

Interview with
Margaret S. Petersen

The Early Years

Q: I'm going to begin by asking you to discuss your family background and childhood.

A: I'm the oldest of three children, and I was born in 1920 in Rock Island, Illinois, on the Mississippi River. I became aware of the river at a very early age. We used to visit my great aunt, who had a farm on the Mississippi. It flooded every spring, and it was a very interesting thing for a child to observe. My brother, who was two years younger than I, became involved in aircraft design during World War II. My youngest brother, who is six years younger than I am, is a mechanical engineer.

I grew up, really, during the Depression. I can remember the day the stock market crashed. I was nine. Rock Island was a small town, a manufacturing town. It was a very depressed area, I suppose, until World War II, at which time all of the manufacturing--Case, International Harvester, companies like that--converted to war production and expanded, and the town became more prosperous. There was a lot more going on.

Rock Island District and the Panama Canal

I graduated from high school in 1938, and I attended Augustana College in Rock Island, Illinois, for one year full-time and then I began working in an architect's office. I continued part-time in evening school until January 1943. I started working for the Corps in June of 1942, as a draftsman, in the Rock Island District. At that time, Rock Island was doing almost all military work. The locks and dams had been finished in the '30's. I remember watching, going down to some of the construction sites, when I was quite small with my father.

The Rock Island District was involved in the Third Locks Project for the Panama Canal. A good many of the engineers in the Special Engineering Division of the Panama Canal had come out of the Rock Island District because of the experience they had on the locks on the Upper Mississippi. Whenever the Special Engineering Division in Panama needed extra staff, Rock Island was requested to loan them people.

In the winter of '42-'43, the Corps reorganized military work among Districts, and Rock Island lost a lot of it. At that time the Special Engineering Division of the Canal requested a loan of ten people; and I was one of the group that went to Panama then. There were four

girls and six fellows. We were all draftsmen, and what we did primarily was ink tracing on linen, mostly electrical diagrams. Construction of the Third Locks across Panama had been started before World War II and a lot of excavation had been done. However, German submarines in the Caribbean were sinking construction materials being shipped to Panama, and it was decided to stop construction until after the war--just finish up the contract drawings--and that's what we were doing. We were in Panama from February-December 1943.

At that time, they assigned apartments to the two older girls, and the two of us, who were younger, were assigned to live with the older girls. We lived in Diablo Heights, a relatively new town on the Pacific side, constructed for the Special Engineering Division. I was assigned to live with Irene Miller. Irene and I lived and worked together for the next thirty years until she died. We went back to school together in 1944; we got our engineering degrees at the same time in February 1947. We worked in a number of Corps offices, and the Corps was very considerate in that they always placed us together. In those days, no woman made enough money to live decently by herself, really.

We managed to save enough money while we were in Panama to go back to school. In Panama we had a choice of either three-dollars-a-day per diem, or twenty-five percent increase in salary. Three-dollars-a-day was more than twenty-five percent of our salary, so we lived on our salary and saved our per diem. We came back with about one thousand dollars each and in the summer of 1944, decided to go back to school and get engineering degrees. I had had several years of liberal arts, and Irene had attended teachers' college and had been a teacher before she took a course in drafting in the summer of 1942. She started working for the Corps in Rock Island about the same time I did, but I didn't really know her until we were assigned to live together in Panama.

Q: What was Panama like when you were there?

A: It was very interesting. It was during the war so we had blackouts, and driving was on the wrong (left) side of the road. It was the first time I'd ever been out of the country so it was quite an experience. We lived in Diablo Heights, which was a town constructed for the Special Engineering Division of the Panama Canal Company. Irene and I went back to Panama twenty-five years later, bird watching. We couldn't believe how much everything had changed.

Q: It changed?

A: That would have been '68. By that time, most of the employees were Panamanian, and the old wooden buildings in Diablo Heights looked awful. Have you been in Panama?

Q: **No.**

A: There was a very elegant hotel over on the Caribbean side, the Washington Hotel. It had been turned over to the Panamanians in the late '50's I think. When we were there in 1968, it had been stripped of the brass banisters; tiles and windows were cracked and broken; it was in a terrible condition.

Undergraduate Study at the University of Iowa

Q: So when you returned from Panama you enrolled in engineering at the University of Iowa at Iowa City?

