# I P S S

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## 1 Stephen Smale

Stephen Smale, one of the greatest mathematicians of the $20^{th}$ Century, was born in 1930, Flint, Michigan. He received his Ph.D. degree in Mathematics in 1957 from the University of Michigan at Ann Arbor under the supervision of Raoul Bott, one of the founders of the modern *Differential Geometry*. In his Dissertation "*Regular Curves on Riemannian Manifolds*", Stephen Smale generalized the work of Whitney on curves in the plane to curves on *d*-dimensional manifolds. Stephen Smale spent most of his professional career at the University of California at Berkeley (UCB). He retired from UCB in 1995 and has since spent most of his time between The Toyota Technical Institute in Chicago and the City University of Hong Kong as a Distinguished University Professor.

Stephen Smale authored many groundbreaking contributions in Mathematics ranging from *Differential Topology* to *Dynamical Systems*. In 1961, he proved a higher-order version of the well-known *Poincaré Conjecture*. For that work, the 36-year-old Stephen Smale was then awarded the *Fields Medal*, very often described as the "Nobel Prize for Mathematics", during the International Congress of Mathematics that was held in Moscow in 1966. An account of Smale's work which led him to the Fields Medal is described by René Thom in [4].
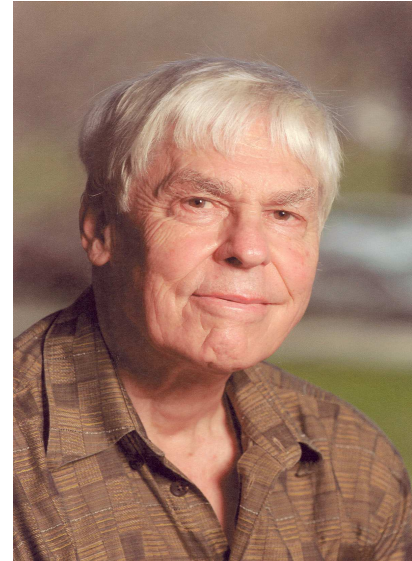


Stephen Smale

In addition to his Fields Medal, Stephen Smale has received many other honors and awards throughout his rich and exceptional career. In 1965, he received the *Veblen Prize* for his "*Contributions to various aspects of Differential Topology*". In 1996, he received the *National Medal of Science* from the hands of President Bill Clinton for "*Four decades of pioneering work on basic research questions which have led to major advances in Pure and Applied Mathematics*". Other honors and awards Smale has received include, but are not limited to, the *Chauvenet Prize* in 1988, the *von Neumann Award* in 1989, the *Moser Prize* in 2005, and the *Wolf Prize* in 2007.

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This Interview is a part of the Special Volume of *Communications in Mathematical Analysis* in recognition of Professor Smale many significant and various contributions to Mathematics, and in celebration of his 80th Birthday. We hope this Interview will help to better understand the life of Stephen Smale as well as his mathematical vision.

## 2    The Interview

First of all, I seize this opportunity to thank you so much from the bottom of my heart for accepting my request to interview you within the framework of the ongoing special volume of *Communications in Mathematical Analysis* in recognition of your many significant and various contributions to Mathematics, and in celebration of your 80th Birthday. Needless to say I am very pleased and honored to have this interview with you.

*Diagana: I would appreciate if we can start with your education. How would you describe your education, in general? Moreover, what role did Raoul Bott play in your graduate education?*

**Smale:** 1. My Formal education was quite erratic. Informal as well.

2. Bott played a very important role especially via his 1 year course in algebraic topology. (for details see [1])

*Diagana: I understand that Raoul Bott was not that famous when you chose to work with him? What did motivate you work with him?*

**Smale:** Bott seemed to have some real character, mathematical and otherwise. Also he was more involved in current research activity than the other topologists at Ann Arbor (e.g. Moise, Wilder, Samelson, et al.). Also he was a great teacher.

*Diagana: In 1960, you proved a generalized version of the Poincaré Conjecture. For that work, you were awarded the Fields Medal during the International Congress of Mathematics that was held in Moscow in 1966. What did motivate you to study a deep unsolved problem like the Poincaré Conjecture?*

**Smale:** I enjoyed (and still do enjoy) working on problems which are central even though difficult.

*Diagana: Is it true that Raoul Bott had some doubts about your proof of the Poincaré Conjecture? If so, why? Did you attempt to convince him?*

**Smale:** No doubt that I know of. He never pretended to understand the proof. It was not in his area of expertise.

*Diagana: Is there a strategy for tackling famous conjectures? What do you think of the Millennium Problems?*

**Smale:** Strategies in doing Mathematics, dealing with mathematical challenges, are complex. Maybe one could say that my own style is to do a lot of groping. The Millennium Problems seem good.

*Diagana: You were only 30 when you first proved the Poincaré Conjecture, which obviously led to your being awarded the Fields Medal. Would you encourage advanced graduate students and beginning researchers to work on famous conjectures?*

**Smale:** Yes but only part of the time. But also there could be other mathematical work perhaps even more important than solving famous problems.

*Diagana: What do you say to those who say that you were not precocious like John von Neumann or Richard Feynman when at the same time you solved one of the most famous unsolved mathematical problems at only 30?*

**Smale:** I would say fine.

*Diagana: What was it like to receive the highest distinction that was available to mathematicians?*

**Smale:** I felt a great satisfaction.

*Diagana: How did you move from Differential Topology to fields like Dynamical Systems or Economics?*

**Smale:** A motivation was the Mathematics of relevance, how to understand the world better via Mathematics. But also at that time it seemed to me a bigger challenge was in understanding dynamics. Changing fields can have some difficulties.

*Diagana: What do you think of the current financial crisis that some economists call the worst financial crisis since the Great Depression of the 1930s? What is it predictable?*

**Smale:** I believe that one cannot predict much especially in macroeconomics.

*Diagana: What do you think of the progress made by mathematicians?*

**Smale:** Impressive! But I also include the contributions to Mathematics by mathematically oriented scientists in various disciplines (as Newton).

*Diagana: How should we train mathematicians of the future?*

**Smale:** By creating an environment where independence is encouraged (even independence from their professors). Use Google for research.

*Diagana: How do you select your research topics? When you make that selection, how do you proceed to deal with the problem you chose to work on?*

**Smale:** Choose problems of importance, where there is potential for progress with available resources.

*Diagana: Thank you so much, Prof. Smale, for your time and efforts in answering our questions.*

## Acknowledgments

# References

[1] S. Batterson, *Stephen Smale: The Mathematician Who Broke the Dimension Barrier.* American Mathematical Society, Providence, RI, 2000.

[2] S. Batterson, The Mathematical Work of Stephen Smale, *Notices Amer. Math. Soc.* **43**(1996), no. 12, 1527-1528.

[3] G. Szpiro, Interview with Stephen Smale. *Notices Amer. Math. Soc.* **54** (2007), no. 8, pp.995-997.

[4] R. Thom, Sur les travaux de Stephen Smale, *Internat. Congr. Math.*, Moscow, 1966 (Moscow, 1968).