LEGO® MINIFIGURES* ONLINE BRINGS CROSS-PLATFORM PLAY TO GAMING

When Norwegian gaming giant Funcom began work on their new hit game *LEGO® Minifigures Online (LMO), they knew playability across Intel® architecture would be key. They also wanted fast load times, snappy graphics, and better battery life, but it was crucial that they achieved an exceptional playing experience no matter which platform gamers logged in from. The Funcom team engaged the help of Intel Software and Services group (SSG) to gain insights for key optimizations, and the result, to quote *The LEGO® Movie*, "Everything is awesome."**

Funcom managing director and chief technology officer, Rui Casais, was a key executive on the production team, working with every part of the technology, including all the tools that allowed the developers, artists, and designers to create their compelling content. He said that early involvement with Intel was instrumental in getting the technology right. "We have been working with Intel for many years, cooperating at different levels, but with this game we saw the opportunity to optimize even further," he said. "We wanted to reach a broader audience with tablets, laptops, and 2-in-1's, using both Windows* and Android*. The Intel® architecture has a lot of multi-core, multi-threading power, but in terms of programming, you need to think of it differently. We needed to use a different set of tools."

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— Rui Casais, Funcom managing director and chief technology officer

The result paid off, with favorable feedback among young gamers and LEGO® aficionados especially. LMO is an online game for LEGO fans of all ages that includes fun Minifigures and plenty of exciting worlds to maneuver through. With success battling pirates and other enemies, players can collect Minifigures and improve their powers.

Funcom already had plenty of experience in the MMO arena with mainstream titles such as *Anarchy Online**, *Age of Conan**, and *The Secret World**. There were some bumps along the way, but Funcom is a recognized expert in online gaming and previously worked with children's titles, including for the Danish company, LEGO, in the past. But LMO was truly different, Casais said, as it completely took over the office.

A 10-year veteran at Funcom, Casais said his Oslo-based team has truly enjoyed the project. "LEGO Minifigures are everywhere. We all have them on top of our computers. We swap their heads, hats, and bodies, and put swords into the hands of the skiers. We have a big LEGO Death Star with LEGO Star Destroyers around it, and people are definitely engaged. All of us played with LEGO as kids, and some of us play with

LEGO now, with our kids. And some of us just play with LEGO as adults, too . . . without the kids."

Start With Good Graphics

Casais understands that a colorful, attractive playing environment is a key component even for children's games, and that was the first example he pointed to in showing how much of an advantage his team gained by working with Intel. He believes the integrated graphics that Intel has been building over the last few years are to the point now where players don't need a discrete GPU to experience good graphics. He said that systems such as a child-targeted tablet will work fine with LMO. "The Intel integrated graphic solutions are actually performing quite well," he explained. "Through this partnership we made sure that the performance was good on all integrated graphics chips, which is important for our target audience."

Casais said LMO is more advanced and more complex than regular tablet games that children typically play. "Visually, we do a lot more, and we push the capabilities of the hardware to provide a PC-like experience on a tablet," he said. "Even on a low-end budget device, we are fully using the processor's 3D capabilities. With Intel CPUs and GPUs, the integrated graphics can actually run 3D games in these devices."

Funcom used a technique called "Conservative Morphological Anti-Aliasing (CMAA)," which is an algorithm for anti-aliasing that removes "jaggies" from the onscreen image. The technique was originally **developed** by Filip Strugar at Intel for use in *GRID2** by Codemasters. CMAA offers a high-performance alternative to traditional multi-sample anti-aliasing (MSAA) while addressing artistic concerns common in existing post-processing anti-aliasing techniques. CMAA runs efficiently on low-to-medium range GPU hardware, such as integrated GPUs, while providing a quality anti-aliasing solution. It also works in a wide range of applications, including worst-case scenarios such as text, repeating patterns, certain geometries (power lines, mesh fences, foliage), and moving images.

"For LMO, gamers will see surprisingly high quality on a budget device," Casais said. "They will see that the quality scales and gets even better as they play on a better device." Going from an Android Intel tablet to a top-end desktop Intel® Core i7™ system will convince players that they keep the performance while the game keeps looking better.

Players will also notice that LMO has interesting shadow effects on all architectures. Casais pointed to a shadow-mapping feature of Intel architecture called Adaptive Volumetric Shadow Mapping (AVSM), which greatly improves visual quality. "For example," he said, "when you see smoke or clouds, in rendering terms, that's a particle system." The particles can now cast realistic shadows on each other so players experience a much better sense of volume. There are typically brighter and darker areas of shadowing in a cloud or

in billowing smoke, and handling those intricacies correctly resulted in LMO players seeing soft, realistic effects from particle systems.

