Autobiographical Notes

by Walter Noll, 1988

Section A. 1925-1946.

I was born on Jan. 7, 1925 in Berlin-Biesdorf, a district in the North-East of Berlin. My parents, Franz Noll and Martha Noll, née Janßen, had lived in Berlin since about 1915. My father grew up in Thüringen in central Germany; his parents had immigrated from Rotterdam, Holland, to Germany in about 1890. My Mother grew up in a rural area near Varel in Northwest Germany. Both of my parents had only an 8-year grade-school education. My mother was employed as a maid until she got married. My father went to a trade school for two years and then became a tool-and-die maker. Most of his life he worked for "Jaroslaw's Erste Glimmerwarenfabrik" , later renamed "Scherb und Schwer G.m.b.H.", in Berlin. He eventually became foreman and division manager. He originated 5 patents. My father was active in the Social Democratic Party of Germany (SPD) from the time he was a young man. During the First World War, in 1917, he gave a speech at a rally of striking munitions workers. As a result, he had to spend the last nine months of the war in prison. Later, he became a very strong opponent of the Nazis. When the Nazis attained power in 1933, he predicted that there would be a second world war, that the U.S. would again fight against Germany, and that Germany would again be defeated. Even as a child, I never doubted that he was right. In fact, the thought that I might not survive the impending disaster was never far from my mind.

In the Spring of 1931, I entered grade school in Biesdorf. Soon thereafter, my parents started building a house of their own near Zeuthen, a suburb in the South-East of Berlin, and we moved to an apartment in Zeuthen. I attended the grade school in Zeuthen from the Summer of 1931 until the Spring of 1935. In the Summer of 1932, our house was completed and I spent the rest of my childhood there (address: Fasanenstraße 32, Miersdorf bei Zeuthen). It was a good thing that my parents moved shortly before the Nazis took power, because my parents' political views were much less well known in the new community, and they therefore escaped recrimination by the Nazis. I cannot have been older that nine, but I still remember my parents discussing how our former family physician in Biesdorf, Dr Philippsthal, who was in attendance when I was born, was kidnapped by Nazi-

Stormtroopers and beaten to death in 1933 or 1934. This incident impressed upon me the fact that Germany was being ruled by a criminal regime, long before this fact had become clear in the Western democracies. Another incident concerned a friend of my parents in Biesdorf. He made some critical remarks about the Hitler regime to a stranger on a street corner. As a result, he was picked up at night and sent to a concentration camp for several months. When he returned he was a broken man and later committed suicide. Perhaps as a result of these and other, similar incidents, I learned never to talk about political matters to anyone except my immediate family.

In the Spring of 1935 I entered secondary School in Eichwalde, a community adjacent to Zeuthen. The school was called "Realreformprogymnasium" and later "Oberschule für Jungen" (Highschool for Boys). At that time, children deemed to be talented enough for university training were sent to special academic high schools after the 4-th grade. During the first four grades, my performance in school had been only slightly above average, but my teacher assured my parents that I had a good chance of success in academic high school. The subject I liked best during my first two years of high school (5-th and 6-th grade) was French. Especially during 6-th grade, we had a teacher who taught us very good French pronunciation. Even now I have less of an accent in French than in English. From the third year of high school (7-th grade) Latin was added to the curriculum. I liked it at first, but in the later grades my interest in foreign languages waned, partly because the teachers were very bad. I never had any formal instruction in English in my life.

My facility with arithmetic was never very good, and still isn't. My grades in arithmetic (Rechnen) almost never exceeded a C. My memory for numbers is extremely poor. I had my first contact with mathematics (as opposed to arithmetic) in my third year of high school (7-th grade), when geometry was added to the curriculum. The teacher, Fuhrmeister (we called him "Bommel"), was authoritarian and very pedantic. We had to memorize the axioms of Euclid and accept them as dogma. The following incident is still very vivid in my mind. Bommel apparently had read the novel "Flatland", a fictional description of an imaginary two-dimensional world. He told us about it and also about an imaginary four-dimensional world. It was quite interesting to me, but when he asked for questions, I made this comment: "Since all matter consists of atoms and molecules, and since these are three-dimensional, there cannot be any two-dimensional objects". Bommel did not

