

# Remembering Bill Tutte

U.S.R. Murty

Bill Tutte was a quiet genius who rose from humble beginnings to become a preeminent cryptographer and a pioneering mathematician of the twentieth century.

Accounts of Bill's cryptographic work at Bletchley Park, and his varied and profound contributions to combinatorics can be found elsewhere. Here, I shall confine myself to reminiscences of a more personal nature. His wife Dorothea was an integral part of my acquaintance with him. So, naturally, she is as much a part of these recollections as he is.



Figure 1: Bill and Dorothea Tutte (1987)

## 1 Excursions

I first met Bill and Dorothea in April 1967 at a conference in Chapel Hill, North Carolina. I was then a postdoctoral fellow at the University of Alberta, but had accepted a position at the University of Waterloo as of September of that year. Bill and Dorothea knew that I was going to come to Waterloo and greeted me warmly. Dorothea asked me to join them to go on a drive through the countryside to see the Spring blossoms. I was touched by her cheerful and friendly manner and accepted her invitation. Throughout our excursion, she spoke animatedly and Bill sat back with a bemused smile and relaxed. He would occasionally perk up to point out a rare bird or plant, but mostly, he spoke only when he was spoken to.

I moved to Waterloo in September 1967. My interaction with the Tuttés in my early years at Waterloo was limited to departmental functions. (Bill was actively involved in research, and Dorothea was engaged in teaching pottery.) Dorothea used to accompany Bill when he attended mathematical conferences. I was often invited to join them to go on excursions. I still remember one of them vividly. It was a drive through the Rockies near Banff during the Calgary conference in 1969. There were four of us in the car. Bill was in the front passenger seat, Jack Edmonds was driving, Dorothea and I were seated in the back seats. As usual, Bill was quietly observing the surroundings. Jack was paying attention to neither the scenery nor the roads; he had his head turned towards Dorothea and was carrying on a lively conversation with her. I was scared, but nobody was paying any attention to me!

## 2 Games, Walks, and Suppers

In the early seventies, I started visiting the Tuttés about twice a month in the company of Herb Shank to play **Scrabble**. Usually we went to their house in West Montrose after lunch on Sundays, played three or four games, had some tea, and left around 5pm. Although Bill (in his quiet way) and Dorothea were friendly, it took me a while to bring myself to be on familiar terms with them. Also, I was not used to pets, and their dogs Digby and Murphy were overly friendly. (After Digby and Murphy died, they had only one dog. He was called Digby Murphus West Montrose-II.)

Herb left Waterloo around 1978. From then on, I started visiting the Tuttés regularly on Sundays. One day, we got delayed for some reason, and Dorothea invited me to stay over for supper. After the meal we played a few more games and had a good time. I offered to do the cooking the following week. They liked my cooking and our games club became a games-cum-supper club.

I would go to their place around 2pm. After a brief chit-chat (between Dorothea and me), we would sit down to play Scrabble. The dog would howl from time to time, intensifying his complaints during the third game. As soon as that game ended, we would go out for a walk for about an hour, much to the delight of the dog. Bill was a brisk walker, and Dorothea was full of energy too until about 1991. When it snowed, West Montrose and its surroundings were like a Winter Wonderland. Bill and Dorothea had big rubber boots to trudge through snow.

On returning home, it would be time to eat. As I mentioned before, Dorothea and I took turns doing the cooking. Dorothea often made a roast, which would already have been in the oven during our walk. I often took semi-prepared meals which needed only baking or broiling or simply warming up. One of the favourites was a lasagna bought at the Waterloo Farmers' Market.

After eating and clearing the table, it would be time to resume our games. We would play three more games of Scrabble and then break for tea. There would often be various treats with tea. Bill was fond of cheese, and Dorothea liked butter tarts. The tea-break would be followed by less serious games. A game called **Can't Stop Now** was one of our favourites. The proceedings would end around 10:30 and I would return home.