This type of shadowing is rarely seen in children's games, and Funcom was pleased that they got such an advanced effect running on systems with a fairly low power/performance budget. Casais and his team especially called out the quality they saw on Android devices, "Players should be especially pleased with our implementation of AVSM on Android."

The Sleepover Example

Besides great graphics across devices, Funcom also worked hard on consistent cross-platform playability. They saw the title as an opportunity to expand the technology uniformly across as many platforms as possible. Casais sees LMO as a game that everyone can play, everywhere, which Funcom established early on as a key success factor. "Kids don't want to care about where they are playing," he said. "They just want to play the game on whichever device is in front of them, whether on the bus, at home, or at a neighbor's house."

Casais called it the "sleepover example." He imagines a scenario where a young gamer is spending the night at a neighbor's house, playing on an Android-based tablet, while another child is using a desktop PC. They're connected to the same server so they see each other, communicate with each other, and they're part of a team. "While playing the game, you don't care which device the other person is using," he said. "They just see that they are there, they can play with you, and that's all that matters."

To accomplish that universal playability, Intel engineers helped Funcom focus on their engine, updating it with Intel insights on the multi-threading functionality to make sure LMO utilized all the CPU's parallel processing power. That was one of the biggest things the teams worked out together, especially to cut down on loading times. They made sure that when levels are loading—or specific assets are pulled in—the game doesn't load one thing at a time. "We load using all the available hardware threads the system has," Casais said, "and that enables us to really speed things up."

Funcom was careful to avoid bottlenecks based on I/O from the hard drive, queuing up different jobs based on whether they're CPU heavy or I/O heavy. "The ability to take full advantage of parallel processing was key there," Casais said, "ensuring that the Android release is not just a port to a different system—it's the same game, using the same assets and the same code."

LMO is now online, available for the PC, and in beta on the Apple Mac*. Next up are the tablet releases. There have been QA challenges working across so many platforms, as the team has to confirm every change across all of them. They have verified the game internally on

Android, but they haven't released it yet. The goal is to make sure that when they release LMO for Android, the experience is at least as good—or better—than when playing on a PC.

Touch control on 2-in-1's and tablets was also important to the Funcom team. "We made it so that the game detects when you change to a mode where touch is the main input scheme," Casais said. The heads-up display of the game changes when it detects a touch-enabled platform, automatically enlarging the buttons for easier use. The location of the attack buttons switches to a more prominent position, and they added a virtual joystick so that if players are grabbing their device with both hands, the left thumb will use the virtual joystick, the right thumb will initiate attacks, and there won't be a keyboard need until players return to normal laptop mode. The entire effort of switching is seamless so the player can continue easily.

Save the Battery

With the recent gaming changes to mobile platforms from traditional desktops, the relationship between power and performance is tighter than ever. Providing the best user experience in the mobile gaming world means high performance and longer battery life, a tricky combination to balance. Fortunately, there are practical methods to improve user experience by managing power issues while boosting the end user experience, regardless of the platform's power constraints.

Funcom worked with Intel to implement battery-saving features in LMO. If users unplug and go mobile, working from battery power only, the game detects the change and runs in battery-saving mode. Casais said that battery power mode saves almost 80 percent of the battery compared to just running in regular mode, depending on the system.

Reaching that level of power conservation required both diligence and innovation. The Funcom and Intel engineers co-presented their **findings** at the 2015 Game Developers Conference (GDC) in San Jose, California. Intel tools that the Funcom team used for power and performance analysis included Intel® INDE for Graphics Analysis, Intel® VTune™ Amplifier for in-depth CPU analysis, and Intel® SoC Watch (Intel® System Studio) for power states.

The teams learned how to quickly reduce processor power consumption by optimizing the gaming workload, performing simple modifications such as capping the frame rate, reducing AI threads, changing the rendering resolution, and choosing the best algorithm. Developers who follow Funcom's example can gain an increased understanding of key power optimizations to take back and use elsewhere in their games.

Looking Ahead

Casais was impressed with Intel's help in the areas of graphics optimization, cross-platform continuity, and overall power conservation, stating that, "Intel is obviously very knowledgeable in these areas." He expects even better battery savings in the future, when Funcom releases the DirectX* 12 version of the game. "It will be very interesting to see how much more we can squeeze out of it," he said.

While working with key Intel engineers, the Funcom team consumed great quantities of helpful documentation. The tools used by his team were especially important, and Casais had high praise for the Intel® Graphics Performance Analyzer (Intel® GPA), now available for Android. Overall, Casais said his engineers have been very happy to work with Intel engineers, and together they continue to discuss different alternatives to current problems. "It is a very open communication channel, which we really appreciate," he said. "We have worked with many vendors over the years, and I can safely say that this is by far one of the best partnerships we've ever had."

Learn more about Intel's optimization tools here.

Check out *LEGO® Minifigures Online* game!