know how to answer this, he just ordered me to sit down. The next time the class met, he asked me to give a verbal report on the content of the previous class. I did this without any further comments of my own. He ostentatiously gave me an A for the report, which was remarkable because he had never before given an A to anybody for anything. I felt very strongly that the A was a reward for shutting up. Perhaps I should note here that I was extremely timid and shy during my first years of high school. In fact, my report cards always contained comments such as the following: "Walter is fairly bright, but he should attempt to become more outgoing". Just before the incident I described happened, I had started to read a book entitled "Du und die Natur" by P. Karlson, a popularization of modern physics. I was fascinated by this book; I learned about atoms and molecules, electrons, protons, and neutrons, the theory of relativity and quantum mechanics. Of course, my knowledge was much more superficial than I realized at the time, and my first contact with genuine physics occurred when this subject was added to the curriculum in the fourth year of high school (8-th grade). I will never forget my first class. The teacher, Rudolf Hohensee was his name, sent an electric current through a long wire, which became red hot and sagged. Then he asked: "What do we learn from this?" He elicited from us that when things become hot, they expand. And then he said with an absolutely deadpan voice: " This is why the days and the vacations are longer in the summer". One student did not get the joke and he repeated this conclusion when he was asked to give a verbal report the next time the class met. During the next few years, Hohensee was my teacher not only in physics, but also in mathematics. He was the first person I ever met who had a true understanding of these subjects. Also, he realized that I had a special talent for these subjects, and he helped me very much with advice and special instruction. He invited me often on Sundays to his apartment to tell me about subjects that were not covered in school. He probably discovered my talent when I was able to solve tricky problems involving constructions of triangles with ruler and compass. Later he recommended that I read the little book entitled "Mengenlehre" (set theory) by Kamke, which I found to be fascinating. Incidentally, I recently read an article by Lipman Bers (retired from Columbia University) in the American Mathematical Monthly, in which he describes how the same book influenced him during his high school years in Poland in the early 1930s. Rudolf Hohensee and his wife Liese, also a teacher of Mathematics and Physics, later became very good friends of mine, and I was in contact with them until they passed away.

When I was about 15 years old, some of my schoolmates and I became interested in Chemistry. We acquired all kinds of equipment and chemicals, some of them dangerous, and we irritated our mothers by attempting various experiments on the gas range in the kitchen. Once I prepared a mixture of potassium chlorate and red phosphorus in a small porcelain container. It exploded in my left hand, and I still have two scars to remind me. Soon afterwards my main interests reverted to mathematics and physics. After the war started, in 1939, the quality of instruction in my high school deteriorated, because many of the better teachers, Rudolf Hohensee among them, were drafted into the armed forces. I often had the feeling that I could learn more by staying home and studying on my own, but of course this choice was not open to me. I did learn ten-finger typing and shorthand by self-study. I read a lot, not only popular science literature and novels, but also philosophy such as Kant's "Critique of Pure Reason". I also participated in activities with my friends and classmates. I particularly remember a very enjoyable vacation trip that five us made in the Harz mountains in the summer of l942. I obtained my "Abitur" (high school diploma) on March 23, l943, with the designation "Gut" (cum laude). At that time, less than 10% of the people of my age obtained the "Abitur".

My principal concern from 1943 until the end of the war was survival. Many of my classmates were killed, among them my best friend Wolfgang Otto. I was very lucky. Not until June 1943 was I drafted into the "Reichsarbeitsdienst", which was then essentially a basic military training unit. We were shipped to Southern France, where I was injured slightly on the shinbone while unloading corrugated sheet metal. The paramedics in my unit were totally incompetent, and the injury led to a severe infection, which almost cost me my right leg. In the nick of time I was driven to the military hospital in Perpignan, where a surgeon operated on me only a few minutes after my arrival. Later I was shipped to a hospital in the Alsace, where I stayed for several months. After I recovered I was sent home just before Christmas 1943. I expected to be drafted into a regular military unit after no more than two weeks, but my papers must have been misfiled, for I was left at home for six months. From March until the end of May 1944 I attended two classes at the University of Berlin, although I could not officially enroll. (At that time, in practice, all classes were open to the public.) One class was "Moderne Algebra", covering much of the material in the book of the same title by VanderWaerden; the other class was "Differential und Integral-Rechnung" (advanced calculus). I even handed in homework. I also studied

books at home, for example "Unendliche Reihen" (Infinite Series) by Knopp. Finally, on June 5, I was drafted into the "Luftnachrichtentruppe" (air force signal corps). Luckily, I experienced very little military action, partly because I again became sick at the right time. I contracted diphtheria in the late Fall of 1944 and spent 6 weeks in an isolation ward. Incidentally, I have never been in a hospital since.

