

# Blending In - The Crowds of *Spies In Disguise*

Mason Evans  
masone@blueskystudios.com  
Blue Sky Studios

Cole Clark  
colec@blueskystudios.com  
Blue Sky Studios

Erin Elliot  
erine@blueskystudios.com  
Blue Sky Studios

Will Moten  
willmoten@blueskystudios.com  
Blue Sky Studios



Figure 1: The varied crowds of *Spies in Disguise*  
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## ABSTRACT

*Spies in Disguise* was the largest and most challenging show the Blue Sky Studios Crowds Team has delivered to date. Crowds were used in 449 of the film’s shots, necessitating a scalable pipeline that could handle a wide variety of crowd characters and performances. From supermassive pigeon flocks to drone swarms, tightly choreographed rings of henchmen to naturalistic groups of pedestrians across multiple cities around the globe, more crowd simulations had to be delivered with greater finesse and artistic fidelity than ever before.

### ACM Reference Format:

Mason Evans, Erin Elliot, Cole Clark, and Will Moten. 2020. Blending In - The Crowds of *Spies In Disguise*. In *Special Interest Group on Computer Graphics and Interactive Techniques Conference Talks (SIGGRAPH '20 Talks)*, August 17, 2020. ACM, New York, NY, USA, 2 pages. <https://doi.org/10.1145/3388767.3407322>

## 1 VARIETY IS THE SPICE OF LIFE

Because of its globe trotting heroes, this film needed a broader variety of background characters than our previous film’s tools and workflows could handle.

### 1.1 Redefining Character Variation

On prior shows, crowd variations were rigidly defined by what clothing, hair, and material combinations were built at the beginning of production, so if the director wanted a change in the style

of a character’s shirt in a given shot, the entire character had to be replaced with one wearing the desired top. For this film, we redefined a variation as a set of instructions that turned on specific garment and hair combinations on what we called an “uber-rig,” which was a character wearing every possible garment with every possible hair-style attached to it. This opened the door for thousands of permutations of character variation. It also brought a new challenge: managing thousands of characters across multiple shots. To solve this, we created a character database that crowd artists used to search variations by body type, film location, and more. The artists could then browse images of the search results and add the characters to their scene.

### 1.2 Retargeting

The Crowds Team worked with the Character Team to ensure that all background characters shared a mesh topology and skeletal rig, so that animation could be retargeted from one character to all background characters. Using the Human-IK tools that shipped with Maya quickly proved insufficient because of the stylized character movement that this film required. The system struggled to handle limbs that changed their length, and fixing retargeted animation became an untenable task. Instead of a joint retargeting system we developed a rig *control* retargeting system. Animation on a single body type could easily and more accurately be propagated onto multiple character types, and if a retargeted animation needed adjustment, the artist had the full character rig at their disposal.

## 2 CROWDING THE CAMERA

The next step was to rework the Houdini-based shot pipeline to make it easier for artists to direct and refine the animation of individual characters. Houdini’s native crowd tools lend themselves well to the procedural placement of many characters in the mid-to-background of a shot. On *Spies in Disguise*, however, the crowds

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*SIGGRAPH '20 Talks, August 17, 2020, Virtual Event, USA*  
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ACM ISBN 978-1-4503-7971-7/20/08.  
<https://doi.org/10.1145/3388767.3407322>

often required precise placements in the foreground, very close to camera, next to their hero-animated counterparts. With characters this “visible,” every detail relating to the exact motion and casting of the characters, from their root transforms, speeds, transition frames, identities, clothing, and cycles, had to be carefully curated before (and sometimes after) simulation.

## 2.1 CC Place

To meet this need, the team developed *CC Place*, an ecosystem of Houdini Digital Assets, shelf scripts, and tool conventions dedicated to the placement and manipulation of crowd agents. Used in over 60% of the film’s crowd shots, *CC Place* split the difference between proceduralism and hand-keyed animation. Artists were able to manipulate agents, including choosing their appearance, cycle animations, and timings, all from Houdini’s viewport. Additionally, geometry generated from *CC Place* was ID safe, meaning manual hand-keyed edits to agents could be safely added to dozens of characters per shot. *CC Place* setups were easy to deploy to different shots, and they allowed the team to create more advanced tools that could ingest the *CC Place* geometry in complicated ways by leveraging its ability to add user-defined data.