A: We went to Iowa City for an appointment to see Dean Dawson, who was the Dean of the College of Engineering at the University of Iowa. He was very cordial, but he really wasn't very encouraging. However, he had a wonderful secretary by the name of Mary Sheedy, (who died in 1995 at the age of 96). He and she both told us later that he had said to her something to the effect of, "Tell them they can't do it. We're not interested in having them here." Mary persuaded the Dean to accept us because she had applied for medical school and was not admitted. So, we were accepted, and we moved to Iowa City in August of 1944.

We were lucky in that at that time the St. Paul District of the Corps had a sub-office at the University of Iowa in the hydraulics laboratory. Martin Nelson was the head of the sub-office in St. Paul. Bob Kriess was the chief in Iowa City, and he was followed by Marv Webster. We worked for both of them, about half-time while we were in school, full-time during vacations. At that time, the university was running three semesters a year. We went back to school in August of '44, and we finished in January of '47. We then worked full-time at the laboratory for the Corps until the summer of '47, when we got jobs in Vicksburg at the Waterways Experiment Station (WES) of the Corps in Mississippi.

Engineering Curriculum

Q: At the University of Iowa, how many courses did you take in hydraulics in your civil engineering curriculum? Were there a lot of courses in hydraulics and hydrology or were there just general engineering courses that may have touched on those subjects?

A: No, there were really quite a number of courses at Iowa. Both Irene and I had some liberal arts work before we went to Iowa so we didn't have to take some of the basic things. I had algebra and trig, English, economics, and Spanish classes. Iowa had a large graduate program in hydraulics at that time and even though we were undergraduates, we took many of the graduate level courses in hydraulics. As an undergraduate, I took classes in Mechanics of Fluids, Fluid Mechanics Laboratory, Water Measurements, Hydraulic Computations, Hydrology, Hydraulic Turbines, and Irrigation and Drainage.

We became interested in hydraulics partly because we worked for the Corps in the hydraulics lab as undergraduates. When we first went to Iowa, we thought designing a bridge would be the most fun, but somehow we got into water from working in the laboratory.

Q: How much in your undergraduate courses was design? Was there much in the area of design, because you did a lot of that in your career?

A: No, Irrigation and Drainage included design. I think that Measurement of Water and Hydraulic Computations both probably had some design, but they did not include design of a major project.

Q: Well, that would have been very unusual, wouldn't it, for an undergraduate to have anything that's...

A: We have now in the senior year, a Capstone Design Course. A group of students work as a team, and they do everything from the planning, structure design, concrete design, hydraulics and so forth. Usually the project is a bridge or something of that type. But we didn't do that when I was in school.

Q: Did your classes include anything related to project management?

A: Nothing.

Q: Nothing at all like that. So this was all sort of the equivalent of getting ready to be what would be called a "junior engineer" at that time?

A: Right. Now, Åke Alin, in his graduate-level dam design course, talked a lot about how everything fit together. You wouldn't really have called it management, but we got some of it there.

Q: Mostly you learned from on the job experience, actually working.

A: Yes.

In looking at old papers that might interest you, I found this 1947 letter from WES saying they have a vacancy, signed by Joe Tiffany. This is a letter from the St. Paul District. I didn't realize who signed it until today, when I looked at it. I knew him later [Walter K. Wilson] when he was Chief of Engineers, but I didn't associate him back to this.

Q: I think he wasn't there very long before he went to Mobile District. But if you had any exposure to him, you'll notice that a lot of his teaching points were by example, stories of personal examples.

A: Oh, really? I knew him mostly through PIANC [Permanent International Association of Navigation Congresses] and ASCE [American Society of Civil Engineers] meetings.

Waterways Experiment Station

Q: After the University of Iowa, both Irene and you went to work at the Waterways Experiment Station at Vicksburg.

A: We didn't have the faintest idea where Vicksburg was. We couldn't find it on the maps we had. WES had planned to assign one of us to Vicksburg and one to Jackson [Clinton, Mississippi] where they were building the Mississippi Basin Model (MBM), and we said, well, we really wanted to live together, and so they assigned both of us to Jackson. The MBM was constructed on what had been a prisoner of war camp where Rommel's *Afrika Korps* had been interned. Actual work on the model was begun in August 1943 with German prisoner-of-war labor. They rough-graded the 200-acre model site and constructed some 85,000 feet of storm drains underlying the site. That work was completed in the fall of 1946, about when the prisoners were repatriated, and the first concrete paving on the Arkansas River reach was placed in August 1947, about when we arrived. The MBM was a model of the 1.25 million square mile watershed of the Mississippi River constructed at a horizontal scale of 1:2000 and a vertical scale of 1: 100. The streams and flood plains were molded in concrete and the overall area was rough-graded and sodded.

