC campus, is a unique facility, designed to encourage communication and collaboration. Five huge plasma screens line the walls surrounding a custom-made table in the shape of a super ellipse. A mathematically determined compromise between a circle and a rectangle, it's a shape that encourages cooperation, not an "us and them" approach. The table is equipped with 10 built-in workstations that can display data and visualizations in any number of configurations, controlled by

the participants.

Plugging into the Ocean
The data visualization, which the MDM student team developed, uses video game technology as a basis for the platform; we believe we are among the first team to implement a scientific data visualization which relies on a video game engine for its backbone. Discussions with the Fisheries Centre led us to adopting Blender as the engine we used, because it is both open source and free.

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The two exceptional artists on our team, David Janer and Vincent Yang, developed the concept art that laid out the vision of how the overall undersea environment would look. Based on these drawings, we used Blender to model and texture the sea floor, complete with sea grass and rocks that are characteristic of a particular region in the Gulf of Mexico. The fish, and one member of the ray family, were modeled and textured in Blender, with some additional help from Maya and Adobe Illustrator. For reference, we had underwater photos of the environment and used www.fishbase.com, the world's most complete database of fish species.

The challenge of this "under the hood" part of project was getting meaningful data from the EcoPath software into the Blender game engine. Once the EcoPath .Net server and the data visualization were up and running, the connection was established from Blender. The message: "sw BEGIN relay handshake:" would be visible in the Blender console window, and pressing the 'Send' button on the .Net server sent the appropriate data to the data visualization. The basic flow of data goes like this:

1. Data is sent from EwE through the .Net server.
2. The server interacts with the client in the data visualization layer.
3. The client distributes the appropriate data from the .Net server to the various global variables in the data visualization layer.
4. These global variables belong to categories including: population controllers, environment controllers, and scene controllers.

Python scripts were used to handle various functions, including world handler events, which defined various states that the fish could exist in. The eventClient.py script apportioned parsed data to the appropriate global variables, located in Python dictionaries.

Our ocean environment was created by establishing a terrain, skybox, cylinder of influence, and active camera track, which the elements then relate to. One script automatically moves one of the four ground tiles dynamically, based on the active camera's current position, to give the impression of an infinite world. Another teleports the skydome to center on the active camera on the X-Y plane.

The fish, sea grass, and particles that populate the ocean are handled by an array of emitters, and their parameters are defined by Python scripts. Each is handled in a specific way. For example, sea grass uses a raycast sensor to find the ground plane and position it correctly in the terrain.

As we developed the look of the ocean, we struggled with caustics, (motion based underwater lighting). We were never happy with the look, though, and eventually took them out. We experimented with mist values; if they were set too far away, the ocean started to look like a beach, too close and things got pretty murky. For the lighting, we eventually used a single source over the skybox. Tiling the ground plane took some work because at first the sea floor just looked like tiles, and some effort went into establishing camera tracks and timing the movement to give it an ocean feel.

One of the main issues we dealt with in an ongoing way was the frame rate. As our ocean became populated with rocks, sea grass, and then fish -- which had their own meshes, textures, animation scripts and some basic AI -- the polygon count and computational demands started to overwhelm the engine. Optimizing the code helped a bit, but we had a balanced design and no one bottleneck was slowing things down. With a hundred fish on screen, both the rasterizer and CPU were working hard, and at various points our frame rate was down to 3 or 4fps. Solutions came in the form of reducing the polygon count for the fish and making them unanimated and stupid once they were off camera. Sea grass was populated as the camera moved, and the terrain was laid down on a need-to-see basis. By the end, we felt we had pushed the limit of what the Blender engine could do.

Along the way, one of our team members, Steve Danic, put together a Blender tutorial for the rest of us, who were not as familiar with the software.

With Steven Pugh being our only full-time programmer and two others on the team supporting his work, the effort to make everything functional was daunting.

Project Management

Early in the project, we adopted an Agile project management system. Agile development is based on rapid prototyping, and relies on a cycle that creates a fully functioning iteration right away, and then improves on it repeatedly to deliver a new version every two weeks. Using this methodology was a great decision for us (although we had some difficulty with it later in the project), as it allowed us to plan a detailed but flexible workflow for the entire project.

Daily Scrum meetings made it easy for the team to share and discuss pending tasks. Having the tasks visible on a white board helped in assessing the progress of the project and incentive to complete each iteration in the cycle. We had two people on our team, Steve Danic and Ashley Blacquiere, who had good project management skills, and it made a huge difference in terms of success and professionalism.

Our Team and Workspace
From day one, the team was well aligned, with the common goal of creating a well polished final product. Everyone was enthusiastic and dedicated to our vision. We had a great working environment and we got along exceptionally well. We're spoiled now.