Bill had a good memory. He remembered fairy tales and poetry, and also other subjects such as history learnt at school. He once played the word *amerce*, meaning *to punish by imposing an arbitrary fine*, and quoted something from the *Magna Carta* where that word was used. He was very pleased with himself when he came up with a word with a nice meaning; an example was *gracile* (an anagram of *glacier*), meaning *gracefully slender*.

Dorothea was happy too when she came up with a nice word. She once played the word *larkiest* (superlative of *larky*) and almost jumped with joy. Both Bill and Dorothea had a childlike simplicity which was very charming.

I had a slight advantage because I started playing scrabble competitively, memorized words, and learned mnemonics for recognizing certain patterns. I guess I had more time to waste than either Bill or Dorothea did! We took Scrabble seriously, but it was not a cutthroat competition. We played open-book Scrabble.

Can't Stop Now is a game of dice. Dorothea and I were more prone to gamble and crash than Bill. He had a conservative strategy which I used to refer to as 'Bill's heuristic'.

Occasionally, there were minor departures from our routine. Each summer, for a few years, we used to go to see a play in Stratford, Ontario. Bill and Dorothea would come to my apartment in Waterloo around 2pm. We would have a shortened session of Scrabble, and

then go to Stratford. (Among the plays we saw, Gilbert and Sullivan's *Mikado* was the play that seemed to amuse Bill and Dorothea the most.) During the Autumn, instead of going for a walk, we would sometimes go for a drive through the countryside to see the Fall colours.

### 3 Conversations

All the above-mentioned activities were often interspersed with conversations. While Dorothea and I chatted away, Bill would relax in his easy chair with Digby on his lap. He would stroke his back and whisper endearments in his ears. Bill liked dogs, but Dorothea loved them. She held the view that pet dogs enhance the physical and mental well-being of their owners, and suggested to me many times that I should get one.

Dorothea sometimes reminisced about the past. She once described to me their trip to England to attend the Queen's coronation. (They acquired passes for the event through their Youth Hostel Association.) She also spoke of their cottage in Dagmar. Apparently Bill used to shut himself up for hours on end in a cabin and work on mathematics. He would say to Dorothea that he had to work hard while he still had the energy, for mathematics was a young man's game. (Their Dagmar cottage was about forty miles from downtown Toronto. I used to jokingly say to Dorothea that some day they would be able to sell their cottage for a million dollars. But they ended up selling it to a friend called Ken who was a tenant for many years. They liked him!)

There were periodic letters from Bill's niece Jeanne, and Dorothea would often tell me about Jeanne's children, especially Ricky and Susan. I have met Jeanne on her visits to Waterloo, but have only heard about her three children. Bill was obviously very fond of Jeanne. Another relative of Bill's, a grand-nephew called Billy Tutte, was living in Boston for a while. His name was mentioned a few times. Dorothea herself had no surviving relatives except for a second cousin by marriage. (A few years after Dorothea's death, Bill and I spent a weekend at this cousin's cottage near Grand Bend. Bill introduced me to the other people present as a friend of Dorothea's.)

I got to know some of the Tuttes' friends in West Montrose. Daveleen and Marie were two of Dorothea's good friends. Daveleen looked after Bill for a few weeks in the Fall of 2000 after his surgeries. Marie took care of Digby after Dorothea's death (Dorothea left some money in her will for this purpose.) Daveleen's husband was also called Bill. So, to avoid confusion, Daveleen used to address Bill Tutte by his second name, *Thomas*.

## 4 Passing Away of Dorothea

Dorothea's health started deteriorating in the early nineties. Then they told me that she had had breast cancer in her younger days and had been operated upon. The cancer had metastasized and now began to invade other parts of her body. She underwent chemotherapy which had some temporary benefits. But there was another complication. She had been suffering from glaucoma for many years. In 1993 she was declared legally blind. She soldiered on, but would sometimes break down and cry. She asked me not to mention her problems to colleagues at the university. Both Bill and Dorothea were very private people.

