Remembering Shoshichi Kobayashi

Gary R. Jensen, Coordinating Editor

Shoshichi Kobayashi was born January 4, 1932, in Kofu City, Japan. He grew up amidst the colossal devastation of World War II. After completing a BS degree in 1953 at the University of Tokyo, he spent the academic year 1953–1954 on a French scholarship at the University of Paris and the University of Strasbourg. From there he went to the University of Washington in Seattle, where he received a Ph.D. in 1956 for the thesis "Theory of connections," (*Annali di Mat.* (1957), 119–194), written under the direction of Carl B. Allendoerfer. There followed two years as a member of the Institute for Advanced Study in Princeton and then two years as a research associate at MIT. In 1960 he became an assistant professor at the University of British Columbia, which he left in 1962 to go to the University of California at Berkeley, where he remained for the rest of his life.

Shoshichi published 134 papers, widely admired not only for their mathematical content but for the elegance of his writing. Among his thirteen books, *Hyperbolic Manifolds and Holomorphic Mappings* and the Kobayashi metric in complex manifolds created a field, while *Foundations of Differential Geometry, I and II*, coauthored with Nomizu, are known by virtually every differential geometry student of the past fifty years. In their articles below, Shoshichi's student, Toshiki Mabuchi at Osaka University and former Professor Takushiro Ochiai at the University of Tokyo summarize many of Shoshichi's mathematical achievements. Several of his students relate their experiences of working under Professor Kobayashi's supervision. Some Berkeley colleagues write of their personal experiences with Shoshichi.

His brother, Hisashi, recounts some details of Shoshichi's early education. Shoshichi's wife and daughters tell a fascinating story of his childhood, his studies abroad, and major life experiences preceding his move to Berkeley.

He died August 29, 2012, of heart failure on a flight from Tokyo to San Francisco.

Photo from the Oberwolfach Photo Collection, courtesy of the Archives of the MFO.

Shoshichi Kobayashi

Toshiki Mabuchi

Many of Professor Kobayashi's books are known as standard references in differential geometry, complex geometry, and other related areas. Especially, *Foundations of Differential Geometry, Vols. I and II*,

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Personal and family photos of S. Kobayashi provided by and used with permission of the Nomizu family.

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coauthored by Nomizu, are very popular with mathematicians as well as with physicists. He and Nomizu received the 2007 MSJ Publication Prize from the Mathematical Society of Japan for this work. His books *Hyperbolic Manifolds and Holomorphic Mappings* (1970) and *Transformation Groups in Differential Geometry* (1972) also influenced many mathematicians. His mathematical achievements range across differential geometry, Lie algebras, transformation groups, and complex analysis. The most important ones are:

1. the Kobayashi intrinsic pseudo-distance,
2. the Kobayashi hyperbolicity and measure hyperbolicity,
3. projectively invariant distances for affine and projective distances,
4. the study of compact complex manifolds with positive Ricci curvature,
5. filtered Lie algebras and geometric structures, and
6. Kobayashi-Hitchin correspondence for vector bundles.

In (1) and (2) we see his outstanding creativity. Kobayashi's distance decreasing property for holomorphic mappings plays a very important role in (1), while the generalized Schwarz lemma is crucially used in (2). His works now give us a fundamental tool in the study of holomorphic mappings between complex manifolds. For instance, Picard's small theorem follows easily from (2). Recently, the above results were being generalized by him to almost complex manifolds.

On the other hand, (4) has led succeeding mathematicians to Frankel's Conjecture and Hartshorne's Conjecture. Among them, his joint work with T. Ochiai, "Characterization of complex projective spaces and hyperquadrics," J. Math. Kyoto U. **13** (1972), 31–47, was effectively used in Siu-Yau's proof of Frankel's Conjecture. It should also be noted that the method of reduction modulo p in Mori's proof of Hartshorne's Conjecture became a clue to the Mori theory on the minimal model program of projective algebraic manifolds.

The Kobayashi-Hitchin correspondence for vector bundles in (6) states that a holomorphic vector bundle E over a compact Kähler manifold is stable in the sense of Mumford-Takemoto if and only if E admits a Hermitian-Einstein metric. Kobayashi and Lübke proved the "if" part, while the "only if" part, conjectured by Kobayashi and Hitchin, was proved finally by Donaldson and Uhlenbeck-Yau.

Since 1995 Professor Kobayashi regularly attended our annual workshop on complex geometry at Sugadaira, Japan.

Takushiro Ochiai[1]

The life and academic achievements of Shoshichi Kobayashi give a definition of what a great mathematician should be. He left us numerous manuscripts of high originality, comparable to great musical compositions. His books, taken as a whole, harmonize splendidly into a great symphony. Though aware of my inability to reach the height of his talent, I dare to write this article to bring attention to the fine personal character and remarkable academic achievements of Shoshichi Kobayashi, outstanding mathematician, mentor, and colleague.

