Karl Gustafson

The Crossing of Heaven

Memoirs of a Mathematician

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“Who can know one’s own destiny?

To the Fabric of Our Lives
And to its Richness and Beauty

Foreword

A few days before his arrival in Greece for the Web Science Master Course Lectures, Karl Gustafson asked me if I would write the Foreword to his autobiography. I agreed readily, of course, considering it a great honor and a personal pleasure. Moreover, I was excited by the prospect, for three particular reasons:

1. I have known and admired Karl for many years: We first met in 1984 when he visited Brussels, where I was working toward my Doctorate Thesis on Time Operator, Irreversibility and Complex Systems with Ilya Prigogine and Baydyanath Misra. With Karl Gustafson, the trinity of my thesis advisors was complete. Since then, I have been privileged to collaborate and discuss with him several conventional as well as unconventional issues, including Mathematics, Computation, Physics, Biology, Cognition, Knowledge, Economy, Philosophical Problems, and Social Dynamics. One of our resonant interactions during the ensuing 25 years was my urging him to write his autobiography, especially for the younger generations, not only because it would be an enjoyable story to read, but mainly because one can easily identify two remarkable qualities of Karl. The second and third reason for my eagerness to write this Foreword are precisely these qualities.
2. Karl Gustafson is a living synthesis of three persons: an Engineer, a Physicist and a Mathematician. During his university studies, presented in Chapter 3, "The Student in Poverty", and throughout his life challenges, Karl managed to operate simultaneously in the three different modes, and get the best out of each in any practical and theoretical matter he was engaged in. This is a rare practical demonstration of multidimensional spirit.
3. There was no island of stability in Karl's scientific journey. Rather, Karl successfully crossed among different disciplines and professional communities, including Pure and Applied Mathematics, Computational Mathematics, Theoretical Physics, Fluid Dynamics, Optical Computing, Neural Networks, Mathematical Finance, and Complex Systems, demonstrating the natural link between different scientific domains. Accordingly, Karl developed a practical realization of the necessary trade-off between width and depth, as expressed in his Generalization-Specialization Paradox, discussed in Chapter 11, "Mathematics".

Why did Karl not follow the widely "recommended" career path to restrict himself to one mainstream field and thereby profit with a socially "better" professional profile? Why did he jump from Engineering to Physics and Mathematics?

The answer is, because he had reached the limits of the procedural knowledge of "how to do things" and wanted to understand "why things and events emerge as such." In this process, Karl experienced the natural beauty of knowledge, which cannot be split to fit into our specific professional disciplines. Karl instead demonstrated the unity of nature, in contrast to our fragmented representation of reality. This is nice to say but hard to experience. Facing the dilemma of power and high social recognition versus the satisfaction of the appetite for knowledge, Karl chose the second. Is this not the quality of a hero?

During his Web Science Course, Karl presented his work on Intelligent Distributed Systems in four lectures, which captivated and thoroughly impressed the students. First, he viewed the Satellite Revolution presented in chapter "Computers and Espionage" as the first stage of the Web Science revolution. Then he showed how his Human Trajectory Analysis discussed in Chapter 13, "The Improbabilities" was a precursor of the Small World Networks and Google Algorithm. Modeling Humans versus Neural Nets and machine learning, Karl realized early on the need for Context and Simplification, anticipating present developments of the Semantic Web and Ontologies. The last lecture involved Finance Networks, presented in Chapter 12, "High Finance", with several remarks on the present financial crisis and the emerging Web Economics.

Here Karl has written a tale that will charm and entertain the reader, while inspiring the mind and soul. The innovative spirit, fresh ideas, and thought power of Karl Gustafson indicate already that there will be a further "Crossing of Heaven" in a few years.

