CHEMICAL HERITAGE FOUNDATION

L. LOUIS HEGEDUS

Transcript of an Interview
Conducted by

Hilary L. Domush and Jacqueline Boytim

at

Chemical Heritage Foundation
Philadelphia, Pennsylvania

on

5 and 6 December 2013

(With Subsequent Corrections and Additions)

CHEMICAL HERITAGE FOUNDATION
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Chemical Heritage Foundation
Center for Oral History
315 Chestnut Street
Philadelphia, Pennsylvania 19106

L. LOUIS HEGEDUS

1941	Born in Budapest, Hungary, on 13 April

Education

1964	Dipl.-Ing., Chemical Engineering, Technical University of Budapest
1972	Ph.D., Chemical Engineering, University of California, Berkeley

Professional Experience

	Research Institute for the Organic Chemical Industry, Budapest, Hungary
1964-1965	Research Engineer, petrochemical process research
	Daimler-Benz AG, West Germany
1965-1968	Group Leader, Materials Testing
	General Motors Research Laboratories, Warren, Michigan
1972-1974	Associate Senior Research Engineer
1974-1975	Senior Research Engineer and Group Leader
1975-1980	Departmental Research Engineer, Catalysis Research
	W.R. Grace & Company, Columbia, Maryland
1980-1984	Director, Inorganic Research
1984-1995	Vice President, Inorganic Research
1995-1996	Vice President, Corporate Technical Group
	Elf Atochem (now Arkema, Inc.), King of Prussia, Pennsylvania
1996-2001	Vice President, Research and Development
2001-2006	Senior Vice President, Research and Development
	Louis Hegedus, LLC
2006	President
	RTI International, Research Triangle Park, North Carolina
2010-2013	Distinguished Visiting Fellow

Honors

1978	Chemical Engineer of the Year, American Institute of

Chemical Engineers, Detroit Section
1980 Professional Progress Award, American Institute of Chemical Engineers
1981 Chemtech Leo Friend Award, American Chemical Society
1988 R. H. Wilhelm Award, American Institute of Chemical Engineers
1989 Elected member, National Academy of Engineering
1991 Honorary Doctor of Engineering, Technical University of Budapest, Budapest, Hungary
1994 Honorary Member, Romanian Catalysis Society
1999 R&D 100 Award for novel method for asbestos abatement, shared with team members at W.R. Grace, *R&D Magazine*
1999 Honorary Member, Hungarian National Academy of Engineering
2000 Catalysis and Reaction Engineering Practice Award, American Institute of Chemical Engineers
2005 Award of Merit in Appreciation of Contributions Rendered for the Continuing Advancement of Chemical Engineering, Chemical Marketing Economics Group, American Chemical Society, New York
2006 Management Division Award, American Institute of Chemical Engineers
2008 Selected to be one of "One Hundred Chemical Engineers of the Modern Era," American Institute of Chemical Engineers
2014 Elected Corresponding Member, Academy of Athens (Greece)

ABSTRACT

L. Louis Hegedus grew up in Szolnok, Hungary, one of two sons. His father and brother were both chemical engineers, and his mother was a teacher. He received what he considers to be a broad and excellent education at the Verseghy Ferenc Gimnázium and and passed the very long and difficult entrance exam to the chemical engineering program of the Technical University of Budapest. After graduation he was recruited to work at the Research Institute for the Organic Chemical Industry, where he worked on the development of a polyester process.

After one year at the institute, Hegedus obtained a visa to tour Europe and ended up with a job as a chemical engineer at Daimler-Benz in Mannheim, Germany. Eventually his fiancée was able to join him, and they married. Having gained a proficiency in English, Hegedus was accepted into the chemical engineering Ph.D. program at University of California, Berkeley; he wrote his dissertation on chemical reaction engineering with Eugene Petersen. He published many papers, seven from his dissertation, and wrote the first book on catalyst poisoning. Early computers required him to learn Fortran at Berkeley; he laughs to think of the meager computing power of those computers now.

The Clean Air Act of 1970 had automobile manufacturers scrambling to design catalytic converters for all their cars, an enormous effort that Hegedus calls one of the largest privately-funded non-government research effort up to that time in history. Hegedus's work for General Motors during those years eventually led to his nomination to the National Academy of Engineering. He says General Motors hired a number of new graduates from top universities to work on the development of the catalytic converter with the thought that they did not know that it was impossible. Hegedus also thinks that the catalytic converter was one of the greatest technical successes of chemical technology ever.

He next accepted a job as a director of central research at W.R. Grace and Company. Although he had moved gradually into management as a research vice president, he continued to stay close to technical research, to publish, and to attend conferences, staying part of the international scientific community. Legal and business problems mounted at Grace, however, and Hegedus was recruited to be research vice president for North America at Elf Atochem, the chemical branch of the French national oil company Elf Aquitaine. The company merged with Total and then spun off Arkema, a worldwide chemical company. Hegedus has retired from Arkema as senior vice president for research and development. In retirement, he founded his own consulting firm, as well as having been a Distinguished Visiting Fellow at the Research Triangle Institute.

Hegedus discusses the balance between process and product research in chemical engineering, and the place of materials science in future work. From his perspective, the next exciting technology, already being worked on, is advanced batteries, which will lead to electric cars for all. Throughout his interview Hegedus evinces his love of and excitement about the challenges posed to chemical engineering. He is an amateur pilot, an area of his life that permits no risk, and he urges everyone to test drive the Tesla S. He has many publications, patents, and awards to his credit.

INTERVIEWERS

Hilary L. Domush was a Program Associate in the Center for Oral History at CHF from 2007-2015. Previously, she earned a BS in chemistry from Bates College in Lewiston, Maine in 2003. She then completed an MS in chemistry and an MA in history of science both from the University of Wisconsin-Madison. Her graduate work in the history of science focused on early nineteenth-century chemistry in the city of Edinburgh, while her work in the chemistry was in a total synthesis laboratory. At CHF, she worked on projects such as the Pew Biomedical Scholars, Women in Chemistry, Atmospheric Science, and Catalysis.

Jacqueline Boytim is a program associate in the Chemical Heritage Foundation's Institute for Research. Before joining the Institute, Boytim worked in visitor services in CHF's museum. She earned her bachelor's degree in Science, Technology, and Society at the University of Pennsylvania.

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INTERVIEWER: **Hilary Domush**
Jacqueline Boytim

LOCATION: **The Chemical Heritage Foundation**
Philadelphia, Pennsylvania

DATE: **5 December 2013**

DOMUSH: Okay. Well, let's get started. So today is December 5, 2013. I am Hilary Domush here at the Chemical Heritage Foundation, and with me [are] Jacqueline Boytim and Dr. Louis Hegedus. Did I say everything correctly?

HEGEDUS: Yes. I call myself Louis.

DOMUSH: Louis. I'm sorry.

HEGEDUS: Yes.

DOMUSH: It's always worrisome when I start out by mispronouncing something, but I always like to check. So as I said, we start the oral histories by talking to you a little bit about where you were born and where you grew up. And I believe that you were both born and then raised in Budapest, [Hungary].

HEGEDUS: Almost. I was born in Budapest, and at age six or so, we moved to a town called Szolnok, [Hungary], and I was actually raised there. More precisely, when I was born, my parents lived in what is now Slovakia, that part of Hungary. After the war, when that part of [. . .] Hungary was assigned to Slovakia, we moved back to the main Hungary, main part of Hungary. And the city's name is Szolnok. I grew up there. [. . .]

DOMUSH: What kind of town is that? I mean, Budapest is, at this time, a big city, with lots to offer. What kind of town is Szolnok?

HEGEDUS: Szolnok? It, at that time, had about forty thousand inhabitants. It is one hundred kilometers southeast of Budapest. It's on the banks of the second largest river of Hungary, called Tisza, T-I-S-Z-A. So it's a nice place. It's a somewhat industrial town on the outskirts. And it was a pleasant place to grow up.

DOMUSH: Did you have siblings as well?

