



A lot has already been written about the relationship between dreams and movies in *Inception*. At its core, though, it's really about the all-consuming struggle to create an original work. So imagine [Double Negative's](#) challenge in trying to help visualize multiple dream states from director Chris Nolan's furtive imagination all interacting together.

It all began with architecture. "Whether it's through the manipulation of structures to show the power of the dreamers, as in the folding streets of Paris, or in the crumbling towers of Limbo, which symbolize the advancing collapse of Cobb's mental state [played by Leonardo DiCaprio], the design of the built environment is always significant," explains [Paul Franklin](#), the overall visual effects supervisor, who collaborated with Dneg's Pete Bebb, the CG supervisor, and Andy Lockley, the 2D supervisor, among others.

Production Designer Guy Dyas and his art department team gathered an extensive library of architectural reference, which the vfx team then built upon through post-production to develop a strong language of structure and style that drew heavily upon the history of modern architecture throughout the 20th century, especially for the climactic scenes in Limbo.

"In terms of the way that the dream worlds were depicted cinematically, the aim was to present everything with the conviction of total reality, as it was essential to the plot that the dreams appear real to the people experiencing them," Franklin continues. "The visual effects of *Inception* needed to integrate seamlessly with Wally Pfister's stunning cinematography which -- for the most part -- was hand-held in full daylight, giving it an immediacy that placed extraordinary demands on the vfx pipeline and the team at Double Negative.

"With the Paris sequences, Guy Dyas and his team had already produced some early concept images of how the folded streets would look when completed, but there was no indication of how we might go from normality to the 'cube city.' One of the great things about *Inception* was that it was the third time around for me on a Chris Nolan film, so I was able to draw on things that we had both experienced whilst working on the *Batman* films: We talked about watching the draw bridges over the Chicago River being raised, which include sidewalks and lamp posts as well as the road surface and how, from certain viewpoints, it looked as if the street itself were lifting up on a giant hinge. This then became the basis for the design of the folding street, hidden mechanisms suggesting a logical underpinning to Ariadne's dream world [played by Ellen Page]. Dneg CG Supervisor Ali Wortman created a previs animation of the folding street, which Chris then used to cue DiCaprio and Page as they stood on the Paris location -- Chris holding my laptop in his hands and directing the actors to look at the imaginary streets as they arced overhead."

According to Franklin, the design for the subsequent dream states came primarily from the locations and art departments (under Nolan's guidance), with the exception of Limbo City. During pre-production both the art department and vfx worked on concept designs for Limbo City, devoting particular attention to the collapsing shoreline, but nothing clicked for Nolan, who was in search of something truly original and spectacular.

"We discussed the idea of Limbo having started out as an idealistic modernist city that collapses back into the sea of Cobb's subconscious," Franklin explains. "Chris wanted the decaying buildings to take on the aspect of a glacial cliff face with the buildings shearing away like calving icebergs. Whilst being extremely evocative in description, it was rather harder to pin down pictorially so instead of tackling it head-on I decided to see if we could 'find' the city through the process that I had developed as an art student back in my college days.

"We started with the basic concepts: a city of modern buildings and a glacier. Senior CG artist Nicola Hoyle took a simple polygonal model of the glacier, built from photographic reference, and developed a [Maya](#)-based space-filling routine that populated the interior with basic architectural blocks with the height of each block being determined by the elevation of the glacier at that point. She then began to



develop a series of increasingly complex rules that added street divisions or varied the scale of the buildings or added damage, all determined by samples taken from the glacial model. After each new rule was added we reviewed the resulting structure and then refined the process. Once we had reached a certain level of complexity, Gurel Mehmet, Dneg's vfx art director, developed a series of paintings from the CG renders provided by Nicola and these then fed back into the development of the rules. In this way, we arrived at a city layout that had familiar features such as squares, streets and intersections, but which also had a totally unique structure that felt more like a natural landform -- a cliff being washed into the waves with architectural 'icebergs' floating out to sea. Vfx animators Kai Stavginski and Danielle Brookes then used *Houdini* to create the collapsing architecture, which was primarily referenced from natural history footage of glaciers rather than from building demolitions, adding giant splashes with Dneg's proprietary Squirt fluids system. The hero shot from the sequence, featured in many of the online trailers, was developed from a helicopter plate that we shot with the *Inception* aerial unit in Morocco -- that's actually Leo and Ellen walking through the waves. The final look of the city shoreline was created by Lighting Supervisor Bruno Baron and his team using lots of reference of derelict housing developments as well as bomb damaged buildings in Iraq and other war zones."