I worked on research projects most of the time and Irene operated the Arkansas and Missouri reaches of the model sections. It didn't take long before we knew that a bachelors degree just wasn't adequate for what we wanted to do. We went back to the University of Iowa in '52

and got a Masters in '53. Our Bachelors was in Civil Engineering; the Masters was in Mechanics and Hydraulics.

Mississippi Basin Model at Jackson

Q: At WES, then, you worked on the Mississippi Basin Model?

A: I didn't really work on only that model, although Irene did.

I was in Jackson, and my research studies were there at the Mississippi Basin Model. I did some basic studies related to the MBM. One of the first research studies was to study the effects of model distortion on hydraulic elements. Before the Mississippi Basin Model was constructed, they had what was called the "pilot model" of a reach of the Kanawha River, which was an exceptionally steep stream. The pilot model was constructed to the same scale as proposed for the MBM. The question was if it could, with artificial roughness, be made rough enough to produce historical flood hydrographs. Irene was involved in that, initially. When we went to Jackson in 1947, construction of the MBM model was just beginning, and it was at least a year before concrete was poured on the first section.

Q: This is the big model?

A: Yes.

Q: So what were your major tasks with WES when you were with the basin model?

A: From August 1947 until November 1949, I reviewed and analyzed data (hydraulic, topographic, and hydrographic) for designs of proposed testing programs and model-operating techniques. I also determined the ranges of automatic instruments developed especially for the MBM for specific model locations. Later I reviewed and analyzed test data from the MBM for compliance with objectives of the testing programs, model-operating techniques, accuracy of model data, and applicability of model data to the prototype. Along with work on the MBM, I also was in charge of several research projects--the effects of model distortion of hydraulic elements; flexible roughness for tidal models, optimum spacing of roughness elements in models, etc. Also, I taught several courses in fluid mechanics for the WES staff.

Q: Did you work with Joe Tiffany?

A: Yes. Joe Tiffany became Technical Director of WES in 1940 and continued in that position until 1969, I think. He was followed by Fred Brown. Gene Fortson was head of the WES Hydraulics Laboratory when we arrived in 1947 until his retirement in 1971. The head of the Mississippi Basin Model was H.G. Dewey--he was still alive a few years ago. He left WES in the mid-'50's to head the Corps model of San Francisco Bay in Sausalito. He was the head of the Bay model until 1959, when he became Chief of Design and Construction for the California Department of Water Resources until retirement in 1971. Dewey was another exceptional engineer. Very bright. We worked directly for H.C. McGee, Dewey's assistant. The MBM at Jackson was a part of the WES Hydraulics Laboratory.

Q: The Mississippi Basin Model was the first really large model the Corps built, wasn't it? I believe a smaller one had been built before.

A: Yes, there was a model covering the Lower Mississippi River at WES in Vicksburg. The MBM was designed specifically to assist in developing coordinated basin-wide plans for flood control and operation of flood-control structures. We looked at the effects of levees on flood heights, the effects of building dams in various places, and a range of maximum releases from dams and how the releases would affect the downstream part of a stream and, eventually, the Mississippi River. These are all conditions that could be routed theoretically for individual streams, but for complex systems it was more reliable to do it on a model where we could change variables one at a time and note the results. Within the Mississippi River Basin in the early 1950's, there were existing, authorized, or proposed, approximately 200 reservoirs, several thousand miles of levees, and numerous other flood control structures.

We verified the MBM reach by reach and stream by stream to where it would reproduce known flood elevations and flood hydrographs. This was accomplished by varying the roughness, the number of small rough elements in the channel bed and the density and location of folded screen wire (representing vegetation in the overbank) and so forth until the flood hydrograph in the model was approximately the same as the flood hydrograph in the prototype. In alluvial streams, the river bed changes a lot during a flood with scour and deposition, and in a fixed-bed model such as the MBM, a lot of little factors are lumped together in one factor, in the roughness.

The 1952 spring flood on the Upper Missouri was the biggest spring flood they'd had, I think, and there was great concern that it would overtop the flood walls protecting Omaha and Council Bluffs. Irene was in charge of the Missouri River section of the MBM at that time. Whenever we had emergency testing on the MBM, my research unit shut down and all of my staff would help out on the Mississippi Basin Model, because many people were needed to read water service elevations manually at many points. We didn't have enough automatic gauges in the model to provide the detailed water level data needed for flood

fighting. I don't think there were any dams except Fort Peck completed on the Upper Missouri River.

Q: You're correct because Gavins Point and Randall wouldn't have been finished then.