On May 1, 1945, I was taken prisoner of war by a British soldier in Lübeck in Northern Germany, but I was released as early as July 7, and went to a sister of my mother in Varel in Northwest Germany. Of course, there was total chaos in Germany at the time. My parents had no idea where I was or indeed whether I was still alive until October 1945. While in Varel I first did farm work and later, for about three months, I was a laborer in a factory. I devoted a large portion of my free time to systematic self-study of English, because I felt even then that one cannot get anywhere in this world without knowing English. I borrowed a textbook from a neighbor and I listened to English lessons given regularly over the radio. By February of l946 my knowledge of English was solid enough so that I never needed any systematic study again.

Section B. 1946-1953

On March 12, 1946 I returned to Berlin to enroll as a student at the Technische Universität. As a condition for enrollment, we had to work 100 hours removing rubble left over from the war. I was able to rent a tiny room in the district of Charlottenburg (address: Kaiserdamm 27) not far from the university, and on weekends I went home to my parents in Zeuthen, which took about an hour by train. Life in Berlin was very hard for the next two years. We were freezing during the winters and we were starving all the time. I found studying very difficult because my mind was always on food. Relief came only occasionally. At one period, I participated in a discussion group that met once every two weeks at the residence in Berlin-Wannsee of Herman B. Wells, the advisor for education to the head of the U.S. military government in Germany, General Lucius Clay. The meetings were chaired by one Mr. Franklin, aide to Mr. Wells. After the meetings we were invited to stay for sandwiches, coffee, and cake. It was difficult for us starving students to behave in a civilized manner and not fight over the food like a pack of wolves. In the summer of 1947, I participated in a two-week

Summer course on social and political topics organized by the French military government in Freiburg in Southwest Germany. I was with a group of about 30 students, about 40% French, 40% German, and 20% from other European countries. We had a wonderful time.

The Technische Universität (T.U.) is an engineering school, and it did not really seem to be the right place for a mathematics major like me. I chose the T.U. only because I could start with the Summer semester 1946, while the Humboldt Universität would have been open to me only until the following Winter semester. However, it was possible to major in mathematics even at the T.U. The only difference was that I was required to take 4 Semesters of "Technische Mechanik" (engineering mechanics), which I would have avoided had I started my studies at the Humboldt Universität. One of the instructors at the T.U. was Istvan Szabó, and I was introduced to him by Liese Hohensee, who at the time was employed as an assistant at the T.U.. Szabó recognized that I was a very good student, and he arranged for me to be employed as "studentische Hilfskraft" (teaching assistant) from the second semester on, which helped me financially during my years as a student in Berlin. At first, I was exceptional in being a very good student of mathematics at the T.U. Starting with the Summer semester of 1947 I had competition; his name was Dietrich Morgenstern. We soon became very good friends and still are. He is now Professor Emeritus at the Technische Hochschule in Hannover. At the T.U. I took a variety of courses in mathematics, mechanics, and physics, not necessarily always in the right sequence. For example, I took Complex Analysis II in my third semester and Complex Analysis I only in my sixth semester. From the Winter semester 1947 on, I also enrolled as a "guest-student" at the Humboldt Universität from time to time and took courses such as "Elementary Number Theory" with Helmut Hasse and "Mathematical Logic II" with Karl Schröter. Much later, in 1951, I took also a course entitled "Quantum Mechanics II" with Günter Ludwig at the Free University in West-Berlin. The concept of "Taking a course" in Germany at that time was not the same as it is now in the U.S. One did not pass or fail a course or obtain a grade in a course. It was possible to sign up for a course and never show up, and nobody would know the difference. I probably learned as much, if not more, mathematics by the systematic reading of textbooks than by attending courses. However, some courses had "Übungen" (something between recitation sessions and a problem seminar) associated with them. These Übungen were conducted by one of the professor's assistants. He designed and graded homework

problems. If a student handed in sufficiently many solutions to problems, he would receive an "Übungsschein" (certificate of participation). This Übungsschein could contain a special mention such as "good", "very good", or "excellent". In some of the very basic courses, one or two written tests ("Klausuren") were required for obtaining the Übungsschein. A sufficient number of these Übungsscheine were required for graduation, but the graduation itself was based on a "Diplomarbeit" (thesis) and on a set of oral examinations administered by the professors. The first set of such oral examinations ("Vorprüfung") took place after the fourth semester of study, and it was necessary to pass them in order to continue. The final oral examinations for a "Diplom"-degree took place after eight semesters at the earliest. Many students were not ready to take them until after the ninth or tenth semester.