HEGEDUS: I had a brother [Mihály Hegedüs], two years younger. My father [Lajos Hegedüs] was a chemical engineer, so I, and also my brother, became chemical engineers. So the whole family is chemical engineers.

DOMUSH: Wow. What about your mom [Anna Hegedüs]? Did she have any . . . any education?

HEGEDUS: She was a teacher. She was a teacher.

DOMUSH: So I imagine, then, with a mother who was a teacher and a father who's a chemical engineer, that education was something that was prioritized, or valued.

HEGEDUS: Absolutely. Absolutely. When my brother or I got a B about something, it was a, basically, family emergency. [laughter] So it was taken very seriously. Yes. Rightfully so.

DOMUSH: You said that after the war, when where you were living was kind of reassigned to Slovakia, or what became Slovakia, that you moved back to Budapest.

HEGEDUS: Szolnok.

DOMUSH: Oh, sorry, back to Szolnok. What—do you have memories of what it was like during the war?

HEGEDUS: Yes, I do. I was born in 1941, and the war reached that part of Hungary in '44. So I remember, as a small child, the bombings. You know, some bomb blasted out the windows of our house, and I remember lots of glass flying around. And I vaguely remember all kinds of stories about fights going on while we were sitting in the basement. I remember one of the [American] bombers was shot down, and I remember the tail pointing up—upwards **<T: 05 min>** in the fields. Apparently he must have made an emergency landing.

I remember bits and pieces as a small child. I remember crossing the Danube, from what has become Slovakia back to Hungary, on a military pontoon bridge, you know, floating bridge. Our furniture was in a truck; the truck had to cross the river.

So I—you know, one has memories of this sort. Yes. Our windows were—I remember the windows were covered with black paper, or cardboard, or something, so the bombers don't see the light. You couldn't turn on the lights. Stuff like that. Typical war situation. Yes.

DOMUSH: Was your father fighting in the war, or was he . . .

HEGEDUS: No, he was too old for that. He was born in 1897, so by that time he was out of military age. Also, he was running the sugar refinery. You know, food production is necessary, even in war. So he fought in the First World War.

DOMUSH: Oh, wow.

HEGEDUS: He fought in the Austro-Hungarian army. Yes. He was a machine gunner. So he had his own experiences.

DOMUSH: Did he tell you guys stories of his experiences?

HEGEDUS: Oh, yes, lots of them. Yes. He fought on the eastern front, first against the Russians. And then he fought in the Italian front, in the Alps, in Northern Italy. They captured him, and he was a military prisoner in Rome, [Italy]. He was, what, nineteen years old or so, maybe twenty. And he learned Italian. Then he escaped and somehow managed to get back to Hungary.

Then he decided to become an engineer, so he signed up at the chemical engineering department in the Technical University in Budapest [now Budapest University of Technology and Economics], and finished there in 1923, I believe. And I went to the same school, and my brother went to the same school.

DOMUSH: What a nice family tradition of education and engineering.

HEGEDUS: Yes.

DOMUSH: We mentioned a couple of minutes ago how, you know, if you or your brother got a B in something in school, that it was kind of this crisis, that kind of excellence in education was expected of you. Early on, what kind of things were you learning? I know that some of the schools in Hungary at this time were already kind of specialized on certain tracks. You could be put on a science track, or kind of a humanities track, fairly early on.

HEGEDUS: Yes. Yes. That's very correct. We are talking about high school. Basically, there were two [directions]. You had to make a decision, or your parents had to make a decision for you, I guess. There was one part, one track, which was called *humán*, and the other is *reál*, human and real. And the *humán* was mainly history, literature, and, interestingly, biology. These were people who wanted to become teachers or doctors or lawyers. And the other, the *reál*, was more for mathematics, physics, chemistry, and those people became either science teachers, or scientists, or engineers. And my father directed both of us to the *humán* side. The argument was that **<T: 10 min>** you would, first of all, need to have an education in the humanities. Without knowing—learning Latin, and history, and literature, you are not an educated person. So we both went through that part, to learn Latin and all the rest. Over the years, you know, you benefit from this in various different ways, of course.

DOMUSH: Did you enjoy that decision at the time? Did you enjoy learning Latin and history and literature?

HEGEDUS: Yes. I didn't enjoy it in the sense of preferring it. I enjoyed it in the sense of enjoying it as it is. I never thought of, "Should I do it this way or that way?" I think it was the decision of my father, and I trusted him completely, and he was right.

DOMUSH: Now even on the *humán* track, do you still take any math or science, or...

HEGEDUS: Oh, yes, of course. Yes, yes, yes. But perhaps obviously somewhat less, given the finite number of hours in a week. We had to pick languages. Russian was mandatory at that time, but I don't remember much of it, and it was not really practiced.

DOMUSH: Was German commonplace?

HEGEDUS: And then I had to choose the second language, which could have been French, English, or German, and I chose English. And after about two weeks of English, I concluded that it's an unpronounceable language. [laughter] So I switched over to German. I do maintain this view that it is extremely difficult to pronounce English. You know, I'm flying an airplane and as a pilot, you of course communicate in English. And it's kind of interesting when you call the flight service, and they ask questions in an automated way to begin with, to put you in the right place. So the first question is always what state you are calling from, and I cannot say "Pennsylvania." I'm sorry, whatever I tried Pennsylvania in so many different ways. [laughter] The machine won't accept it. So anyway, that's a side track here.

DOMUSH: I've heard—my husband is not a native English speaker, and he's very particular about things related to grammar. I think he's much more attuned to it because he learned it later.

HEGEDUS: Yes.

DOMUSH: But I read that because English . . . as opposed to some other languages really is much more of a mish-mash of so many languages, whereas other languages kind of developed more on their own, that English does not have the same kind of grammatical rules that other languages do. Other languages have much stricter structure and kind of rules for the way people follow things, or the way people pronounce things. And . . .

HEGEDUS: Which makes English very suitable for, you know, quite sophisticated expression. Because it's contextual, in which it is the context that the words which surround the word influence the meaning of that particular word. It's not necessarily so in many other languages, who decide to have different words for expressing different things. It's not that the English has a lesser number of words, but, you know, the structure, which you pointed out, makes English both very sophisticated and complicated, and also very easy to learn. How about that? And that's why it has become the language, the *lingua franca* of the world, because you can learn it so easily. There are various levels of English, **<T: 15 min>** obviously.

DOMUSH: Yes. So when you made the switch after a couple of weeks from English to German, did you find the German . . .

HEGEDUS: Yes, that's a phonetic language. It's WYSIWYG, what you see is what you get. And if you are an engineering mind, you know, you realize it is very structured, precise, et cetera. One word has one meaning. [laughter] Grammar can be worked out on a very large sheet of paper put on the wall, so as you read something in German, you can pick out the proper place in the matrix on the wall, as to what the endings of the words are. [laughter] You know. So . . .

DOMUSH: Many many more rules. Much more structure.

HEGEDUS: But it's harder to learn it, at the end. Of course, eventually, as you know, I ended up in Germany, and you have to work hard on it. English somehow penetrates your brain, because it is less of a grammatical burden. At least, you know, broken English is not very grammatical.

DOMUSH: No. I would say most spoken English, broken or not, is not very grammatical, but . . .

HEGEDUS: Yes. The funny thing is, I'm jumping ahead, but for a while in [the University of California at] Berkeley, I took my notes in German, because in German, I found it so precise. You can write—of course, after a while, you switch to English.

DOMUSH: Interesting.

BOYTIM: Can I ask really quickly what the name of the school was?

HEGEDUS: In Szolnok? I have to write it down. But I can spell it for you. Let's write. Verseghy [Ferenc Gimnázium]. [. . .] It is a very good high school, one of the best in Hungary. At that time, it was very strict, and I think the education we received was, in hindsight, fantastic. Really good. And very good teachers, and it's very nice. It's in a beautiful park along the bank of the river, so it's kind of a very nice place.

DOMUSH: It sounds it. We have—as I mentioned during the Heritage Council meeting, we have, kind of without having planned it, a growing number of oral history interviewees that were born and educated in Hungary, and so we're trying to kind of figure out if any of them went to the same high schools or anything like that.