The 500 shot-count was spread across 30 different sequences woven throughout the film, all with their own unique demands. As with *Batman Begins* and *The Dark Knight*, the role of vfx was to support and enhance the narrative. Still, Nolan wanted the film to be extraordinary and to offer startling and arresting visual concepts. "In many respects, the vfx has ended up much more to the fore than in the *Batman* films, mainly through necessity as the surreal nature of some of the images could only be achieved through a vfx approach," Franklin contends.

Nolan views previs as a conceptual design tool, using it to develop ideas for specific moments such as the hall of mirrors effect on a Paris bridge or the pyrotechnic destruction of the Fortress base. "As with his previous films, Chris got as much in camera as possible and previs became extremely important in technically demanding moments like the Penrose steps: the impossible, 'endless staircase' made famous in the drawings of M.C. Escher," Franklin relates. "For the high angle shot of the looping staircase and the subsequent reveal of the forced-perspective trick, the camera had to be placed in precisely the right position above a carefully designed set. We carefully mapped the distortion patterns of all of the camera department's lenses and the Aleks Pejic team used them to work out the exact shape and dimensions of the set and what kind of shot would be achievable within the limitations of the location and the available camera setup. The camera, mounted on a 50-foot telescopic crane, had to swing down through a 45-foot arc. At the apex of the move, it had no more than two inches of clearance with the ceiling, so Dneg's previs had to be spot on.

"There was no formal postvis period: instead postvis became a continual part of shot development, running pretty much all the way up to final delivery in May. One of the great advantages of having such close contact with Chris was that we could move rapidly from discussing an idea to working up a shot concept on an HD QuickTime supplied from editorial without a lot of debate and negotiation. Sometimes Chris would request specific things and on other occasions I'd get the Dneg team to develop a quick shot idea and offer it up to Chris. The speed at which we were able to work meant that we were still in a position to develop new shots and deliver them on time with only a few days to go before final delivery -- a good example of this is the shot of the skyscraper being torn apart by the winds in Limbo at the end of the film, which went from concept to film-out in nine days!"

Aside from the development of the Limbo City shoreline procedural layout system, a key area of CG R&D was in lighting and rendering. But *Inception* required an even higher level of realism than Dneg has achieved with Gotham City or the magical worlds of *Harry Potter*. That's because all the environments are seen in broad daylight. Lead by CG Supervisor Philippe Leprince, the Dneg team raised the bar for photorealistic architectural lighting, and recent advances in fluid dynamics and rigid body animation were brought together in the scenes of destruction and disintegrating reality.



Early on, Ariadne is taken into a dream world version of Paris by Cobb. When she realizes that she is actually dreaming, she panics and the fabric of the dream starts to unravel, disintegrating violently and flying apart in all directions. Special Effects Supervisor Chris Corbould created a series of in-camera explosions using air mortars to blast light weight debris into the Paris street location. Pfister used a combination of high-speed film and digital cameras to capture the blasts at anything up to 1,000 frames-per-second, which had the effect of making the turbulent debris look like it was suspended in zero gravity, giving the impression that the very physics of the dream world was failing.

Starting with a rough cut of the live action, Dneg Vfx Animation lead May Leung used the in-house Dynamite dynamics toolset to extend the destruction to encompass the whole street. Compositing lead Jan Maroske and his team retimed the high-speed photography to create speed ramps so that all explosive events started in realtime before ramping down to slow motion, which further extended the idea of abnormal physics. As the destruction becomes more widespread, the team added secondary interaction within the dense clouds of debris to sell the idea of everything being suspended in a strange weightless fluid medium.

Returning to the Paris environment, Ariadne demonstrates her newfound ability to control the dream world by folding the streets in on themselves to form a giant "cube city." The Dneg vfx team, lead by CG Supervisor Dan Neal, spent a week documenting the Paris location where main unit was scheduled to shoot. Lidar VFX Services scanned all of the buildings and then delivered highly detailed data from which Dneg built a series of Parisian apartment blocks. It wasn't possible to get above the buildings, so Dneg artist Lee Tibbets sourced photographs of typical Paris rooftops to fill in the missing areas. CG Supervisor Philippe Leprince implemented the new ptex texture mapping techniques in Dneg's RenderMan shaders to allow the CG team to avoid the laborious UV coordinate mapping that is usually associated with models of this type. The final folded streets featured fully animated cars and people; anything that's not on the flat in the final images is CG. Ariadne then continues her exploration of the limits of the dream world by creating a bridge out of the echoing reflections between two huge mirrors.