In the late Summer of 1948 I participated again in a two-week Summer course organized by the French military government, this time in Inzigkofen near Sigmaringen, also in South-West Germany. The topic was "The Peace". For a time, I thought I would not be able to go because the Berlin blockade had begun and all land connections to West Berlin were severed. Surprisingly, the French military government put us on a plane to get us out of Berlin. This was first plane trip in my life (the plane was an old German JU 52 trimotor transport) and it also marked the end of starvation for me. From then on I never again experienced severe hunger. I did not return directly to Berlin after the Summer course. Rather, I went on my first trip abroad after the war, namely to Britain as a participant in a program organized by the British Foreign Office. This program made it possible for some German students to see Britain. In exchange, the students worked for about two months as farm laborers to help bring in the harvest. I stayed with a group of German students for two months in a camp in a rural area in Yorkshire. Most of the time we gathered potatoes. But on weekends we went on hitch-hiking trips, one of which took as all the way to Scotland (Glasgow and Edinborough). After my stint as a farm laborer, I went first to London to visit an English student I had met at the Summer course in Germany, and then for two weeks to Cardiff in South Wales to stay with a family that had volunteered to host a German student. They were very kind and I had a very good time. After our return to Germany in late December, the students from Berlin were scheduled to be flown back into the city. Because of bad weather, our plane was delayed for an entire week (it was more important to ship coal rather than people into the blockaded city). I finally arrived in my

parents house in Zeuthen late on Christmas eve like Santa Claus, laden with goodies that I has acquired in England.

During the Spring and Summer of 1949 I continued my studies in Berlin, but in early October I traveled to Paris to spend the academic year 1949/50 at the University of Paris, then also known as the "Sorbonne". I had obtained a fellowship from the French Government which paid for tuition and room and board. I learned a lot of mathematics in Paris, especially through participation in problem seminars and through independent reading in the library of the Institut Henri Poincaré, a building in which mathematical activities were concentrated. I also participated in a seminar at the École Normale Supérieure entitled "Fonctions analytiques de plusieures variables". It was conducted be Henri Cartan and the participants included Jean-Pierre Serre and Armand Borel. The discussions were way over my head, and the experience did something for my humility.

It was in Paris that I had my first contact with the work of N. Bourbaki, which is a pseudonym that was used by a group of brilliant French mathematicians including J. Dieudonné, A. Weil, and H. Cartan. They were trying to reorganize, systematize, and unify much of the mathematical knowledge known at that time. I saved enough money from my fellowship allowance so that in July 1950 I could buy all the volumes of Boubaki's "Éléments de Mathématiques" that had been published by then. Some of these volumes I studied systematically later on.

In the Spring and Summer of 1950 I took three examinations at the Sorbonne and thereby acquired "Certificats d'Études supérieures" in "Calcul différentiel et intégral", "Algèbre et Théorie des nombres", and "Géométrie supérieure". These titles may be misleading. For example, "Calcul différentiel et intégral" included advanced calculus, complex analysis, and ordinary and partial differential equations. The crucial part of such an examination was the written portion which took seven hours, all in one day. It was not easy to pass. For example, only 49 out of 296 candidates passed the examination in "Calcul différentiel et integral" when I took it; of those 49, only four got a "très bien" (A), and another four a "bien" (B). I received only a "bien". As a result of passing these examinations, I acquired the degree of "licencié ès sciences".

It must not be thought that I spend all my time in Paris studying mathematics. I went to museums, theaters, movies, and concerts, I went to parties, and I made excursions to Versailles, St. Denis, St.Germain, Fontaineblau, Chartres, etc. I met not only French students but also other foreign students from many countries. In particular, I made my first American friend, Ralph Raimi. Also a mathematics major, he lent me some of the most recent American advanced textbooks (one of these was a translation from Russian, Pontryagins "Topological Groups"), and we met regularly to study together. He is now Professor of Mathematics at the University of Rochester in New York State. During the Easter recess 1950 I traveled to Cardiff, South Wales, to revisit the family that I had stayed with in December of 1948. After my stay in Paris I made two hitch-hiking trips. The first took me to the Loire valley where I visited most of the famous castles. The second took me to the South of France, where I visited Avignon, Nice, Cannes, and Monte Carlo.

After my return to Berlin in August of 1950 I stayed for about a year with my parents, who had moved to West-Berlin from the suburbs. I continued my studies and prepared for my graduation. On May 5, I acquired the degree of "Diplom-Ingenieur" with the mark "Ausgezeichnet" (summa cum laude). Despite the title, it was a degree in mathematics, not engineering. The topic of my Diplomarbeit (thesis) was "reproducing kernels, with applications to the theory of analytic functions". The following excerpt from the introduction already reflects the philosophy on which much of my later work was based.

