Genius at Play - The Curious Mind of John Horton Conway
Excerpts from the Roberts Biography

Ingo Althöfer, ingo.althoefer@uni-jena.de
December 25, 2015

Siobhan Roberts has presented a fantastic biography of John Horton Conway. Her work on the project started in 2005. Due to Conway's jumping mind (and also his strokes and other illnesses) it took 10 years until the book finally was published in Fall 2015. A few dates from Conways life: he was born in 1937 somewhere in flat England, studies and teaching of Mathematics in Cambridge (UK), Ph.D. in 1967, switch to Princeton University in 1986 / 87.

The hardcover book with its 470+ pages and more than 70 photos, pictures and diagrams (costing only slightly more than 20 $) is packed with material, anecdotes, open problems. It would be impossible to give an senseful list of content on a few pages. So, we restrict ourselves to quoting some of the highlights.

Ph.D. Years

* Harold Davenport (a famous number theorist) was Conway's mathematical advisor. Davenport wrote: I had two very good students: Baker (who later won a Fields medal) and Conway. To Baker I would give a problem and he would return with a very good solution. To Conway I would give a problem and he would return with a very good solution to another problem.

* The task for Conway's doctoral dissertation was: prove that every natural number is the sum of at most 37 fifth powers. Conway meet with his advisor every Thursday to discuss the fifth-power problem. About 10 minutes before their meeting. he'd think of something to say about the problem, making it seem as if he'd been diligently working away on the problem all week. Conway couldn't muster much enthusiasm for the fifth powers. He did no work and no work and no work. Finally, full of guilt, he gave himself the summer. He worked in the library every day from opening until closing, and 6 weeks later, success. Conway gave the manuscript to Davenport. At the next meeting, Conway was expecting some warm congratulations. Instead, Davenport said 'what you have here is a poor Ph.D. theses'. He took Davenport's advise and never submitted it. In 1967, Conway submitted and successfully defended his Ph.D. thesis in Cambridge, entitled "Homogeneous ordered sets".

Conway's Annus Mirabilis

* One day, Conway learned about an interesting open problem in Mathematical group theory. He decided to go for a proof. He told the kiddies that Daddy wasn't to be disturbed. He set aside Wednesday nights from 6 o'clock to midnight and Saturday from noon to midnight, for as many months as necessary. As he told a colleague: "On the first Saturday, I had a last cup of coffee and kissed the wife and the kids good-bye, and locked myself in the front room and started to work." He expected to keep his house-arrest work ethic for weeks or months or beyond. But by evening of this first Saturday he'd figured it out. He telephoned Thompson (the best group theory guru in Cambridge), dictated a number to him and said that it was either this number or twice this number. Shortly later, Thompson phoned back with the correct number. Then Conway did more calculations, and at about 10 p.m. he phoned Thompson again and told him that he had found the corresponding matrix ("character table") and was going to bed now. Then Conway hung up the phone ... and off to bed he did NOT go. At a quarter past midnight Conway had completed his proof. "It was absolutely fantastic. 12 hours had changed my life. And I had expected it going on for months."

* This happened in 1969, Conway's "Annus Mirabilis". In that year he also introduced the surreal numbers, becoming the base of modern "Combinatorial Game Theory". And he invented the "Game

of Life" cellular automaton (covering more than 100 pages in the biography; including a fantastic photo with Conway sitting in a dark room; the only light coming from an old-fashioned round monochrome monitor with LIFE configurations running.

* “When I found these things [surreal numbers], I did go around in a daydream for a long, long time. Most of my waking hours were taken up with thinking about it, not in any technical way, just contemplating it.”

On the Cellular Automaton “Game of Life”

* Creating the game had taken years of tinkering, tweaking the rules at morning coffee, afternoon tea, often all day in between and into the night.

* "Life" with just 2 primary states ... each neighbourhood was comprised of 9 cells ... meaning there were only 2-to-the-9 possible configurations of states - a considerable improvement on von Neumann's older self-replicating model (from the 1950's) with 57,000 states and 20,511,149 configurations. At one point Conway learned that not von Neumann had been the founder of this complicated model, but Stanislav Ulam. Conway reported to Gardner: I knew about the vonN stuff, but didn't realize that Ulam was the real founder.

* When a friend had written a fast computer program for running LIFE instances, John sometimes stared at the screen for a good hour longer than he had wanted.

* Eventually a walking piece was found in LIFE. Conway christianed it the "glider". Though now he wishes he'd called it the "ant".

* In the book "Winning ways" (joint work of Conway with Elwyn Berlekamp and Richard K. Guy) there is a chapter titled "what is life?" An answer by the wife of Abraham Fraenkel was: "Life's not always as simple as mathematics, Abraham."

Games

* Conway is the inventor of the paper-and-pencil game "Sprouts". It happened back in 1966/67, and Sprouts was made popular via Martin Gardner's column in Scientific American. (This was the first time that Gardner presented Conway material in his column in the Scientific American.) Side remark: Sprouts was treated in a paper and talk by Cameron Browne, in the ACG conference in Leiden, 2015.

* Conway rarely if ever played the game [of Go]. Conway: I never understood Go. But I did understand that near the end of the game it broke up into a sum of games. That provided the spur for me to work on the theory of sums of partizan games.

* Conway did not invent "Domineering". But he improved [?!, the reviewer] the name from Crosscram to Domineering.

* Conway in an explanation to biographer Siobhan Roberts: “We are thinking of the game in reverse now, if you understand me . Because when you are analysing a game, you always do it from the end of the game towards the beginning.” [Side remark by the reviewer: Ms. Roberts has no strong background in Mathematics; for our ICGA community it is the most normal thing to analyse games in backward direction.]