Kobayashi published papers in academic journals every year without fail, starting from his virgin paper in 1954 until his last days. Among a total of 134 papers, there are 85 single-author papers and 49 collaborative works. A unique feature of his single-author publications is their brevity. There are 34 papers of less than five pages, 28 papers of less than ten pages, and 15 papers of less than 28 pages. Every one of them is deep and rich in content with transparent and easily comprehensible explanations, as is evidenced by his invention of the concepts of the *Kobayashi distance*, hyperbolic complex manifolds, and the Hermitian-Einstein vector bundles. Inspired by Chern's result, which further improved on the generalization of the classical Schwarz's lemma by L. Ahlfors ("The holomorphic maps between Hermitian manifolds" by S. S. Chern), Kobayashi became interested in Schwarz's lemma and read all the related papers one by one. He especially admired Carathéodory's point of view and devoted himself to and took advantage of the holomorphic maps, which he admitted led him to the discovery of the Kobayashi distance.

Expanding all his papers, paying attention to the historic background and development, Kobayashi subsequently published thirteen self-contained books, every one of which is easily comprehensible by graduate students. Professor Kobayashi once said to me: "When I write books, I prepare one or two years for the first manuscript and make certain to give lectures based on it for one or two years in order to deepen the contents before finally completing the final manuscript."

To convey to the public his philosophy of mathematics, or rather of differential geometry, I include here passages from his essays in Japanese as published in well-known magazines on mathematical

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[1] *This is a translation into English of some part of my article "Kobayashi-sensei wo shinonde," which appeared in* Sūgaku Seminar, *2013.*

First row: T. Ochiai, S. Kobayashi, S.-T. Yau; Second row: H. Mori, S.-S. Chern. Tokyo, 1977.

sciences which deeply reflect his mathematical achievements. The transparency, beauty, and open-mindedness of his viewpoints, which he sharpened well to the limit, express my personal and eternal yearning.

"Differential geometry is one viewpoint over mathematics, and a method, in itself. When various fields in mathematics reach the point of being well understood, the phenomenon called 'algebraization' occurs. I think it is possible to see different fields of mathematics from a differential geometric viewpoint as well as from an algebraic viewpoint. The raison d'etre of differential geometry is to offer a new viewpoint and powerful methods rather than being considered like a theory of numbers. Moreover, the concepts and methods understood from a geometric point of view are so natural (different from artificially created nonsense) that development beyond anticipation later occurs in many cases. Differential geometry can produce limitless developments by carrying its methods into all the fields of mathematics. It is especially important, then, to know how to make use of the differential geometric method to make connections in fields such as the theory of functions (one or several complex variables), algebraic geometry, topology, a differential equation theory." (*Suuri Kagaku*, August 1965)

"Wonderful theorems in mathematics are proven with breakthroughs of originality which cause everyone to understand them. A mathematician gets the greatest feeling of happiness when he finds such a new idea. A problem, which is solved merely by understanding and following a routine process, is a petty problem, and a theorem whose proof does not use any idea which comes involuntarily, is really tedious. It seems that any problem which does not open a new field, or any result which has no application in any other field of mathematics, disappears after a while. An eternal life is given only to a beautiful result." (*Sūgaku Seminar*, December 1965)

"Some percentage of the work in mathematics consists of the creation of suitable notation. Suitable notation makes calculations easy to handle, makes formulas look beautiful and easy to memorize, and makes theorems apparent at a glance. Suitable notation is important not only from a passive role to make descriptions beautiful and easy, but also from an active role, even to suggesting what should be done next. We cannot explain in one word what kind of notation is suitable or what kind of theorem is good. It is a mathematical sense that will take it in somehow." (*Sūgaku Seminar*, September 1967)

"When you study subjects in mathematics which are not restricted to calculus, I would like to urge you to study the history of its development together by all means. Since modern mathematics requires too much stringency, lectures as well as textbooks rarely touch historical background. However, I think that one can understand the subject more deeply by getting to know the history and 'why this concept was produced.' I want people who become school teachers to study the history of mathematics by all means." (*Suuri Kagaku*, February 2001)

Through my acquaintance with Professor Kobayashi for many years, I am convinced that his passion for mathematics was motivated by his love for human beings and for scholarship. I am extremely fortunate to have collaborated with Professor Kobayashi on some of his mathematical work.

Joe Wolf

I met Shoshichi Kobayashi when we both arrived at Berkeley in September of 1962. We got to know each other quite well for two reasons. First, the differential geometry group at Berkeley, just then forming under Professor Chern's guidance, was very cohesive, both socially and mathematically. Second, we shared an office where we had many informal conversations about differential geometry, mathematics in general, and academic life. I always learned some interesting mathematics when Sho and I talked. Years before, I had read Nomizu's short paperback *Lie Groups and Differential Geometry*, and I was thrilled to learn that Shoshichi had just completed his monumental work on differential geometry with Nomizu. At various times during the 1960s the geometry group at Berkeley included S.-S. Chern, Sho Kobayashi, Phil Griffiths, Jim Simons, Alfred Gray, Peter Gilkey, Jeff Cheeger, Blaine Lawson, Nolan Wallach, Manfredo do Carmo, Wu-Yi Hsiang, Hung-Hsi Wu, me, and many others. It was

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very collaborative and did not draw distinctions between big shots, young academics, and graduate students. And there were many famous and influential visitors attracted by Chern, including Gene Calabi and Fritz Hirzebruch. So it was a kind of mathematical heaven. During this time Shoshichi constructed his pseudo-metric, with the associated notion of Kobayashi hyperbolicity, and also his reproducing kernel methods for irreducibility of unitary representations.