"In the past hundred years mathematics went the way of more and more specialization and subdivision. However, recently there has emerged again a tendency for methodical unification. There has been a realization that only a few fundamental structures are at the basis of all branches of mathematics. The discovery of these structures leads to deeper insight and above all to considerable simplification. This development is necessary, for how else could the accumulating profusion of mathematical knowledge be preserved and transmitted." (My translation.)

From the Fall of 1950 until the Fall of 1951 I again obtained part-time employment as "studentische Hilfskraft", not only at the T.U. but also at the new "Freie Universität" in West-Berlin. My first scientific paper ([1] in my list of publications) came about as a by-product of a task assigned to me by Prof. E. Mohr at the T.U. Much later I was gratified to find that one of the

results obtained by E. Mohr and me is included in the book "Inequalities" by Beckenbach and Bellman (Springer-Verlag, 1965).

After obtaining my diploma in May 1951, I tried to obtain a position as "Wissenschaftlicher Assistent" with a Senior Professor of Mathematics. Such a position was the first step in an academic career in Germany. It was a full time civil service position, with a two-year contract, extendable by another two years. One's duties were whatever the Senior Professor assigned. It has no counterpart in the American system. There was no opening with a Professor of Mathematics, but Istvan Szabó, who had become a Senior Professor of Engineering Mechanics, offered me such a position at his Institute, starting in October 1951. Thus, it was almost by chance that I became involved with mechanics. Now I could afford to rent a nice (by my standards then) furnished room with kitchen privileges. I lived there, with a one-year interruption, until June 1955 (address: bei Emilie Neumark, Binger Str.10, Berlin-Wilmersdorf).

My principal duty in my new job was to help Szabó to write scientific books. In particular, I put considerable effort into a revision of "Mathematische Formeln und Tafeln" in "Hütte, Des Ingenieurs Tachenbuch", Akademischer Verein Hütte, E.V., 1955. This work involved rewriting much of a 200 page summary of mathematical definitions and results considered to be of interest to engineers. Also, I wrote a major part of "Höhere Mathematik, Teil VI, Integration und Reihenentwicklungen im Komplexen, Gewöhnliche und Partielle Differentialgleichungen", B.G. Teubner, 1953. Had I been in the United States, I surely would have been named a co-author of these two books. On the other hand, Szabó gave me more autonomy than his other assistants, who had much more involvement than I with the unpleasant task of conducting the "Übungen" for the basic engineering mechanics courses. I did not spend as much time as I should have on preparing a doctoral dissertation, partly because I lacked suitable guidance. I spent too much time with the game of GO (a 5000 year old Chinese board-game, now very popular in Japan) to which I had recently been introduced by Paul Winkler, who was a mathematics student then and has remained a friend to this day. In February of 1952, I met my future first wife Helga Schönberg at a costume ball. We saw each other a great deal from then on, and in the Summer of 1953 we went on a camping trip to Brittany in France with another couple.

Section C. 1953-1956

In the Fall of 1952 I came across a pamphlet from the "Graduate Institute for Applied Mathematics" of Indiana University, with instructions on how to apply for a "research assistantship" there. The pamphlet had been sent to Georg Hamel, then living in Bavaria, who was a Professor Emeritus of the T.U. and also a member of the Editorial Board of the then "Journal for Rational Mechanics and Analysis", edited by C. Truesdell at Indiana. Hamel forwarded the pamphlet to Szabó, who showed it to me. I always had been very eager to visit the United States, so I applied early in 1953. I also applied for a Fulbright travel grant. Despite some problems with deadlines, I was successful with both applications. At that time, air travel was still much more expensive than travel by ship. Also, it was very difficult to book a passage on a ship because there still was a shortage of ships due to the losses in World War II. I finally managed to book a passage on the Khedive Ismail, an Egyptian ship going from Genoa, Italy, to New York in early September. I obtained a one-year leave of absence from my position at the T.U. and left on August 30, 1953 by train to Genoa in order to board the Khedive Ismail. The arrival in New York was very exciting, I had never seen skyscrapers before. The ship landed in Hoboken, but somebody gave me a ride to Grand Central Station, from where I took the train to Rochester, N.Y. I stayed there a few nights at the house of Ralph Raimi and his wife Sonja, whom I had befriended during my stay in Paris in 1949-50. One evening he invited several people from the University to a party to meet me. I still remember that it was very exhausting for me to converse in English for several hours. The next day I proceeded by train to Indianapolis, and from there by bus to Bloomington.

