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In Memoriam, Martin Isenburg, 1972–2021

To whom it may concern,

Martin Isenburg was born July 6, 1972 in Weiskirchen, Germany and died in early September 2021 (between the 2nd and 10th) in Sámara, Costa Rica. His software and algorithms for Geographical Information Systems have been influential and very popular. He was also a charismatic and socially fearless friend.

Martin obtained his Master's Degree in Computer Science from the University of British Columbia, joining the program in August 1998 and completing his M.Sc. at the end of 1999 under the supervision of Jack Snoeyink. Martin and Jack both moved to the University of North Carolina at Chapel Hill in January 2000, and Martin received his Ph.D. at the end of 2004, still under Jack's supervision. Jack has written, "As my M.Sc. and Ph.D. student from 1998 to 2005, he was a delight because he was always teaching me new things. He also made me look good: All I had to do was to keep sending him to conferences in interesting places, or to visit and collaborate with top people in the field, and he keeps producing new results, papers, and ideas and adding my name to them."

I, Jonathan Shewchuk, had the pleasure and privilege of supervising Martin when he visited the University of California at Berkeley as a Post-Doctoral Scholar from the summer of 2005 to the summer of 2007. I don't remember exactly how or when I first met Martin, but it was probably during one of his summer visits to the International Computer Science Institute in Berkeley. What I do remember is that he showed me the video he had made to illustrate his paper *Mesh Collapse Compression*; the production quality was outstanding compared to the standards for research videos at that time. The paper appeared in the Twelfth Brazilian Conference on Graphics, Patterns, and Images (aka SIBGRAPI 1999) and the video appeared in the Fifteenth Annual Symposium on Computational Geometry (1999). I was so impressed by the video, I obtained a copy of the videotape from Martin and showed it to my class on Mesh Generation at Berkeley.

In early 2004, Jack Snoeyink, Martin's Ph.D. advisor, contacted me about the possibility of writing a grant proposal to fund a post-doctoral position for Martin, who was very keen on the idea of living in Berkeley. Martin, Jack, and I (but mostly Martin) put together a very nice proposal very quickly, and it was duly funded by the National Science Foundation in September 2004. I was a bit astonished by how easy the whole process was, but Martin's high-quality writing and previous research successes made it easy. He arrived at his new office at Berkeley in July 2005.

I had the good fortune to work with Martin during what was probably the high point of his career and life. Martin was extremely energetic, productive, and creative throughout his two years at Berkeley. Before, during, and after that time, he pioneered ideas and software for *streaming geometry processing*, which have become standard methods for handling huge geometric data sets on commodity computers (like your laptop). “Huge” meant hundreds of gigabytes in 2006, and means many terabytes today. His papers and software included algorithms for streaming mesh compression and decompression, mesh simplification, interpolation, isoline extraction (for mapmaking), visualization, and rasterization (to create high-resolution Digital Elevation Maps, aka DEMs). These operations are central to the field of *Geographical Information Systems* (GIS), which was and is a large industry. We detailed Martin’s amazing streaming GIS toolchain in a paper in *GIScience 2006*.

Perhaps the most impressive of Martin’s achievements in streaming geometry were the programs he wrote at Berkeley, and the algorithms we developed, for computing Delaunay triangulations at a very large scale, in two dimensions and three dimensions. The two-dimensional triangulations are known in GIS as Triangulated Irregular Networks (TINs), and are a central part of the field. The main paper describing these algorithms, *Streaming Computation of Delaunay Triangulations*, was co-authored with me, Jack, and Yuanxin Liu, and appeared at SIGGRAPH 2006, the premier conference in computer graphics. (He had two other papers published in SIGGRAPH as well, which has an acceptance rate of about 15%.) I was astonished and delighted to discover that it ran about a factor of twelve times faster than the previous best out-of-core Delaunay triangulator. In 2006, it could construct a nine-billion-triangle Delaunay triangulation of a planar point set in under seven hours with an off-the-shelf laptop computer plus a firewire drive, using 166 MB of memory to produce a 152 GB triangulation. Better than a billion triangles per hour!

I hope you will humor me while I describe the most important technical idea that Martin contributed to the world. A *streaming* computation makes a small number of sequential passes over a data file (ideally, one pass), and processes the data using a memory buffer whose size is a small fraction of the length of the stream. One of Martin’s innovations is to store meshes in a *streaming mesh format*, and points (to be triangulated) in a *streaming point format*. Streaming mesh formats contain not only points, triangles, and tetrahedra, but also *finalization tags* that certify when a point (or another entity) is seen for the last time. Finalization tags permit a geometric algorithm to output partial results and discard associated information, freeing room in memory for more data to stream in. For example, when a vertex finalization tag appears in an incoming stream, it tells the application that no more triangles will arrive that adjoin that vertex. Therefore, the application can discard the vertex and some of the adjoining triangles, making room for more to stream in. Martin’s streaming Delaunay triangulation implementations use a related idea called *spatial finalization*. These ideas make it possible to process huge data sets in a small amount of memory, which completely changes our notion of what kinds of geometric processing ordinary computers (as opposed to large servers or supercomputers) can do.