Although there were a few low points, when the stress of meeting a deadline or achieving a particular result took a toll on each of us, we were great at encouraging and helping each other. We were also good at finding things to distract ourselves with: late night sessions of Rock Band and high-quality chocolate powered us through the difficult times.

Our project room was the perfect fit for the six of us. Initially, the desks and tables were pushed against the walls, which meant that we were all facing away from one another. We quickly changed this and found that the new configuration worked well for us. We had three desks in the middle of the room, each one shared by two people, all facing each other. It gave the entire project a much more collaborative feel.

We covered our walls with a lot of the drawings done by the two artists on our team, as well as colourful posters of underwater scenes of reefs and fish. We also had a significant amount of pre-production paraphernalia on our project room walls: contextual maps, cost-benefit analysis, risk assessment, vision statement, and so forth. These were great tools to use throughout the project, and it was good to always have them visible. Everyone could quickly see where we were, identify problems, and be clear on where we were headed.

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Mentorship

Our faculty lead, Patrick Pennefather, played an important role in the project. He had the insight to see where we should be left alone to figure things out, and where to step in to foster better communication and support us in dealing with the client. We were also very fortunate to have the support and advice of a mentor, Tarek El-aydi, who visited every Wednesday evening for a few hours on his way home from work at EA Canada.

Much of El-aydi's professional experience has been in CG films as a technical lighter, and he was able to give us some excellent advice on handling the flow of the project, and dealing with technical issues. He also has a great eye and was instrumental in pushing us to use our concept art as a guide to our final product. Without that anchor, we would have been chasing a moving target. His generosity and commitment to us was one of the best things about the project.

El-aydi was an excellent artistic mentor in terms of establishing the look and feel of the project. It would also have been beneficial to have had a dedicated programming advisor who was knowledgeable about game engines. This would have been helpful in designing our overall architecture as well as in providing advice on appropriate engines to use for the project.

The initial decision to use the Blender game engine might have been different had we had the advice of a senior programmer. Blender served its purpose well for creating a proof of concept, but for future expansion and sustainability, another more advanced or recent engine might be more effective.

Publicity

We did not have to sign an NDA for this project; in fact, UBC Fisheries Centre encouraged us to publicize the project as much as possible. This situation is more likely in the context of an educational institution than a corporate one, and it was great for us.

We posted blogs and submitted an article on the project to BlenderNation, which drove a considerable number of hits to the MDM web site. We posted YouTube videos on a bi-weekly basis, primarily for the client, but which still generated interest online. The project was featured in an article in the Vancouver Sun, and we presented it at the annual MDM Student Showcase to more than 300 industry professionals, friends, and family. We did two radio interviews for a technology program at the Simon Fraser campus radio station, and our working process was documented on video for a "making of' piece.

The Challenges with Agile Development

Our Agile workflow worked very well for the first four cycles or so, about half the time. However, we began to fall behind our projected deadlines. Some tasks were pushed back week after week. Eventually, no one was really working from the task list on the board; we were just working on what we thought needed to be done to finish the project.

Part of this problem was that some of the tasks weren't measureable. We neglected to create accurate time estimations for each task, and many of our task descriptions were too broad, which made completing - or even starting -- them difficult.

The lack of adherence to the Agile workflow resulted in miscommunication on whether certain features were completed. As each cycle came to a close and certain issues had not been resolved, we sometimes used quick fixes instead of real solutions. This lead to confusion about what was finished, what was temporary, and what had to be updated from a patch. Some of this was precipitated by the perceived need to have a new feature to show our client every week.

Overall communications were pretty good, but a common reference for the look of the project was difficult to arrive at and took a while to establish. Initially, the client suggested that the final product be similar to "Ocean Dive," an aquarium screen saver. However, the team determined early on that the visual quality of "Ocean Dive" was not realistic enough and that a scientific visualization needed to be more accurate in the way it handled underwater color temperatures and suspended sediment.

Our concept artist sent visual targets to the client for approval, but we didn't think we got enough feedback to feel confident about the direction we should take. The issue was eventually resolved by us deciding what the product should look like and delivering that to the customer. In the end they were happy.

On our side, we should have shown our fish models to people at the Fisheries Center much earlier than we

did. It wasn't until the last few weeks of the project that we understood how inaccurate the fish animations were. Each species has a very specific way of moving and it would have been better if we had organized a critique from a fisheries expert sooner.

Swimming Forward
Future phases of the project will produce visualizations for other regions as well as games designed to generate sustainable strategies for fisheries around the world. All of us who have worked on the project feel that it may have considerable impact on the management of future marine ecosystems and hope we've played a small part in supporting a sustainable future for our oceans.

Aerlyn Weissman is a graduate student in the Masters of Digital Media Program at Great Northern Way Campus in Vancouver and is responsible for camera, lighting, and overall visual quality in this project.

Project Team
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