# CATEGORICALLY THINKING

One of the world's most distinguished mathematicians, Samuel Eilenberg, is a Visiting Professor at Macquarie University this month.

Professor Eilenberg is a founding father of Category Theory which began in 1942 in his paper with Professor Saunders Mac Lane. Dismissed initially as just another form of mathematical language, Category Theory today has close to 1000 mathematicians working in the field and some 40 to 50 books published on it.

'Saunders and I were working on algebraic topology together and the subject of naturality came up. In mathematics, categories are basic structures and functors are the relationships between them. Linking the functors are natural transformations. We wanted to know what was "natural" or obvious and what wasn't. We needed a precise mathematical meaning for naturality, and categories and functors became the vehicle for explaining this,' Professor Eilenberg said.

The resultant Category Theory, he said, took about 10 years to 'take off' but escalated in the 1950s. 'It is now being increasingly used in other fields such as economics, psychology, biology, physics and education. People have felt similar constraints in their fields and latched on to the language and ideas of the theory of categories.'

'It's rather like statistics. The discipline grew out of mathematics but is now used across all fields. It's the same with English. The English language is studied in Departments of English but is used by all,' he said.

This year Professor Eilenberg was awarded the Wolf Prize, one of the most prestigious in the world of mathematics, crowning a career that took him from the University of Warsaw in Poland in the 1930s to the hallowed halls of American academia as a naturalised citizen of the United States.

There are stories of his first visit to Princeton University, the then-Mecca of Mathematics, in 1939 at the age of 26, only to see a fellow academic stand on a chair and recite line-by-line the young Pole's latest paper on algebraic topology, so well-known was his work already.

Professor Eilenberg has been based at Columbia University, New York, since 1947, with forays as a Fulbright and Guggenheim Fellow to Paris, and Visiting Professorships to India, Israel and France throughout his teaching career.

He has been a member of the Applied Mathematics Panel of the National Defence Research Council in the United States Office of Scientific Research and Development and is currently a member of the Mathematical Association of America; the American Academy of Arts and Sciences; and an honorary member of the Mathematical Societies in London and South-East Asia.

The four major books he has written are now standard references and classics in their fields, ranging from *Foundations of Algebraic Topology* with Norman Steenrod (1952), *Homological Algebra* (1956) with Henri Cartan to *Automata, Languages and Machines*, two volumes completed a decade ago. His earlier joint papers with Professor Saunders Mac Lane were recently published as a single volume by Academic Press because of their current value in modern research into algebraic topology and cohomology.

His books have been translated into many languages and published both legally and illegally. One of his prized possessions, is a pirated copy of his *Homological Algegra* printed in Taiwan. In all, Professor Eilenberg has written 112 articles and research memoirs in mathematical journals.

He is listed in the *Encyclopaedia Britannica*, in *The World's* Who's Who in Science and is on the illustrious List of Great Mathematicians through the Centuries at the Chicago's Museum of Applied Arts and Sciences.

Professor Eilenberg is at Macquarie University to work with Associate Professor Ross Street, whose current research into homology and past work on Category Theory, Topos Theory and Homological Algebra has caught the American mathematician's eye. The two men first met in Illinois in 1969.

Professor Street lectured on cohomology while on an Overseas Study Program in the United States last year, then he and Professor Eilenberg attended an international conference on Category Theory at the Isle of Thorns in Sussex in 1985. Professor Street first felt the pull of Category Theory almost 20 years ago when doing Honours at Sydney University. Since then he has gained considerable international recognition for his work.
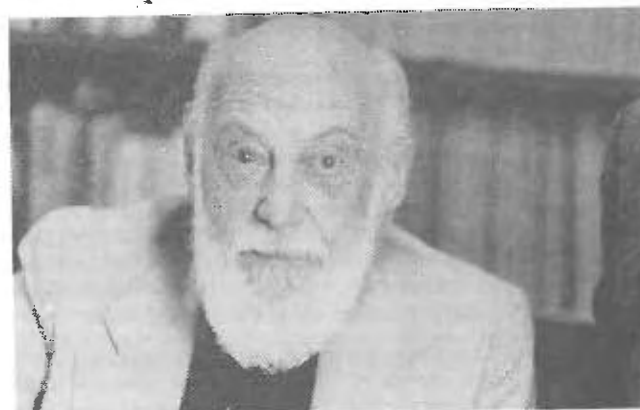
A remarkably agile 72-year-old, Professor Eilenberg is one of the key figures in a remarkable explosion of mathematical talent since World War II. The international guide to what is happening in the mathematical world is *Mathematic Reviews* which indexes all major publications. In 1972, for example, one slim volume listed all work for that year, indexed by author and by subject. In 1981, the field had expanded so rapidly that the indices alone ran to four fat volumes.

'Mathematicians are not just writing more, but much of the work is brilliant. Almost all of the conjectures formulated up to the 1940s—some of them a 100 or more years old—have now been answered.

'People struggled with conjectures for years. Now most of their work has been forgotten and their theories boiled down and refined to perhaps two pages in a text book,' Professor Eilenberg said.

In spite of the great leaps forward, the professor is somewhat pessimistic about the state of mathematics instruction in high schools in the United States. 'I'm not too optimistic about what teachers of mathematics can learn. There is no incentive for teachers to do additional training while they are working. American teachers still don't command the respect or salaries they deserve from the community. In America it is better to be a butcher than a teacher. But talented high school students still learn mathematics in spite of their teachers,' he said.

If students survived until university level, they could still find they were better than some of their professors. 'It is up to the graduate schools to sort out the goats from the sheep,' he said. 'In large American institutions you can have up to 100 PhD mathematicians on staff and students can seek out the talented and catch fire.'



*Professor Samuel Eilenberg*