Martin’s ideas arrived with perfect timing, coinciding with the advent of LIDAR (Light Detection and Ranging), an airborne laser scanning technology that can quickly measure the altitudes of billions of points of landscape. To give one example particularly relevant to Martin and Jack, the North Carolina Floodplain Mapping Program was initiated in 2000 in response to the flooding of thousands of square miles of eastern North Carolina by Hurricane Floyd in 1999. The program was charged with updating North Carolina’s flood hazard data and identifying areas of the state at risk of flooding. By 2006, North Carolina had gathered high-resolution elevation data for the entire state . . . about four years later than originally intended, because of the complexity of processing. The need to process billions of measurements of land elevation was rising sharply everywhere just as Martin provided the tools to meet this need.

Martin was charismatic and fun. While in Berkeley, he lived in a house with about five roommates, with

a communal ethic that had the residents taking turns cooking group dinners. During that time, they also started farming chickens in their back yard. I visited Martin there—particularly while we were writing the SIGGRAPH paper on Delaunay triangulations—and I was impressed by the stately old home with its classic wooden features. He became very enthusiastic about the chickens.

Martin's job search was exciting: he received job offers from the National University of Singapore, Hong Kong University, the Lawrence Livermore National Laboratory (LLNL), and the Environmental Systems Research Institute (ESRI). He had a near-miss at his first choice, the University of California at Santa Barbara; he was one of eight candidates and the graphics group liked him, but ultimately the department hired in a different research area. Ultimately, Martin chose Livermore because he loved the Bay Area and wanted to stay.

I will always wonder if his life would have turned out very differently if he had taken the job at the National University of Singapore (his second choice). Because, unfortunately, his life took a dark turn in the next few years.

Martin's first two years at LLNL seem to have gone well. He bought an old farmhouse in downtown Livermore and raised chickens there. But by 2010 (perhaps sooner), he was afflicted by a severe bipolar disorder, which haunted him the rest of his life and ultimately took his life. By March 2010, he entered a manic episode that lasted several months. I had dinner with him once during this period. He spent the meal obsessively describing his plans to create an urban chicken farm in which he would use laser range scanning and surface reconstruction algorithms to transmit online, 24-hour, three-dimensional live animations of his chickens in action to the world. "Laser chickens," for short. He told me that he was looking for funding for this project, and that he had had some online contact with Britney Spears and thought that she, or some other Twitter personality, would probably provide the two million dollars of funding he needed. It was a very entertaining dinner; his odd notions that celebrities were going to invest millions of dollars in his projects were the only real indication to me that something was not right.

During our dinner, Martin's intensity seemed harmless to me, but soon there followed a train of long, bizarre emails from Martin (to many recipients) through which he cast paranoid accusations and alienated his co-workers and many of his friends. Fortunately, many of his friends recognized the signs of his growing insanity and made heroic efforts to help him. Unfortunately, he was arrested (I think for violating a restraining order against his ex-girlfriend, though I may be mistaken) on July 13. He spent several months in the Santa Rita Jail, and he was deported home to Germany in September or October. (LLNL terminated his position in July, so he was out of immigration status.) I regret to say that, as I was busy and had no car to visit him with, my only contact was to have Amazon mail a book to him at the jail. (I found out later that they didn't tell him who sent it.)

Although he was in very bad spirits upon regaining some clarity and realizing what he had done, he was able to stabilize his mental health at his father's home in Germany. I quote Martin's words from an email he sent me in February 2011, words that I think he wants the world to know: "Unfortunately persons experiencing their first manic episode have no idea they are manic. Regrettably, the LLNL psychiatrists just stripped me of my badge but did not connect with any treatment program. For three months I 'worked' in coffee shops to get support for my ideas elsewhere with my untreated mania getting worse and worse. . . . Medically, manic episodes are quite easy to treat. All it takes is 1500 mg of depakote for 3–4 weeks. But one needs to put serious efforts into either 'tricking' or 'forcing' the manic person into taking medication. LLNL's choice to have me deported before the authorities were able to 'force' me into treatment was unfortunate. It wreaked havoc to both my social and financial life as well as my 15-year academic career in North America."