Dorothea was admitted to Saint Mary's hospital a few days before Christmas 1994. I was planning to travel on December 23. I went to see her at the hospital on the 22nd, but she was in a drug induced coma. After an hour at her bedside, I got up to go and muttered a goodbye. She woke up, held my hand, and said something to the effect that that was going to be our last meeting. I had a feeling that she would not last long. So, before leaving for Auburn, Alabama, the next morning, I left my phone number with Dan Younger. Minutes after my arrival in Auburn, there was a call from Dan informing me that Dorothea had passed away and that the funeral would be held the following day. I flew back to attend the ceremony, which took place at a church in Elmira. It was difficult for me to hold back tears. Bill seemed remarkably calm, but when the time came for him to kiss her before the coffin lid was closed, he broke down and cried. After the funeral, Dan, Phyllis, Bill and I drove to West Montrose. Bill offered each of us an article of our choice from Dorothea's works of glazed pottery.

Dorothea's death brought to an end a chapter in Bill's life. He stayed on in West Montrose for some time after that, and I continued to visit him on Sundays. But he needed a change. His niece Jeanne persuaded him to go to England and live with her. It must not have been easy for him, but Bill sold the house where he and Dorothea had lived since 1962, and moved to Newmarket in 1996.

After living with Jeanne and her family for three years, Bill moved back to Waterloo in 1999. I guess the bonds with this place he had developed, especially those with the University, were strong enough to make him come to the decision that this was where he wanted to spend the rest of his life. (All the colleagues in the Department of Combinatorics and Optimization were delighted to have him back. His work at Bletchley Park, and its significance for the war effort, had become widely known by this time; and even the university administration was cognizant of the prestige his presence brought to the institution.)

Dan Younger helped Bill find an apartment in a building called the

*Beacon Tower* which is close to the University. I used to visit him regularly to play games and share meals. But the magic of West Montrose was no longer there!

## 5 Travels

Bill was interested in travelling. He travelled with Dorothea a fair amount in North America and Europe (including Iceland and Greenland). They also went to far off places such as China, Japan, Australia and New Zealand. The primary reason for some of these trips was academic. But some were purely for sightseeing; he once travelled to the Antipodes just to witness a total eclipse.

Bill visited Brazil twice. The first was in 1999. After a week-long conference in Campinas, Bill and I set out on a trip to Mato Grosso do Sul; Marcelo de Carvalho, who is from that state, was our guide. Our destination was Pantanal, a swampy area which is well-known for its flora and fauna. Marcelo arranged rooms for us in a farm in the centre of that region. Getting to that farm, and returning from it were both adventures which stand out in my mind.

That region was experiencing a severe drought that year. Rivers which would normally be overflowing were shallow. After travelling for about an hour through the muddy waters of Rio Miranda, our boat entered the muddier waters of a tributary called Rio Vermelho. The water was so shallow that the motor of the boat had to be turned off. After a while, even rowing the boat became impossible. We could see that we were surrounded by literally hundreds of crocodiles and, although we could not see them, we knew that the river was full of piranhas. The boatmen got off the boat and pushed it until we reached the farm. Throughout this journey, Bill sat quietly and showed no signs of agitation!

Something worse happened on the way back from the farm to the main road. The pickup truck that was transporting us, together with two farmhands with their chickens and a sick child, got stuck in a muddy pond. The heat was oppressive, the child was in agony and there were crocs all around. But Bill did not seem to be perturbed at all; he started humming some old English songs! It was not always easy to tell how he actually felt as he rarely displayed any feelings of annoyance or frustration or anything!

After leaving Pantanal, we flew south to Foz do Iguaçu to see the famous and spectacular waterfalls, and the hydroelectric dam near *Sete Quedas*, which is an engineering marvel. After the end of our tour, Bill returned to England.

As I mentioned before, Bill came back to live in Waterloo in the Summer of 1999. He became a member of the Golden Triangle

Scrabble Club in Cambridge where I had been a member since 1996. We used to go there on Fridays, but also meet on Sundays.