A: Yes, Randall was the next dam to be finished and, I think, Randall was completed in '53. Gavins Point was closed while we worked in Omaha, probably in 1955, and the other dams followed. So in 1952, Omaha District had known releases from Fort Peck Dam, which they routed downstream to Gavins Point. The upper limit of the Missouri River in the MBM was at Gavins Point, because Gavins Point Dam was planned to be the most downstream point of control. Omaha District estimated what the flood hydrograph would be at Gavins Point, and we would put it in the MBM and route the flood downstream taking water surface elevations to see what could be expected especially in the Omaha-Council Bluffs area. This assisted the Omaha District in concentrating their flood fighting measures in critical areas. As a precaution, low-lying areas of Council Bluffs were evacuated at the height of the flood. However? flood-fighting efforts were successful, and there were no failures of flood walls or levees in the Omaha-Council Bluffs reach.

If you want to talk in detail about the Mississippi Model, you should talk to James Foster in Jackson. James finished college in about '48 or '49, and he worked for Irene at the time we were in Jackson. He took over the Missouri River section in 1952 when we left and following McGee's death in the '60s, was in charge of the whole operation at Jackson for the last few years the MBM was active. He worked then on similar models at WES in Vicksburg until he retired, probably in the middle '80's.

Q: Okay. You found you didn't like this kind of work?

A: No, I liked. ..

Q: I mean the model work.

A: No, this is what happened in '52 when we decided to go back to school. You may already know this--many people in the Corps in Vicksburg and at Jackson belonged to an engineer Reserve group.

Q: There was a big Army Reserve engineer command down there.

A: Yes. This was a Reserve unit. It included almost everybody from Fortson, who was head of the WES Hydraulic Laboratory, right on down through Dewey, who was Chief of the MBM at Jackson, and most of the fellows who worked for us at the MBM. The 434th. ..

Q: It's the 412th Engineer Command now, but it might have had some other designation then.

A: Well, that probably was what it was. It was my understanding later that they were called up by mistake, but they were called to active duty suddenly and sent to Korea, and the staff of the Hydraulics Laboratory was reduced to a skeleton force. We had applied for a leave of absence without pay, beginning in June 1952, to go back to school for a year. However, most of the people who made such decisions were all in Korea. A lot of decisions were made by the personnel office and by others who were not used to making decisions. There was concern felt that when the reserves on active duty at that time came back and had to be reinstated, there would be a problem because there wasn't a lot of work or a lot of money at that time. Accordingly, they wouldn't give us a leave of absence, and we had to resign to return to school. After we finished graduate work in 1953, we decided that it would be just more fun to work in a district.

Mississippi Basin Model Board

Q: I asked you about Tiffany. Did he really have a major role? Did you see him very much? Did he have an influence on the younger staff there?

A: Yes, I think he did. We attended many meetings at the Hydraulics Laboratory in Vicksburg, and Tiffany came to Jackson to visit the MBM regularly. There was a MBM Board established to set policy and determine programs for development and operation of the model. The Board included the President of the Mississippi River Commission; Division Engineers of the Missouri River, Upper Mississippi River, Ohio River, and Southwestern Divisions; Gail Hathaway of the OCE. The Director of WES was the recorder. The Board established a working committee to recommend construction programs to the Board, develop procedures to evaluate test data and benefits, and to review model operation. Tiffany and Fortson were actively involved in Board and working committee activities. Both Gail Hathaway and Al Cochran of OCE were also actively involved. In the Corps there were always briefings, and briefings. That is how everyone knew what was going on.

Q: Sam Powell is still there, by the way.

A: When you asked did these people have influence on us, almost all of the people we met when we were very young in Vicksburg and Jackson influenced us, stimulated our interest in hydraulics, and encouraged us.

Q: Because they'd be coming through looking at the models and. ..

A: The Mississippi Basin Model included five Corps divisions and about 15 districts. Representatives of those Corps offices and the Office of the Chief of Engineers would come to Jackson for annual meetings of the Mississippi Basin Model Board and the working committee, and for other meetings to discuss tests of specific model sections. In listening to them, we learned what the various districts were doing, their problems, the characteristics of their rivers, things that you don't learn in school.