When the building that currently houses the math department (Evans Hall) was built, math was to have floors seven, eight, nine, and ten. Sho and I went into the building to choose our offices before the elevators were installed. We walked up the stairs together, and at some point I realized that he was speeding up. I couldn't keep pace, but he had to stop at the seventh floor and I managed to get to the eighth. So his new office was on the seventh floor and mine was on the eighth. Later, when Sho was math department chair, the chancellor's office informed him that we were losing our space on the seventh floor. With Sho in charge we came out of these "space wars" pretty well, retaining most of the seventh floor.

It is hard to realize that Sho is no longer with us. It was a great privilege to have been a friend and colleague of Shoshichi Kobayashi.

Hung-Hsi Wu

I first met Sho in 1962 at one of the AMS Summer Institutes in Santa Barbara. I had just finished my first year as a graduate student at MIT, and he told me he was on his way to Berkeley. We ended up being colleagues for forty-seven years when I myself got to Berkeley in 1965. Although as colleagues we could not help but run into each other often, I think it was in the ten or so years from 1980 to 1990 that I had extended contact with him every week when he drove me home after each differential geometry seminar late in the day on Friday. We had to walk a bit before we could get to his car and that gave us even more of a chance to chat and gossip. I am afraid the intellectual quality of the conversations was not particularly high, but the entertainment value was off the charts. It was most enjoyable. However, the one thing that has stuck in my mind about Sho all these years is probably the fortuitous confluence of events surrounding the discovery of the Kobayashi metric in 1966.

In the summer of 1966, Professor Chern and I attended the AMS Summer Institute on entire functions in La Jolla, and Professor Chern gave a lecture on his new result on the volume decreasing property for holomorphic mappings from (basically) the unit ball in $\mathbf{C}^n$ into an Einstein manifold of the same dimension with negative curvature in a suitable sense. This is a generalization of the famous Ahlfors-Schwarz lemma on the unit disc, and it is to Professor Chern's credit that he recognized it as the special case of a general theorem about holomorphic mappings on complex manifolds. At the time, the idea of putting the subject of holomorphic functions in a geometric setting was very much on his mind. In the following fall, he gave a similar talk in one of the first lectures of the Friday geometry seminar, but this time he had a manuscript ready. The main ingredient of his proof is basically a Weitzenböck formula for the volume form; his observation was that negative curvature (in one form or another) of the target manifold limits the behavior of holomorphic mappings. This is the beginning of what Phillip Griffiths later called *hyperbolic complex analysis*. Of course both Sho and I were in the audience, and within two or three weeks Sho came up with a generalization using more elementary methods.

M. Berger, S. Kobayashi, W. Klingenberg, K. Yano, S.-S. Chern, 1970s.

At the time I was fascinated with Bloch's theorem (in one complex variable) and was trying to understand why there would be a univalent disc for holomorphic functions into the unit disc. Professor Chern's paper contains a reference to a paper of Grauert-Reckziegel which can also be said to be an application of the Ahlfors-Schwarz lemma. Upon reading it, I got the idea that Bloch's theorem was a consequence of the phenomenon of normal families and, as a result, I could prove a qualitative generalization for Bloch's theorem for holomorphic mappings between complex manifolds. I wrote up my findings and, as it was the tradition then among the geometers at Berkeley, put copies of my manuscript in my geometry colleagues' mailboxes.

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Nomizu and Kobayashi, 1954.

In a few days, Sho came up with the manuscript of his announcement that all complex manifolds carry an intrinsic metric, the metric that now bears his name. Sho recognized that with the availability of the Ahlfors-Schwarz lemma, the construction of the Carathéodory metric could be "dualized" to define the Kobayashi metric. His paper took the focus completely out of the holomorphic mappings themselves and put it rightfully on the Kobayashi metric of the target complex manifold in question. This insight sheds light on numerous classical results (such as the little and big Picard theorems) and inaugurates a new era in complex manifolds.

Robert Greene

Berkeley in the 1960s was an earthly paradise for people interested in real and complex geometry. When I arrived in early 1965 as a new graduate student, Professor Chern was the unquestioned leader of the geometry group, and indeed of the field itself, and Kobayashi occupied a special place as an organizer and presenter of the field as a whole. He was, after all, the author with K. Nomizu of The Book, *Foundations of Differential Geometry*, which was to function for many years as the veritable bible of the subject. It was a summit all the new students in geometry were determined to climb. When Volume II appeared in 1969, the whole became a definitive work indeed, a position which the passage of time has not dimmed as far as the field up to that point is concerned.