Some shots took *CC Place* to the extreme. The thousands of pigeons that populate Piazza San Marco used *CC Place* data to generate procedural curves that could animate the birds taking off and landing, with the ability to tweak their flight paths individually. The film’s ragdoll simulations of collapsing drones relied on *CC Place* for timing their physical properties and applying unique forces to each character to perform in a way that matched the exaggerated style of the film. The thousands of drones that swarm Washington, D.C. were placed in formations that used *CC Place* data to determine their sizes and compositions. Crowds work on the sequences where Lance triumphantly enters and subsequently flees The Agency was actually begun before *CC Place* was developed and it suffered from the lack of precision available in the native Houdini crowds tools, resulting in some very stilted crowd behaviors. Adopting *CC Place* allowed the artists to craft performances out of the available cycles, enabling the team to seamlessly choreograph the crowds with the fast-paced action of the hero-animated characters and cameras. Overall, *CC Place* streamlined the shot workflow, allowing artists to turn simpler shots around in a day instead of three.

## 3 CROWDS AS WEATHER

For multiple shots in *Spies in Disguise*, the directors wanted the Crowds Team to create simulations that provided more than background noise—they wanted crowds to characterize and convey key story moments. We were tasked with creating not one but two tornado-based crowds, each requiring new simulation and procedural work flows.

### 3.1 Bird-nado

The sequence in Piazza San Marco culminated in over a thousand pigeons swarming the film’s villain, Killian, in a funnel cloud of feathers. The challenge was creating a graphic tornado-cone shape comprised of birds flying in a way that looked believable. To this end, we programmed the birds to follow multiple tornado-shaped meshes that we animated using Houdini’s procedural geometry

capabilities, which gave us control of the funnel cloud shape. To add hundreds of birds joining the funnel cloud, we prototyped a curve based flight system for animating crowd characters through space without requiring simulation, which gave us precise control of their timing and allowed predictable editing of flight paths. This technique was so beneficial that the tool was promoted for use across production. Finally, we grounded Bird-nado with a large group of pigeons pecking and scratching the ground before ultimately taking off to mimic the churning dust cloud of debris that forms at the base of a tornado.

### 3.2 Drone-nado

In the film’s third act, the directors wanted to give Killian a drone-nado controlled by his robotic arm. We started by scaling up Killian’s animated claw then scattered several hundred drones within the resulting volume. We created their flight trajectories by using a DOP network to smoothly blend between their starting claw formation and several spiraling tornado paths. These paths could be fed into our procedural flight path tool developed for Bird-nado, creating a controllable system that allowed us to iterate on director notes in a matter of hours and provide wedge tests quickly.

### 3.3 It’s Raining Drones

The drone attack sequence at the climax of the film challenged the crowds rendering pipeline like never before. With the largest shots exceeding seventeen thousand agents, early render tests in the studio’s proprietary renderer exceeded one thousand hours per shot. Late in production, the decision was made to render the drones in exterior shots in a separate ad hoc Mantra-based rendering pipeline. Because Mantra was not known by most artists at the studio, the Crowds Team rebuilt the drone render asset from scratch with Houdini materials, shaders, and light instance rigs. A small Mantra task force between the Crowds, FX, Compositing, and Stereo Departments was created to render and troubleshoot the issues with the ad hoc pipeline. In the end, the Crowds Department rendered nineteen crowd shots in this Mantra-based pipeline, with much time and money saved.

## 4 GOING FORWARD

Building on the lessons learned from *Spies in Disguise*, the Blue Sky Studios Crowds Department is continuing to develop its pipeline to bring its artistry and storytelling abilities to new heights. Since *CC Place* has established itself as a major toolset for the team, it is being re-engineered in C++, providing performance gains averaging from five to twenty times the speed of the original version and allowing for the development of new procedural tools designed to maximize their interoperability with *CC Place*. As the team strives to blur the line between crowds and hero animation, new tools are in development to allow for hero rig promotion and secondary simulations (i.e. cloth and fur) on crowds characters. As Blue Sky Studios transitions to a USD-based pipeline, the uber rig concept translates nicely to USD variant sets, freeing us to push crowds technology into new arenas. Going forward, all of these innovations and more will enable the team to improve the art directability of the crowd systems and create the highest quality (and coolest looking) crowds possible.