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Special Issue in Honour of Dan S. Archdeacon Guest Editorial

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On February 15, 2015, Dan Archdeacon passed away at his home in Burlington, Vermont, after a short battle with cancer.

Dan was born in Dayton, Ohio, on May 11, 1954. He spent his early years in Centerville, Ohio, and went on to earn a B.A. at Earlham College (1975), and a Ph.D. in Mathematics at The Ohio State University (1980). There, under the supervision of his advisor Henry Glover, he wrote the groundbreaking and highly cited dissertation

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entitled, "A Kuratowski Theorem for the Projective Plane" which contained the proof that there are exactly 103 minimal obstructions for a graph to be embeddable in the projective plane. From 1980 until 1982, Dan was an Instructor at the University of Kansas. In 1982, he moved to Vermont and joined his graduate school roommate, close friend and colleague Jeff Dinitz on the faculty of the University of Vermont (UVM). Recognized as a leading expert in topological graph theory, Dan published over 80 articles, was an invited speaker at mathematics conferences across the globe and held the position of Visiting Professor at universities in New Zealand, Japan, Denmark, and England. Dan's talks were always well organized and entertaining and his colloquial manner made them very much fun to attend. Dan had a great sense of humor and a contagious enthusiasm for mathematics and many other things.

Dan helped shape the development of scholarship in his field: a prodigious reviewer (averaging over 20 referee reports per year), he was on the Editorial Board of the *Journal of Combinatorial Theory (Series B)* from 1987 to 1999, and on the Editorial Board of the *Journal of Graph Theory* from 2000 until 2015, acting as the Managing Editor from 2000–2007. From 1987 until 1995, Dan and Jeff Dinitz co-organized the highly successful series seven Vermont Summer Workshops on Combinatorics and Graph Theory. Dan also was a co-chair and local organizer for the SIAM Discrete Math Meeting held in Burlington in 2008. Dan started and maintained an online compendium of open problems in topological graph theory, which was an inspiration to several generations of the researchers in the field.

Dan was widely regarded as a leading expert in topological graph theory. His most cited work is his early breakthrough paper in 1981 on the Kuratowski theorem for the projective plane [2]. His other highly-cited and regarded works (including [18, 25, 26, 28, 38, 41, 42, 51, 67]) all demonstrate his exemplary skills at solving some of the most perplexing challenges involving graphs embedded on surfaces. Dan has also demonstrated his vast knowledge of graph theory and combinatorics by contributing to significant papers in domination theory (e.g. [65]), and design theory [1,24,31].

Dan especially enjoyed mentoring young scholars: he supervised six M.S. students and had two Ph.D. students, Melanie Brown and Kirsten Stor. He remained profoundly dedicated to his students and passionate about his field, even in the last days of his life. Dan taught a wide variety of courses, probably more different courses than anyone in the history of the Mathematics Department at UVM. One of Dan's former students commented that he had a unique talent for turning difficult mathematical concepts into fun puzzles—this was certainly true. In 2003–04, Dan was honoured by UVM as a University Scholar, the highest research honour bestowed by the University.

Besides being a world-class researcher and an inspiring teacher, Dan was an exemplary Department and University citizen. He willingly sat on a multitude of committees during his time at UVM. In particular, he was the longtime chair of the University Faculty Standards Committee, he was the head of the Departmental Graduate Committee, and he was on numerous search committees including for the University Provost and for the College Dean. No one took these committees more seriously or worked more diligently on them than Dan.

Dan had many loves in his personal life, most notably his wife Mara and sons Talis and Nick. An avid skier at Mad River Glen and fan of the Ohio State Buckeyes, Dan also enjoyed kayaking on the Lake Iroquois (his home was situated on that lake), sitting on his tractor and mowing his property, hiking in the Green Mountains, playing softball with the Math Department team (the "Eulers"), and traveling the world with Mara. He was also an avid reader and for many seasons he was in a fantasy baseball league. He was exceptionally sharp and witty, with a keen sense of humor. Dan was driven by an unwavering sense of duty—to his work, to his family, and to his friends; he never failed to follow through on his commitments and was ever devoted to the wellbeing of the many people he cared for in life.