After qualifying examinations, I began work with Hung-Hsi Wu as my dissertation advisor, a happy association that turned later into a long-term collaboration. Almost as soon as Wu had accepted me as a student, he went on sabbatical in England for a term, so he asked Kobayashi to take me under his wing. The proposal was that I should read Helgason's *Differential Geometry and Symmetric Spaces* under Kobayashi's guidance. Kobayashi was the soul of politeness in dealing with my obvious disaffection from the book I was supposed to be going through. And in spite of this somewhat rocky start—I think Kobayashi never quite entirely forgave me for not liking Helgason's book—we became friends.

Impressive though Kobayashi and Nomizu's great survey book was and is, it was another of Kobayashi's books, *Hyperbolic Manifolds and Holomorphic Mappings*, that demonstrated best the elegance with which he could present a subject from its beginnings. When his "little red book," as we young people thought of it, appeared it had a big influence on us, flowing along as it did like a crystal stream. It was seductive, and indeed it did convince people that hyperbolic manifolds had a good bit more vitality as an independent subject than it in fact did in the long run, vital though the Kobayashi metric became and remains as a tool. The hyperbolic idea swept through Berkeley like a California wildfire in the hills. I did not work on hyperbolic manifolds directly at that time, but later in the mid-1970s Wu and I developed a refinement of the strictly negative curvature criterion, so I did get into the hyperbolic act eventually. And the general circle of ideas did influence me in the direction of thinking about complex manifolds. In this somewhat indirect way, Kobayashi shaped my mathematical life, since complex geometry has remained my principal mathematical interest.

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Gary R. Jensen

For me, Shoshichi Kobayashi was the ideal thesis advisor and mentor. Without his help and guidance at many stages, I would never have become a professor of mathematics. Here is the story.

After four semesters of course work at Berkeley, I could imagine only Professor Kobayashi as someone I might talk to. When I asked him to be my advisor, his response was cautious but not cold. After all, I had taken no courses in differential geometry other than the required curves and surfaces course. He suggested that I spend the summer reading his new book, written with Nomizu, *Foundations of Differential Geometry, Vol. I*. Thus began my lifelong love of differential geometry.

At the beginning of the fall semester he agreed to be my advisor. He handed me a list of problems he and James Eells had edited for the proceedings of a recent conference in Kyoto, Japan, with an indication of two or three problems that might interest me. A week later we agreed that I look at the problem proposed by Eells and Sampson: Does

any simply connected, compact Riemannian space of nonnegative curvature admit a Ricci parallel metric? During that academic year I read papers and got nowhere. When I finally told Professor Kobayashi that I felt I was making no progress, in fact, that I really had no idea of how to begin trying to solve this problem, his reply was simple and profoundly helpful. "Why don't you just look at the dimension four homogeneous case first," he said. It is embarrassing to remember that for a year this idea had not occurred to me. Along with this advice he suggested a paper by S. Ishihara on four-dimensional homogeneous spaces. At last, a paper I understood and saw how to apply to my problem.

Graduate school at Berkeley in the mid-sixties was wonderful. In our meeting at the beginning of the fall 1967 semester, Professor Kobayashi quietly mentioned that this would be my last year. "But I don't have enough results for a thesis," I reminded him. Yes, he agreed, but he stated again that this would be my last year. I got the message and it was a powerful motivator. In our weekly meetings I started presenting partial results, bits and pieces that at first seemed to hit a wall, but soon began yielding to the assault. By the end of December I had found all homogeneous Einstein spaces of dimension four.

Meanwhile, Professor Kobayashi had raised the issue of a job for next year. Strangely enough, I was very vague on this point, no doubt due to my subconscious desire to remain a graduate student for the rest of my life. He introduced me to some mathematicians from a university in the East, and I told them I would like to join their department. Weeks passed with no communication from that department. I didn't give it much thought, but one day Professor Kobayashi asked me, with some anxiety, whether I had heard anything. Hearing the answer and hearing that I had not applied for anything else, he took me by the arm and escorted me to the library's collection of notebooks of available jobs. Together we picked out a few. He told me to write a letter of application to each and to find two more people to write letters of recommendation for me. It still frightens me to think what might have become of me if he had not intervened so effectively at that time to make sure that I had applied for jobs. In early March I interviewed at Carnegie-Mellon and accepted their offer.

In June my family and I headed out for Pittsburgh with a copy of the manuscript of *Foundations of Differential Geometry, Vol. II*, in the trunk of the car. After reading it I struggled to find new research problems. I wrote to Professor Kobayashi that I needed more contact with differential geometers. I asked him if a postdoctoral fellowship somewhere might be possible. In early March a call came from Washington University in St. Louis asking me if I would be interested in coming there to interview for a one-year postdoc position connected to a special year in symmetric spaces. Professor Kobayashi had suggested my name to them for this position.