The first national conference for hydraulic engineers in this country was organized at the University of Iowa in 1939; in the order of 200 people attended. That conference was followed by five others at Iowa, in 1942, 1946 (while we were undergraduates), 1949, 1952, and 1955. Attendance ranged from 150 in 1942 to 425 in 1949; the Corps was always well represented. There weren't many people directly involved in hydraulics in this country at that time and most people who were attended the Iowa conferences. The conference papers were excellent, and there was much exchange of information. The conferences were a great forum for interaction among hydraulic engineers. There were many basic questions; many projects were under design and construction; we all learned from each other. The 1949 conference was very special. It was attended by 425 people, and the 000-page proceedings was published as a hardbound book by Wiley entitled *Engineering Hydraulics*, edited by Hunter Rouse. The proceedings covered fundamental principles, hydraulic similitude, flow measurement, hydrology, ground water, steady flow in conduits, water hammer, channel transitions, gradually varied flow, flood routing, wave motion, sediment transportation, and hydraulic machinery. That book was the basic reference book for hydraulic engineering for many, many years.

In 1950, the Hydraulics Division of ASCE sponsored a hydraulics conference at Jackson. Albert Fry, chief of the design division at TVA [Tennessee Valley Authority] and responsible for the establishment of TVA's hydraulic laboratory at Norris, was the initiator of that conference, and he was strongly supported by both Tiffany and Fortson. Irene and I both served on organizing committees for that conference. The ASCE Hydraulics Division sponsored a second conference in 1953 at the University of Minnesota, jointly with the International Association for Hydraulic Research, and that series of conferences has continued annually to date. Following the 1955 Iowa conference, Rouse concluded that the need for annual hydraulic meetings was being met by the ASCE conferences, and the series of Iowa Conferences was discontinued.

By 1981 there were about 10,000 enrolled in the Hydraulics Division of ASCE and today there are about 27,000 enrolled in the Water Resources Engineering Division of ASCE. Also, the number of papers published and the number of journals have both increased dramatically in the last forty years. There was a lot more personal exchange of information, I think, in the 1950's. So many projects were being planned or under design, under construction, and we all learned as we went along.

Q: So there was a lot of activity'?

A: Yes, there was a lot of activity

Importance of the WES Experience

Q: How important was that WES experience in your later career?

A: It was really very important because: (1) we were exposed to a wide variety of hydraulic engineering work (rivers, sediment, hydraulic structures, flood control); and (2) of the people we worked with. All the people in the Hydraulics Laboratory at WES were very competent. And the consultants we had were helpful and wonderful role models. It was great to work with all of them. Many were active in the local branch and the Hydraulics Division of the American Society of Civil Engineers. My own long-term involvement in the ASCE Hydraulics Division dates back to those people.

Graduate Work at the University of Iowa

Q: You mentioned earlier that Irene and you returned to the University of Iowa in 1952?

A: Yes. When we finished there in 1947 with our Bachelors, we didn't think we were ever going to get a job. We sent out, I don't know, a hundred applications. I think that we had two offers. One, I remember, was from one of the paper companies in Wisconsin to work in their library. The other one was something similar--I really don't remember what it was. We enjoyed Panama, and we would have liked to have gone overseas again at that time.

One of the most interesting letters we got in response to our applications was from Harza Engineering Company, which was building a railroad in Brazil at the time. We both spoke some Spanish, and we thought even though Brazil is Portuguese, it's not that much different. We got a very nice reply from Ed Fucik at Harza saying that working overseas was no place

for a woman and we should do something else. Anyway, we felt we were very lucky to get the job offers from Vicksburg in 1947.

When we finished with our Masters in 1953--this was at the time of Eisenhower--there really wasn't a lot going on. Corps civil works was almost at a standstill. We had offers from the Tennessee Valley Authority in their hydraulics lab, at Norris, Tennessee. Then at the last minute, we received offers from the Missouri Division of the Corps in Omaha. We knew people in the Missouri River Division from our work on the Mississippi Basin Model in Vicksburg.

We decided to go to Omaha because TVA wasn't really doing a lot of hydraulic work at that time; they thought it would be a chance to add two young hydraulic engineers to their staff for the future. We consulted with Albert Fry who had made us this TVA offer and was chief of the TVA design branch about which job we should take, and he advised that Omaha would really be better experience. We were always quite lucky in the way things worked out.

Q: Now, when you went back to the University of Iowa for your Masters in Civil Engineering, what did you study? Did you do a thesis?

A: No, we didn't do a thesis because we were more interested in the new courses added after we left there in '47. Joe Howe was the head of the Department of Mechanics and Hydraulics. He felt that, since we had written a number of reports at that point, we'd get more out of additional class work than we would out of doing a thesis.

Q: Were there any specific projects that you were working on as a graduate student with a professor?

A: No. When we went back, we did not work. We had saved enough money in the five years that we worked for WES in Jackson so that we didn't have to work the year we were in graduate school. We'd been out of school, really, a little bit too long. It was hard to go back and take the advanced classes, especially math.

