Seminar:	Geometry
Title:	Pleasures, Challenges and New Results on Polyhedra
Speaker:	Wayne Deeter
Date:	11-05-15
Place:	Neckers 356
Time:	12:00-12:50

Abstract:

Wayne Deeter*, has produced many of the leading recent results worldwide regarding* ***roundest polyhedra****. Wayne will tell us – mathematically, computationally and visually – about his ongoing work and results. He'll illuminate the insights, techniques, and the computational methods behind his leading-edge results. As an intrepid hiker and explorer (which he is also) would do, Wayne will also guide us afield through many further interrelated findings and explorations where he is path finding as well. His methods involve words and proofs and software and fascinating visual imagery. Amongst these results and methods we also can unlock and unleash many other wide-open challenges in polyhedra research. New results and constructions for polyhedra, as we discover them, will be of major significance to mathematics, computation, engineering and biology.*

Background and Details: The human fascination with beautiful shapes and their construction has guided and defined cultures for thousands of years, since long before the dawn of language or storytelling or writing and history. Geometric shapes transcend language and culture and are not captured within any one narrow "research field." Geometric shapes at first simply fascinate us with their beauty – a beauty written in the laws of nature and in the forms we see produced living creatures all around us, (even simple insects such as bees and spiders). As human tools and culture began to evolve though, shapes then spring to life in the arts of human hands. And beautiful shapes spring forth even when we produce them using only the simplest construction methods such as straightedges or strings or shadows or folding.

> Legend says that the famous ancient Queen Dido received a rich plot of land as a gift. But the size of Dido's plot was not given immediately – only stated as the (unknown) solution of a geometric puzzle:
> "What amount of land, at most, could the Queen's horses plow in one day? Dido would receive whatever land her horses could encircle, plowing sunrise to sunset, enclosing a shape drawn by the furrow of her horses' plow.
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> Mathematicians eventually named Dido's-plow-challenge for themselves as **the isoperimetric problem**. And this "**IP**" required centuries of brainpower, generated by topnotch mathematicians, before its challenge was finally solved precisely and proved formally: Dido's best horse-path is a circle. Yet it inspired the invention of fundamental and entirely new mathematical methods to provide Dido's "simple" answer.

The story of mathematics never ends: The isoperimetric problem and its descendants are still very much alive today, inspiring mathematical inventions, discoveries and challenges such as Wayne Deeter wonderfully exemplifies, work that continually startles us with its difficulty and the beauty of its forms. Wayne Deeter will tell us his own results and offer many challenging suggestions for future explorations and research. Future results from "roundest polyhedra" will have major significance in *many diverse fields:* Mathematics, Computation, Physics and Engineering Design, Biology and more.

Roundest Polyhedra:

If we attempt to enclose a circle, or a sphere – or a hypersphere in any number of dimensions – within an intersection of planes or hyperplanes (in general terms, within a "**polyhedron**") we will find that the any chosen polyhedron of course never contains the sphere, or hypersphere perfectly within the linear enclosure formed by its faces. *(Just as we shall never succeed in writing out all of the digits of* π *with any pen or any computer.)* But no matter about the misfit; we ask instead, "How **closely and approximately** can any polyhedron-enclosure of the sphere *possibly* fit? How many of its faces would be identical? How many different types of faces would this roundest polyhedron have?" *(Just as we might wish to find the best rational approximation to* π*, when we allow no more than N decimal digits for our fractions digits – numerator digits plus denominator digits.)* Thus we are asking for polyhedra:

> "What is the **Roundest Polyhedron** of any given level of complexity?" or equivalently
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> "What polyhedron (with no more than N faces) encloses the sphere ***as well as possible***, (compared to all other polyhedra with the same number of faces)?

(In fact, we'll be finding the polyhedron containing a unit sphere whose own (polyhedral) surface area is as small as possible).

Today there are no known formulas to specify the roundest polyhedra. (In the land of polyhedra, $\boldsymbol{\pi}$ has gone missing.) Working with polyhedra offers its own unending mathematical delights though – There are many beautiful and intriguing results, and further questions that fascinate us, many beautiful images and connections we will continue to discover and construct. There will be polyhedra surprises in store for us, far beyond what we even suspect at present.