HEGEDUS: Yes. There are stories about that. As you know, books have been written about this high school in Budapest. Several big-name physicists went there. And you can read up on that. They have a particular teacher, I think [László] Rátz was his name, who basically motivated them. But that's a different subject.[1]

DOMUSH: You mentioned that your teachers were very good teachers.

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[1] Hegedus refers to the Lutheran Gymnasium in Budapest (Fasori Evangélikus Gimnázium). Notable alumni include physicist Eugene P. Wigner and mathematician John von Neumann; they acknowledged Rátz's impact on their education throughout their career. See István Hargittai, *Martians of Science: Five Physicists Who Changed the Twentieth Century* (Oxford: Oxford University Press, 2006).

HEGEDUS: Yes.

DOMUSH: Did you have any that particularly motivated you or that were particularly important to you in some way?

HEGEDUS: Yes. I was—at the beginning, I was very much impressed with, amazingly, geography and read a lot about, you know, how the various parts of the world were discovered, and read stories about faraway places. So that was my first interest, which I remember. And then I became very interested in biology. We had a very good biology teacher, and I thought that it was fantastically interesting, biology.

And then, of course, I was always good in chemistry, physics, and I liked math as well. So you kind of gradually advance in, or move forward in, your interests.

DOMUSH: And it was clear, as you moved on, that you wanted to move into kind of the sciences, the more technical . . .

HEGEDUS: Yes. Then for a while, the idea was that I should be a doctor, an M.D. So I shadowed one of—our family doctor. He was a family friend as well, so he **<T: 20 min>** invited me to shadow him. [. . .] So for a while, it looked like I may end up in medical school.

But the real difficult thing in Hungary at that time was somehow to get into the Technical University. That was considered to be—you know, if you want to be a doctor, yes, there are several universities, they are very good, all the rest. But my perception was that at that time, that it is not that tough to become a doctor. The real tough thing is to get into the Technical University and become an engineer. That was considered to be very difficult. So you set out to do that.

DOMUSH: Was there an exam required to get into the Technical University?

HEGEDUS: Yes. There was an entrance examination, which, I remember, was extremely long and difficult, and you had to get a certain number of points. And at that time, there was some classification of people into groups. You know, whether your parents belonged to the intelligentsia, that means have a university degree, or whether they are workers, or peasants, or clerks, or whatever. So depending on what class you have been assigned to, you needed different number of points.

So if your father had a university degree, that means you were classified as a member of the intelligentsia. Then you had to get more points, so it made it more difficult to get in. But we made it somehow. [laughter]

DOMUSH: Other than having to learn Russian in school, and being classified as intelligentsia, and needing these extra points to get into the Technical University . . .

HEGEDUS: These were the fifties, you know, nineteen fifties.

DOMUSH: Were there other things from this time period that you remember as kind of influences from the Soviet Union or the Communist governments?

HEGEDUS: Yes. All these things are well-documented from that period. So I grew up at that time obviously exposed to all of that. And you saw lots of things. But that period has been so well-documented and so well-covered by historians. It's still being researched, interestingly. There are museums now which display materials from that period. So I don't know what can I add to it, other than that I grew up in that time period, just like anyone else at that time.

[I would like to add, to younger readers who may not know, that these times of Stalinist communism and Russian occupation were extremely difficult in Hungary's history. Many were jailed or worked in labor camps. Later I learned that our favorite high school teacher worked in a labor camp before.]

DOMUSH: In addition to working hard in school and kind of making your way into the sciences and preparing for the exam, was there anything that occupied your time? Any outside interests or hobbies?

HEGEDUS: Yes. I played goalie in a soccer team, and that was just totally wonderful, to play in a team. My father was technical director. I don't know if there is a title here. It's more than chief engineer, but basically he was the technical president of the sugar refinery [*Szolnoki Cukorgyár* (Szolnok Sugar Factory)]. It was one of the largest in Hungary. And it was certainly the largest company in Szolnok. So it had a soccer team, and it had, also a junior team. So as a high school student, I was a goalie in their junior team. And that was fantastic.

But in the last year of high school, my father put some severe restrictions on playing soccer. His fear was that if you break your leg, you cannot prepare for the entrance examination; therefore, you don't get into the university; therefore, you won't become an **<T: 25 min>** engineer; therefore, you don't . . . . [laughter] So he derived this out all the way to the point of making sure that I don't—I basically stopped playing soccer. Same thing happened to my brother. We were protected from failing the entrance examination.

DOMUSH: Well, one wrong move in that soccer game and . . .

HEGEDUS: Yes. Well, in hindsight, he was just, he was right. You know, it gave us more time. But anyway, I enjoyed soccer very much. Very much.

DOMUSH: And you said your brother played as well?

HEGEDUS: Yes. He was a forward. He was fantastic. He was really highly talented. I was just a reasonably good goalie, but he was phenomenal. Yes.

DOMUSH: What was your brother's name? I don't think I got that.

HEGEDUS: Michael, in English, or M-I-H-Á-L-Y in Hungarian. He died a few, some years ago; he had cancer and died.

DOMUSH: I'm sorry.

HEGEDUS: [Thank you.] He became a professor, university professor, and became well-known in his own career.

DOMUSH: That's wonderful. Did he stay in Hungary?

HEGEDUS: Yes. Yes. I tried to invite him out, you know, to come, but he somehow felt that he is, "Just fine, thank you." [laughter]

DOMUSH: So after you took the entrance exam you needed more points, but you made it and got your acceptance. What was the education like at the Technical University? Did you have to decide chemical engineering right away, or had you decided that . . .

HEGEDUS: You had to decide right away. You were admitted into chemical engineering. My memory is that there were about a hundred people admitted to the incoming class. It was extremely hard. At that time in the world there [were] no free Saturdays. You guys are too young for remembering things like that, but we had to work six days a week, not five. The university, of course, thundered on for six days. And the way classes were, we were there the whole day, you know, from early morning until sometimes well into the evening, so the workload was extremely high.

It was very structured. The nature of education at that time in Europe, in Hungary, was more along the [traditional] German lines. As you know, the old style German education focuses on knowledge. The American education has been focusing on understanding, figuring things out. And the combination is, of course, necessary in the [real] world. And so when you pass through such an extremely rigorous, fact-based education, what we had, and then are exposed to the American way of, you know, figuring things out and understanding things, the combination is very good. It's outstanding.

That might be the explanation of why some people who were trained in that system, and then came over to the U.S., and were also either exposed to or trained in the American system, why they became so successful. Because, kind of, they've gone through both of those dimensions, if you like.

So it was very tough, I remember. We had classes galore. The dormitory was on top of the Castle Hill in Budapest. It was an old, historic building, and there were, [about] one thousand students in that humongous dormitory. I remember we—you know, there were large rooms with multiple two-level beds, **<T: 30 min>** like double-decker buses. [laughter] And I remember there were six of us in the room when we started. There were two Mongolians, and it was kind of—we had never seen anyone in our lives who could learn Hungarian. [laughter] And these two Mongolians learned Hungarian, which was kind of like a natural wonder. You know, how did they do it? Because the language is so complicated. And obviously, they must have had some talent.

So we had to get up early in the morning, and then race down six-hundred some steps from the Castle Hill to catch the streetcar. And when a thousand or so students all go at the same time to the same place with the same streetcar, right? You can imagine the scene. [laughter] You had to hang onto the car, et cetera.

It was very strict. You had to attend. There was no way of not attending classes. It was enforced in a peculiar way. They randomly made a roll call. And if you missed a class three times, I believe, you were sentenced to failing that class, and you had to take a repeat examination. The way it worked is you would take an exam. If you failed it, you could take a repeat exam. Then with the permission of the dean, if he judged it appropriate, you may have taken the dean's exam, and if you missed that one [too], then you were out of that [semester]. So you can imagine, you missed the roll call of these three levels, you missed the first one, you had two more shots. So it was very interesting.