Q: So what did you focus on at this time, for this one year?

A: We took everything they offered related to hydraulics. As a graduate student, I took courses in Analysis of Hydraulic Problems, Intermediate Mechanics of Fluids, Intermediate Fluids Lab, Flow in Open Channels, Masonry Dams, Flow Measurements Lab, Hydrology, Hydrodynamics, Water Power Engineering, Advanced Mechanics of Fluids, Hydraulic

Design, Flood Control and Sediment. We took a two-semester course from Åke Alin. Have you encountered that name?

Åke Alin and Dam Design

Q: Åke Alin?

A: Yes. Åke was Swedish--he had come here as a young man after he finished his schooling in Sweden. I don't know what he did initially, but he had worked for the Corps on the Muskingum Project in Ohio. Then he worked on Denison Dam on the Red River, north of Dallas, which was built during the early '40's. He later worked for the Missouri River Division in dam design in hydraulics and geotech. After he retired from the Omaha District, Joe Howe had prevailed on him to come over to Iowa City every third week and teach a graduate course in dam design. So every third week we had a three-hour class three days a week from Åke Alin. There were, of course, no books. He had his own mimeographed notes, which I still have. When I started teaching here at the University of Arizona, I went back to his notes for some material because it was still relevant. In fact, his notes might be something that you would like to have for your history collection. A lot of his notes came out of feasibility reports and other work on Denison, and some of the other dams. That was probably the most interesting course we took.

At the end of the school year in June 1953, he took the dam design class on an inspection trip through the Muskingum area and the Tennessee Valley to look at various dams and hydroelectric plants. TVA still had several dams under construction at that time.

Q: The Muskingum Project had a lot of small dams, didn't it?

A: Small dams, yes.

Q: So that was basically the Miami River Conservancy District, with a number of small impoundment dams. Was there navigation?

A: No, and in fact, most of the impoundment areas are dry most of the time; they are to retard flood flows.

Q: Sort of like the Los Angeles District's debris dams.

A: They're smaller. Many of the dams looked just like a grassy hill. Well, they did then. I don't know what they look like now.

Dam Design

Q: I've never see one. Dam design is sort of an exotic field, isn't it?

A: Dam design is very interesting in that there are a lot of hydraulic problems involved, such as hydraulics related to hydropower plants and seepage through earth dams, in addition to design of hydraulic components such as spillways, outlet works, diversion, etc.

Q: Is that an area that has suffered a lot recently, because of the lack of building big dams?

A: We're losing our expertise as people retire, for sure. What bothers me is that the infrastructure is there and we have to have people who understand the design; the operation, maintenance, and rehab problems, and what can be done about them. If you don't have experience. .. I don't know what the Corps is doing now, but from time to time there's been a push to contract out various kinds of services.

We did this in the environmental area when I worked in Sacramento because we simply didn't have enough environmental staff for the volume of work. What happened on the environmental contracts I was involved in was that we basically specified what was needed and then we reviewed and revised the reports because they didn't understand the projects sufficiently to have taken everything into consideration. I suspect that at this point there's a better understanding of what is involved, but I'm not sure that there's a good understanding of how projects operate or the inter-relationship of projects.

Q: Well, that's one of the things that some of the people that I've talked to, like Frank Snyder, are concerned about--that the expertise is disappearing because there are no projects anymore, and if there are no projects, nobody is doing that work. You had some dams with power in MRD.

A: Yes.

Q: Fort Peck, Gavins Point, and Randall all had power.

A: They all had power, yes. There are still a few dams being built including several large dams in southern California, but certainly nothing like in the '40's and '50's. There are still some sites and (while they will tell you the best sites, the cheaper sites, have already been built on), there are still a lot of places where you could build a small power dam or where you need good quality water. But with the environmental climate that we have, they'll never be built. You know, we couldn't build Hoover today. Yet without it, Southern California, Arizona would be. ..

Q: Yes, without Hoover and Lake Powell, Glen Canyon--it would be almost unlivable in that area.

A: Yes, as I mentioned earlier, when we were graduate students we took a two-semester course in dam design from Åke Alin, a Swedish engineer who had worked for the Corps.

Q: Did. he go into much on the designing that was then being done in MRD on the main stem dams?

A: Yes. When I read his class notes, I can hear him talking in his thick Swedish accent. He was always going to make his notes into a book, but he never got to [do] it.

Q: Too much work?

