

quality of the planetary surfaces [p13] was immensely increased. Arrived on the planet, we can leave the cockpit and walk around a seemingly realistic 3D environment. The topography and terrain look great and with the view over the sea we notice the correctly simulated curvature of the horizon. The technical basis allows to simulate every planned star system in the game, so the planets and moons orbit around the suns. This will also lead to, for example, that one will see the day and night side of a stellar object when flying around it.

“Regarding the gameplay, the procedural generation is a huge step forward”, Chris Roberts explains during the presentation, and continues: “We can now design missions so that you, for example, accept a mission on a space station and the mission will lead you seamlessly to planetary surfaces and back”. *Squadron 42* will also immensely profit from that, Roberts promises us.

The exploration aspect of the game will also be considerably more exciting. If someone looks up to the moon of a planet from the surface, they will actually be able to hop in their ~~space chariot~~ *space chariot* and fly there. Compared to the genre colleague *Elite: Dangerous* every planet and moon in the galaxy of the game will be landable in *Star Citizen*. To be fair, in Chris Roberts universe we talk about around 100 star systems, while Frontier Developments simulates the whole milky way.

Automatic algorithms with hand crafting bonus

The space game *No Man's Sky*, which will release on the 10th of August 2016, will also use procedural technology, but with completely automatically generated planets and without story gameplay. With *Star Citizen* it will be different, because it's conceived to be a real online role playing game. There's already a meticulously elaborate lore to the game, filled with different factions and planetary descriptions. For that to be implemented in the game, and to be visible to the players, the developers showed us using their editing tools how the algorithmic generated planet surfaces will get the appropriate amount of life, so they won't seem repetitive or even boring.

The designers have always full control over the generated content. So, for example, the topography of a planet can be edited by hand in the editor. Predefined templates - so named eco systems - contain then, for example, trees, buildings, vegetation and also ~~procedurally generated birds~~ animals, which can be set by a “brush stroke” in the editor on the available terrain. After that the surface transitions will be modelled and blended by the Cry-Engine so that the terrain looks of a piece. With that you will be able to find hidden temples, salvage, stations, mines or other game relevant things during your exploration trips.

The next steps

After our play we were able to get a good picture of the working technologies at Foundry 42, so we wanted to know, when we will be able to play it live. Chris Roberts thus told us, what the next steps for the alpha builds for backers will be.

At first, there will be a rather soonish update to version 2.5. Included in that build will be amongst other things, a new space station for the mini PU. “This station is thought to be for players, which, let's put it that way, want to play outside the law”, Roberts explains. [p14] This reference is to the pirate base called Grim Hex, which was shown briefly in their online video show “Around the Verse”. Grim Hex will be the counterpart to the already available station Port

Olisar in the playable Stanton system. “With that we want to allow gameplay between two factions, to see what players will do with it”, according to Roberts.

After that the next version, 2.6, which will introduce the FPS module *Star Marine*. *Star Marine* will be playable outside the persistent universe, like the current module *Arena Commander*, in which you are able to test your flight skills. It’s specifically designed for multiplayer shooter sessions, with separate maps. “We have invested a lot of time in the FPS mechanics, you will notice that in comparison to the current, rudimentary implemented system in 2.4”, Roberts says. The developers show us an appropriate gameplay slice, which leaves a very good impression: animations, controls and the feeling of weapons were completely revamped, so it also feels good for a fps player. The result: fluid movement and clean gunplay - please keep it up!

With the version 2.7 CIG plans to implement the procedural planetary technology into the live game universe. In the first step that will mean, that the complete Stanton system will be visitable. Currently, 2.4 is only a small part of Stanton, in which it isn’t even really possible to land on any planet and the appropriate stations there. This will change completely. “Version 2.7 is the next big step for us, which will contain considerably more playable content for the backers”, according to Roberts.

Planets and moons in the Stanton system will be directly approachable and the players will be able to land on them, like for example on the previously mentioned Grim Hex outlaw station. With the following patches, more landing zones will find their way into the Stanton system, like Hurston and Microtech, two important corporation locations in the *Star Citizen* universe. The stated goal of CIG is to make Stanton completely playable before the end of 2016, with all stations and landing zones, which Roberts numbers to be around 40 locations. In that it also will be possible, to accept more missions [p15] and different jobs, to gain credits. Coming with the content upgrade, CIG wants to improve important elements in the background. Exemplary the new server structures will allow, that more players will be able to play in the same server instance than before. The goal is to reduce instancing tremendously, so *Star Citizen* will come closer to their goal to be an online MMO for a big number of players.

Until all those steps are implemented, CIG has a lot of work to do, that’s clear. Manager Brian Chambers explains it that way: “Game development is a huge puzzle, that you have to solve. Every time when you change your game at one place, it reflects to different areas. To what extent that will be, is never foreseeable”.

Thus it will stay fascinating to see how the progress of the development of *Star Citizen* and *Squadron 42* will be and what good and bad surprises will emerge from the situation. The concentration and enthusiasm for the work shown to us by the team are a good sign, though.