"I got together with Corbould, who got his team to build an 8-foot x16-foot mirror that could be swung shut on a hinge, effectively forming a huge reflecting door," Franklin recalls. "Lead Compositor Graham Page and his team set about removing the support rig and crew reflections, adding in the infinite secondary reflections as well as the surrounding environment. I'm particularly fond of that sequence because, aside from being a bravura piece of complex compositing and CG environment work, it is so subtle that you're not really sure if anything is really happening until the end of the sequence, when you realize that everything you've been watching has been totally manipulated as part of an ingenious optical illusion."

Arthur (played by Joseph Gordon-Levitt), is thrown into a weightless environment by the freefall of a van in a previous dream state. He must negotiate the labyrinthine corridors of the hotel dream level as if it were now in deep space, rotating 360 degrees (recalling both *2001* and *Royal Wedding*). He gathers the dreamers together and bundles them into the elevator, his plan being to wake them by accelerating the elevator along its shaft with explosives.

"Weightlessness was achieved through a clever combination of actors on wire rigs in a vertical hotel corridor set and a hand-operated seesaw rig on a horizontal version of the same rig," Franklin continues. "Joseph Gordon-Levitt trained intensively with Tom Struthers' stunt team for weeks with the result that he appears as himself in the vast majority of the finished shots. Double Negative 2D lead Astrid Busser-Casas and her team removed all of the wires and rigs, carefully rebuilding the sets where necessary. Costume Designer Jeffrey Kurland came up with fantastically stylish outfits that were also vfx friendly, adding little touches like stiffened shoelaces that didn't flop about giving away the direction of the vertical. One particularly demanding shot, which shows Arthur wrapping the dreamers in cable in preparation for their journey to the elevator, was shot in the hotel room set turned on its side. Numerous wires ran across the



stunt actors' faces and CG lead Stuart Farley created digital doubles of Cillian Murphy and Ken Watanabe to hide the fact that the actors themselves weren't in the rigs.

"The elevator shaft was built as a horizontal set inside the vast Cardington hangar outside of London... Joe was suspended on a mobile crane rig, which ran on the same rails as the elevator, and Double Negative added flailing elevator cables and pyro hits to the scene where Arthur blows out the elevator's emergency brakes. Corbould's team rigged the elevator to blast along the rails, propelled by a compressed nitrogen cannon. During post, Chris Nolan decided that the shots looked more effective when turned on their side, so Dneg CG lead Alex Pejic created a detailed model of the elevator shaft to extend the set, filling in the gaps left by rotating the image 90 degrees."

For the snowy action sequence, Dyas' art department built a Fortress set in the mountains of Kananaskis County in Canada. CG lead Vanessa Boyce and 2D Sequence Supervisor Richard Reed created seamless digital extensions of the practical set as well as a fully CG version of the whole base for use in wide establishes. New Deal Studios provided a highly detailed miniature (supervised by Ian Hunter) and a pyrotechnic destruction that complemented the full scale demolition provided on location by Corbould's team. Numerous digital enhancements were added to the destruction, including extra debris, dust and collapsing tower structures. Both miniature and digital models derived their textures and details from the full-size set with a great level of integration being achieved as a result.

Later, as Cobb and Ariadne advance in Limbo City, they pass through a canyon-like street that was based on an actual housing estate in Morocco that resembled Bauhaus-style architecture. Dneg CG artists lead by CG Supervisor Alison Wortman and CG lead Becky Graham provided detailed building extensions and the vfx animation team added wind-blown clouds of debris to the streets. Deeper into Limbo, the narrow streets give way to open squares with colossal towers marching to the horizon. CG Supervisor Phil Johnson developed the structures from composites of un-built Utopian high rise developments designed by Walter Gropius (designer of the original Bauhaus), Mies van der Rohe and Le Corbusier.

"*Inception* raises the bar in a number of areas," Franklin concludes, "especially in photorealistic daytime environments and complex dynamics work. For me, it also marked a new level of interaction with the filmmakers where I was able to talk directly with Chris and the other department heads, which made a huge difference to the end result. From the point of view of Double Negative, I think *Inception* is the latest example of a developing trend in which filmmakers are approaching vfx studios directly to handle shows in their entirety rather than appoint an independent supervisor and break the work up across several vendors, which results in a far greater degree of integration between the vendor and the production than is possible with the old model. I think the results speak for themselves."