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Preface

I am not a famous mathematician, nor a Nobel Prize winner. I am well known in the sphere of world-class mathematicians – both at home in the United States and more-so internationally, where I have worked at the highest levels throughout my career. But that is not why I chose to write this book, this "story of my life," if you will. No, it has little to do with my being famous, or infamous. The seeds of my desire to write an autobiography were first planted by friends and colleagues, who long urged me: "Karl, you should write a book about your life! You have so many tales to tell." And I do have stories to tell that have never been told. Experiences and events that I wish to share, so that they are not lost to history. Then five years ago, a much respected junior colleague in Greece (with whom I share special bonds of being long ago his Ph.D. advisor, and then for many years as scientific collaborator) put the pressure on me. He wrote: "Karl, you express a talent for fresh/ historical/ philosophical writing which allows you to insert much easier messages not only to scientists but also to intelligentsia in general. Do it now! Write the book of your life! Everything you have done so far is just preparation. Sorry if I was too spontaneous."

I was of course much moved by this honoring of my life and affirmation of our long friendship. I vowed to get to the task. But the inertias of a busy professional life kept me fully occupied in those directions.

The tipping point came 2 years ago when at a class reunion I met an old college classmate who had risen to the top levels in the intelligence agencies. In confidence I told him that I too had been thrust into intelligence work of great national importance early in my career. Those special and unusual circumstances led, in what I regard as an accident of fate, to my writing the software for the world's first spy satellite. He replied: "Karl, I have seen that satellite. The program was recently declassified. Do you want me to send you a picture of it?"

Indeed, it seems that I have witnessed – and been an integral part of – the technological revolution that has transpired during the last 50 years. *En plus,* my mathematical and scientific interests have been wide and varied, resulting in many exciting plenary speaking invitations through which I have traveled and seen much of the world. I must add to those two components, those of active participant in an astounding scientific revolution, and of world traveler, a third and more personal one: I am hardly your rich or Ivy League type, or as I sometimes too irreverently refer to

them, the "effete-elite" scientific type. My life has had hard knocks and brushes with death and as a consequence I most closely identify with the common man.

I measure this incredible scientific and technological revolution which has forever transformed our lives as starting about 50 years ago on October 4, 1957, when the Soviet Union took humanity into the Space Age with their launch of Sputnik, the first artificial Earth Satellite. A few days after, I and a few other physics students ran outside from our Physics honor society banquet on a crystal clear night high in the Colorado mountains to watch Sputnik trace its orbit across the heavens above us. I can remember that night, and the thrill and the drama, still.

The United States went into panic-mode and in classic American fashion, united to fight back, to compete. I was a direct beneficiary. Mathematics, especially applied mathematics, was deemed of paramount importance. Even 30 years later when I lectured at Moscow State University, there were many military officers of high rank in the audience, testament to the very close links between the academics there and Soviet military science. Sputnik and the critical scientific and political challenges it brought dramatically to the fore caused money to pour into mathematics and mathematics education in the United States. As a result I was one of a contingent of 12 top engineering students who were selected and paid to become Applied Mathematics undergraduate Engineering Problems Instructors. We taught all engineering first-year students the mathematics of slide rule and mechanical calculators. We had our own individual classes (a lot of them...) and that early initiation into university-level teaching not only built my confidence but also soon converted me from an engineering physicist to an applied mathematician. Some years later I would go all the way to a pure mathematician.

There is a substantial, nontrivial, and not widely understood gap between the training needed to become a pure mathematician and that of just being an engineer or physicist. This gap cannot be fully appreciated by applied scientists unless and until they successfully complete the committed step of taking many course-years of algebra, topology, measure theory, geometry, and real analysis, among others.

Sputnik and the ensuing satellite and more general Space Race not only changed my life, but it is fair to say that for a time, it captured my life. Happily ensconced as a full-time Instructor of Applied Mathematics at the University of Colorado, and starting to enjoy skiing and the good life, a strange sequence of events led to my being drafted into the U.S. Army Reserves so that I would be forcibly assigned as a young computing expert to a top secret U.S. Navy military espionage project for four years. It was within that environment that in a furious two-week effort I wrote the software for the world's first spy satellite, a project so secret that I was not even officially cleared to know of it.

