(from The New York Times…)

Eitan Grinspun, the director of Columbia University's Computer Graphics Group, doesn't quite qualify as hairdresser to the stars. But if you want computer-generated hair (or fur) to look convincingly real when it is twisted, clumped, matted, coiled, soaked, dusty, wind swept, singed — or just about anything else a film director could possibly think to do to it — then Mr. Grinspun is the man to consult.

Walt Disney Pictures

Among the film projects the Columbia group has helped with is "Tangled," Disney's recent adaptation of the Rapunzel story.

From a spacious office and workroom on the 10th floor of Columbia's Schapiro Center in Morningside Heights, Mr. Grinspun and his team of graduate students have helped scientists from Walt Disney Studios, Pixar, Weta Digital and Adobe Systems solve their toughest C.G.I. problems, whether recreating the dab of a bristled paintbrush or getting Rapunzel's hair in the Disney film "Tangled" to float in an underwater cave.

"There's not a huge number of people who can do this," said Alasdair Coull, head of Weta Digital's software development team. "We're essentially looking for the best in the world." Weta has joined with a handful of universities, including a half-dozen or so in California, on C.G.I. — computer-generated imagery — and related projects.

Mr. Coull, who traveled from Wellington, New Zealand, last year to spend a month at Columbia, contacted Mr. Grinspun after reading about his inventions in hair simulation and fur grooming. Let's just say it is no coincidence that Weta ("Avatar," "The Lord of the Rings") is creating the computer-generated brainy apes who take over the world in "Rise of the Apes," the back story to the classic 1968 movie "Planet of the Apes," due to be released in 2011, as well as working on Steven Spielberg's forthcoming version of the adventures of Tintin and his dog, Snowy. On this gray morning, however, Mr. Grinspun, 34, is putting out coffee and pastries for a meeting with Rasmus Tamstorf, a senior research scientist for Disney. As Mr. Grinspun scurries around in his stocking feet, his frame tall and lanky, with a curly mop of dark hair and large eyes that droop at the outer corners, it is easy to imagine him as an animated character: sweet-natured and a little goofy, but whip smart.

What distinguishes his work from that of other computer scientists is that he creates not only beautiful pictures but also beautiful mathematics.

Mr. Grinspun turns on one of the half-dozen or so computer screens in his office to show off the lifelike strands of animated hair that his lab helped create and stares lovingly at the screen. “The mathematics behind this is really gorgeous,” he says.

Mr. Tamstorf uses another word —“principled” — to describe the Columbia group’s approach to problem solving.

What he and others mean when they refer to work as “principled” or “beautiful” is that the images on screen are not the result of a patchwork of technical tricks, but of precise mathematical equations based on the way the world actually looks and operates — in a word, physics. They use what is known as discrete differential geometry, a field so new that the first textbook on the subject was published only two years ago.

“We find equations that describe lots of different kinds of physical systems,” Mr. Grinspun explained, “the shape of a cable on a bridge, a spinning top, cilia.” He started pumping a large, colorful top that he keeps on his desk to illustrate. Those equations are then used to create a violent splash of waves or the layered folds of a skirt.

Predicting and controlling flexible materials and collisions, however, is tricky. Very tricky. With hair, for example, you need to take into account how every one of the 150,000 or so strands on a head interacts with the other strands, gravity, friction, air and so on. Imagine trying to come up with a couple of equations for that.

In general the process of animation involves painstaking trial and error that Mr. Tamstorf at Disney compared to “operating blindfolded.” The animators may get some of it right, but not all of it: a patch of scalp peeks out while a character is running, or a shirt keeps inching up a character’s belly even after he has stopped moving. Sometimes the studio is forced to resort to “brute force” to achieve a desired effect, he said, which could mean calling in Disney’s army of artists to paint over every single image in the film to satisfy the director.

As long as it looked good on the big screen, though, no one cared much how a result was achieved. It was like patching a leaky roof by nailing on a wooden panel, tying down a tarp, taping over a crack, sticking an umbrella in a hole. As long as it kept the water out, no one complained.

“That’s not our philosophy,” Mr. Grinspun said. “We said, ‘Let’s show the world you can have mathematically principled approaches.’ ”

Mr. Grinspun’s crucial idea was to throw out the jury-rigged models instead of trying to improve upon them, as Apple did with its operating system when it abandoned DOS and command prompts. “The programming had to be rethought from the ground up,” he said. Instead of trying to force a system that was designed to simulate straight hair to produce curly hair too, for instance, Mr. Grinspun created a more sophisticated system that could do both.

“We’re like psychoanalysts,” he added. “We try to find what the underlying problem is. You have problems with your mother? Let’s go back and look at your toilet training.”

The uses of discrete differential geometry go far beyond animation. Johns Hopkins Medical Center, for instance, is using Mr. Grinspun’s computer simulations to predict how needles

move through human flesh, so that doctors can train to do laparoscopic surgery on virtual bodies instead of the real thing.

The approach was alien to most animators, though, and initially greeted with skepticism. “It was controversial at first,” Mr. Grinspun said, “but the strategy has paid off in the long run.” It significantly cut down the time it took to produce what the director wanted, to minutes from days, and provided better results. “You get more bang for the buck,” Mr. Grinspun said.

Disney did not work much with academics before Mr. Tamstorf’s partnership with Mr. Grinspun began about five years ago. Since then the company has looked more to universities. After Disney acquired Pixar in 2006, it ramped up its academic connections and in 2008 opened two collaborative labs on university campuses, one at Carnegie Mellon in Pittsburgh and the other at the Swiss Federal Institute of Technology in Zurich.

Mr. Grinspun generally does not sell or license the programming that comes out of his lab. Graduate students get to be interns for three or four months at places like Disney and Weta, where they gain valuable experience, and the team gets unusual and interesting problems to work on.

At the recent meeting Mr. Grinspun asked Mr. Tamstorf to list the technical conundrums he would like the lab to work on. “One of the areas where our current systems are far behind where they need to be is that garments don’t come to rest where they should,” Mr. Tamstorf said. “The character has stopped, but his shirt keeps crawling, crawling, crawling.”

Mr. Grinspun chimed in, “It’s the inability of simulations to stay still.”

Another persistent problem is having certain types of materials keep their general shape even when they’re moved or pushed. In “Tangled” keeping Rapunzel’s puffed sleeves puffed was an impossible task. (Artists ultimately had to draw in the puffs.) “We need better bending models or control,” Mr. Tamstorf said, so that the shape remains stiff but the fabric looks soft.

Mr. Grinspun enjoys working with studios, but he is not tempted to work for one full time, he said. At heart he is an academic. He does like contributing to the artistic enterprise, however.

As he sees it, his work frees the artists from worrying about a puffed sleeve so they can focus on what they do best, like capturing expressive emotion. His reward is different: “As long as you make pretty pictures, you get to keep learning all this math and physics.”