Now, of course, it was literally impossible to attend four, five, six, seven, eight classes every day [. . .] so occasionally, disaster hit. In the basement of the dormitory, there was a medical office. There was a very nice doctor, and when some big disaster hit—like the electrical engineers, there were, maybe, four hundred of them in their class, you know—when the roll call hit them, there were, forty, fifty electrical engineers standing in line for the doctor. [laughter] He lined them all along the wall:

"Everyone, open your mouth." They open their mouths.

"Say *ah*." They all said *ah*.

He went along with the flashlight, and told the nurse, "They all have a throat infection." [laughter] And then everyone got a piece of paper. So there were some humorous elements, but basically, it was very tough. Very tough. You had to memorize lots of things. It was more similar to what I observed in the medical school education of Monica [M. Hegedus], our younger daughter. You know, in medical school, you have to memorize a large number of things. It's not enough to understand how your ear works. You have to also be able to fix it. So that was a tough element, to memorize so many things.

They fill your head with facts. It turned out to be useful in the long run, of course. That's just useful to know. At that time, there were twenty-one essential amino acids, to give you an example. You had to know the names of all of them, with their chemical formula. Right? So you developed mnemonics in your brain to recite them, you know? [laughter] Or [in] mineralogy, I remember we had to memorize the names and structures and compositions of hundreds of minerals, which sounds bizarre. But you at least have **<T: 35 min>** some idea of what crystals are. So it became . . . in most professions, as you go through year one, two, three, four, five, it somehow peaks, somewhere, always. The difficulty peaks, and I think the third year was probably where it may have peaked. It was very tough at the . . . in the first year, tougher at the second, very tough in the third. And then, once you start to feel that you will make it, and everything is fine.

DOMUSH: In addition to all of the memorizing for so many of these classes, were there hands-on components, or laboratory components?

HEGEDUS: Oh, yes. Definitely. We had all kinds of labs. The first one was in the first year, in fact, analytical lab, wet chemical analysis. You—and that famous basement, that basement lab is still there. I go back to Budapest, and [. . .]

[cell phone ringing]

[END OF AUDIO, FILE 1.1]

DOMUSH: So we were talking about the laboratory, and . . .

HEGEDUS: Yes. So it was an analytical, wet analytical lab. And at that time, you had to learn everything, how to analyze. You got solutions with various ions, anions, and cations in them, and we made color reactions and precipitations, you know, all the old-style chemistry. So you learned an enormous amount of hands-on chemistry. You knew what [compound] is a gas, [. . .] what compound is a liquid, what compound is a solid, what is their color. Are they poisonous or not? How do they smell? Sometimes, even, how do they taste, because you had to use [mouth] pipettes.

DOMUSH: Hopefully not the poison ones. [laughter]

HEGEDUS: Yes, hopefully not. We dealt, at that time, with horrendous acids and fumes all over the place, and it was just tremendous, you know, hands-on chemistry. And then we also had, late in second year, I believe, an organic chemistry lab. That was my personal nightmare, organic chemical reactions. You had to go to the library and look up how things are being made. There was a book called Vogel, if my memory is right, which had the recipes.[2] And so, of course, you had to translate them. There's—those were all. . . . Vogel was in German, if my memory is right. [The modern edition is called *Vogel's Textbook of Practical Organic Chemistry*; it is in English. I do not remember if the one we used was in English or in German.] So we had to translate, figure out, and write down the steps of what you do. So then you worked out what chemicals you need, and you had to stand in line to get [them]. You need 3.4 grams of this, and 17.9 grams of that, et cetera, et cetera. So you got that.

Then you start doing the work. And so you go through this recipe. And the way Vogel is written, or was at that time, at least . . . I'll just make this up for you. "Put in 3.4 grams of potassium bromide." So you stand in line, get 3.4 grams of potassium bromide, and put it in.

Then you continue reading, "...which you previously have dissolved in . . . " [laughter]

I said, "Oh, my God." [laughter] So as a result, you know, I was really suffering. I mean, I passed, but I was suffering in that lab.

And, you know, after the fifteen steps, you were supposed to filter out some, let's say, beautiful white crystals, and all you had was a brown glob, kind of floating underneath some suspicious-looking liquid. So you filter it out. So now it's on the filter paper, and it looks horrible, of course. And you go to the professor to show him, and you drop it. So that was . . . .

[2] A. I. Vogel, A. R. Tatchell, B. S. Furnis, A. J. Hannaford, and P. W. G. Smith, *Vogel's Textbook of Practical Organic* Chemistry (New York: Prentice Hall, 1996).

[laughter] All this work on the floor. So I didn't like organic lab. I'm just kidding. But everyone has to learn it, and it was, it was fine. I did survive, obviously.

The very interesting thing is perhaps historically speaking, the professor, the young [assistant] professor who oversaw our organic labs, he told me he wants to talk with my father. Or vice versa, I don't remember. But my father advised him to, you know, be tough. So he was. And many, many, many years later, the same professor became the dean, and he nominated me for an honorary doctorate at that university, and I **<T: 05 min>** got it. I went to receive my honorary doctorate at the university, and said, "Wow, this is really remarkable history. [laughter] The way the world functions and evolves is amazing because at that time, you didn't have much hope for me, and now you have nominated me for an honorary doctorate, and I won it for you, you know." [laughter]

Anyway, so it was a good hands-on education. It had all kinds of labs, physics lab as well.

DOMUSH: So if the organic lab was kind of your least favorite, what was the best class or best laboratory that you took while you were there? Is there anything that really stands out?

HEGEDUS: I don't think that I—in the early years, they were all kind of the same, very hard work, enormous amount of material to learn, et cetera. Later on, I kind of drifted into liking electrochemistry, and so I did my thesis, which would be like a master's thesis, I guess, here, in electrochemistry.[3]

DOMUSH: Did you have one particular professor that advised you on that thesis?

HEGEDUS: Yes. They assign you to professors. I was under Professor [J.] Petro, who was a rather well-known catalytic chemist. So I liked catalysis as well, and later on that became my kind of home base eventually.

DOMUSH: Now I'm just curious. Of the students in chemical engineering, was it all men at that time?

HEGEDUS: No, it was about, rough memory would be fifty-fifty. And there were lots of ladies as well in chemical engineering, and a large number of foreign students as well at that time. They mostly came from the, at that time, communist countries. We had Bulgarians. I remember we had some North Africans, a few. So quite a number of foreign students we had as well. And

[3] L. Louis Hegedus, "Master's Thesis" (Budapest: Technical University of Budapest, 1964).

as I say, they learned Hungarian. The education was in Hungarian, and it's a difficult language to learn, and they learned Hungarian. It's just remarkable to me. How did they do it? Because I met so many people who have tried. We know people who, you know, married some pretty Hungarian girl, and they're spending the next thirty years trying to learn Hungarian. [laughter]

DOMUSH: You mentioned that when you were doing the organic lab, you would have to go to the library and read the Vogel publication and translate it from the German. Was there any difficulty that you were aware of in terms of getting publications or, perhaps, up-to-date information from the West?

HEGEDUS: That was never considered, never thought of. And I think the philosophy at that time was that you don't necessarily teach and learn very up-to-date things.

[telephone ringing]

You want to teach and learn well-established things, certainly at that level. I'm sure the professors, when they did their research, they were more interested in [the] leading edge. We were taught mostly modern, but basic things. And we **<T: 10 min>** were then—okay—we were then exposed to current literature in doing our thesis work. So we had to do literature search, et cetera

At that time, you know, there was no internet, of course. There were no computers. And you went to the library, and the university had a great library. Really a beautiful building, probably built in 1900, or before. A very glorious building. Huge shelves, and you could climb way up, and find various books, and bring them down you know, and get your dictionary and try to . . . . We had *Chemical Abstracts* available. And so we didn't feel—at least I, as a student, did not feel that you don't have access to anything. But in reality, probably, I would assume the access was probably limited if you did some kind of forward research. But we found what we thought we needed to do our work at that level. Students, you know.

DOMUSH: Now one of the things that Jacqueline and I know from some of the other oral histories in the collection, of course, just from general historical readings, is that during the 1956 uprising, the university was one of the main sites of that.

