

*UFD-middag i Det Norske Videnskaps-Akademi tirsdag
15.01.02
i anledning opprettelsen av Abel-prisen*

Your Excellencies, dear ladies and gentlemen.

The question I have been asked to address is: **WHY
MATHEMATICS?**

Try to imagine a world without mathematics — an alternative evolution of society where mathematics did not exist. Or a non-mathematical human being? Any model of how the human brain works — artificial intelligence — is based on mathematics. We all know that

Mathematics is the language of science and technology

In fact, it is an ideal tool for describing scientific theories and deriving qualitative consequences of them. Mathematics has become more and more important in all scientific disciplines, including medicine and biology, and is today of fundamental importance because of its many applications. We live in a society which depends on, and benefits from, mathematics. Instead of going into the technicalities of computers and mathematical models, let me just illustrate the ubiquity of mathematics by giving you some samples — a golden section. This sheet of paper is a golden rectangle! The ratio between the sides is 21 to 34, about 0.62. (All your credit cards are golden rectangles!) These two numbers appear in the Fibonacci sequence: 1, 1, 2, 3, 5, 8, 13, 21, 34, ... the limit of the ratio of consecutive numbers is the golden ratio.

Mathematics is also the language of nature

Look outside — at the snow crystals and their beauty — and their hexagonal symmetry[\[1\]](#). There is a lot of symmetry in nature, also in living organisms and organic structures. Interestingly, there are many pentagonal symmetries in living organisms, but only hexagonal in the inorganic, like

crystals. In a pentagon, the ratio between a side and a diagonal is precisely the golden ratio! Pentagons and hexagons put together explain chemical structures (buckyballs) or can be sewn together to form a soccer ball[2] — note that only hexagons won't do.

There is math in the flowers on this table! Phyllotaxis: the spirals formed by the florets of the sunflower (*Helianthus maximus*) — there are 21 spirals going one way, 34 the other! — similarly on pineapples and pine cones. And the golden section appears in the beautiful logarithmic spiral shape of the shell of *Nautilus pompilius*.

Mathematics is an essential part of our cultural heritage

Look around in this room: to construct a building, you need mathematics, and architecture is applied geometry. The Parthenon on Akropolis has the proportions of the golden rectangle. The golden section was used by the functionalists, e.g. le Corbusier. There are old buildings with a hexagonal base — and a famous newer one in the shape of a pentagon[3]. Modern architects use also modern mathematics: Otto Frei constructed roofs (for the Olympic games in Munich 1972) in the shape of minimal surfaces, by using soap film models. (What I have around my neck is a (golden) minimal Möbius surface[4]!)

The use of geometry in decorations — in the Alhambra, all 17 possible types of periodic tiling patterns are represented. Penrose has constructed a non-periodic pentagonal pattern that involves thin and thick “golden” rhombi or diamonds — and where the ratio between the numbers of thin and thick diamonds is the golden 0.62.

In painting: from the influence of projective geometry on renaissance paintings and vice versa to cubists — a group[5] of French cubists called themselves “Section d'Or.”

Or mathematics and music — and so on and so forth.

Is mathematics too difficult for non-mathematicians?

Mathematics is omnipresent, but then why are mathematical achievements — so difficult, so time-consuming, demanding so much talent and hard work — not recognized in any comparable way to similar achievements in sports or other disciplines? It shouldn't be because math is not considered important, so maybe because it is too foreign or totally incomprehensible, or simply because there are much fewer mathematics lovers than music lovers, so much fewer fiends of mathematics than soccer fiends? How can we produce more math lovers?

Do we expect love by first sight, or love through learning and long time exposure? Apparently Abel didn't love math at first sight, nor was he exposed to it as a child, but he had the good fortune to have a great teacher, Holmboe. Not everybody will become an Abel just with the help of a good teacher — but maybe more little Abels could come into being if mathematics existed as a positive part of their environment. Hopefully the Abel Prize can play a role in making mathematics more visible.

A former minister of research and education, Jon Lilletun, recently said that in his opinion, the most important decision our previous government made, was to create the Abel Prize. I want to applaud that, but I don't think it would have happened without the active support and good work from the Ministry of Education and Research. On behalf of our little “working group,” I would like to take this opportunity to thank you! and also all others, some of whom are present, who have contributed to make the Abel Prize come into being. A toast to Abel!

Ragni Piene

Dept. of Mathematics, University of Oslo, ragnip@math.uio.no

[1] Hermann Weyl, in his book *Symmetry* quotes an interesting passage from Thomas Mann's *The Magic Mountain*, about the "hexagonale Unwesen" of the snowflakes.

[2] 12 pentagons and 20 hexagons — $12/20 = 0.6$

[3] In the 1952 book by H. Weyl (loc. cit.), he says about the Pentagon: "By its size and distinctive shape, it provides an attractive landmark for bombers."

[4] For a picture, see <http://www.gang.umass.edu/minimal/>

Möbius (1790–1868) was a pioneer in topology; in a memoir presented to the Academy of Sciences, discovered after his death, he discussed the properties of one-sided surfaces, including the Möbius strip, which was named after him.

[5] A group of Cubist painters concerned with the proportion and rhythm of geometric forms. The group's name was suggested by Jacques Villon, and members included Robert Delaunay, Marcel Duchamp, Raymond Duchamp-Villon, Albert Gleizes, Juan Gris, Roger de La Fresnaye, Fernand Léger.