



Rockmore thinks computers can authenticate art better than any connoisseur can.

# THE REMBRANDT CODE

**Identifying true old masters – and spotting the fakes – is a rarefied art. Dan Rockmore wants to make it a science.**

by Bijal P. Trivedi

photographs by Richard Ballard



In a photography studio nestled in the high attic of New York's Metropolitan Museum of Art, mathematician Dan Rockmore stands in front of *Flora*, rocking back and forth on his heels like a shy schoolboy. He leans close to the figure on the canvas to peer at her face. Unshackled from her heavy wood gilt frame, the beautiful Roman goddess of spring and flowers appears vulnerable. "It's like seeing actors backstage at Broadway, without their makeup, drinking beers, and smoking cigarettes," Rockmore says quietly, as if the mere vibration of his voice could send the





350-year-old painting, worth about \$40 million, crashing to the floor.

*Flora* is one of 25 works attributed to Rembrandt van Rijn that are now under intense scrutiny. Some of these paintings have dubious origins; experts believe that others, like *Flora*, are bona fide Rembrandts. She, for example, shows telltale signs of the 17th-century Dutch master: the cascading brushstrokes that create the decadent, billowing folds of her sleeve, the horizontal flow of light pouring from her flower-filled apron, the oversize hand. But these characteristics are in the eye of the beholder, and Rockmore, a professor of computer science at Dartmouth College, wants to bring digital technology to the art of authentication. Using hi-res digital cameras and software that he wrote himself, Rockmore aims to examine the brushstrokes from *Flora* and 24 other works to reveal Rembrandt's unique mathematical fingerprint.

"The fact that you can put everything on the computer means that everything is numbers," Rockmore says. "As soon as everything is numbers, it makes perfect sense to ask mathematical questions about what the numbers represent." If he's right – if computers can distinguish between artists more accurately than connoisseurs can – the art world is in for some high-stakes corrections. Rockmore's scientific approach will boost the value of some collections by millions of dollars – while devastating others that are tainted by imitations and fakes.

**AUTHENTICITY IS A BUGABOO** that plagues the art world in general but Rembrandt collectors in particular. Over three decades, Rembrandt had about 40 pupils in his studio who emulated his style. Many of these often-anonymous student works fell into the hands of Amsterdam dealers who resold them as the real thing, occasionally augmenting them with Rembrandt's signature – forever muddying the task of attribution.

A hundred years ago, about 700 works were attributed to Rembrandt. That number has now dropped by more than half, due in large part to connoisseurs who have spent years identifying features and nuances that distinguish master from student. Lousy luck for the owners of the mislabeled works, this smaller supply means bigger bucks for the possessors of authentic masterpieces. Today there is at least an order

of magnitude difference in price between a Rembrandt and a creation by one of his pupils, says Anthony Crichton-Stuart, head of old master paintings at Christie's New York. For example, a "sublimely beautiful" painting by Rembrandt pupil Willem Drost sold for \$2.6 million in 1997. Three years later, Rembrandt's *Portrait of the Old Lady*, which the same critic dubbed merely "wonderful," fetched \$28.6 million.

The Met owns 42 paintings that were once believed to be Rembrandts, but the attribution of more than half of them is now in question. Only two have original documentation and a reliable paper trail tracing passage from the artist's hand through various collectors over the past 350 years.

In 1995 the museum took the debate public when it mounted the exhibition *Rembrandt/Not Rembrandt*. The show contrasted works considered to be genuine Rembrandts with those done by pupils and admirers painting in his style. Each attribution was accompanied by an explanation of how the connoisseurs made their call. The experts don't agree on a handful of works, and the debate rages on. Walter Liedtke, a curator in the Met's European painting department and an expert on Dutch and Flemish art, believes that 20 of his museum's Rembrandts are real and says that the world's top Rembrandt scholars would agree with almost all of his choices. "There's a border zone of about five or six paintings that would be debated and probably will be for generations," Liedtke says. "This is not a hard science."