HEGEDUS: Yes. Yes.

DOMUSH: Did you have any personal connections? You had personal connections with the university through your father and then later your brother, but did you have any connections to that uprising in '56?

HEGEDUS: Well, I was a high school student, you know. I was fifteen years old. There was a big Russian statue in, kind of diagonally across [from] the high school. And so, obviously, the students wanted to level it, but you couldn't touch it. It was enormously strong and heavy, and made of reinforced concrete, covered with marble. You know, it was really kind of industrial strength. So then people came and tried to attach some ropes to it and pulled on it, and of course, they didn't have the remotest chance.

Then some people came and had very, brought very heavy wire cables, military grade, and attached it to the end of a truck, and tried to pull it off. And of course, that lifted up the rear of the truck. [laughter]

Then came the Caterpillar [Inc.], kind of an agricultural machine, came, *rrrrrrrrrrr*, you know. And they attached this big, heavy cable to it. That lifted the Caterpillar. Then more—

DOMUSH: This is a well-made statue.

HEGEDUS: More people came. And finally, they came with an air jackhammer, and then they did it properly. [laughter] They dug underneath, and then used the Caterpillar, and finally a huge celebration when this thing was leveled. So the Russian tanks, when the Russians came to beat down the revolution, the tanks came from east to west. And Szolnok is the place where you cross the Tisza River, and it [was on the] main road from, basically, Russia to Budapest. So all the tanks passed through Szolnok, and there was huge rumbling, and as they made their turns, they dug into the road. And there were all kinds of things going on. You know, most people were hiding, because they probably would be shot, I would assume, if they got close to what's going on.

So I remember that. We listened to the radio all the time, and there was Radio Free Europe, **<T: 15 min>** which everyone was listening to. Things changed on a daily basis. It was, it broke out on October 23, and as you know, November 4 is when it was [over]. So it was a relatively short time period in which Hungary declared itself to be neutral, wanted to exit the Warsaw Pact, and et cetera, become a neutral country.[4] [. . .] This whole history is well-documented. The Russians beat it down with enormous force. Many people died. A couple of hundred thousand managed to go through the border to the West, which is a large percentage of such a very small country, of course.

And by the time I ended up at the university [in 1959], those were really dark times because it was in the wake of the failed revolution, so politically it was absolutely no fun whatsoever. Given the role of the university in its outbreak, as you mentioned, the university

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[4] On 1 November 1956, a week after being reinstated as Hungary's Prime Minister, Imre Nagy began to act on insurgents' demands and announced Hungary's withdrawal from the Warsaw Pact (formally entitled The Treaty of Friendship, Co-operation, and Mutual Assistance, 14 May 1955, 219 UNTS 24). On the same day, Nagy also appealed through the United Nations for Hungary to be recognized as a neutral country.

was also tightly supervised in that respect, so those were not very good times. Yes. But we mostly focused our attention at that time on trying to survive the university somehow. It was so difficult! The workload was extreme. And as I said before, it all turned out to be useful for later life because never again have you ever been overloaded in that way, you know. Yes.

Other—about the revolution and what I experienced. The outbreak was very interesting. One day before in high school, October 22,’ [a] student said that there will be a revolution. I said, “What?” [laughter] And *voilà*, the next day the revolution broke out. It was like—I’m still wondering, how did [he] know? So maybe [he] listened to the radio or something. So it was very, very amazing times, obviously.

DOMUSH: Of course, unless there’s anything else you want to say about that, I’m . . .

HEGEDUS: One more thing.

DOMUSH: Sure.

HEGEDUS: You know, 99.99 percent of everyone I knew was for it, so it’s just completely obvious that everyone was on one side at the time, at least anyone I knew, or met, or heard of.

DOMUSH: I was curious about—you mentioned that the workload and the intensity of the classes and laboratories kind of increased the first, second, and third years, and then maybe leveled off a little bit in the last year.

HEGEDUS: Yes. We kind of probably got used to it. And also, you know, we started to have less number of classes, more . . . Like for example, we spent a few months in companies. We had projects to work on, little research projects or engineering projects. So it became more, a little bit more practical. Yes.

DOMUSH: How did you go about looking for a position [. . .] when you were going to be finished with the university?

HEGEDUS: That’s another very interesting thing, looking back. I found a fantastic position at—there was a research institute for the—it was called Research Institute for the Organic Chemical Industry, and it was right downtown in the middle of Budapest. Every Hungarian at that time wanted to somehow **<T: 20 min>** move to Budapest, if they just could do it. Then that was really the place to be. And this research institute was a very well-known research institute, smack in the middle of town. Fantastic place.

So how did I get in there? It's kind of amazing. One of the fellow students, a lady, knew somebody who worked there. And this student told [a] gentleman who worked there that I would be interested in working there. They invited me in, and I spent a very short time, like half an hour, discussing the [job]. And they say, okay, you can start on September 1. [laughter] In hindsight, this is completely amazing. [laughter] But it did happen exactly that way. So I got a phenomenal job just by dropping in.

DOMUSH: That's excellent.

HEGEDUS: Yes. There was really no majorly organized job search. Most people, as I remember, were kind of assigned to companies. At least that's my memory. In your last year, you had to—I have to say this—you had to choose a sub-direction. So the pharmaceutical industry in Hungary was at that time very significant, relatively speaking. So some people were assigned to work in the pharmaceutical companies. There were several around Budapest. And there were other chemical companies, oil companies, et cetera, and research institutes. So in most cases, people were assigned. But somehow, this way of me finding this job, I was not assigned to anywhere because I told them I already have a job.

BOYTIM: So your plans to become a physician had kind of dissipated? [. . .]

HEGEDUS: In high school, yes, that kind of faded away. I gradually became more interested in becoming, and wanted to be an engineer. You know, in the U.S., it is kind of a different thing, because it is extremely difficult to get into medical school in the U.S., and the medical profession's remuneration practices are also rather different from engineering salaries, typically. So there is this huge drive in the U.S. to try to get into medical school.

The exact [opposite] thing happened in engineering in Hungary. If you really wanted to make it, you tried to get into that engineering school. That was viewed, at that time, to be much more difficult, and, at least in our house, more prestigious at that time. Whether it is true or not, I cannot tell you, but in our family, the biggest thing you could have possibly achieved is to become an engineer. Yes, and it was very difficult to get in there.

DOMUSH: By the time—since your brother was younger, he must have felt even more pressure and excitement to try and get into the program.

HEGEDUS: Yes. And in the, at the first try, he could not get in, didn't have enough points. So he—you could get credits against your points by doing physical work. So he worked in a chemical factory for a year, and then when he tried again, he got in. Yes. This is not a reflection of him being less smart than I was. It was a reflection of me being more lucky than he was.

DOMUSH: Well, as you said, the exam and the education there was extremely difficult, so certainly no reflection . . .

HEGEDUS: Yes. And the other interesting aspect is that only a very, very small fraction of high school students ended up in **<T: 25 min>** universities, and a small fraction of elementary school students went to high school, so the typical level [of education] at that time was elementary school. Eight years. So those were very different times.

DOMUSH: So when you had this thirty-minute interview. They said, "Show up to work on September 1." What was it that you did there? What was the experience there like?

HEGEDUS: We were doing process research, chemical process research. We were working on polyester, trying to develop a polyester process. It started with toluene, oxidize it to benzoic acid, and convert the benzoic acid to terephthalic acid, and then react it with the polyethylene glycol to make polyester. And my job was at the front end, the conversion of toluene to benzoic acid. Specifically, my sub-task was to somehow figure out how the reaction products can be analyzed with a gas chromatograph [GC]. So gas chromatography was brand new at that time. It was 1964. And there may have been only very few gas chromatographs in Hungary at that time.