Lot of things happened in the year 2000. As he seemed to have liked our adventures in Brazil the previous year, I proposed a holiday during the Spring to see the rain forests of Costa Rica. Bill enthusiastically agreed and went shopping with Dan to buy tropical gear. He was especially pleased with a pair of shorts he bought that could be extended into long pants.

Bill appeared to enjoy our brief holiday in Costa Rica, but it was clear to me that he was getting weaker. (Even during our Brazilian holiday the year before, I noticed signs of diminution of his stamina.) He became anaemic, and tests showed that he had tumors in his colon. As he was too anaemic to be operated upon, they first gave him a blood transfusion. When Bruce Richmond and I went to the hospital to bring him home, he joked that he had turned into a vampire and was thriving on somebody else's blood. A few days later, he underwent two surgical procedures. Then, as I mentioned before, he spent a few weeks convalescing at Daveleen's place. Although he was still weak, he attended my sixtieth birthday party on the 23rd of December.

By March 2001 Bill felt well enough to make his second visit to Brazil. Ricardo Dahab made the arrangements for this trip. Bill and I flew together from Toronto to São Paulo. We first participated in a week-long conference in a city called Fortaleza in north-eastern Brazil. It was held in a beautiful hotel by the sea. Bill gave a talk on his work at Bletchley Park.

From Fortaleza we flew to Manaus, the capital of the state of Amazonas, and then travelled by motorboat for about three hours to get to the Treetop Hotel. This hotel, where we spent four nights, is located in the middle of an enormous expanse of water and is built on stilts. Each day we were taken by boat to see a nearby island or a native village. We saw many interesting trees and plants and learnt of their medicinal significance, and hundreds of colourful birds. (Bill was an avid bird watcher. For many years, Bill and Dorothea used to visit Point Pelee every Spring to watch the return to the north of migratory birds.)

We spent the last two days of our visit to the Amazon region at the Tropical Hotel in Manaus. On the last night of our stay there, we went to the dining room around 8pm. Halfway through our meal, a band started playing deafeningly loud music. Bill was obviously uncomfortable, but did not complain. After finishing the main course, he simply said "Perhaps we should skip dessert". This was typical of Bill!



Figure 2: Bill and I in Fortaleza

## 6 Other Interactions

Over the years, I attended many talks given by Bill. He prepared meticulous notes for his lectures and wrote them out on sheets of ruled paper. He had an understated, typically British, sense of humour. He also had a sense of drama. His presentations would often build up to a surprisingly beautiful formula or theorem. He would state his conclusion and, pleased with himself, would finish with a flourish by tapping the desk with the gathered sheets of his notes to square their ends.

Bill had an unorthodox and remarkable way of drawing circles on the blackboard, using his forearm as a sort of compass. He would clasp the chalk with all five fingers, twist his forearm (and wrist) in an anti-clockwise direction, and by starting around the three o'clock position and rotating and untwisting the forearm at the same time, he would succeed in tracing a large, nearly perfect, circle.

My co-author Adrian Bondy and I together organized conferences in Bill's honour for his sixtieth and sixty-fifth birthdays. In preparing the list of speakers for the one on his sixtieth, we approached him and asked him for suggestions. If Bill had a mathematical hero, it was Hassler Whitney, and that was the only name he suggested. Whitney accepted the invitation and gave a talk on teaching mathematics in schools.

I digress to tell a story that Dorothea once related to me. In the early sixties, Bill was invited to Princeton for a few weeks, and they were accommodated in a beach-side cottage. One evening, around supper time, Whitney showed up at their cottage. After exchanging greetings, he mentioned that he was on his way to music practice, and inquired:

“Bill, do you play any musical instruments?”

Bill replied:

“No Hass, I am afraid I don’t.”

On hearing this response, perhaps disappointed, Whitney bade them a polite goodbye, and left abruptly. That was the only time Bill saw Whitney during their stay in Princeton! Like Bill, Whitney was not a man of many words. (In his autobiography, the Polish-American mathematician Stanislas Ulam wrote the following about Whitney:

He was friendly, but rather taciturn - psychologically of a type one encounters in this country more frequently than in central Europe - with wry humour, shyness but self-assurance, a probity which shines through, and a certain genius for persistent and deep follow-through in mathematics.

