# Stephen Smale

Although he is one of the outstanding research mathematicians of the
20th century, **Stephen Smale** (July 15, 1930 -) serves as a
counterexample to the popular myth that to become an outstanding
research mathematician one must show significant evidence of this
potential as a youth. Born in Flint, Michigan, he was not considered a
mathematical genius nor did he show any particularly precocity during
high school. Things were about the same at the University of Michigan
where he spent more time on campus politics and travel than on his
studies. He earned a B.S. in 1952 and a M.S. the next year. Even in graduate school his promise was
not apparent to all. T.H. Hildebrandt, the department chair wrote that Smale was a "marginal,
underachieving graduate student." Things picked up when he became the student of Raoul Bott, one of
the founders of differential topology. Bott provided Smale with an excellent topic for his 1957 doctoral
thesis, *Regular Curves on Riemannian Manifolds*.
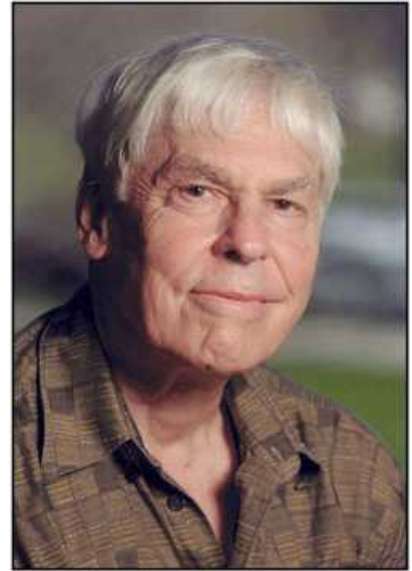
From 1956 to 1958, Smale was a mathematics instructor at the University of Chicago. During this time
he proved a very general fact about the immersions of spheres. One consequence of the proof was the
counter-intuitive idea that a sphere in 3-space can be turned inside out. For a while his claim was met
with skepticism. A number of years passed before various mathematicians described explicit
immersions that showed Smale was correct. Interestingly enough one of the first mathematicians to
understand how a sphere could be turned inside out was the Frenchman Bernard Morin who is blind.
The computer animation *Outside In* shows how a sphere can be turned inside out by means of smooth
motions and self-intersections. The 22-minute film was produced at the Geometry Center under the
direction of Silvio Levy, Delle Maxwell, and Tamara Munzer. It concludes with Bill Thurston's

"corrugations" method of turning a sphere inside out. Both the film and the companion 48-page book *Making Waves* are still accessible.

From 1958 to1960 Smale was at the Institute for Advanced Study in Princeton on a National Science Foundation Postdoctoral Fellowship. In 1960, he was appointed an associate professor of mathematics at the University of California at Berkeley. He was a professor at Columbia University (1961 – 1964), and then returned to Berkeley, remaining until he retired in 1995. Immediately thereafter, he became a Distinguished Professor at the City University of Hong Kong. In 2003, Smale was one of the first seven faculty members in residence at the University of Chicago's newest academic institution, the Toyota Technological Institute at Chicago.

Smale's work encompasses a wide variety of mathematical areas: differential topology, chaotic dynamical systems, calculus of variations, and theories of computation, mechanics and mathematical economics. He was awarded the Fields Medal at the International Congress at Moscow in 1966, for his work on the Poincaré conjecture, one of the famous unsolved problems of the 20th century. It asserts that a simply connected closed 3-dimensional manifold is a 3-dimensional sphere. Smale showed that any closed n-dimensional manifold that is homotopy equivalent to the n-sphere must be the n-sphere when n is at least 5. Michael Freedman proved the conjecture for $n = 4$ in 1982. At this writing, the mathematical world is verifying the proof of a result given in 2003 by Russian mathematician Grigori Perelman, which, if correct, establishes the general Poincaré conjecture as a consequence.

In the late 1960s, Smale moved into applications, focusing on economics, to which he applied topology and dynamics to the study of general economic equilibrium. His most recent work has been in theoretical computer science. Smale has received many honors for his work, including the Veblen Prize

for Geometry by the American Mathematical Society and the National Medal of Science in 1996 for "four decades of pioneering work on basic research, which have led to major advances in pure and applied mathematics." For many years Smale has been a certified crystal expert and has had exhibitions of his collection of rare pieces.

In addition to his mathematical work, Smale was often in the forefront of the fight to protect freedoms guaranteed to Americans under the Constitution. But that's not how many would have characterized his political activism. At Berkeley, he was active in the Free Speech Movement and the anti-Vietnam War Movement. His actions caused his enemies to accuse him of being a Communist-sympathizer even when he was an undergraduate at Michigan. He was the target of McCarthy-like Communist hunters, the Congressional Un-American Activities Committees, and the John Birch Society. He was accused of expressing the wish that the Viet Cong would defeat the United States in Southeast Asia so that its power elsewhere in the world would be weakened, making it easier to achieve radical social changes in America. His views and causes were not generally well received by the public during the height of the Cold War. Some among his mathematical colleagues were embarrassed by his actions, particular by his taking his protest to the steps of Moscow University at the time of the International Congress of 1966. Those wishing to learn more about Smale's mathematical achievements and his political activities will find Stephen Batterson's *The Mathematician Who Broke the Dimension Barrier* interesting.

The 1950s and the 1960s were difficult times during which there were many, often violent, debates about the rights and duties of American citizens in the face of a Communist threat. Some felt then that there were worse threats to the nation than external enemies. Teachers were required to swear loyalty oaths that they did not advocate the overthrow of the government by violent or other means, as if those who were contemplating the overthrow of the government would have any reluctance to swear an oath. Students were paid by Communist hunters to spy on their professors and report any signs of disloyalty

or sympathy for the "enemies" of the United States. Once in Springfield, Illinois a group of students were forcibly removed from the State Capital area where they were urging passersby to show their support for guaranteed American civil rights by signing copies of The Bill of Rights. The next day the local paper accused the group of being Communist sympathizers and to clinch the case they noted that a number of them were wearing red shirts. It sounds ridiculous today, but it wasn't funny at the time.

Quotation of the Day: "Obstacles to creativity come from the main leaders in the science and arts fields because of their reluctance to accept new ideas. Even after making a discovery that is a new, important and sound idea, you still need to have an established reputation to overcome rejection and get your discovery the attention it deserves." – Stephen Smale