At the end of my postdoc year, I accepted a tenure-track offer from Washington University. Professor Kobayashi's mentoring continued. He was instrumental in arranging a visiting research position for me at Berkeley during the summer of 1971. In one conversation that summer he directed my attention to his 1963 *Tôhoku Math. J.* paper "Topology of positively pinched Kaehler manifolds," which formed the basis of my best-known paper of the 1970s, "Einstein metrics on principal fibre bundles," a paper that probably tipped the tenure decision in my favor.

Myung H. Kwack

I am very fortunate to have had Professor Shoshichi Kobayashi as my teacher, mentor, and advisor. He was instrumental in my work as a mathematician, and I am grateful for his support and encouragement throughout my career.

My father left Korea to study in the US in 1954 right after the Korean War. He left the rest of his family of four: a wife and three children. After seven years of separation, he brought his family to the US I had just finished high school and a semester of college in Seoul, Korea, and I found myself enrolled in San Francisco State College unable to communicate in a foreign culture. I found that I enjoyed studying calculus textbooks. I transferred to Berkeley, getting a BA degree in mathematics in 1965, and then entered into the graduate program at Berkeley. I still felt socially uncomfortable, as my language skills were not much improved. In addition, only one or two girls were in mathematics courses. It was a pleasant surprise that I passed the qualifying examination in 1967. I met Professor Kobayashi and somehow felt comfortable with him and had enough courage to ask him to be my thesis advisor.

With his usual warmth and understanding nature, Professor Kobayashi was able to make me feel at ease during visits to his office to learn and ask questions about mathematics. He introduced me to the concepts of hyperbolic manifolds. He suggested the problem of extending the classical Big Picard Theorem to hyperbolic manifolds and gave me many articles dealing with related problems. Many times I rushed to his office having "solved" the problem and started writing

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Photo provided by Professor Emeritus Masaru Mitsuishi, Shinshu University, Nagano, Japan.

Muneo Hayashi, circa 1948.

my "solution" on the blackboard until I could no longer continue, having come to a gap or an error in my "proof." Professor Kobayashi always had time and patience to listen to my wrong "proof" and never suggested that I should try to check my "solutions." Instead, he encouraged me as I sat discouraged after discovering my error. Without his encouragement I would not have been able to find a proof of a generalization of the Big Picard Theorem and experience the deep pleasure of discovering a mathematical theorem which has come to be known in hyperbolic geometry as Kwack's Theorem.

Professor Kobayashi understood not only the difficulty of doing mathematical research but also the challenges faced by a young girl from a foreign country at the time when girls were not encouraged to study. Professor Wu at Berkeley once said that Professor Kobayashi had the most female thesis students, making him the envy of the faculty of the Department of Mathematics at Berkeley.

Professor and Mrs. Kobayashi came to visit Howard University while I was there when Professor Kobayashi gave a week of lectures. He continued to support and encourage me to do mathematical research by sending many articles, his as well as many related ones, especially whenever I mentioned any interest in some problems. Furthermore, whenever I come to the Bay Area to visit my parents, he and his wife would take me to lunch and any gatherings of mathematicians he was attending.

I will be grateful to Professor Kobayashi for the rest of my life for enabling me to become a mathematician.

Eriko Shinozaki

I first met Professor Kobayashi twenty years ago, during my junior year of college, when he was a visiting professor at International Christian University in Tokyo, Japan. I had always wanted to study mathematics at university and had started as a math major at ICU. I began to doubt this decision, however, because out of all the math courses offered at ICU at that time none felt comfortable.

High school was where I always felt confident when studying mathematics and always knew what I was doing. I had to choose between geometry, algebra, and analysis after the fall of my junior year, but at that time I never considered geometry as my area of study. I was even thinking about changing to a chemistry major. I took Professor Kobayashi's class, since it was a required subject, not knowing that it would totally change my life. Thus, in my third year of mathematics studies, I thanked God for giving me this opportunity to meet Professor Kobayashi. I knew he would soon be leaving after the second term (ICU's academic year is divided into three terms), so I fully focused on geometry, solving everything I could, and visited his office almost every day.

After the end of the term exams, for the first time since high school, I finally achieved a grade at ICU with which I was familiar. When I got my exams back from Professor Kobayashi, he asked me if I was willing to continue in differential geometry. To tell the truth, all I wanted to do was ask him how I could possibly study differential geometry, due to the fact that there was no differential geometry teacher at ICU!

Subsequently, he kindly advised me to continue my differential geometry studies under Ms. Makiko Tanaka (currently a professor at Tokyo Science University), who was at the time helping us, the ICU students, with our calculus recitations. Fortunately for me, she was also a differential geometry major studying under Professor Kobayashi's colleague, Professor Nagano at Sophia University. Professor Kobayashi also offered to let me continue my differential geometry studies under his guidance, as well as advise me on my senior thesis, which was to be submitted the following year.

During most of my senior year he was at Tokyo University evaluating its mathematical curricula, enabling me to meet with him often on the Hongo campus. I even met him on the day he was returning to Berkeley. We worked on the thesis, then walked to Ueno station together and took the train to Narita as we continued our mathematical discussions on the train, shaking hands and saying good-bye at the airport.