[p18] Interview with Chris Roberts

PC Games: Running concept sales and pre-sales of ~~space chariots~~ ships always brings up concerns with critics why this is necessary and if the money is actually running out for *Star Citizen*?

Roberts: “We always have a specific amount of money in the reserve, the concept sales help us increasing the teams even mid-development. This allows us to bring even more active people into the game right now. Because we want to realize a big online game. We are lucky to have a big community behind us, so when the game is finished, we will have a large population in the universe. This is good to know, but also essential, because only when you have a stable player population, an online game can be successful in the long run. This is one of the reasons why we are selling things this early in the project, so players can take part on *Star Citizen*. The concept sales not only allow us to do more development, but also to maintain and keep the current live servers of the persistent universe alive. We have to pay monthly bills for the game servers in the cloud, and for the servers that give players access to the enormous patches - there’s a lot of data coming together, which gives us continuous costs. Also the alpha builds, which we distribute to the backers, cost us extra time, which we need to evaluate the feedback and improve and optimize the builds, so we have even more running costs here.

On the other side the early alpha versions don’t represent the current development status of *Star Citizen*, we are way farther advanced, which you have seen here in your studio visit in Frankfurt. The procedural planetary tech, which will bring us so much farther, won’t be possible if we’d have stopped at some point of the funding campaign and said “Stop, the funding ends here”. Sure, we had a stretch goal for procedural technologies, but we didn’t expect that we will apply it for the whole universe and all planets and moons. And this only works, because we are able to continuously get more new players and money into the development process. My personal goal is still to make *Star Citizen* as cool as possible. For me it’s not about to earn as much money as possible. In fact, the money that we gain is for hiring the best programmers, designers and artists. I don’t want to justify the concept sales with this, in my opinion they just belong to the process to make the game bigger and better. There is no publisher in the world that would invest so much money in a project with this ambition and scope, especially not for the PC. We can only do this, because there’s such a big community and fan base that dreams of a game like this. Thus they support us and we are very glad of it, because only they allow us to realize this project.”

PC Games: The sheer size of the project must create extraordinary pressure. What are the biggest challenges for you?

Roberts: “Oh that’s a good question, well *Star Citizen* is without doubt a demanding beast. One of the most difficult things to handle is, that we have multiple studios running. This one in Frankfurt, a big one in Manchester, then a headquarters in Los Angeles and finally a studio in Austin. While we manage a lot of the organization online, everything is connected with a lot of travel. Being at the location, looking the programmers over the shoulder to see the current state of the production, talk with them in person, giving feedback - I can’t replace this with a skype conference. Thus I’m travelling a lot, which is quite exhausting, since one has a family. In some ways it’s some kind of sacrifice when you are part of such a big project as *Star Citizen*.

Another huge hunk is the fact, that we are a live project, due to having playable modules, which we give to the backers in parallel of the development. There's this big community, you give them a small part of the game and naturally they want more as fast as possible, in the best case monthly. I mean, you guys as a magazine, you know that, you have to deliver content regularly, because if you can't deliver you'll be gone very fast. Thus you have way a more and a different kind of pressure from the start in such an open project as *Star Citizen* compared to the typical game production. There you have your project for the next three, four years clearly defined and enough time to work behind closed doors before you show it to the public. Sure, you have some crunch time before the release, but this is still something completely different compared to a public crowd funding project like *Star Citizen*. I always get new personal challenges resulting of that, like being able to be in every studio long enough, so the perspective for the big whole will not be compromised.

In addition to that, I'm the biggest critic for the project. I want to realize the idea that I have for *Star Citizen* in my head, everything that I envision. This is some kind of inner obsession, and I'm not willing to depart from that, so in the end the game will be created like I want it to. When I'm not able to see the vision that I have in my head on the screen, then I am [p19] very angry and tell myself that this must be possible somehow! Or when things take too long, I push myself from the inside and tell myself 'Come on, we finally have to move on in the project'. So I'd say that the most pressure onto me being from myself and not from external sources, which also happen all the time. Of course you have to have a thick hide, otherwise I'd never been able to do all my project in the past. Even the first *Wing Commander* was a complex and ambitious production, but nothing in comparison to *Star Citizen*."

PC Games: How do you handle the huge expectations, which increase with every feature that you plan to implement?

Roberts: "Sure, it's a challenge. We work from the start on a very ambitious project and can now access technologies, which we didn't expect to from the start, like the procedurally generated planets. We want to implement such progresses as fast as possible into the live game, since it's necessary to improve the player experience, the possibilities in the game and the very valuable resulting feedback. This leads to difficulty decisions, because if you want to increase the scope and complexity of a game, this will cost you a lot more time, additionally you need more people and more investments.