A: He' been dead for a long time. He was interested in why dams fail. I don't know whether he worked on Fort Peck, but he was very knowledgeable about the slide at Fort Peck Dam when it was under construction.

Q: Which professor most influenced your subsequent career, who impressed you the most or influenced you the most?

A: I don't know. That would be hard to say. I suppose that the hydraulics people influenced me the most. We had several young professors. Maury Albertson and John McNown were there, in addition to Rouse and Joe Howe. Joe Howe was the head of Department of Mechanics and Hydraulics, which was separate from the hydraulics laboratory and the Civil Engineering Department. They all influenced us. We were also, of course, influenced by the Corps people we worked for in the lab, Robert Kreiss, Marvin Webster, and Martin Nelson, because we worked there so much of the time. We learned a lot from all of them.

Q: How would you weigh the relative influence on you of the Corps people you worked with, who probably had more practical experience in engineering and hydraulics, versus your civil engineering instructors, who were possibly more theoretical?

A: Lane was the only one who had a lot of practical experience. John McNown and Maury Albertson were young. I think Maury received his Ph.D. at Iowa at about that time; he had worked briefly at TVA before returning to Iowa. McNown had degrees from Iowa and Minnesota and had worked a short time at a Navy Laboratory in California before returning to Iowa to teach. Joe Howe had taught at Iowa for some time and done some consulting; he was somewhat older than Albertson and McNown. But the Corps people we worked for, both Bob Kriess and Marv Webster, had worked for the Special Engineering Division of the Panama Canal.

Then, of course, Martin Nelson, from the St. Paul District, who supervised the Corps' Iowa City sub-office, had worked for the Corps for a long time and he knew more about locks than anybody else. In many ways, he may be the one who influenced us the most. He came down from St. Paul to visit the laboratory about once a month and review what we had done. In an instant he would see what we should have done differently, or why the results weren't what we expected, and so forth. Speaking of locks, have you interviewed John Davis?

Q: **No.**

A: John was in the Ohio River Division, initially, I think. Later he was in the Chiefs Office in Washington, and he became the lock expert. He retired about the same time I did, I think, but he did a report for WES on the locks just a few years ago as a consultant. I've known him since the late '40's.

Q: He worked for Jake Douma at OCE in structures?

A: Yes, he would have. I just found out about the lock report he did about four years ago from someone at Vicksburg who sent me a copy. It is kind of a summary of everything the Corps had done on locks. The innovative lock study that Huntington District is doing now is something totally new.

Q: Actually, you probably had less influence from the professors because you already had been out for a long time so. . .

A: That may well be, especially when we went back for graduate work, yes.

A Woman's Place in Civil Engineering

Q: You already mentioned the problem you had with Dean Dawson, who had tried to discourage you from going to school there. How did you find the environment while you were working on your degree?

A: It was fine. It really was. Once Dean Dawson saw that we were serious, he was very supportive. The first year we were at Iowa in the fall of '44, there were perhaps ten young women in my classes, but I don't think any of them stayed more than one year. I think Irene and I were the second and third women to be graduated from Iowa in engineering, and two young women finished about a year after we did. Now, when I look at Iowa newsletters and alumni publications, I note that most of the honors in civil engineering go to women. They apparently have a larger percentage of women at Iowa in civil engineering than we do here at the University of Arizona.

Q: That's quite a change in 50 years, isn't it?

A: Yes. I don't know whether the younger women today are really having a problem with discrimination in school and in the work place or whether they are overly sensitive. To some extent, the school atmosphere today may have to do with foreign professors who dominate many engineering faculties now and who have a problem with women in engineering. But, no, at Iowa the faculty and the students were very supportive when we were there.

Q: So once you got into it and showed what you could do, they had no problems.

A: Once they saw that we were serious, yes. We were a little older, too, because we had worked several years. In '44, when we began studies at Iowa, I would have been twenty-four. At that time all undergraduate women were required to live in dormitories, and it was very difficult to get an exception. We petitioned to share an apartment and we eventually received an answer saying that "because of our advanced age," permission would be granted.

Q: Advanced age of twenty-four. Did you ever find any problems in the Corps?

A: No, really not. Again, there were not very many young hydraulic engineers in the '40's, '50's, even in the '60's. I used to say that if you could do the work, the Corps wouldn't care if you had two heads.

Q: But you were dealing with people who were professional engineers, basically.

A: Exactly.

Q: And they were looking at you based on your professional credentials and what you could do for them.