This issue of the *Australasian Journal of Combinatorics* is a recognition of Dan's contributions and influence in the area of topological graph theory. In this introduction we include tributes to Dan written by Jo Ellis-Monaghan, Jonathan Gross, Paul Bonnington, and Jozef Širáň. We also include a complete list of his publications. This is followed by the contributed papers, written by some of Dan's close collaborators, colleagues and friends. Dan was extremely productive in the last few years of his life and we are pleased to have four of his coauthored papers in this issue.

We would like to personally thank all of the authors who contributed their work to this volume, and the people who acted as referees for the papers. The quality, breadth and depth of these papers is a fitting tribute to Dan—the consummate academic. He would have loved to read every one of them!

Reminiscences of Dan

Jo Ellis-Monaghan

Dan was a remarkable mathematician, and the very papers in this special issue testify to his lasting legacy as a gifted graph theorist. He was also a warm and wonderful human being, and he significantly advanced the field of graph theory not only through the many mathematicians whose research he influenced with his own work, but also through the encouragement, collaboration, mentoring, and example he offered. Dan was incredibly kind. We first met in 1984, when he nearly tripped over me and another brand new graduate student as we were sitting, apprehensive about starting a new program and a little lost, blocking the front steps of Lord House (the main Math Department building at UVM). Dan was the first to say hello, make us welcome, and tell us a bit about what to expect. He made a point of descending regularly into the basement grad student 'dungeon' just to see how students were doing and offer ongoing support.

We could count on Dan for donuts. He was funny, self-deprecating, and a gifted teacher. He made a point of teaching as wide a range of topics as possible, covering almost every course in the UVM curriculum, and this both reflected and contributed to his great flexibility and creativity as a mathematician. He had a warm and easy rapport with his students, and we clearly thought so highly of him as a teacher that

he could freely make a joke of giving us a photo of his son (whom he said would be homeless if he didn't get tenure) and cider donuts with the course evaluation forms. We ate the donuts, wrote glowing evaluations, and Dan of course got tenure. His sons are grown and doing well.

In the early days, Dan often kept small infants on the floor of his office while he was working. It is hard to over-emphasise how important this example was to me as a young female mathematician, particularly since I started my own family before finishing my PhD. To learn, and especially to learn from a man in the 1980's, that it was possible to be a good parent and a good mathematician simultaneously was a pivotal moment in my career, and I will always be grateful for his example and the top-of-the-line stroller he helped pick out for my first baby.

Dan was a bit of a couch potato—as long as there was a whiteboard covered in math across from the couch. Over the years, the combinatorialists at UVM progressively commandeered Mansfield House, an historical president's residence repurposed as offices. Dan's and Jeff Dinitz's offices anchored the second floor, being situated on either side of a comfortable lounge area equipped with comfy chairs and couches and with whiteboards around the perimeter. Dan would sit on the couch staring across at the whiteboard and you could see him thinking. This lounge (affectionally dubbed the "combo lounge") became a collaborative cooking pot for his many visitors and coauthors, and was the birthplace of countless theorems and papers. He always asked the right questions and he brought out the best in everyone else's thinking.

Dan organized many, many conferences over the years, including summer conferences at UVM and then jointly at SMC, and Discrete Math Days. He co-organized the joint SMC/UVM Applied Combinatorics Seminar for a long time. The topics ran the gamut of pure and applied combinatorics: design theory, statistical mechanics, algebraic combinatorics, VSLI design, topological graph theory, DNA sequencing and assembly, computational complexity, and more. Dan was interested in it all. He had an enviable ability to see the heart of the matter in any presentation, no matter what the subject, and without fail had several very perceptive and relevant questions at the conclusion of every talk. He made a particular point of encouraging and engaging with early-career speakers.