Rockmore thinks it can be. His mathematical analysis of drawings by a Flemish Renaissance artist last year intrigued the art community and art collectors alike. Curators at the Met didn't really believe that his work could supplant theirs. But they were intrigued enough to invite him to examine the museum's Rembrandts.

**AS MATHEMATICIANS GO**, Rockmore is something of a celebrity. He defies the stereotype of a calculator-wielding, tweed-jacketed, sedentary academic holed up crunching numbers all day.

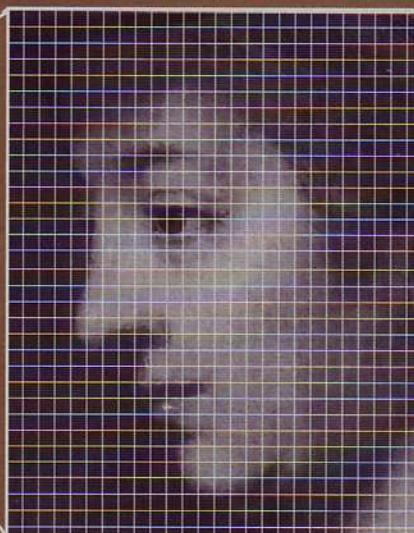
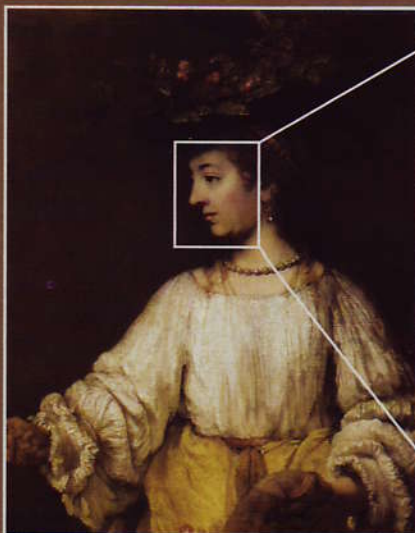
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## Is This Rembrandt Real?

1

### Digitize

Rockmore starts with a photograph taken with a Sinar 54 camera that spits out 20-megapixel images – about four times the resolution of a regular digital camera file.



2

### Analyze

Software converts the picture to grayscale and divides it into squares. The pixels in each square are coded with a number between 0 (black) and 255 (white) – everything in between is a shade of gray. It does this so that it can see the distinctions caused by brushstroke style, not by color.



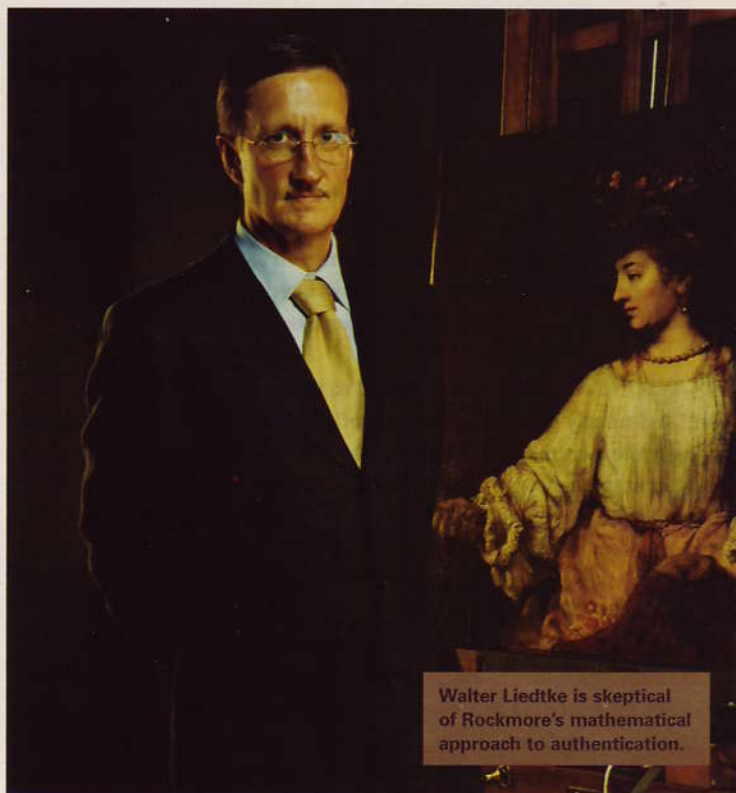
He's tan and lean. Laugh lines are etched deeply around his mouth. He's also busy. He spent last summer shooting math documentaries, puts a mathematical spin on everyday life for essays on Vermont's public radio station, and has written a book about Bernhard Riemann's 19th-century quest to discover the occurrence and distribution of prime numbers.