Conway Teaching

* In the mid-60's, Conway glanced at an open notebook of one of his students and recognized material from his course on automata. He asked the student: "Were my lectures anywhere near that coherent?" Later, the acquaintance with this automata stuff put him in position to invent the "Game of Life".

* Conway liked to give "untitled talks". He still didn't know what the Untitled Talk would be about. He never likes to decide until the absolute last minute - a strategy he uses for keeping himself fresh and his synapses young. Sometimes he gives his audience a choice of topics and lets them vote.

* Conway sometimes rebuked his students: “No no no no no! You're being far to REASONABLE.”

* As Conway likes to say (borrowing words of wisdom he learned from a graduate student): "The day can be saved with 45 minutes of work." [Reviewer: I think, Jaap van den Herik has a different work ethic.]

* Conway "introduced" handshake numbers: In 1904 or 1905, Cantor (the father of "modern" set theory") met a little girl, Cecilia Tanner, and shook hands with her. When Conway heard this he found a way for a handshake with the now elderly Lady Tanner, claiming that he was within two handshakes of Cantor. Later he found out that he had a second 2-handshake route to Cantor, via Bertrand Russell. (Side remark: This reviewer is within two handshakes of Claude Shannon. I saw him in 1989 in Edmonton, during the Computer Chess Olympiad. I had no handshakes with him, but saw that he shook hands with Jonathan Schaeffer. And already in 1987, in Noordwijkerhout, I had had handshakes with Jonathan.)

Some Moments of Family Life

* With his first wife Eileen, Conway had four daughters. Eileen: "He worked on math endlessly and everywhere, with the children crawling all over him." The girls were born in 1962, 63, 65, 68. So he called them the 60-fib-girls (remember: 2 , 3, 5, 8 are the first non trivial Fibonacci numbers).

* Once, Conway proved some deep mathematical theorem over Christmas. Thereafter, the corresponding object was renamed by Eileen as "the problem that spoiled Christmas".

* Conway made a habit of staying up all night at least once a week, and when he didn't, he tossed and turned in bed until his wife threw him out.

* In pursuing his investigations on Penrose's puzzle pieces, Conway usurped some of Eileen's territory, covering the dining table with an infinite nuisance of tiles. He studied the dining table mosaic for a year, relegating family meals to the kitchen and prohibiting dinner parties.

Winning Ways for your Mathematical Play

"Winning ways for your mathematical play" is a famous pair of books by Elwyn Berlekamp, John Horton Conway and Richard K. Guy, first published in 1982. It centers around combinatorial game theory, a field that started back in 1902/03 by C.L. Bouton with his famous analysis of the Nim game. Conways surreal numbers became a solid foundation of CGT, as it is abbreviated nowadays. The German translation (shortly titled "Gewinnen!") was published only a few years later, by Konrad Jacobs (the academic grandfather of this reviewer) and a student of him. It was special in the following sense: Page x in the translation ended exactly with the line that was last line on page x of the original. The same for the first lines of each pages. So it was very easy to switch between

original and translation, when preparing a course on the book.

* Team work for the book was not always easy, in particular because Berlekamp and Conway were very different characters. As Roberts writes: To Conway's wild child, Berlekamp was and is the sensible adult. Berlekamp: "Conway is a very good showman"(which was a problem for Berlekamp sometimes). Berlekamp: "If he weren't so good I wouldn't tolerate him. He is certainly original."

Colleagues on John Horton Conway

* Conway did joint work with Physicist Simon Kochen on a "Free Will Theorem". Their collaboration was so successful in particular because they were so different. Conway: My contribution was "not understanding" all the quantum mechanics stuff. And that was an important contribution. It freed us to think about things in very simple terms. Kochen: A lot of people dig deeper and deeper and deeper, use very technical modern (mathematical) machinery. That's not the way John works... He works at ground level, the level that he could explain to anyone, using intuition. Conway: I personally can only understand things after I've thought about them for ages and make them very, very simple.

* David Bailin, another physicist, met Conway in his young years: "Conway was the guy who was already an independent mathematician. He had all sorts of interests ... Of course, I subsequently discovered that I was the normal one, and he was abnormal."

* Starting with an article on Conway's game Sprouts, Martin Gardner became a sort of mouthpiece and later also a good friend of JHC. Likely, without Gardner's columns in Scientific American several inventions and ideas of Conway (including the Game of Life) would not have reached such popularity.

Open Question: Backgammon Long Games

Traditionally, each English Math department has a common room. You get tea or coffee there. But what is more important: you meet colleagues there in all calibres, from the young students over graduates and postdocs, up to honorable professors. Of course, Mathematics is one of the hot topics in talks and discussion. But also games are played "all the time".

Conway liked to live in the common room. And by his aura he tempted many others to stay there for hours and sometimes whole days. Backgammon was one of the games popular in the common room. Conway was not really a strong player, but his preference for backgame positions from time to time led to spectacular comeback wins. During these game sessions ... (one of Conway's good friends) came up with the question if both players can enforce a game of infinite length if both try to achieve this instead of going for a win. The question was never answered. This reviewer believes the answer is yes. The "yes" might come in two different ways: either the existence of a strategy pair that guarantees infinite game length, independently of the dice rolls. Or (somewhat weaker) a strategy pair where the game may end but has infinite expected length.

Acknowledgement

The reviewer is greatfully indebted to Guy Haworth, who made him aware of Robert's biography.