At every step of my career for the past thirty-odd years, Dan was an indefatigable and astute mentor and supporter. We were colleagues, collaborators, coauthors, and occasional conspirators. He regularly and generously tipped opportunities to other people, and so over the years I learned from him about refereeing, writing, editing, presenting, negotiating, campus politics, teaching, professional ethics, work-life balance, and more. Throughout it all he was always very kind and always very wise. From the simple single moment of an insightful and encouraging question or suggestion leading to new directions in someone's research, through years of conversation and collaboration with his many colleagues, he contributed to the growth of so many other mathematicians, and hence to the whole field. He is greatly missed and will be long remembered both as a deeply influential mathematician and also simply as a warm and caring person.

Jonathan Gross

Dan was involved early on in major programmatic developments in topological graph theory, starting with his Kuratowski theorem for the projective plane, which established that the number of forbidden subgraphs in non-simply-connected surfaces can be much larger than in the sphere. I could easily continue talking about Dan's mathematical accomplishments. However, my focus here is primarily on how much we enjoyed his exuberant presence. We share the recollection of how he could fill a room with energy, and this experience of Dan will be sadly missed. I want to think the editors for enabling me to include in this memorial volume my acknowledgment of a radiant personality and a gift at humor[1] that made Dan Archdeacon very special.

In the 1990's, Dan co-organized a couple of conferences at Smuggler's Notch and at the Trapp Family Lodge. These conferences gathered the topological graph theory community together, in an ambiance that provided, beyond the math, the opportunities for some of us to bring our spouses, significant others, and children. For some of us at these conferences, Vermont is reachable by a moderate drive. However, to draw mathematicians from far and wide, which Dan succeeded in doing, it takes the construction of a really good conference. At these conferences, we got to know each other better. His years as an editor of the *Journal of Combinatorial Theory, Series B*, and the *Journal of Graph Theory*, were additional service to the graph theory community.

Even his clothing would add sparkle to our conferences. It was part of his spirited presentations at conferences and at special sessions of the AMS meetings that made his talks a highlight. Let's face it, dear colleagues, for most of us, professional dress means relatively conservative clothing, informal to be sure, but nothing that draws attention to itself. But not for Dan. Dan dressed with flair—often in brightly coloured island shirts. And even if we aren't up to matching Dan's level of flashiness, at least a few of us have been inspired by Dan's example to occasionally wear clothing with some more personality ourselves.

In contributing to so many topics within topological graph theory, it seemed that Dan wrote his papers and explained his results at meetings in a way that made the members of our community feel that he was supporting our own initiatives in the various topics. Many of us were co-authors with Dan on at least one paper. It came as a shock when we understood why Dan had begun to decline invitations to speak. We will miss his larger-than-life presence.

Paul Bonnington

It was 1992, and I was in the final stages of my Ph.D. in New Zealand. My first paper had just been accepted for publication [33], co-authored with my supervisor Charles Little, and somebody I had never met but immediately admired (Dan). His contributions were absolutely masterful! "Where does he get this insight? How does

[1]For instance, Dan published a pair of consecutive papers in the *Journal of Graph Theory* entitled "The nonorientable genus is additive" and "The orientable genus is nonadditive".

he think? Could I meet him?", I thought.

Over a year later, after a successful post-doc in Austria, I was offered a tenure-track position at the University of Auckland. But there was a problem: that position wouldn't start for another five months. I nervously reached out to Dan. "Any chance I could come to visit you, between jobs?" Almost immediately I got the response. "Absolutely!" Dan was gracious and understanding of the situation. Little did I know that it would be the start of a close friendship and mathematical collaboration that would span over 22 years and now, with this issue, 14 joint-papers.

Shortly after Dan's passing I saw a billboard advertising my university. "New problems are solved by new thinking" it proclaimed. Reflecting now, this captures how I saw Dan approach mathematics. Working at the whiteboard with Dan was intense but exhilarating—Dan was the fastest and sharpest thinker I have ever known. And whenever we hit a problem along the way, he started throwing completely new thinking at it. He had finely-tuned intuition, and with each new idea he was rapidly able to discern its merits.