In Bloomington I found my way to Rogers Center, the graduate student dormitory which was to be my home for the coming year. I arrived just when a get-acquainted party for new arrivals was in progress. I still remember how friendly everybody was. I found that Americans, on the average, are much friendlier and less reserved towards strangers than Europeans (with the possible exception of the British). My year in Bloomington turned out to be one of the happiest and most eventful of my life. I became friends with many of my fellow graduate students. One of them, Robert Byrne, a philosophy student, was also a grandmaster in chess who had competed in international competitions. He organized a chess tournament in Rogers Center. I won the

tournament and received a color film as a prize. Of course, he himself did not compete. I remember being absolutely amazed at his ability in chess. He repeated, from memory, a game he had played a year or so before against a Russian in Helsinki. Once I played against him in a game in which he started without his queen. He beat me in about 20 moves. Byrne is now writes the chess column for the New York Times.

The University had an outstanding program of activities for foreign students. In December 1953 I was one of 26 participants in a tour to the city of Chicago arranged by the University. In addition to visits to the Museum of Science and Industry and other standard sights, special visits to the offices of the Chicago Daily Tribune and the Research Laboratory of the Standard Oil Company were arranged for us. We were guests at Don McNeil's famous Breakfast Club Radio Broadcast on the ABC network and also appeared briefly on Chicago's ABC TV Station. In the Spring of 1954 the University arranged a similar tour to Washington, D.C. The highlights of this trip were specially arranged tours of the White House and the Capitol.

As a foreign student, I automatically was a member of the Cosmopolitan Club on the Indiana Campus, where one could go to socialize and relax. One day I saw there a familiar face: Mr. Franklin, the person who chaired the discussion group I participated in Berlin-Wannsee in 1947. He was still an aide to Herman B. Wells, who was now President of Indiana University. As a result, I was invited by the President for dinner, a concert by Arthur Rubinstein and then for a reception after the concert.

Local civic organizations also helped make the foreign students welcome. I was invited by a church group to talk about the political situation in Berlin. The local Lions Club invited all foreign students to a picnic in a nearby state park. I spent the afternoon of Thanksgiving 1953 with a local family and I had a second Thanksgiving dinner in the evening at the Truesdells house. I don't think I have ever eaten as much in one day before or since. Since I had suffered from starvation only a few years earlier, I was overwhelmed by the abundance of good food.

During the first semester I shared my dormitory room with a native of the Soviet Union. He was classified as a displaced person after the war and was then permitted to immigrate to the U.S. He was at Indiana University because the linguistics department wanted to study his native language,

which was spoken only in a small region of the Soviet Union. He was a nice person, but his English was very poor, so I could not talk to him very much. During the second semester, I shared a room with Dietrich Morgenstern, who had been my friend since 1946 and was now also a "Wissenschaftlicher Assistent" at the T.U. Berlin. I had encouraged him to join me in Bloomington with the same arrangement as I had. After I left Bloomington in September 1954 he stayed on for another Semester, and he also obtained an American Ph. D., under the direction of Eberhard Hopf.

Before arriving in Bloomington, I had a completely wrong idea about what my duties as a "research assistant" would be. I did not realize that I was to be a paid graduate student. In fact, the concept of a graduate student was unknown to me. German universities do not have the kind of Ph.D. programs that American universities have. In Germany, I had finished my courses and examinations. The only thing left to write and defend a thesis. I found out that, in order to obtain an American Ph.D., I had to pass a qualifying examination and language examinations in German and French, I had to take several courses with examinations at the end, and I still had to write a thesis. On the other hand, I had no other duties and so it seemed to me that I could try to make it in a year. I had missed the deadline for the language examinations, but after I talked to the head of the French Department in French for 10 minutes and after I read out loud a passage from a German novel printed in Fraktur to the head of the German department I obtained a dispensation. I had to take the qualifying examination without much preparation, but I passed despite the fact that I could not answer several questions, perhaps because the examiners realized that I could think on my feet. The courses I took included one in hydrodynamics from Clifford Truesdell and one in partial differential equations from David Gilbarg. Both were on a high level and I learned a lot. After I handed in some good solutions to homework problems, Gilbarg asked me to grade the other students' homework in lieu of doing the homework myself. I also participated in a seminar on statistical mechanics conducted by Truesdell. The lecture that was assigned to me in this seminar led to a published paper.