"The worst part is that I cannot return home, home to the Bay Area that is. Since coming to Berkeley in

1996 I had always planned to settle down here one day. But as soon as I do buy a house . . . boom . . . all falls apart. . . . I mostly sit all day in a small room in my Dad's house. I don't really know anyone here. All my usual activities . . . biking, nature hikes, skiing, beaches, road trips, urban farming, cooking, green grassroots stuff, . . . and the people I did those things with are gone. So I sit and work on my LAS software to pass the time and to avoid thinking about my losses."

Martin's fortunes picked up again as his LAStools software and his personal company, rapidlasso GmbH, became successful. During the decade of the 2010s, Martin told me he had paying customers that included government agencies like the U.S. Geological Survey, the National Oceanic and Atmospheric Administration, and the U.S. Army Corps of Engineers, and survey companies like Fugro, Blom, COWI, and Watershed Science Inc. He also had about 40 universities using his software. He wrote on his company website, "Since the beginning of 2013 rapidlasso GmbH has conducted well over 50 seminars, training events, and hands-on workshops at universities, research institutes, and government agencies in Thailand, Malaysia, Myanmar, Vietnam, Indonesia, Singapore, Taiwan, Japan, and the Philippines." LAStools and rapidlasso won two Wichmann Innovation Awards ("in the startup and software categories") at the conference INTERGEO in 2017.

The catalyst for Martin's efforts during these years arose when Martin learned about "Project NOAH," which ultimately became a 15-university project to scan the entire Philippines at 2 samples/m² to assist with water management and flood mapping, funded by the Philippines' Department of Science and Technology. Martin loved teaching as much as writing software, and Project NOAH provided him with the perfect opportunity to support a meaningful project and teach students how to use geospatial processing tools (whether he was paid or not). He visited the Training Center for Applied Geodesy and Photogrammetry at the University of the Philippines–Diliman to help. Hence began a long love affair with the Philippines, its people—many of whom he trained in LIDAR analysis—and its beaches—on which he did a great deal of software development in the ensuing years, laptop on table on sand. He ultimately bought a vacation home in Costa Rica so he could always work on the beach.

Several recent memorial web pages about Martin document his impact during these years. OpenTopography writes, "Martin was a giant in the field of LIDAR and topographic data processing. . . . His tools were easy to use; they worked and scaled; and they drove standards and became the foundation of countless LIDAR processing workflows." Marco Bernasocchi writes, "Martin Isenburg was one of these great minds—his work on LASTools and making LiDAR data accessible to the world was truly groundbreaking. The .LAS/.LAZ formats for point cloud data have become ubiquitous, supported by virtually all point cloud processing tools in existence." Sam Pfeifle writes, "he was a tireless advocate for the democratization of scan data throughout the world, working in his fashion to get taxpayer-funded government data freely released for public use. Often, it was in pursuit of preservation efforts and other projects designed to make the world a better and more equitable place." I note that one outcome of those preservation efforts is that Martin received a Green Asia Award from the Chinese Society of Photogrammetry and Remote Sensing.

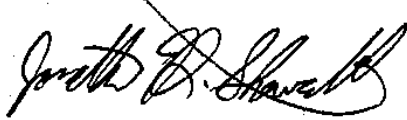
I did not follow Martin closely during his rapidlasso years, but he sent me occasional Facebook messages about his travels. As we were both traveling to the Philippines regularly, he hoped we would be able to meet there sometime. Sadly, the timing never worked out. Martin had another major manic episode—he sent me a lot of Facebook messages about laser chickens starting in July 2020—followed by a depressive episode in summer 2021. He was stranded in Costa Rica by COVID-19 travel restrictions. He lost the ability to manage his illness, and his friends and family were unable to intervene in person as they had in Livermore in 2010.

In his last blog post, Martin writes, "Suddenly the pandemic hit and trapped me . . . in Costa Rica. The virus stress triggered my long dormant bipolar condition into a manic episode. Alone and under lockdown in

small village far from friends and family there was nothing that could stop my mania. It spun out of control and lasted about a year. . . . I am in a place now where my mania cannot hurt the people I love. I am sorry for all the pain I caused.” He was found in his home on September 10.

It is with sadness that I look back on a brilliant mind—and a charming personality—that shone very brightly for a while, but could have illuminated the world longer and more intensely if not handicapped by his late-onset mental illness. May God gather Martin’s soul into His Kingdom, grant him a resurrected body free of illness, and protect him and his brilliance for eternity.

Sincerely,

A handwritten signature in black ink, reading "Jonathan D. Shewchuk". The signature is written in a cursive, flowing style with a large, prominent initial 'J'.

Jonathan Shewchuk
Professor

Postscript: I am pleased to learn that the conference *3D GeoInfo* is naming their best paper prize in Martin’s honor this year. They have asked Jack to say a few words and present the first Martin Isenburg Award on October 13, 2021.

Martin himself has posthumously won the David A. Hastings Award, presented at FOSS4G-ASIA 2021 in Dhulikhel, Nepal.