How did developers create 'Starfield,' a video game with a galaxy of 1,000 planets?

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Bethesda Game Studios used procedural generation to create virtual galaxy. It increased the game's scope, but at what cost? Credit: Bethesda Game Studios

When Todd Howard, director and executive producer of Bethesda Game Studios, announced in June that the team's upcoming, highly anticipated

game, "Starfield," would feature a galaxy of more than 1,000 planets, fans were beyond excited.

To say the scale of "Starfield" is ambitious would be an understatement. Set in the far future when humanity has cemented its place among the stars, "Starfield," which hits Xbox Series X/S and PC on Sept. 6, allows players to fly, shoot, talk and explore their way through an entire galaxy. It's not just an open world; it's an open universe. It's why the next thought many people had was, "How?"

Bethesda has offered few details about how it designed an entire galaxy, but Howard has confirmed that a method called procedural content generation helped achieve the scope of "Starfield."

According to Chris Martens, an associate professor of game design at Northeastern University who teaches a course on the subject, PCG involves the creation of game content ranging from trees and rocks to entire levels using an algorithm. It includes a broad range of tools that are commonly used in game development. Howard has openly talked about using PCG not just in "Starfield" but in the studio's other games like "The Elder Scrolls" and "Fallout."

Martens says players often experience PCG in roguelike games where players run through and die in levels over and over again, and each "run" involves a different set of dynamically generated levels. A PCG tool could pull from a set of elements—like level size and enemy placement—and randomly create levels with different combinations of those elements.

"A lot of times, the way these things work is you can describe the design process as a sequence of choices that you would have to make," Martens says. "How big do I want my level? Where do I want my corridors to be? How connected do I want it to be? … Once you enumerate those, it's

easy to sprinkle a little randomness into each choice point and come up with a bunch of different variations."

With "Starfield," Bethesda took that approach a few steps further, going from single levels to entire planets. Discussing the team's use of PCG in an extended gameplay overview, Jean-Francois Levesque, lead technical producer on "Starfield," said it involves a foundation of PCG complimented by handcrafted elements like flora fauna, space pirate camps or caves.

"Our system builds a planet as the player approaches it, and we stitch together a block of terrain," Levesque said. "After that, we have a system that adds interesting locations for the player to explore, creatures to encounter or plants to pick up. It allows us to add that touch of environmental storytelling that Bethesda is known for."

Howard has stressed that "Starfield" also has more handcrafted content than any other game the studio has put out so far, including massive cities and more than 200,000 lines of dialog.

Martens says Bethesda could have used something called a noise algorithm, "a fancy way of making things look really random in a controlled way," to generate the foundations of its planetary surfaces. Some noise algorithms even borrow ideas from how natural processes work to craft virtual spaces.

"A lot of terrain generation algorithms work by simulating erosion," Martens says. "[Designers will] say, "Let's first make a bunch of hills and valleys, and we'll make that appear more natural by then simulating the process of erosion that would add variation and smooth things out.'"

After creating an array of spheres and the planetary paint jobs, Bethesda could then add further layers of procedural generation to create countless

combinations of weather, gravity and lifeforms for each planet.

"If [a planet] has crazy weather, you can add a bunch of water and you can slowly add all these things on, which is usually how you have to do it where you start with something very simple and then you add things on to make it more and more complex," says Colan Biemer, a doctoral student at Northeastern whose research focuses on AI and PCG. "It's like a multi-tiered generation system."

PCG can seem like a massive boon for game designers, especially those on smaller teams that don't have the resources a major studio like Bethesda has. But Martens says there are definitely tradeoffs that "Starfield" may have to contend with.

"[Developers] can spend all this time tinkering with making the perfect procedural generation algorithm and it turns out it makes things a little bit awkward because they're not necessarily considering the sorts of design choices a designer would make—and players can tell," Martens says. "Players respond to that by saying, 'You're just trying to cut corners here and not give me a real custom, handcrafted experience.'"

If used with purpose, PCG can create replayability and the potential for spontaneous, emergent opportunities for players. But developers also run the risk of what is called the 10,000 Bowls of Oatmeal Problem, where every level or planet looks vaguely the same but with slight differences.

According to Biemer, some developers also tend to think that PCG will save time and effort, but it can create more design challenges than solutions.

"Right now, I could generate a million Mario levels … but the fact is there's no guarantee that those levels would be fun," Biemer says. "The problem with PCG is that, yes, you can make a million things, but the

question has never been 'What can we make?' It's a question of 'Can we make something people actually want to play?'"

Whether "Starfield" will be the intergalactic home run Bethesda—and parent company Microsoft—hopes it can be or if the game crashes after takeoff will be decided when players finally get their hands on it.

"You want to make sure that's actually giving the players a better experience than if you did spend the resources to do it by hand," Martens says.

Provided by Northeastern University

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