The faculty at the Indiana Mathematics Department was of very high quality. It included, in addition to Truesdell and Gilbarg, Eberhard Hopf, Max Zorn, Vaclav Hlavaty, William Gustin, and T.Y. Thomas (the latter on leave during my stay). Truesdell's interests included mechanics and I asked him to serve as my thesis advisor because I thought that a thesis in mechanics

would help me with my position in the Institute for Engineering Mechanics in Berlin. Truesdell handed me the paper "Sur une conception nouvelle des forces intérieures dans une fluide en mouvement" by S. Zaremba, published in 1937, and gave me the task to make sense out of it. This led to my examination of the fundamental concept of continuum mechanics, a task I am still occupied with to this day. I succeeded in producing enough material for a thesis. After feverishly typing the final version, mostly at night because of the unbearable summer heat, I submitted the manuscript of 114 typewritten pages on July 26. My thesis defense took place on August 9 and I was awarded the Ph.D. degree on September 7.

The relation between the professors and us graduate students was very friendly. We were often invited to dinners, parties, and picnics. Clifford Truesdell and his wife Charlotte were particularly nice to me throughout my stay in Indiana. I was invited to their house many times. Although the ideas of my thesis were entirely mine, Clifford helped me very much with putting them into clear English. He also taught me respect for good writing, something that is sadly lacking among too many mathematicians. At first he was uncomfortable with my coordinate-free, conceptual way of mathematical reasoning, and he persuaded me to include versions with coordinates of all equations in my thesis. (A few years later, he himself wrote papers in which no coordinates were used.)

I left Bloomington on August 18 and hitchhiked to Rochester, N.Y. to stay again at the Raimis' house for a few days. From there I proceeded to visit first Boston and then Providence. There, at Brown University, I had a meeting with Ronald Rivlin, with a letter of introduction by Truesdell. When Rivlin learned that I had obtained my Ph.D. at Indiana after only a one-year stay there, he said: "They must be giving away their Ph.D. there now". While in Providence I experienced the great hurricane of 1954, in which downtown Providence was flooded, shop windows were shattered, walls turned over, and trees uprooted. After a five-day sightseeing stay in New York I boarded the "Gripsholm", which was filled with European students going home and American students going to Europe. I arrived in Bremerhaven on September 17. After a short visit with my relatives in Varel I returned home by plane from Hamburg (the fare was still covered by my Fulbright travel grant).

In Berlin I spent one more year as "Wissenschaftlicher Assistent" at the Technical University. Since my contract could not be renewed after that, it was time to look for a new job. At the time, the prospects in Berlin were not very promising, at least for a university position. While still in Bloomington, I had learned that it was very easy to get a university job in the U.S. In fact, I had received two offers before I returned to Germany. Already then I had played with the idea of eventually returning to the U.S. as a permanent resident. My fiancée Helga was not averse to that idea. In January 1955, on Truesdell's advice, I applied for post-doctoral positions at Harvard and Princeton, but I was not successful. In December 1954 I received an inquiry from the University of Southern California as to whether I would be interested in a position there. After some back and forth, I received and accepted a definite offer in March 1955. The effort to obtain immigration visas for me and Helga involved a fair amount of red tape but was eventually successful.

Helga and I got married on April 1, 1955, and I moved into the apartment where she and her mother's lived (address: Berlin-Wannsee, Ulricistraße 10). For our honeymoon we took a two-week guided bus tour that included Florence, Rome, Ravenna, and Venice. The guide, Dr. H. Eberle, with a doctorate in art history, was first-rate, and we not only enjoyed the trip, but we also learned a lot about art. Years later, when I saw Kenneth Clark"s T.V. series "Civilization", I was very much reminded of Dr. Eberle.

It was still very difficult to book passages across the Atlantic. We finally succeeded in finding places on the Prins Frederik Henrik, a tiny freighter leaving Rotterdam on Sept. 3 and arriving in Montreal about 12 days later. Since our finances were extremely limited, we made the trip from Montreal to Los Angeles by bus. We entered the U.S. in Detroit on Sept. 17. Our only overnight stay was in Bloomington, at the Truesdells' house. They had a party for us in the evening, so we did not get very much sleep. After passing through Arizona at night, we finally arrived completely exhausted in smoggy Los Angeles several days after classes had started at U.S.C.

The Mathematics Dept. at U.S.C. had arranged for us to rent a small furnished apartment within walking distance of the university (address: 1108 1/2 Exposition Boulevard, Los Angeles 6). I started teaching an evening course immediately, even before the electricity had been connected in our apartment, which meant that Helga had to wait for me in the dark.

Fortunately I soon met John Ferling, a graduate student at U.S.C. who had immigrated from Germany in 1948. He helped us very much to get adjusted. He showed us Hollywood, Beverly Hills, and Redondo Beach, where his parents lived in an oceanfront apartment. In the beginning of November, he not only helped me to buy a used car but he also taught me how to drive. (I had a German driver's licence but no experience, so I flunked my first California driving test.) Originally we had planned to live without a car for about a year, but this proved to be impossible in L.A.