A: Yes. When we were draftsmen in Rock Island during World War II, we had a problem with one of the head draftsmen, but the fellows had problems with him, too. The basic problem, I think, was that he was a male chauvinist, but also he was German and sympathetic to the Nazis. Because of his political views he was not loaned to the Panama Canal, and he was enraged that we went. He was hardly civil to us after we returned to the Rock Island District from Panama.

Q: As you say, it's an exception. It was probably more the person.

A: He was certainly the exception, yes. The fellows had similar problems with him.

Missouri River Division

In Omaha, the work was interesting, but we had never worked as engineers in a Corps district. In the Rock Island District, we were draftsmen. In the St. Paul District, while we were in school, we were engineering technicians. We operated the models; we analyzed the data; but we weren't engineers. So, in reviewing District work in Omaha, we felt the need for a better understanding of what the districts did. Also, Omaha was not a very interesting place to live. On weekends, we frequently drove up to South Dakota to watch construction of the dams on the upper Missouri River. It was the most interesting thing to do, and, really, it was a good thing to do because we learned a lot about dam construction that was useful in later years.

Decision to go to the Missouri River Division

Q: So you had taken all of these advance courses at Iowa, and when it came time to get another job, because you had resigned at WES, did Åke Alin influence you or was it the fact that you were close to Omaha?

A: No, it was the fact that we knew what they were doing on the Missouri River, and we just thought it would be interesting work. We thought of the two, we would have liked to have gone to TVA, but it seemed to make more sense to go to Omaha, so we did. Life would have been different had we gone to TVA.

Q: Would you have gone to Knoxville?

A: Knoxville.

Q: Is that where the lab is?

A: No, the lab is actually at Norris.

Q: That's not too far though.

A: Thirty miles.

Q: Yes, it's not too far. I've been up to Norris one time. So you were working for the Corps in Omaha at the height of the work on some of the big mainstem dams on the Missouri?

A: Yes.

Work on the Missouri River

Q: You were with the Missouri River Division?

A: Yes.

Q: But you worked very closely with Omaha District, I imagine, which was building the dams along with Garrison District?

A: Garrison Dam was under construction at the time. Randall was closed just before we went to Omaha by a couple of months. Gavins Point was closed just before we left. It must have been '55, so that we really didn't work on the design of those dams to any great extent. I was more concerned with the Missouri River.

Q: With the river itself?

A: Yes.

Q: And the effect that those dams were going to have?

A: The Missouri River used to be a mile wide, two miles wide, five miles wide. It had been narrowed with dikes to provide a deeper, narrow navigation channel on a stable alignment.

Q: How far did the navigation go on the Missouri? I know it went to Omaha.

A: Well, it used to go all of the way to Sioux City just below Gavins Point Dam. Later they cut the upper limit of navigation back to Omaha. I don't know how far they maintain the navigation channel now. I think, traditionally, there's been a lot of grain moving on the river, but outside of grain, I don't know that there's very much traffic. So it's very seasonal traffic.

Q: Yes, I think grain and raw materials, basically, are what they move.

A: Yes.

Q: How fast was the Missouri when they were first starting to work on it? Was it anywhere near as rapid as it is today? I lived in Omaha for three years, and I used to go down and watch the river.

A: When did you live there?

Q: In the early '70's.

A: Early '70's. Was this during high flow?

Q: It was in the spring, yes.

A: Yes, when they would have been releasing flood water.

Q: It was considerable. I mean it was very, very, fast.

A: It would have always been like that.

Q: In the spring?

A: The Missouri River had high flows in the spring from snow-melt runoff from the upper basin.

Q: Regardless of whether the dams were there?

A: Yes. In fact, it would have been worse before the dams were constructed. This picture (in *River Engineering*) shows the Arkansas River rectified with dikes and with bank protection to stop the bank erosion and bring the channel into a nice, smooth alignment.

Q: With the wing dams and the revetments and. . .

A: Yes. There can be a large difference in the bed elevation of an alluvial river during floods with scour on the rising side of a flood hydrograph and deposition on the recession side. There is a figure in the Linsley, Kohler, Paulhus hydrology book showing the change in bed elevation of the Missouri River in the 1952 flood through the bridges in Omaha. It deepened about 30 feet on the rising side of the flood hydrograph and by the time the flood was over, it had filled in 15 feet. If measurements were taken before and after the flood, you'd never know how deep the maximum scour had been.

Q: You had that huge scouring effect when it came down in the spring.

A: Yes. If you talk to people in Omaha, you'd probably see the same cross section.

Q: I mean just the speed with which the water was going by was very impressive. And you could see why it could be real dangerous for. . .

A: Do you have any idea what the discharge was?

Q: No.