We had to build our own columns. We had to build our detectors, using light bulbs. [. . .] We operated out the innards of a light bulb, you know, and put the heated wire, hot wire anemometer inside the structure. You had to synthesize your own column materials, and also the carrier. I remember we powderized bricks, chamotte-type of bricks, and synthesized, you know, the Carbowax or whatever you wanted to put on your column, and built your detector, et cetera. I remember one of the greatest treasures we had was the Hamilton [Company] syringes. They were—you know, that was an absolute treasure, a Hamilton syringe. It was held by our department head, and when you wanted to use the Hamilton syringe, you had to qualify. Boy, if you bent the needle, it was disaster. [laughter] So I remember I learned how to properly insert the needle through the septum, which was silicone rubber. There was another kind of variable thing. And then we had a strip chart recorder, which I remember cost three or four times my annual salary. So anyway, I figured it all out, and put it all together, and it worked very well.

DOMUSH: Where did you guys acquire the Hamilton syringe that was so . . . . Was it that it was difficult to come by, or that it was so expensive?

HEGEDUS: Both. Somehow, somebody bought it from the West, obviously.

DOMUSH: Yes.

HEGEDUS: It's an American company. But it was just something extremely valuable at that time.

DOMUSH: I'm sure they would love to know how valued their syringes were.

HEGEDUS: Yes. But, you know, I enjoyed the research very much. It was just totally wonderful to work there. It was very, very nice. We had a huge degree of freedom, I remember. What do we want to do? How do we want to do it? Et cetera. And smart people. So I enjoyed that year there.

DOMUSH: You mentioned that when you were at university, it was six days a week, pretty much all day. What were, kind of, your hours like when you started moving into the professional world? Were you still working **<T: 30 min>** all day, all the time?

HEGEDUS: No, it was eight hours Monday through Friday. And I think—my memory is that we were like off at, like, Saturday at two p.m. or so, so we got like a couple of hours off on the sixth day. So you could go out, Saturday evening, you could go out, and then Sunday was yours. But it was basically six days. And that was also the case in Western Europe at that time, and probably in the U.S. as well.

DOMUSH: Did you have any opportunity or means to go home? You said that Szolnok was about one hundred kilometers south . . .

HEGEDUS: That is a very interesting question. A hundred kilometers was not quite like the moon, but let's say halfway to the moon. [laughter] There were two trains, the express train and the regular train. The express train was just way too expensive for a student. The regular train took four and a half hours. So you divide one hundred by four and a half, you realize that that train moved very slowly. [laughter] And in fact, you could jump out of it and jump back, almost. So yes, you did that maybe—certainly for Christmas and summer break. I don't remember doing it ever in mid-semester, but I may have. It was basically perceived to be a tremendous distance.

And we had one telephone on each floor of this dormitory. And in theory, you could have called home from there, but we never figured it out, because you needed to put in coins not money, but a specific type of coin, and it would have been probably a very large number [of them]. So you went to the post office. In the post office, you know, there were cabins, and you signed up for a call to Szolnok. Huge crowd, of course. And then they finally shouted, "Szolnok, cabin eight! Szolnok, cabin eight!" And you had to work your way through the crowd to the cabin. And then you had to listen in as they were plugging from town, to town, to town, to town. "Abony! Abony!" [the name of a small town in-between]

And finally, you got connected and your mother, "My son, my son!" [laughter] Big excitement. And you could talk, like, for three minutes, and it was a significant portion of your monthly allotment. So I didn't do this too frequently.

So yes, it was . . . we were far away, very far away. Yes. It was interesting to suddenly—you spend your first eighteen years with your parents, and then suddenly being so well isolated from them. Yes. It was a difficult transition. Yes.

DOMUSH: Yes. Your parents also probably figured you couldn't get into too much trouble, considering how busy you would be with school, so . . .

HEGEDUS: No, they were very supportive. And they, of course, wanted to talk. My father often came up to Budapest. And I remember many times we went out to have lunch. He liked nice restaurants, so we always went to some nice café-style restaurant. He bought me a great lunch always. I remember that. It was very pleasant. And then he went back. You know, at that time, you wouldn't even think of a hotel. You know, "What do you mean?" It **<T: 35 min>** was just . . . it was perceived to be only for foreigners, basically. So he came up with the train, had lunch, and went back with the train.

DOMUSH: Wow.

HEGEDUS: Funny sort of story for you. [. . .] Whenever I came up from Szolnok to Budapest, in the train station, as you were leaving, there was a transparent sign, "T-I-X-E." I [saw] it for a few years. And once I looked back, and turns out it's "EXIT" looking from the other direction. [laughter] For several years, I was always wondering, "What the [heck] is 'tixe'?" [laughter]

DOMUSH: Well, I'm glad that you were able to figure it out.

HEGEDUS: Just on this side, you know.

DOMUSH: Yes.

BOYTIM: Right.

DOMUSH: Getting back to your time at the Research Institute for the Organic Chemical Industry, once you got that GC machine working, how long did something like that take? What was the . . . you know, you weren't at that position for that long.

HEGEDUS: Yes, I spent from September '64 to June '65.

DOMUSH: Okay.

HEGEDUS: Yes, I got it—you know, there was work before me. I didn't start absolutely from scratch. I just picked up on the work and continued, and got it running. It also had the flame ionization detector [FID], to be technical. And mysteriously, occasionally, it had a big negative peak, going negative rather than positive. So we were wondering, "What is this? What is this?" And we eventually correlated it with the secretary of our boss, who wore a lot of perfume. [laughter] And then and of course, the flame ionization detector, you know, had an air supply, it drew the air from the lab air. So whenever she passed by there with her perfume, the FID made a departure.

DOMUSH: Oh, wow.

HEGEDUS: We were joking about that. Yes.

DOMUSH: So what happened that caused you to leave that institute?

HEGEDUS: Well you know, many of us were dreaming about the West, and I was dreaming about the West. It was difficult circumstances at that time, in many different ways. You did not really see much future or hope, and so I was really hoping to somehow come to the West. In the summer of '64, after finishing school but before starting at the Research Institute, a friend of mine and I, we drove a motorcycle to East Germany, all the way across Czechoslovakia, and Berlin, and then to the North Sea and back.

DOMUSH: Oh, wow.

HEGEDUS: It is like landing on Mars or something, extremely complicated thing to do at that time, with the 4.5 horsepower motorcycle, which is a good lawnmower here. [laughter]

So anyway, we were in Berlin, and we were at the Brandenburg Gate, and the Brandenburg Gate separated East from West, right? And we were on the eastern side. And of course, it was heavily reinforced. There were all kinds of fortifications on the eastern side. But you could get close enough on the *Unter den Linden*, the street which leads there, at the end, that you could see through the Brandenburg **<T: 40 min>** Gate, and you could see the West.

And [my friend] and I said, "Whatever it takes, we will somehow make it there." And so we did. So we did, both of us, in different ways, but yes.

DOMUSH: How—I mean, you did make it there, and I assume that was difficult, but how did that come about, that you did get to the West?

HEGEDUS: Well, basically, the situation started to loosen up in Hungary. In '64, already, they gave out passports to travel to the West as tourists. And most people or many people applied in '64, [but] I didn't, because I considered it to be kind of hopeless. But in '65, you know, three of us friends, we decided to apply. One of my friends, he was turned down probably because he was—he had no family—he was an orphan, and probably they must have felt that they, you know, don't have anyone to hold liable if he doesn't return. And then the two of us, a mechanical engineer friend and I, to our absolute amazement, obtained permission to spend a month in Austria,[Italy]], Germany. We kind of planned a roundtrip. You had to submit, you know, what are you going to do, and show, eventually show also that you bought roundtrip tickets. So we said Italy, Austria, Italy, Switzerland, Germany, then back—Austria—so we bought the train tickets. And you got fifty U.S. dollars, which was worth about two months of your salary at that time. So you got fifty dollars of hard currency. And to our amazement, we got passports. And we said that we'll see. We will try our best to somehow stay there.

It's a very long story. When you are twenty-four years old, you know how you think. The absolute first thing we wanted to do before anything else is to go to a place in Italy called La Spezia. It's on the [Italian] Riviera. We saw this movie with Vittorio Gassmann driving around a white convertible Lancia Aurelia on the cliffs, around the cliffs of La Spezia.[5] And we said, "Whatever happens after, we don't care." [laughter] "First, we want to go to La Spezia, at all costs." So we did. And once we had done that, then we said, "Oh, my God, what should we do next?"