Regarding the expectations when the game will finally release, I want to say following: If you backed the game in 2012, then you expect the game to be finished in two, three, four years - maybe not with all the facets, that might be possible. I understand, that players question why it takes so long. The simple answer is: the more complex and bigger the game will be, that you want to make, the more time it will take to make it. As a developer you need the time, to first create and set up the necessary systems and mechanics. There are two development strategies with which we could have created *Star Citizen*: the one would have been to create only the base game. This we could have improved continuously with add ons and additional content, to at the end, reach the final vision. The second way is, to set a set goal for the game and question yourself what is necessary to make it, to create all the necessary tools for that. I'm personally not sure which of those development strategies is better. Let's take as an example *Elite: Dangerous* - while their final goals were different than with us and *Star Citizen*, they chose the

way to create a smaller game to completion. Now they have a season pass with which you can land on planets and drive around in a vehicle, also multi-crew features and fps are in planning and will be available at a later time. The issue with this kind of development is, that you don't have access to all necessary systems in the pipeline from the start to reach the final goal. That means, you have to touch the working mechanics again to make them working for the new gameplay features. This costs you a lot of time and increases effort and costs. I want to compare it to this picture: if you know from the start, that you want to build a castle, you can create that concept. But if you build a house and decide to change it into a castle, that will mean that you have to demolish things completely and start anew. Both ways of development work, we chose the second way and yeah, short-term it brings us a lot of development-related delays, no question here. But I think, that long-term it will bring a better player experience in *Star Citizen*."

[p20] Tech check: Star Citizen

Of course with our visit at Foundry 42 the technology was a big part of it, after all the intentions of Chris Roberts and his team take up extensive changes with the Cry-Engine. Some of those, like the change to the integer format in 64bit to increase precision with big (virtual) environments or the integration of physic based materials, have been already taken on in the past. Others, like the procedural generation of planets and moons are in work. Further, for example the deep optimizations or switch from multiple servers to a server network that should work like a single entity, are still projects for future days. And whileas we have seen many different aspects during production, the star of our visit was the procedurally generated content - to elaborate: the approach from space and the the seamless landing on the planetary surface.

The planet presentation

Naturally a complex object like stellar object can not be displayed even with the completely reworked Cry-Engine in a whole, since that would overload every computer and overflow every memory. Thus *Star Citizen* utilizes a dynamic detail system which adds more and more detail on approach to the planet continuously. From afar even a whole virtual world is just a small point in the darkness of the simulated universe. On approach, this point slowly changes into a sphere, which will be correctly illuminated and shadowed by the sun. Then only the atmosphere will be visible, which is made out of volumetric dust, out of which slowly mountain peaks arise while the planet itself now completely fills the view and the Cry-Engine continuously adds polygons where necessary. Some pop-up is surely seen here, but it's still very impressive how clean and smooth the translation happens. Also impressive is the cloud layer: it's not a simple texture, like in many different games, because to what determines if the clouds obscure the landscape is depending on their altitude. While valleys usually are heavily obscured, mountain ranges are often clearly above the clouds. For [p21] the whole atmosphere 3d calculations are taking place, this is especially visible when on the ground: the volumetric atmospheric haze also works in the horizontal plane and leaves valleys and mountains realistically diffused in the distance - a virtual limit on the view distance does not exist.

But not only the rendering of the distant objects is impressive: to get the high amount of details that is wished for in *Star Citizen* but still be able to play it on non-NASA computers, the drawing of the landscape utilizes parallax occlusion maps and dynamic tessellation. The former allows a very plastic look for textures, the latter adds polygons to mountains and valleys close by. With that, simultaneously unevennesses like rubble and hills can be realized without overstraining the CPU, GPU and memory. This already works very well, even without optimized multi CPU usage - the GTX 980 in the presentation computer showed in the editor around 100 FPS, and when changing into the game including the ~~space-chairet~~ ship and its complex simulation there were still over 45 FPS.

Future of the technology

Thanks to the procedurally generated game content and simultaneously allowing hand crafting through the designers, the gigantic universe of *Star Citizen* with the 100 planned systems, each with planets, moons and stations, can be created. For living in the universe with many players, the switch from single servers to a server network has to happen - no single computer would be able to compute all the data streams. In the current version, the server

performance is already with few players a bottleneck, even more than the system where the game is being played on, given that it's powerful enough.

Thus, in the future many single servers will communicate with another and essentially work like a giant multi core CPU. Optimizations especially for that are already being implemented in the code for *Star Citizen*. Those will also give the client-side a smaller performance boost.

Another factor is the AI, since finally 90% of the population in *Star Citizen* will be AI controlled NPCs. Those will show a complex and believable behaviour, while do everything that a player can also do. Yes, even details like hobbies or a virtual mind, that can be influenced by other players, will give NPCs a real life like existence. For that *Star Citizen* will utilize the Subsumption-AI. Essentially any given NPC will have decisions on their own based on predefined settings, his environment and external triggers. The Subsumption-AI is also used in reality with the programming of robots with human-like behaviour. To not let the *Star Citizen* universe come down to a crawl with AI calculations, the technology will be scaled over the distance and more seldom refreshed. Instead of calculating everything with 60 FPS and thus 60 Hz, this might be with possibly only 1 Hz, when no player is around the NPC.