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Since that time, for almost twenty years, I continued to meet with Professor Kobayashi each time he visited Japan for meetings, seminars, university evaluations, and special lectures. What we worked on together changed over the years. During my senior year Professor Kobayashi helped me choose a thesis on the topic of conjugate connections, helped me find a theorem and then sent it to the *Tokyo Journal of Mathematics* under the title "Conjugate connections and moduli spaces of connections." However, since I decided to work full-time as a mathematics teacher in a Japanese high school rather than pursue graduate studies (finding a job was very competitive in Japan in 1995), it became difficult for me to continue with my research.

One day Dr. Kobayashi asked me if he could give my topic to another of his graduate students and asked me to help him translate and type, using LaTeX, his book *Differential Geometry of Curves and Surfaces* into English instead. I thanked him very much for allowing me the opportunity to continue working in the field of mathematics with him and appreciated his confidence in my translation and understanding of his work. Unfortunately, we weren't able to complete the translation together, but I plan to continue working on it with Professor Makiko Tanaka.

Hisashi Kobayashi[2]

I realize how different was the world around Shoshichi, the first son of our family, from that around me, the third son, although we were raised by the same parents. I knew pretty much about his career, but I was not well aware of what Shoshichi felt or thought in his youth.

He published several essays in a Japanese journal, *Mathematical Seminar*, and elsewhere, but I read them for the first time only after he had passed away. Shoshichi was a quiet person like our mother and did not say much even to us, his younger brothers, about his memories and stories of younger days. I wish I had read these essays while he was alive; then I could have asked more details. Since my childhood, Shoshichi has been my role model, teacher, and the person I respected most among those I have personally known. He has been my hero, so to speak.

Soon after his birth our parents moved to Tokyo and opened a futon (Japanese bed) store in Koenji, Suginami-ku. By the time I grew to the age when I could remember things, our parents moved the store to Kyodo, Setagaya-ku, Tokyo. Apparently Shoshichi liked mathematics since his childhood, but he had some difficulty with a homework assignment given when he was a fifth- or sixth-grader, in which the student was asked to compute the volume of the cone that can be created from a fan shape. He recalls this incident in his essay "Deeply impressed by a beautiful theorem" in the May 1973 issue of *Mathematics Seminar*.

January 18, 1950. L to R back: Shoshichi (18), Toshinori (15). L to R front: Mother Yoshie (41), Kazuo (2), Father Kyuzo (45), Hisashi (11).

In April 1944 Shoshichi entered Chitose Middle School in Tokyo. This school emphasized military training, but discussions with the older students began his thinking of going on to high school. It was a big surprise for me to find that it was not until he entered middle school that he developed the idea of going to a high school, despite the fact that he was talented enough to be inspired by the Pythagorean Theorem.

In the spring of 1945 when he became a second-year student of the middle school, our family evacuated from Tokyo and moved to Minamisaku, Nagano-Ken, and the war ended soon after. Thanks to the kind people of Hiraga Village, the family stayed there until the fall of 1948. When Shoshichi became a fourth-year student of Nozawa Middle School[3] there, the mathematics teacher was Mr. Muneo Hayashi. His encounter with Mr. Hayashi turned out to be a giant step to nurture the mathematician Shoshichi. He writes about that period in another essay, "The mathematician I luckily encountered: Muneo Hayashi, math teacher in middle school."

It seems that Mr. Hayashi's encouragement allowed Shoshichi to gain confidence to apply to

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[2] *This is an excerpt of the speech "Rediscover my brother Shoshichi," presented at the memorial reception held May 25, 2013, at the University of Tokyo. The complete speech is at* `http://www.shoshichikobayashi.com`.

[3] *Shoshichi's classmate Noboru Naito wrote in detail of this school and Mr. Hayashi in "Newsletter No. 2, August 2013" at the* `http://www.shoshichikobayashi.com`.

Shoshichi, age 3.

Ichikoh (high school), and our parents came to realize that their first son was talented enough to advance to Ichikoh and then Todai (University of Tokyo). Shoshichi must have been the pride and emotional mainstay of our parents, who had lost everything in the war.

In 1948 Shoshichi succeeded in entering Ichikoh in his fourth year at middle school (skipping the fifth year), and the following year he entered the University of Tokyo under the new education system just introduced. In 1951 he advanced to the mathematics department, the Division of Sciences, and studied with the late Professor Kentaro Yano (1912–1993), who encouraged Shoshichi to strive to win the French Government's Scholarship. I was in a junior high school at that time, and I remember well that Shoshichi attended French classes at Athénée Français and Institut Français du Japon on his way home after a day of studying at Todai.

He was told that the examination for the French Government Scholarship was stiff and advised to make a first trial when he was a senior at Todai. To his and Professor Yano's surprise, he made it in his first attempt.

After a year of study in France, he moved to the University of Washington in Seattle, where he got his Ph.D. in less than two years. I was wondering all these years why he did not go to Princeton or Harvard, whereas he advised me to go to Princeton later. He explains his situation at that time in another essay, "My teachers, my friends and my mathematics: the period when I studied in the United States" in *Mathematics Seminar*, July 1982.