When I read this, it occurred to me that some of it may also be used to describe Bill.)

The sixty-fifth birthday conference we had was a lot of fun. Adrian had two brilliant ideas. At the conference banquet, we gave Bill a T-shirt with **Last year I was a perfect square** printed on it. We also presented him with a specially crafted **perfect rectangle** in which the nine constituent squares were made of different precious woods. Despite its considerable weight and size, Bill lifted it with ease and, with a beaming smile on his face, showed it to those present.

In 1974, Adrian and I finished a draft of our first book *Graph Theory with Applications* and submitted it to Macmillan. Bill was kind enough to write a letter supporting its publication. When the book appeared in 1976, he reviewed it for the Bulletin of the American Mathematical Society under his *nom de plume* Blanche Descartes. While the review was complimentary, it was more about his *alter ego* Blanche and her vision of graph theory than about the book; she waxes poetical, laments that the visual aspect of graph theory is being obscured by the invasion of algebra, and concludes with the compliment: Why, Appendix III alone (Some Interesting Graphs) is worth “a thousand pounds a puff”. Seven of the eight references are to her own works, the eighth being to Shakespeare’s “As You Like It”. I wonder if Bill would ever have written such a review under his own name!

Bill retired from his regular duties at the university in 1985. During his last term, he gave a course of twelve lectures entitled *Graph Theory As I Have Known It*. Some years later, I persuaded him to revise the notes that he had prepared for those lectures, found a publisher (Oxford University Press), and had them published as a book. He gave me an autographed copy in which he inscribed *To Rama Murty*. (Although he addressed me as *Murty*, he knew that *Rama* was the name by which I was known in my family.)



Figure 3: Bill Tutte celebrating his eightieth birthday

Towards the end of his life Bill was working with Robin Wilson on a book about Whitney's contributions to graph theory. As always, Bill was typesetting his notes himself. (I was trying to help him to use LaTeX.) Unfortunately, that project remained unfinished.

I first saw a reference to Bill's cryptographical work in Alan Turing's biography by Andrew Hodges which came out in the 1980's. I asked him about it at one of our Sunday get-togethers. But he was reluctant to say anything about his work at Bletchley Park. It was only around 1997 that he started to speak about his work there. Now, through his own published articles, Dan Younger's well-researched and dedicated efforts to bring awareness of Bill's work on the Fish machine to the mathematical community, and the BBC documentary *Forgotten Heroes of Bletchley Park* we know the pivotal significance of Bill's wartime contributions to code-breaking.

Once I asked Bill which of his many significant contributions to combinatorics had brought him the most satisfaction. His answer surprised me. He said, without any hesitation, that it was his enumeration of convex polyhedra that pleased him the most. He added, by way of justification, that he felt that he had accomplished something by answering a question that had engaged mathematicians since antiquity.

## 7 Final Years

As I remarked earlier, Bill enjoyed a robust constitution during most of his life. But his health started declining dramatically during his eighty-third year. He succumbed to cancer and congestive heart disease and passed away two weeks short of his eighty-fifth birthday.

It is a matter of satisfaction to his friends and admirers that, during his final years, he was able to speak about his wartime work at Bletchley Park, and win acclaim for it. The Canadian Government honoured him by making him an Officer of the Order of Canada. But Bill's services to his homeland have yet to be adequately recognized by the British Government. I often wonder if this has anything to do with his humble origins!

**Acknowledgements:** I would like to thank my friend and co-author Adrian Bondy for going through earlier drafts, pointing out errors, and suggesting improvements. He and I organized two conferences in honour of Bill and edited their proceedings. Bill was one of the three mentors and friends to whom our second book *Graph Theory* was dedicated. I would also like to thank my friend, collaborator and LaTeX guru Cláudio Lucchesi, my student Nishad Kothari, and Dan Younger for their help.