Some of our possessions had been sent by freight from Germany, but due to a foul-up came into our possession only in late November. Finally, by Christmas, we felt a little bit at home. From Dec. 26 until Jan. 2 we made our first tour by car, to Escondido, San Diego, Tijuana, Ensenada, Mexicali, Imperial Valley, Borrego Springs, Mount Palomar, and then back to L.A. Everything was new to us, and we fell in love with Southern California. Later in 1956 we made two more tours, one to Twenty-nine Palms and Joshua Tree National Monument, and the other to Sequoia National Park.

Exposition Blvd. was a very noisy street, with railroad tracks in the center, and our apartment there was shabby and run down. Therefore, on Feb.15 1956, we moved to a much nicer neighborhood and into a much better apartment, with modern conveniences and brand-new furniture (address: Apt.9, 4010 Palmwood Drive, Los Angeles 8). From then on we really enjoyed living in L.A. Helga improved our financial situation by working as a salesperson.

The acting Department Chairman at U.S.C., Ralph Phillips, and my new colleagues were very friendly and very helpful. I became friends, in particular, with Robert Finn, who was also at the beginning of his career. We saw each other frequently and we collaborated on a paper in fluid dynamics. He and his wife had frequent social contacts with Helga and me. He even confided to me that he had voted against offering me a position at U.S.C. because I was German (he is Jewish). Phillips, Finn, and I participated in a weekly joint evening-seminar with several people from U.C.L.A. and the California Institute of Technology, including Samuel Carlin and Charles DiPrima. We usually met for dinner in a restaurant before the seminar. Sometimes the seminar took place in Phillips' house and we had a little party afterwards. The seminar almost always led to animated discussions, and I

learned a great deal. Years later, I used this seminar as a model for an evening-seminar I organized at Carnegie Mellon.

In December 1955 I received a letter from Walter Leighton, then Head of the Mathematics Department at Carnegie Institute of Technology (now Carnegie Mellon University). The letter began: "You have been nominated by Professors Truesdell and Gilbarg for appointment in our department". After showing some interest, I was offered, in January, a position as associate professor, with a five-year contract and a salary of $7000 for the academic year. The offer was hard to refuse, because at U.S.C. I had only the rank of an instructor and a salary of $4500. (I received an additional $1500 in the summer under a government research grant, but a summer salary was also available at Carnegie Tech.) Of course, I showed the offer to Ralph Phillips, but U.S.C. thought that the offer was unreasonable and was unable or unwilling to match it. I accepted the offer on Feb. 4.

In January 1956 I received two letters from my old boss in Berlin, Istvan Szabó. In the first, he in effect offered me a position at the T.U. as a "Diätendozent", a position that was newly created as a first step of an academic career. I declined the offer in favor of the one from Carnegie Tech. In the second letter he hinted that there might even be a possibility for me to obtain a "Lehrstuhl" (full professorship) because of a recent retirement. In March he sent me another letter indicating that it had become very likely that I would be offered a Lehrstuhl at the T.U. if I was interested. This was very unusual, because a Lehrstuhl is the high point of an academic career in Germany and is not very often offered to a person as young as I was then. As an "Ordinarius" (full professor), I would have had three full-time assistants, a secretary, and a lot of power, but also a lot of administrative responsibility. The situation forced me to make a definite choice between life and an academic career in Germany or the United States. I chose the United States, and I have never regretted the decision. Helga was also in favor of staying in the U.S. I wrote a long letter to Szabó explaining our decision.

In August 1956 we sent some of our belongings to Pittsburgh by freight, put the remaining ones into our car and left on the 15th. We drove up the West coast via San Francisco to Seattle, where I participated in the Summer Meeting of the American Mathematical Society and gave a 10 minute lecture. Our plan to see a lot of the U.S. on our way to Pittsburgh was

somewhat curtailed by a car accident in Coeur d'Alene, Idaho. Rain had combined with oil on the road to form a slippery layer. The car turned over and ended up in a ditch. Fortunately, we were only lightly bruised, but the body of the car was badly damaged. The repair took several days, and we had to give up our plan to visit Glacier National Park. However, we did see Yellowstone National Park, the Badlands, the Black Hills, and Mount Rushmore. At night we camped most of the time. When we arrived on the turnpike at the border of Pennsylvania, we were almost refused entrance because our car was in such bad shape, and Pennsylvania had very strict standards. In fact the car had to be junked soon thereafter. We arrived in Pittsburgh in early September.