In recapitulating Shoshichi's life from his childhood until his marriage, I believe that his encounters with his seniors at Chitose Middle School motivated Shoshichi to think about going to a high school. Mr. Muneo Hayashi at Nozawa Middle School discovered Shoshichi's talent in mathematics and took time personally to nurture it. Professor Kentaro Yano encouraged him to study in France. Dr. Katsumi Nomizu egged Shoshichi on to study in the US Professor Allendoerfer hired him as an assistant. Shoshichi's friends and all of these wonderful encounters served as the sources of energy that drove Shoshichi to work as a mathematician for over fifty-five years. He led a fruitful life, blessed with a wonderful spouse and family.

Mei and Yukiko Kobayashi

Shoshichi Kobayashi was born January 4, 1932, during the Japanese New Year's holiday celebrations in the seventh year of the reign of the Emperor Showa.[4] Shoshichi was the eldest of five sons born to his parents, Yoshie and Kyuzo.

Several months after the arrival of Shoshichi, the family moved to Tokyo, where business opportunities were more promising. Within a few years, Kyuzo had saved enough to open his own futon store.

When the war ended, Shoshichi's math teacher, Mr. Muneo Hayashi, advised his parents to allow their son to apply for Ichiko (number one high school) in Tokyo. Shoshichi passed the entrance exam in his fourth year at middle school.

At the end of his first year in Ichiko, Shoshichi took the entrance exam for admission to the University of Tokyo. He passed it on his first try and entered the university after only one year at Ichiko.

At the University of Tokyo (Tokyo-daigaku or Todai) Shoshichi found that he was among the top students in mathematics. At the end of his sophomore year he declared his major to be mathematics and registered for a program to receive high school teaching certification. At this time he was unaware that people could make a living "just doing mathematics." The situation soon changed.

Mei Kobayashi is Shoshichi's daughter. Her email address is `mei.kobayashi@gmail.com`.

Yukiko Kobayashi is Shoshichi's wife. Her email address is `yukikokobayashi@gmail.com`.

[4] *The name Shochichi is an abbreviation for Showa-shichi-nen (seventh year of reign of Emperor Showa, 1932). Showa is the postmortem name of Hirohito.*

When Shoshichi started looking for a major advisor, his assigned undergraduate advisor told him about a charismatic young professor named Kentaro Yano, who would be returning from the Institute for Advanced Study at Princeton the following academic year. Just hearing about someone returning from Princeton seemed exotic and exciting to Shoshichi. Sure enough, Professor Yano lived up to and exceeded all expectations. Advisor and advisee made quite an odd but inseparable pair. Yano was a vivacious chain smoker who enjoyed drinking and clubbing, while Shoshichi was a quiet bookish type, a nonsmoker who drank modestly and only during social occasions. Words cannot express the admiration, love, and respect that Shoshichi had for his thesis advisor. Their kinship lasted until Yano's death during the year-end holiday season in 1993. Under Yano's guidance Shoshichi was bitten by the research bug.

Soon it became clear that postgraduation studies in France would be better than remaining in Tokyo. Shoshichi enrolled in night classes at Athénée Français to learn French to prepare for the exam for a fellowship to study abroad. The effort paid off handsomely. Shoshichi won a fully funded fellowship to study at the Universities of Strasbourg and Paris for one year (1953–54). He was elated by the news.

The fellowship required recipients to pay for their boat fare and transportation to Paris. This cost Shoshichi's parents nearly a fifth of what they had paid for a house three years before. Costs for room, board, and tuition in France plus a small stipend would be covered by the French government. The fare for the return trip at the conclusion of the year was also included in the package.

On what was the hottest summer day in Tokyo recorded at that time, Shoshichi boarded a French passenger ship with other fellowship recipients and waved to his relatives who had travelled to the port of Yokohama to wish him well during his year abroad. No one imagined that Shoshichi's departure would be permanent. He would return for his first brief visit to Japan in 1965 as a husband, father, and visiting professor from the University of California at Berkeley, courtesy of a Sloan Fellowship.

The journey to France was quite an adventure. Shortly after the ship passed through the Suez Canal, Shoshichi began running a dangerously high fever and was admitted to the hospital quarters onboard. He was only semiconscious when the ship arrived in France. The first months of his postgraduate experience were spent in a French hospital recovering from typhoid.[5].

