Princeton University

Honors Faculty Members
Receiving Emeritus Status

May 2013

The biographical sketches were written by colleagues in the departments of those honored, except where noted.

350509-13

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John Horton Conway

John Conway is a mathematician whose interests run broad and deep, ranging from classical geometry to the 196,884-dimensional Monster group to infinity and beyond. Perhaps his greatest achievement (certainly his proudest achievement) is the invention of new system of numbers, the surreal numbers—a continuum of numbers that include not only real numbers (integers, fractions, and irrationals such as pi, which in his heyday he could recite from memory to more than 1,100 digits), but also the infinitesimal and the infinite numbers. When he discovered them in 1970, the surreals had John wandering around in a white-hot daydream for weeks. His only regret, in this regard, is that he has not yet seen the surreals applied. The conventional wisdom, however, is that the surreals no doubt will find application; it is just a question of how and when.

Notwithstanding his serious chops, John is equally if not more renowned for his persistent playing around, which makes him a great teacher and a wonderful speaker, especially to a general audience. Forever the showman, always seeking the center of attention, he gained a reputation for carrying on his person ropes, pennies, coat hangers, cards, dice, games, puzzles, models, sometimes a Slinky—props deployed to extend his winning and charismatic imagination. In this sense, John is one of his discipline's best ambassadors, bringing mathematics to the masses—be it at summer math camps teaching some of his more trivial and eccentric mathematical inventions to wide-eyed students, or delivering public lectures on Archimedes and Escher and the like to standing room only crowds at McCosh Hall. At the drop of a hat, he can also discuss the conversion of the Hebrew calendar to the Roman one, as well as constellations and phases of the moon, the strange etymology of English words (such as "floccinaucinihilipilification"), or the symmetry of brick patterns in walls. Once, in a talk to a general audience on symmetry, John invited the then-president of Princeton University to remove his shoes and socks to illustrate footprint patterns. The president demurred.

Born on December 26, 1937, in Liverpool, England, John, as his mother once recalled, became interested in mathematics at a very early age, reciting the powers of two when he was four years old. Also, from a young age he could calculated the day of the week for any given date (a skill he later refined, on the urging of Martin Gardner, with his Doomsday algorithm). At age eleven, his headmaster asked what he wanted to do with his life and he replied: "I want to read mathematics at Cambridge." He received his B.A. from Gonville and Caius College at the University of Cambridge in 1959, and received his doctorate in 1964. He remained at Cambridge until 1986, when he came to Princeton as a professor of mathematics and was named John von Neumann Professor of Applied and Computational Mathematics. John was entrusted with the task of teaching the pre-major mathematics courses—a task he has continued to do throughout his time at Princeton.

Over his long career, John has made significant contributions to mathematics in the fields of group theory, number theory, algebra, geometric topology, theoretical physics, combinatorial game theory, and geometry.

In group theory, he worked on the classification of finite simple groups and discovered the Conway groups, and was the primary author of the *ATLAS of Finite Groups* (1986). The *Atlas*, as it is called, took the better part of 15 years to produce and provides basic information about the properties of finite simple groups. With Simon Norton, he conceived of the complex of conjectures named "Monstrous Moonshine." He also investigated lattices in higher dimensions, and with Neil Sloane authored *Sphere Packings, Lattices, and Groups* (1988).

In number theory, John proved as a graduate student the conjecture by Edward Waring that every integer could be written as the sum of thirty-seven numbers, each raised to the fifth power. In 1993, he proved with his student, William Schneeberger, that if an integral positive definite quadratic form with integer matrix represents all positive integers up to fifteen, then it represents all positive integers.

Working with quaternions, he invented the system of icosians in algebra. And he authored *On Quaternions and Octonions* (2003, with Derek Smith), *The Sensual (Quadratic) Form* (1997), and *Regular Algebra and Finite Machines* (1971).

In geometric topology, John's approach to computing the Alexander polynomial of knot theory involved skein relations, and led to a variant now called the Alexander-Conway polynomial. He further developed tangle theory and invented a system of notation for tabulating knots, now known as Conway notation, while completing the knot tables up to 10 crossings.

In 2004, John and Princeton's Simon Kochen proved the Free Will Theorem, working off of the Kochen-Specker No Hidden Variables principle of quantum mechanics. It states that if an experimenter can freely choose what to measure in a particular experiment, then elementary particles can also freely choose their spins in order to make the measurements consistent with physical law.

John is perhaps most widely known for his contributions to combinatorial game theory, a theory of partisan games. He collaborated with Elwyn Berlekamp and Richard Guy, and they coauthored the book *Winning Ways for Your Mathematical Plays* (1982). Additionally, he wrote the book *On Numbers and Games* (1976), which lays out the mathematical foundations of this theory. With Richard Guy he authored *The Book of Numbers* (1996). He invented several games—sprouts, philosopher's football (or Phutball), and Conway's soldiers—and developed detailed analyses of many others. He also invented the Game of Life, one of the early celebrated examples of a cellular automaton, which he introduced to the world via the inaugural *Scientific American* column by his good friend Martin Gardner. He formulated the angel problem, which was solved in 2006. His surreal numbers inspired a mathematical novel by Donald Knuth, which includes the line: "Conway said to the numbers, 'Be fruitful and multiply.'" He also invented a naming system for exceedingly large numbers, the Conway chained arrow notation.

At heart, John considers himself a geometer, in the tradition of the great classical geometer Donald Coxeter, whom Conway considered one of his mathematical heroes and mentors. In the mid-1960s, during the initial stages of what became an abiding interest in polyhedra and polytopes, John and Michael Guy established that there are sixty-four convex uniform polychora excluding two infinite sets of prismatic forms. They discovered the grand antiprism in the process, the only non-Wythoffian uniform polyhedron. John has also suggested a system of notation dedicated to describing polyhedra called Conway polyhedron notation. Throughout his geometrical researches, he has often been governed by a lifelong fascination with symmetry. His most recent book is *The Symmetries of Things* (2008; coauthored with Heidi Burgiel and Chaim Goodman-Strauss). He is currently at work on *The Triangle Book* (among others).

Over the course of his career, John has been honored with numerous awards and accolades. He received the London Mathematical Society's Berwick Prize (1971) and Pólya Prize (1987), Northwestern University's Nemmers Prize in Mathematics (1998), and the American Mathematical Society's Leroy P. Steele Prize for Mathematical Exposition (2000). He was elected a fellow of the Royal Society of London (1981) and a fellow of the American Academy of Arts and Sciences (1992).