At first I couldn't keep up; every new idea had me spinning as I tried to understand the consequences. But he taught me (and many others) to trust my instincts. He had a way that made everybody feel comfortable doing mathematics around him. To him there were no bad ideas, just ideas whose time hadn't come. He taught us to appreciate the pure joy and privilege of problem solving, and that joy has sustained me since.

One of his proudest moments was when we, with Jo-Ellis Monaghan, solved a conjecture of Grünbaum on realizations of toroidal triangulations [67]. This 30-year-old problem required an arsenal of new approaches and new thinking—some of the ideas he applied here are stunningly beautiful.

I was honoured that he chose to spend two sabbaticals with me in New Zealand, and in return I could call Vermont my second home. I feel very privileged that someone I connected with professionally was also one of my closest friends for many years.

Jozef Širáň

It was 1990. People in Czechoslovakia and other post-communist countries were enjoying their first year of freedom after the fall of the iron curtain. For me, as for many other researchers, this also meant freedom of travel, without needing permission to leave the country. And this was the time when Bruce Richter kindly invited me to visit him in Ottawa for two weeks. 'This is a perfect timing', he said in our email exchange, 'because we can go down to Vermont the last week of June for a workshop organized by Dan Archdeacon'. And this was the first time I met Dan.

My meeting him, and the June 1990 Stowe workshop he set up, turned my academic life upside down. At that time, seven years after completion of my Ph.D., I considered myself still at the beginning of my research career, trying to make advances in some open problems in topological graph theory. By reading books and

papers, I knew all the about 25 'big names' in this area of research but never met any of them. And, suddenly, there they were, all of them, at Dan's workshop! I felt like I was in a dream, but just try to imagine being in my shoes after lifting all the traveling restrictions. And there was Dan, with his highly original approach to running the meeting: full of care, enthusiasm and informality. To give one example for all, at the very beginning he said: 'There is no program schedule. Everybody is asked to sign up for a talk, and then we go by first come – first served basis'.

During the days of the workshop we got together and started working on our first joint research paper. But what a start it was: I saw for my very first time a real fast thinker, approaching the problem of construction of highly symmetric maps with certain extra properties in a completely novel and, for me, a totally non-standard way.

We then managed to get together a couple more times and a bit later I was extremely lucky to get a two-semester position at the University of Vermont and thus a possibility to really work with Dan (and also with Paul Bonnington at the same time). The 8 months of intense research under Dan's research leadership were one of the true highlights of my academic life. We spent hours not just discussing mathematics but also history, culture, sports, and so on. He, together with his friends Jeff Dinitz, Jonathan Sands and Dan Zwick, took me out a number of times on the weekends to enjoy the beauty of Vermont, including skiing in the wonderful Mad River Glen area and kayaking in the Adirondack Lakes.

Later, Dan visited me in Slovakia—with the original intention to spend a couple of months there, but due to an unfortunate foot injury (which occurred while playing basketball) he had to cut his visit short. We nevertheless managed to start another couple of papers. Since then we met each other in various parts of the globe (Auckland, U.S., Canada, and Europe) at various conference and I feel extremely privileged to have a total of 12 papers with Dan. The last two joint papers we managed to (almost) complete when came to spend 4 months of his sabbatical visiting me at the Open University in Milton Keynes, U.K., in the first half of 2010. Needless to say, I was very proud of this choice by Dan, and so was the Maths Department at the Open University.

The work on our paper with Marston Conder on 'super-symmetric' maps that we almost completed at the Open University was again a demonstration of his non-standard way of looking at problems, as he has done so many times during our collaboration. Dan suggested we construct these 'super-symmetric maps' by lifting with branch points at both vertices and faces. Fine, but how can one demonstrate that new 'super-symmetries' will be there for you? Well, it turned out that they were there for Dan—by some magic mathematical forces that he certainly possessed! When I asked him how he got this idea he answered that he thought of images created when looking into a kaleidoscope. He then insisted we call such maps 'kaleidoscopic, with trinity symmetry', fully reflecting his imagination.

Thank you so much for everything, Dan. I miss you a lot. And I am sure that others do as well.

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