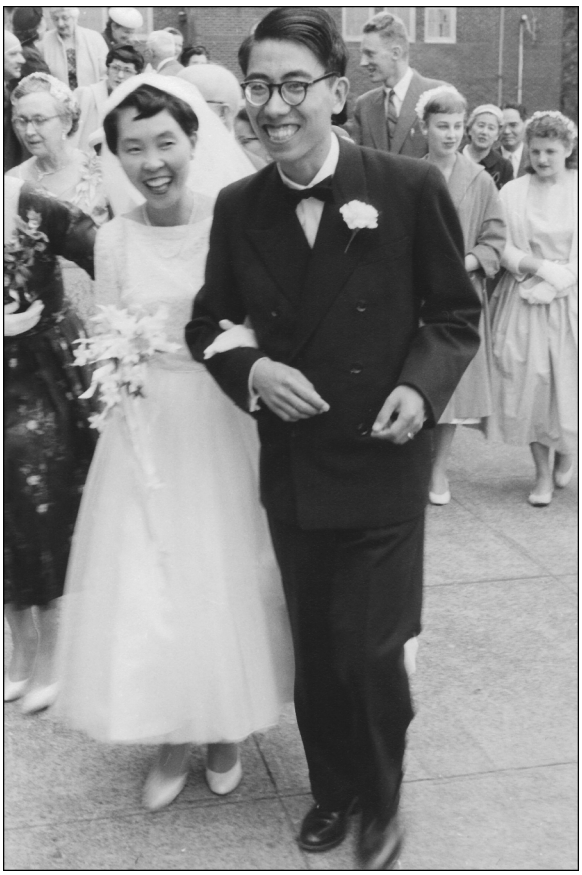
The family at Yokohama to wish Shoshichi bon voyage to France, August 20, 1953.

The French mathematical community was very friendly. Shoshichi attended seminars organized by famous professors.[6] He discovered that he might be able to make a living "just doing mathematics." One day in Paris he met Katsumi Nomizu, a young Japanese mathematician who had just finished his Ph.D. under Chern at the University of Chicago. Nomizu suggested that Shoshichi return to Japan via the United States. He mentioned two great mathematicians from whom Shoshichi could learn the art of mathematics: Chern at Chicago and Allendoerfer at the University of Washington. Shoshichi sent a personal statement together with reprints of his recent publications to these two universities. A few weeks later he received an acceptance letter from the University of Washington stating that all expenses would be covered upon arrival. From Chicago he received a thick envelope of application forms. His decision was not difficult. The French authorities agreed to cover his boat fare to the United States in lieu of travel costs back to his parents' home in Japan.

Shoshichi was overwhelmed by the generosity and kindness of the members of the university community in Seattle. On his first day at the university, the department chair, Professor Carl Barnett Allendoerfer, made time to greet Shoshichi and inform him of special arrangements to have his stipend paid in advance at the beginning of each month for just the first year. The administration had heard from more senior foreign students of the difficulties in securing a loan after arriving with little money. Shoshichi took an immediate liking

[5] *See Shoshichi's account of his first five weeks in France in his article "My memory of Professor Henri Cartan" in the* Notices of the AMS ***57**, no. 8, 954–955*

[6] *The seminars of Henri Cartan, Andre Lichnerowicz, Marcel Berger, and others in Paris. He worked with Charles Ehresmann in Strasbourg.*



Wedding of Yukiko and Shoshichi.

to the professor. Over the course of a few months he found Allendoerfer to be a great statesman and scholar and was very happy when Allendoerfer agreed to be his doctoral thesis advisor.

Later that year Shoshichi was best man at the wedding of his friend Akira Ishimaru. The bride's maid of honor was Yukiko Ashizawa, who was also from Tokyo but from a different section of the city. She was on leave from her duties as a teacher at Rikkyo Elementary School in Tokyo. Had it not been for the war, it is doubtful that Shoshichi and Yukiko's paths would have crossed in Tokyo. They were formally engaged before he left for the Institute for Advanced Study in Princeton for his first postdoc in 1956, one year after his arrival in the United States. Shoshichi returned to Seattle the following spring for Yukiko's graduation and for their wedding on May 11, 1957.

After the wedding the couple drove to the University of Chicago, which had indisputably become a leading international center of geometric research under the leadership of Shiing-Shen Chern. Shoshichi was excited over the prospect of meeting Chern in person. Although Shoshichi had heard many stories of the great mathematician while in Paris, he was even more impressed by Chern's kindness. Shoshichi enjoyed the open and productive collaborative atmosphere as a summer research associate sponsored by Chern.

In the fall the Kobayashis returned to Princeton to complete his second and final year at the institute. Eleven months following their marriage, the couple welcomed their first child, Sumire. In the fall of 1958 Shoshichi and Yukiko packed up for another move, this time to MIT, where Shoshichi would be a postdoctoral research associate. Just as they settled in and learned that they would soon be parents to a second child, Shoshichi received a tenure-track offer from the University of California at Berkeley. Chern would be moving to Berkeley, and he was working to establish a world-class center for mathematical research. He asked whether Shoshichi would be interested in joining the faculty. There could be no greater privilege.

Since United States visa regulations at the time required applicants to leave the country during administrative processing for a green card, Shoshichi accepted a very generous offer from the University of British Columbia in Vancouver, Canada. In 1962 Shoshichi and his family received visa clearance, and he joined the faculty at Berkeley. A year later Volume I of *The Foundations of Differential Geometry* was completed and published. In 1966 Shoshichi became a full professor at Berkeley. He remained on the faculty at Berkeley after his retirement, first as professor in graduate studies and then as professor emeritus.