[5] *Il Sorpasso*, directed by Dino Risi (Fair Film, 1962).

[If] you look at the map of Europe, and [its] cities, et cetera, there is a huge glob of cities in the middle of Germany, in the Ruhr: Essen, Düsseldorf, Duisburg, Dortmund, Bochum, Mülheim, all these big cities, all in one place. And we said, well, if we want to find some work, we would want to go where most people are, because that's where the work is. So if you look at the map, the middle of the whole thing is Essen.

So we get out of the railroad station, the train in Essen. And you sit on the steps and say, "What should we do next?" [laughter] **<T: 45 min>** No money, no papers, don't know anyone. You know, what do you do next? So it starts there. Yes. But eventually, you know, I found a very good job. What you do, they give you some temporary permit to work. At that time, [West Germany] was booming. So they were looking for help. And, you know, you buy a newspaper and read the ads, try to learn German. And then in a very short time, I had several offers, job offers. One was from Siemens [Siemens & Halske AG] in Munich, [Germany], I remember. Another one was from Siemens [Siemens & Halske AG] in Karlsruhe, [Germany]. Anther one was from a company called Erdölraffinerie Mannheim [GmbH], which was an oil refinery. Another one was a company called Standard Elektrik Lorenz [AG], making TV tubes in Stuttgart, [Germany].

And then I had one from Daimler-Benz [AG], Mercedes. When you grew up in Europe at that time, you were *dreaming* of Mercedes. That was absolutely, you know . . . . So I arrived. I accepted that job. They also had the highest offer, and I was to run a materials testing laboratory. I had nine German technicians. At age twenty-four, not speaking [fluent] German, it's a remarkable thing. But the country was growing like crazy, with the economy. They needed engineers.

And so I arrived there on November, I believe, 2, 1965, and that was a Tuesday, because Monday was All Saints Day, and it was a holiday. So it was Tuesday. And on Thursday, I ordered a brand new Mercedes. [laughter] And I wrote to my father, "Look what I have done. I just bought a Mercedes." And he wrote me back that this is a difficult day for him, to realize that for the first time ever his son, he doesn't believe his son.

I said, "Well, I'll send you a picture." You know? He just couldn't imagine that. Of course, we got a huge discount from the company and didn't have to pay for it for a year. And a year later, you got a new one, and gave this one back. So it cost nothing, basically. Yes.

DOMUSH: When you applied for the tourist visas with your friends, and you had these intentions of hopefully staying in the West, did your family know that that was your plan, or your goal?

HEGEDUS: I did not want to put them on the spot. I am sure they knew it, but I felt that, you know, my parents were very, extremely, honorable and straightforward people, and I didn't want them to lie. So I did not really tell it to them directly. I just allowed them to say, tell the truth, that they did not know. But I was very secure in thinking that. The picture which is in my mind, when I left Szolnok, my parents came to the railroad station, and I remember them waving. And I'm sure they weren't sure if we would see each other for a while. So it was a very—as the train moved away and they disappeared on the horizon, I thought, "My God, when will I see them again?" Because the Iron Curtain was at that time basically impenetrable.

DOMUSH: Yes.

HEGEDUS: Yes. But, you know, it worked out just wonderful. You have to be an optimist. [laughter] Especially when you are that young. You think completely differently. When you get older, you learn about what's called the mountaineering technique of life. You know, **<T: 50 min>** three extremities on the rock, one extremity moves at the time. [laughter] But at that time, when you are so young, and so you think you have nothing to lose, basically, or not much. Yes.

DOMUSH: Well, perhaps this is a good time to take a little break.

HEGEDUS: Okay. [. . .] Thank you.

[END OF AUDIO, FILE 1.2]

DOMUSH: Okay. Back on after a quick break. And I realized that I wanted to ask, the friend that you visited Berlin with, that you went on this big adventure before you started work, you said he got to the West as well, although he was not the one that you traveled to the West with, to Italy, to Germany.

HEGEDUS: That's right. Yes. Yes. He has—he didn't get the passport at that time, and he decided to leave anyway. He climbed through the mountains from Yugoslavia to Italy under rather extreme circumstances and made it to Italy. And then from Italy, he ended up in Canada. Sorry, first in Switzerland, and married there. He became a computer person, systems analyst, there. And then they moved to Canada, and then back to Switzerland. And then he died prematurely. He had some . . . some problem which killed him. So he died. But he made it. He made it.

DOMUSH: Good.

HEGEDUS: He had a twenty-dollar bill in his shoe as he climbed through the mountains, and the twenty-dollar bill got quite damaged as he was climbing through, at night, in the rain, through the mountains. So he ended up in Italy in a refugee camp, and sent me the twenty-dollar bill, if I could somehow get him a better bill. [laughter] So I of course sent—

DOMUSH: Hopefully, you helped him out.

HEGEDUS: Sent him some. Yes. Yes.

DOMUSH: So you got the position with Daimler in Mannheim. You were in charge of the materials testing laboratory. And as you said, at about twenty-four years old, you have nine German technicians working for you with very little German that you have.

HEGEDUS: I was a *Gruppenleiter*, you know, group leader. It was very interesting to interview with them. Actually, I had [only] kind of a vague understanding of what's going on. [laughter] But I remember they really wanted me to come. So the impression I had is they *really* want me to come. So that influenced me, when they were so hospitable and so friendly, and they *really* wanted me to come. [laughter]

I wasn't exactly sure what exactly has been said, but never mind. It looked—it's a famous company. They were very nice. You know, this probably—I couldn't have imagined a better place at that time. So I was glad to join them. Yes. So I said, "Yes, I will come."

DOMUSH: And the friend that you were traveling with, that you had made this trip with, did he also find a position that enabled him to stay?

HEGEDUS: No. He had—you know, keep in mind, we were twenty-four, okay? So he had his girlfriend, Beata, back in Hungary. And as we were traveling, he kept on buying presents for her. Especially in Italy, he bought some very nice sweater for her or something. And by the time we were in Essen, and not knowing what to do, there we sat on the stairs of the railroad station. He felt that, you know, if he sends this sweater back to her [by mail], it surely will be stolen, and it's a very expensive sweater, so he will take it to her. [laughter] And I said, "Okay. Sure. Hope to see you again." We shook hands. He went back.

DOMUSH: So when you were in Mannheim, how long did it take before you felt like your German was improving?

HEGEDUS: Every day I bought the *Bildzeitung*, which was the cheapest newspaper. I think five *pfennig*, if my memory is right, which was like, it would be one and a quarter cents, at that time. And then I **<T: 05 min>** had the dictionary, and I read the newspaper. I worked out the grammar. I developed [a] big wall, you know, table, with the German grammar. And I learned it properly. And there is no such a thing as broken German. Broken English is a world language. Many more people speak broken English than English, so we are in [the] majority, actually. [laughter] You guys are a minority. But there's no such a thing as broken German. It's not an accepted language. So if you are in Germany, you'd better learn German. So I learned proper German. Yes.

DOMUSH: Were there any other Hungarians, either at Daimler or in Mannheim that you connected with?

HEGEDUS: There were some Hungarians in Mannheim. I met a young fellow, became good friends, and we drove around, you know, on vacations, and to the bars in Heidelberg [Germany], student bars. Not so many Hungarians, but some. None—I didn't know anyone in the company. But later on, I learned that one of their famous, famous designers, who had, like, thousands of patents, et cetera, who was a Hungarian engineer, apparently had the idea of a collapsible steering wheel. He had the idea of a collapsible structure, you know, for crash, the rollover cage, et cetera. So Barényi was his name. Barényi. So if you go to Wikipedia, B-A-R-E-N-Y-I, first name Béla, B-E-L-A. He was one of the all-time greatest automobile engineers, and I think he was around [at my time there]. But, see, Daimler and Benz originated as two separate companies [Benz & Cie. and Daimler-Motoren-Gesellschaft]. And Daimler was in [Bad] Cannstatt, and then later on moved to Sindelfingen and Untertürkheim, which are suburbs of Stuttgart, which is a completely different part of Germany than Benz. Benz was in Mannheim, Mannheim, Waldhof. So the two companies were separate until 1923, and they became Daimler-Benz after the First World War. So Mr. Barényi was at the Stuttgart location, and I was in [the] Mannheim location. But I was just a young guy there. I didn't know about a famous Hungarian engineer there, so . . . . [laughter]

DOMUSH: So what kind of things were you doing in the materials testing laboratory? What were your technicians working on?

