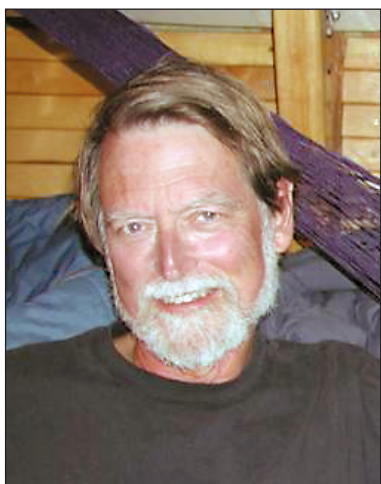# Mumford and Wu Receive 2006 Shaw Prize

David Mumford   **Wu Wentsun**

DAVID MUMFORD and WU WENTSUN have received the
2006 Shaw Prize in Mathematical Sciences. Pre-
sented by the Shaw Foundation, the prize carries
a cash award of US$1 million, which will be di-
vided evenly between the two laureates. Mumford
was honored "for his contributions to mathemat-
ics, and to the new interdisciplinary fields of pat-
tern theory and vision research," and Wu was hon-
ored for "for his contributions to the new
interdisciplinary field of mathematics mechaniza-
tion."

The Work of the Laureates

*The Shaw Prize in Mathematical Sciences Commit-
tee wrote the following essay about the work of
Mumford and Wu.*

David Mumford and Wu Wentsun both started
their careers in pure mathematics (algebraic geom-
etry and topology respectively) but each then made
a substantial move towards applied mathematics
in the direction of computer science.

Mumford worked on computer aspects of vi-
sion and Wu on computer proofs in the field of
geometry. In both cases their pioneering contri-
butions to research and in the development of the
field were outstanding. Many leading scientists in
these areas were trained by them or followed in
their footsteps.

Mumford's early work, for which he received
the Fields Medal in 1974, was in algebraic geome-
try and especially the study of algebraic curves. This
is an old and central subject in mathematics with
contributions from many of the great names of the
past. Despite this, much remained to be done, and
Mumford's great achievement was to revitalize and
push forward the theory of moduli. Algebraic curves
depend on an important integer, the genus g. For
$g = 0$ the curve is rational, for $g = 1$ it is elliptic and
depends on an additional continuous parameter or
modulus. For $g > 2$ there are $3g - 3$ moduli, form-
ing a (complicated) space whose features give us
information about the totality of all curves. Mum-
ford laid the foundations for a systematic and
fruitful study of this moduli space. This has been
widely influential even, surprisingly, in the physics
of string theory.

After two decades in this field, Mumford made
a drastic switch to computer vision, where he used
his mathematical abilities and insight to make orig-
inal and fundamental contributions. He helped to
provide a conceptual framework and to provide ex-
amples of specific solutions that can in principle
be generalized to a range of problems. His 1985

paper with Shah on variational approaches to signal processing was recently awarded a prize by the Institute of Electrical and Electronics Engineers (IEEE).

Mumford's many original contributions to pattern theory and vision research were described in his 1999 book *Two and Three Dimensional Patterns of the Face* (A K Peters, Ltd.) and the forthcoming *Pattern Theory through Examples.*

Wu Wentsun was one of the geometers strongly influenced by Chern Shiing-Shen (Shaw Laureate in 2004). His early work, in the post-war period, centered on the topology of manifolds that underpins differential geometry and the area where the famous Chern classes provide important information. Wu discovered a parallel set of invariants, now called the Wu classes, which have proved almost equally important. Wu went on to use his classes for a beautiful result on the problem of embedding manifolds in Euclidean space.

In the 1970s Wu turned his attention to questions of computation, in particular the search for effective methods of automatic machine proofs in geometry. In 1977 Wu introduced a powerful mechanical method, based on Ritt's concept of characteristic sets. This transforms a problem in elementary geometry into an algebraic statement about polynomials that lends itself to effective computation.

This method of Wu completely revolutionized the field, effectively provoking a paradigm shift. Before Wu the dominant approach had been the use of AI search methods, which proved a computational dead end. By introducing sophisticated mathematical ideas Wu opened a whole new approach that has proved extremely effective on a wide range of problems, not just in elementary geometry.

Wu also returned to his early love, topology, and showed how the rational homotopy theory of Dennis Sullivan could be treated algorithmically, thus uniting the two areas of his mathematical life.

In his 1994 *Basic Principles in Mechanical Theorem Proving in Geometry* (Springer), and his 2000 *Mathematics Mechanization* (Science Press), Wu described his revolutionary ideas and subsequent developments. Under his leadership mathematics mechanization has expanded in recent years into a rapidly growing discipline, encompassing research in computational algebraic geometry, symbolic computation, computer theorem proving, and coding theory.

Although the mathematical careers of Mumford and Wu have been parallel rather than contiguous they have much in common. Beginning with the traditional mathematical field of geometry, contributing to its modern development and then moving into the new areas and opportunities that the advent of the computer has opened up, they demonstrate the breadth of mathematics. Together they represent a new role model for mathematicians of the future and are deserved winners of the Shaw Prize.

Biographical Sketches

David Mumford, born in 1937, is currently a professor in the Division of Applied Mathematics at Brown University. He received his Ph.D. at Harvard University in 1961, under the direction of Oscar Zariski. Mumford was a professor at Harvard for many years before moving to Brown. He received the Fields Medal in 1974. In 1975, he was elected to the U.S. National Academy of Sciences. From 1987 to 1992, he was a MacArthur Fellow.

Wu Wentsun, born in 1919, is an academician of the Chinese Academy of Sciences and a fellow of the Academy of Sciences for the Developing World in Trieste, Italy. He is presently the Honorary Director and Researcher of the Institute of Systems Sciences, Academy of Mathematics and Systems Sciences at the Chinese Academy of Sciences, Beijing. He graduated from the Shanghai Jiaotong University, China, in 1940, and received his *Docteur ès État* from the Université de Strasbourg in 1949, under the direction of Charles Ehresmann.

About the Prize

The Shaw Prize is an international award that honors individuals for achieving distinguished breakthroughs in academic and scientific research or applications, who have made outstanding contributions in culture and the arts, or who in other domains have achieved excellence. The award is dedicated to furthering societal progress, enhancing quality of life, and enriching humanity's spiritual civilization. The Shaw Prize is managed and administered by the Shaw Prize Foundation based in Hong Kong.

Previous recipients of the Shaw Prize in Mathematical Sciences are Shiing-Shen Chern (2004) and Andrew Wiles (2005).

—From Shaw Foundation announcements