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In Archimedes' Puzzle, a New Eureka Moment

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)

By GINA KOLATA

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Twenty-two hundred years ago, the great Greek mathematician Archimedes wrote a treatise called the Stomachion. Unlike his other writings, it soon fell into obscurity. Little of it survived, and no one knew what to make of it.

But now a historian of mathematics at Stanford, sifting through ancient parchment overwritten by monks and nearly ruined by mold, appears to have solved the mystery of what the treatise was about. In the process, he has opened a surprising new window on the work of the genius best remembered (perhaps apocryphally) for his cry of "Eureka!" when he discovered a clever way to determine whether a king's crown was pure gold.

The Stomachion, concludes the historian, Dr. Reviel Netz, was far ahead of its time: a treatise on combinatorics, a field that did not come into its own until the rise of computer

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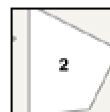

Graphic: 14 Pieces, 17,152 Solutions

Graphic: A Jigsaw Puzzle With

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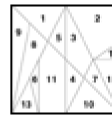

Versatile Pieces

The goal of combinatorics is to determine how many ways a given problem can be solved. And finding the number of ways that the problem posed in the Stomachion (pronounced sto-MOCK-yon) can be solved is so difficult that when Dr. Netz asked a team of four combinatorics experts to do it, it took them six weeks.

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While Dr. Netz acknowledges that his findings cannot be proved with absolute certainty, he has presented the work to other scholars, and they say they agree with his interpretation.

On a recent snowy Sunday morning at Princeton University, three dozen academics gathered to hear Dr. Netz speak, and then congratulated him, saying his arguments made sense. "I'm convinced," said Dr. Stephen Menn, a McGill University historian of ancient mathematics, in an interview at the end of the two-hour session.

Among all of Archimedes' works, the Stomachion has attracted the least attention, ignored or dismissed as unimportant or unintelligible. Only a tiny fragment of the introduction survived, and as far as anyone could tell, it seemed to be about an ancient children's puzzle — also known as the Stomachion — that involved putting strips of paper together in different ways to make different shapes. It made no sense for a man of Archimedes' stature to care about such a game. As a result, Dr. Netz said, "people said, `We don't know what it is about.' "

In fact, he has concluded, the prevailing wisdom was based on a misinterpretation. Archimedes was not trying to piece together strips of paper into different shapes; he was trying to see how many ways the 14 irregular strips could be put together to make a square.

The answer — 17,152 — required a careful and systematic counting of all possibilities. "It was hard," said Dr. Persi Diaconis, a Stanford statistician who worked on it along with a colleague, Dr. Susan Holmes, who is also his wife, and a second husband-and-wife team of combinatorial mathematicians, Dr. Ronald Graham and Dr. Fan Chung from the University of California, San Diego.

Independently, a computer scientist, Dr. William H. Cutler at Chicago Rawhide, a manufacturer of oil seals in Elgin, Ill., wrote a program that confirmed that the mathematicians' answer was correct.

Perhaps as remarkable as the discovery that Archimedes knew combinatorics is the story of a manuscript that dates to 975, written in Greek on parchment. It is one of three sets of copies of Archimedes' works that were available in the Middle Ages. (The others are lost, and neither contained the Stomachion.)

"For Archimedes, as for all others from antiquity, we don't have the original works," Dr. Netz said. "What we have are copies of copies of copies."

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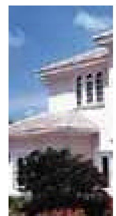
Investigators evaluate copies by asking whether they agree on the text they have in common, and by looking for unique passages, which lend them particular interest. By those measures, the manuscript was invaluable. But it was nearly lost.

In the 13th century, Dr. Netz explained, Christian monks, needing vellum for a prayer book, ripped the manuscript apart, washed it, folded its pages in half and covered it with religious text. After centuries of use, the prayer book — known as a palimpsest, because it contains text that is written over — ended up in a monastery in Constantinople.



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