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A close-up, profile view of a woman wearing a clear space helmet. She is looking out of the helmet towards the left, where a bright, curved horizon of Earth is visible against the blackness of space. The woman's face is partially illuminated, showing her eyes and nose. The helmet has some mechanical details and a chin strap visible.

Extra- Vehicular Activity

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BY JOE FORDHAM

The plot of *Gravity* was sparse. The space thriller — co-written by filmmaker Alfonso Cuarón and his son, screenwriter Jonás Cuarón — began 400 miles above Earth, with NASA mission specialist Dr. Ryan Stone (Sandra Bullock) and mission commander Matt Kowalski (George Clooney) performing maintenance on the Hubble Space Telescope from the space shuttle *Explorer*. A shower of satellite debris shatters the orbiter and kills all other crewmembers. With the next debris orbit imminent, Kowalski and Stone use their dwindling resources to strike out for refuge on the International Space Station, seeking their only hope for a safe passage home.

The film was a conceptual departure from most space film classics, and was single-minded in its focus, with its protagonist — Stone — in almost every shot. “*Gravity* isn’t sci-fi,” declared the film’s visual effects supervisor Tim Webber, “and it’s not a space fantasy. It’s set a few years into the future, but it features contemporary space technology with a few minor changes. Alfonso wanted it to feel at all times like real space. Our first concern was how to deal with zero gravity because more than half the film was located with the characters out in space. The second challenge was re-creating a realistic space

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environment. Our third challenge amplified both those factors in a colossal way — and that was Alfonso's style of shooting extended takes."

Cuarón and director of photography Emmanuel 'Chivo' Lubezki reunited with London's Framestore, with whom they had created long, fluid takes on their previous film, *Children of Men* — but transposing the technique to Earth orbit imposed new complexities. "Shooting long takes made it impossible to use many of the tools that filmmakers have used previously to simulate zero-g," said Webber. "Whatever tricks that were possible in a five-second shot simply were not possible in a shot that began extremely wide, moved to a mid-shot, pushed in for a closeup, panned to a closeup of another actor, and then swung behind that actor, who was upside down." Lengthy takes, however, served an important narrative purpose. "We were not trying to emulate a documentary. The moving camera created the feeling of sustained physical reality, a feeling of being there. Alfonso wasn't interested in creating the longest shot just for the sake of it. In fact, he initially planned the first shot of the movie to last 20 minutes but, during previsualization, he realized there was a natural break at the 13-minute mark; and so, we cut there and followed that with a six-minute shot. That was still pretty long, but it was right for the movie."

Previous realistic space epics served as topics of discussion, including Stanley Kubrick's *2001: A Space Odyssey*, which remained a benchmark with its use of gimbal sets and wire work, and Ron Howard's *Apollo 13*, which featured moments of real weightlessness filmed inside an aircraft performing parabolic dives. "I went up in a zero-g Vomit Comet," recalled Webber. "Early on, we were hoping we would find a way to use that to shoot our actors in some way. We did 42 dives, and it was useful to experience — I did



not throw up — but it wasn't practical for our needs. It was not controllable, and moments of weightlessness were relatively brief."

The production explored ground-based mechanical zero gravity rigs with Neil Corbould Special Effects Limited at Longcross Studios. "We spent about eight months testing on a shoestring budget," recalled special effects supervisor Neil Corbould. "We used stock equipment and shot tests on videotape. We dissected the movie and figured out with Alfonso where we could use some of those techniques. From that, we came up with a list of specific gags. But it left a lot of holes where we had to design new rigs."

To analyze techniques for integrating live-action performances with visual effects, Cuarón developed previsualizations at Framestore. "We wanted to allow as much flexibility for performances as possible," noted Tim Webber. "We planned to use motion control selectively because we wanted to allow the actors to be spontaneous. If they made changes while working through the scenes on set, we wanted to accommodate those adjustments. In shots that required motion control, we still needed the ability to change speed and timings live during the take, taking the lead from the performances. That was tricky because we were using motion control to not only move the camera, but also to move lights, set pieces and effects rigs. We spent a long time choreographing elements, working out the physicality of the zero-gravity environment of space."

Mechanical requirements of lengthy camera moves were too complex to shoot by maneuvering space-suited performers around greenscreen set pieces. "Instead, we decided that whenever characters were out in space we'd just shoot actors' faces," explained Webber. "For scenes inside spacecraft, we planned to shoot the full performer. The rest



was computer generated. The rule was wherever we'd see flesh, it would be real; everything else would be CG — although sometimes when we saw flesh, that was CG, as well."

While investigating techniques for shooting zero-gravity performances, executive producer Christopher deFaria — executive vice president of digital production and animation at Warner Bros. Pictures — discovered a 2010 issue of *Wired* magazine, which contained a story that profiled Bot & Dolly, a San Francisco company that had adapted car-assembly robots as dexterous camera platforms. "Chris called to ask if the article was true," recalled Bot & Dolly executive producer Julia Gottlieb. "He asked if the robots in the story were just props in the background of the shot. I assured him that our technology was real, and he introduced us to visual effects supervisor Chris Watts, who was researching the project at the time."

Bot & Dolly staged a proof-of-concept test using a robotic camera to orbit a female stand-in, while another robot moved in synchrony, wielding a light source. The results gave the filmmakers the confidence to use Bot & Dolly's control systems and a robotic camera platform, known as IRIS, to choreograph a complex ballet of motion control systems. "One of our primary innovations was that our system cut out the middleware between the previs world and motion control," explained Bot & Dolly technical director Tarik Abdel-Gawad. "We planned all our robot motion paths in Maya. That was instrumental in enabling us to get Framestore and its legion of animators working with our robots. Framestore's work directly led to camera movement on set." The IRIS was capable of extending 3.5 meters vertically and 3.1 meters horizontally, performing precision

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