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In Archimedes' Puzzle, a New Eureka Moment

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A computer-enhanced image of a 1,000-year-old manuscript reveals the faint traces of a [copy](#) of Archimedes' Stomachion treatise. It had been overwritten by monks in the 13th century. (Rochester Institute of Technology, Johns Hopkins University/The Archimedes Palimpsest)

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Johan Ludvig Heiberg, a Danish scholar, found it in 1906, in the library of the Church of the Holy Sepulcher in Istanbul. He noticed faint tracings of mathematics under the prayers. Using a magnifying glass, he transcribed what he could and [photographed](#) about two-thirds of the pages. Then the document disappeared, lost along with other precious manuscripts in the strife between the Greeks and the Turks.

It reappeared in the 1970's, in the hands of a French family that had bought it in Istanbul in the early 20's and held it for five decades before trying to sell it. They had trouble finding a buyer, however, in [part](#) because there was some question of whether they legally owned it. But also, the manuscript looked terrible. It had been ravaged by mold in the years the family kept it, and it was ragged and ugly.

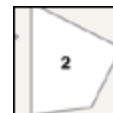
In 1998, an anonymous billionaire bought it for \$2 million

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and lent it to the Walters [Art](#) Museum in Baltimore, where it still resides.

"I should emphasize how incredibly uncommon the situation is," Dr. Netz said.

With the manuscript in hand, a small group of scholars set out to reconstruct the original Greek text. It was not easy. "You look with the naked eye and you see nothing, absolutely nothing," Dr. Netz said.

Ultraviolet light revealed faint traces of writing, but it included both the prayers and the mathematics. "The major problem is the combination of the fact that many characters are hidden with the fact that many are so faint that they are invisible," Dr. Netz said. Then there are the gaps where the pages were ripped or eaten away by mold.

Computer imaging helped. Dr. Roger Easton of the Rochester Institute of Technology, Dr. Keith Knox of the Boeing Corporation and Dr. William Christens-Barry of Johns Hopkins University managed to write programs to pick out writing from the "noise" around it, and in many places the Greek letters fairly pop off the computer screen.

"The product of the software is incredible," Dr. Netz said. But it too has limitations, especially near the tattered edges of the pages. To reconstruct the writings, Dr. Netz and Dr. Nigel Wilson, a classics professor at Oxford University, are using every tool available: ultraviolet light, the computer images, Mr. Heiberg's [photographs](#) and their own intimate knowledge of ancient Greek texts. Still, in some areas, "the text is likely to remain a conjecture," Dr. Netz said.

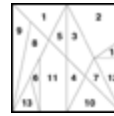
It was chance that led Dr. Netz to his first insight into the nature of the Stomachion. Last August, he says, just as he was about to [start](#) transcribing one of the manuscript pages, he got a gift in the mail, a blue cut-glass model of a Stomachion puzzle. It was made by a retired businessman from California who found Dr. Netz on the Internet as a renowned Archimedes scholar. Looking at the model, Dr. Netz realized that a diagram on the page he was transcribing was actually a rearrangement of the pieces of the Stomachion puzzle. Suddenly, he understood what Archimedes was getting at.

The diagram involved 14 pieces, and the word "multitude" seemed to be associated with it. Mr. Heiberg and those who followed him thought this meant that you could get many figures by rearranging the pieces.

"This is [part](#) of the reason people didn't see what it was about," Dr. Netz said. But the old interpretation seemed trivial, hardly worth Archimedes' time.

As he examined the manuscript pages, piecing together their text, he realized that what Archimedes was really asking seemed to be, "How many ways can you put the pieces together to make a square?" That question, Dr. Netz said, "has mathematical meaning."

"People assumed there wasn't any combinatorics in antiquity," he went on. "So it didn't



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trigger the observation when Archimedes says there are many arrangements and he will calculate them. But that's what Archimedes did; his introductions are always to the point."

But did Archimedes solve the problem? "I am sure he solved it or he would not have stated it," Dr. Netz said. "I do not know if he solved it correctly."

As for the name, derived from the Greek word for stomach, mathematicians are uncertain. But Dr. Diaconis has a hunch.

"It comes from 'stomach turner,'" he said. "If you get involved with it, that's what happens."



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