As a consequence of this fantastic and favorable situation within which I found myself, I was permitted at the same time to pursue a Ph.D. at the nearby University of Maryland. I chose Mathematics over Physics. Thereafter I embarked on two postdoctorals in Europe. Eventually I returned to Colorado as a Professor of Mathematics. The rest, as they say, is history.

That history was, however, far from mundane. During my lectures in Colombia I was under constant threat of being kidnapped. In Russia a young former Soviet

Union general and I almost fell on the floor when we broke out laughing together about our open discussion of stealth technology. In India I was thrown together with a Fields prize winner as fellow refugees, as religious violence swept that entire subcontinent. In Tibet I traveled with an American ex-CIA agent who exactly five years earlier had been in Tiananmen Square the day it happened. My invited keynote lectures in Iran were thwarted two times by visa cancellations contrived by the Conservatives but at the last minute the Liberals prevailed, and upon discovering my birth date, they delightedly insisted on having not one but two fabulous birthday dinners for me. Twice I have found myself a single parent with sole responsibility for the care of young children. I stopped rock climbing at age 50 after a dangerous pendulum off-route on a high peak exactly three weeks after my girlfriend had died on a climbing trip to Peru.

Still, two years ago, I could not begin this autobiography. I was, in the vernacular, just plain stuck. One of my favorite early reads was *Zen and the Art of Motorcycle Maintenance* by Robert Pirsig. Being stuck is part of the process. To deal with it, you must care, and keep on caring, as you think on solutions. What was wrong? Here I was, the most prolific mathematician in the history of Colorado mathematics, with 270 published papers, 5 to 15 books depending on how you count, over 100 plenary addresses at international conferences in 35 countries – and I could not even begin my own autobiography.

When one is stuck, one should consult friends. Also, it is okay to lower that pride-shield and admit to needing a little help. Out of a casual lunch came an offer of more than a little help. The telling of my life story would not have happened without the editorial assistance of Jillian Lloyd, who got me started and held my hand throughout the process (and at times, the ordeal) of writing. Any man would be inspired by the attention of such a beautiful and intelligent young woman.

Once when joking with her as she insisted on raising the quality and depth of some passage in my exposition, I joshed, "Look, *cherie*, I'm just a poor scrap of a fun-loving western boy, with some serious sides and unique insights, who found himself in some very unusual situations." But she would not let me get by with such excuses. Gradually it became clear: I am not introspective. In particular, like many males, I do not want to deal with my emotions, I do not want to ruminate upon them. Rather, I am extrospective: I am interested in the world. These tendencies are further enhanced by my scientific training. So whatever introspective thoughts you will find in this book were mostly coaxed out of me. At times to get them out was tough going. . .but they are part of me and therefore an essential part of the book.

For me, it was much more enjoyable spinning the tales of the adventures of my life, the action, the close calls with death, the women, the science, the mathematics, and how my life interacted, many times unexpectedly, with important world events and Nobel prize winners and other famous and sometimes strange personalities. Events and accomplishments hold their own interest, but it is in the flavor of human interactions that our lives find their true meaning. You will find many in this book. – Karl Gustafson.

Contents

1. The Child in Iowa

. . .a cold, bright, sunny day. . .

I was born in the middle of the economic Great Depression on May 7, 1935, in the small town of Manchester in the slightly rolling hills of northeastern Iowa. My first vivid memory is that of being outside pulling my wagon along the sidewalk on a cold, bright, sunny winter day. I was 3, alone, and very happy. My mind was clear, and I was struck by the beauty of the world.

My entry into this world had been in a small house on Butler Street. The image of that cold, bright, sunny day, there on Butler Street, comes to me often. I see a small yellow house with a black coal-bin on the side, surrounded by not very deep snow. The sidewalk has a few barren oak or elm trees at intervals along it. I see only the trunks, quite dark against the snow. I am warmly dressed in my black sheepskin coat and helmet hat with ear flaps tied under my chin. The coat had those big buttons and thong fasteners, rather than button holes, and probably I had those old-fashioned galoshes over my shoes. Certainly that was the first time I had been allowed to venture out by myself. As I felt the crisp wind frosting my nose, and as I saw the black of the trees, the yellow of the house, and the brilliant blue of the sky overhead, I first became consciously aware of the world. Probably that was as happy as I have ever been.