Rockmore comes to art more through theory than through the works themselves. He says he first connected to art when he read manifestos written by mid-20th-century abstract expressionists. "It might be total bullshit," he says of the artists' writing, "but somehow it resonates." The process of creating art especially fascinates him, and he points to an interview he read with the contemporary American artist Chuck Close. "He certainly talks like a mathematician. He talks about getting the materials down, working on a piece like trying to prove a theorem, and sometimes it's wrong, so he tosses it out and starts again."

Rockmore's casual interest in art became something more serious in 2001 when he met George Goldner, chair of the Met's department of drawings and prints, while the two were walking their dogs in Central Park. Goldner, in turn, led the professor to Nadine Orenstein, who curated a Met exhibition of drawings by 16th-century artist Pieter Bruegel the Elder.

At one point, Orenstein explained to Rockmore how she figured out which works were real. She described distinctive features like the density of lines, their orientation, and specific sorts of curves characteristic of Bruegel. Hearing this, Rockmore's mind jumped to the work of two colleagues at Dartmouth who had used statistics to distinguish between real and fake photos. The similarities between his colleagues' work and Orenstein's led Rockmore to wonder whether a computer could analyze the linear content of the drawings and reach the same conclusion as a connoisseur. He tested his hunch using eight genuine Bruegel drawings and five sketched by other artists of the day.

Rockmore begins his procedure by analyzing the digital image pixel by pixel and creating statistical summaries of each painting or drawing. These summaries capture what Rockmore calls the



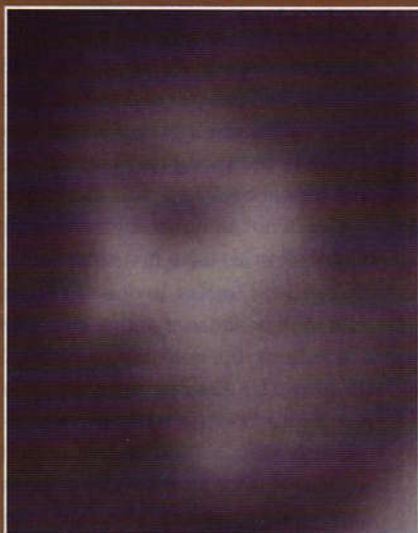
artist's mathematical signature, which in theory will be consistent from painting to painting. Just as everyone's handwriting is unique – with characteristic letter spacing, slant, and design – so is everyone's painting style, with characteristic brushstroke direction, thickness, and length.

At least that's what the software showed with the Bruegels. When the mathematical signatures of the 13 drawings were mapped, eight works clustered together – the same eight deemed by experts to be authentic Bruegels. The other five were scattered in space. The clarity of the results startled the art world, and holds out the promise that Rockmore will be able to work backward from his current analysis

### 3

#### Search

The software combs the image, identifying and stripping out the horizontal, vertical, and diagonal lines of the brushstrokes, searching for patterns that reveal the artist's style. With each pass, the software creates "a blurry version of the original," peeling away minute details and better exposing large-scale features. The computer does this five times, eventually gathering 72 pieces of data that statistically summarize each square.



### 4

#### Plot

Rockmore takes this data, which describes the brushstroke elements like slant and thickness, and reduces the information into a point on a 3-D grid. This point is compared to points generated by other paintings. Works by the same artist should cluster together. Rockmore might then work backward to determine what differentiates master from pupil.