Now it is another cold, bright, sunny day many years later and I am in Boulder, Colorado, in the foothills of the Rocky Mountains. The world is in the midst of another economic depression, and I am happy. Much has happened, but my mind and spirit are still refreshed as I take a snowy path in the green of the pine trees under an incredibly deep blue sky. There is a sense of harmony with the universe.

My thoughts go back to my childhood days in that simple life of Manchester, a small town of about 3,000 folk on the Maquoketa River. Iowa was Heartland America and like many small towns in Iowa at that time, its main function was to host the local small businesses that supplied the surrounding farming community. The summer days and nights were hot and humid. Winter days and nights were cold. In the fall we all raked the leaves into the curbs on the street and then burned them, roasting marshmallows on slender sticks. In spring we waited for the thaw in which the river ice broke free and piled up into great dams before the pressure behind broke those free too.

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I was the second child and second son of Edwin Gustafson and Jeanette Anderson Gustafson – both of whom were born early in the 20th century to Scandinavian immigrants in America. My paternal grandfather, Carl August Gustafson, was born in Rya, Sweden, a tiny place about 40 km south of Laholm on the West Coast. At a young age, he was apprenticed out as a tanner. There, he was beaten badly, and ran away to Germany at age 16. He found a job sweeping floors at an eating establishment, where he learned to cook. He soon emigrated to America, arriving at Ellis Island before the Statue of Liberty had been installed. He then walked from New York to Virginia to look for work on the railroad. Having no money, he survived by eating sweet potatoes he found in the fields. In spite of speaking no English, he soon obtained work on the railroad. One night, the cook for the railroad got so drunk that Carl replaced him. Before long, he was contracting all the food purchases himself, and making a personal profit of $27,000 for three months work.

In Chicago, my grandfather met my grandmother Sofie Paulson (née Anna Sofia Palsdotter), who had been born in Vaxtorp, Sweden, a town about 20 km south of Laholm. She had emigrated to America at age 16 for a job as a domestic helper with a Swedish family in Chicago. They met at the urging of their families in Sweden, who knew each other. By around 1890, they married. As Carl continued to work as a cook and food supplier to the railroad crews heading south and west from Chicago, he amassed a small fortune. He and Sofie, who by then had two daughters, decided to "retire" back to Laholm, Sweden, in 1897. There, a third daughter was born, and Carl developed a drinking problem. By 1900, with most of their money gone, Sofie convinced Carl to return to America. At first, he worked in coal mines and brickyards, and later returned to his specialty as cook and food supplier to the railroads pushing West. They finally settled down in the cowboy town of Plaza, North Dakota, where Carl built his own hotel in 1907. He and Sofie went on to have six children, four daughters and two sons, including the youngest, my father Edwin, born in 1910 in Plaza.

Their hotel burned to the ground in 1935 and my grandfather Carl decided to retire again, this time to North Hollywood, California, where he bought a city block. But he lived only two years more, and to my knowledge, we never laid eyes on each other.

Back in Plaza, North Dakota, my father Edwin Gustafson had been senior class president and a hot basketball player. Afterward, he had been sent to Carleton College in Northfield, Minnesota. He majored in economics and became a top intercollegiate debater. He also met my mother, Jeanette Anderson, a music major preparing for a career as a concert pianist. But soon after, she became pregnant – and they quickly married. He graduated, she did not; and he faced the daunting prospect of supporting a family in one of the worst economic times in the history of this country. Eventually, in 1933, with a $3,000 loan from his father, he bought the Gambles Hardware store in Manchester.

My brother Dick, born three years before me in 1932, has often helped me remember some of the circumstances of our childhood. He always believed that our parents had not wanted him. I have no idea at all if I was wanted. Nor have I ever worried about it. But it always bothered my brother Dick.