HEGEDUS: This was a huge manufacturing operation. About twelve thousand people worked in that complex. They had the largest electric foundry in Europe, for example, made engine blocks, axle components, any cast iron components. We tested fuels, lubricants, ferrous metals, nonferrous metals, plastics of all kinds, solvents. We [also] tested environmental conditions, you know, in the workplace. We were the chemists of that enormous operation. It was the largest bus and truck company in Europe. So we were the chemists. We did everything. Yes [for example], some window of some vehicle cracked, and we investigated what caused that. We did everything, you know.

So it was really very, extremely interesting to work there. **<T: 10 min>** It was a great company. The pride in that company was enormous. That was kind of the premier company in Germany. And when you are an engineer in Daimler-Benz, well, you have made it. So it was just totally wonderful.

The one interesting thing, looking back at—I am now seventy-two. Looking back all these years, the amazing thing I can tell you is that I liked all the various jobs I had, all of them. I don't know. It's very fortunate, yes? And I liked all the places we lived in. So I don't know. You could argue maybe my standards are too low, but no, I don't think so, because I worked for very well-known, good companies. [laughter] So I don't know. I just found all these jobs to be extremely interesting.

So we are at Daimler-Benz, you know. I learned German relatively quickly. You asked about that. Because I worked on it so hard. And the company had rental apartments, and I rented a nice little apartment there. A nice life. And eventually, in January or so, '68, Eva [J. Brehm Hegedus] managed to—my future wife—managed to come out of Hungary to Vienna [Austria]. They had some relatives in Vienna. So she called me right away. And she is of German extraction. Her name is a famous, familiar name in Germany, Brehm [. . .]. There is a series of books called *Brehm's Tierleben*, *The Life of the Animals*.[6] All students who go through the German schooling system know this series of books about the animals. So when you hear somebody with that name . . . and it's a branch of the family, I think. Very quickly, she could come to Germany, and within weeks she was German citizen.

DOMUSH: That's wonderful.

HEGEDUS: So we married in March '68, in Mannheim.

DOMUSH: Now how long had you known her? You'd obviously been keeping in touch.

HEGEDUS: We met fifty-two years ago, and she died one year ago, so we knew each other for fifty-one years. She was seventeen when we first met.

DOMUSH: That's wonderful.

HEGEDUS: Pretty long. Yes.

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[6] Alfred E. Brehm began publishing an encyclopedia of zoology in the 1860s. Four editions of *Brehm's Tierleben* (*Brehm's Life of Animals*) were printed throughout the nineteenth century, and newer, condensed versions have maintained popularity in the twentieth century.

DOMUSH: When she was able to get to Vienna, was any of the rest of her family able to get to the West with her, or just her?

HEGEDUS: No. She was alone. So it was very interesting. Some humorous element: I had to drive to Vienna, Hainburg [an der Donau, Austria], which is a [far]suburb of Vienna,to pick her up. So, you know, I had this brand new Mercedes, of course, and every year we got a new one. So I invited a friend to come along, so we can change; you know, it is a long, long, long, long drive from Mannheim to Vienna. And we had this accident. We ran on some ice, and it mangled up the front of the car. But we made it to—we hit some trees. We drove like crazy. [laughter] And so we arrived in Hainburg and met Eva, et cetera, et cetera. And then she came out to take her stuff out, and she said, "I was told that you have a new car." [laughter]

I said, "Well, yes, it is a new car." [laughter] "It's not a junk car. We just wiped out, you know, the—some of the Mercedes cooler grille, you know."

DOMUSH: That's so funny.

HEGEDUS: Yes. **<T: 15 min>** So I drove back to Mannheim.

DOMUSH: What was Mannheim like? It's not a city that I'm familiar with.

HEGEDUS: It's a medieval town. It is one of the first cities designed to . . . you know, by people with a ruler. So that there's this chessboard structure of streets surrounded by a ring. So it was one of the first cities kind of artificially laid out like that by some king, I guess. It's an industrial city. In the surrounding areas are famous big companies. And the Hockenheim racetrack [Hockenheimring], the famous Formula One racetrack, is there. There are all kinds of beautiful historical towns around Heidelberg [Germany], nearby. All the Americans know Heidelberg, which is a small university town. It's nearby. That's where you go in the evening, if you are young, to the bars. So the favorite bar we had was called the *Falle*, [. . .] and it means "the trap." And it was laid out with animal skins that supposedly [implied that] we all fell into a trap. So, full of students at that time. Yes.

DOMUSH: What was the , kind of, energy of the city, or the life of the city, like, compared to when you'd been in Budapest? I mean, and you said that things in Budapest were somewhat bleak, and not particularly hopeful.

HEGEDUS: Well, [Budapest was] bleak politically and economically. I don't mean that it was bleak in terms of your daily life. We had quite a wonderful group of friends. You know, the hills around Budapest are glorious. You can go out there on the weekend, and it's a beautiful city. And there are lots of cafes and really interesting things. So no, it was not drab in that sense. It was very nice. In fact, for years I was dreaming that somehow, eventually, I get back there and walk around, looking at things which I haven't seen for a long time. No, it's a very nice place.

Mannheim was also very nice,very pleasant, nice restaurants. The Germans were extremely friendly, very friendly. Very quickly, you had a number of friends. It was also very pleasant. As I told you, somehow I never had any unpleasant circumstances. [laughter]

DOMUSH: That's wonderful.

HEGEDUS: I don't know why. But it's a reasonably big city, Mannheim. Good stores, department stores, we had . . . . I remember when I started working there, at Daimler-Benz, that first day, I desperately needed shoes, and some better attire, and a winter coat. It started to get cold. And umbrella, and things like that. But, you know, you have to wait for your salary.

DOMUSH: Right.

HEGEDUS: So I went to the *Personalabteilung*, the HR [human resources] department, and asked for an advance, [and] they gave me an advance. And so I went to one of these department stores in Mannheim and bought all kinds of stuff. The overcoat was so good that much, much later on, when we moved from Berkeley [California] to Detroit [Michigan], I still had that same German overcoat.

It was pleasant in Mannheim. And what you could do, once you have a car, you could drive along the Neckar [River], into the mountainous area, and there were very nice little restaurants there. You know, good excursions. Also into the Pfalz [Palatinate], there are wine-growing areas there. Lots of **<T:20 min>** castles you can visit. And that was very, very nice. Very nice.

DOMUSH: Did you ever make it back up to Berlin to stand on the Western side of the Brandenburg Gate?

HEGEDUS: Oh, yes. You better believe it. Much later. Much later. But yes. Yes. It was in . . . somewhere, 2000, around 2000 maybe, when I made it back on a business trip. And I stayed in the Adlon Hotel [Hotel Adlon Kempinski], which is on the eastern side, the East Berlin side, which has by then become West Berlin, you know.

DOMUSH: Right.

HEGEDUS: But I started there, and I slowly walked across the Brandenburg Gate. East to west, again. Just wanted to do that. Yes. So I did but it took a while.It took some doing.

DOMUSH: It must have been a wonderful experience to finally get to do that, though.

HEGEDUS: Yes. Totally amazing. Yes.

DOMUSH: So after Eva was able to join you in Mannheim, and you were able to get married, if my chronology is right, not long after that, you left Germany for the United States.

HEGEDUS: Well, okay. I made some observations in Germany. As nice as it was, the Germans [. . .] who had the status or level, what I would like to reach . . . wanted to reach . . . in career, in life, they had two properties I did not possess. One of them is they were *Herr Doktor*s. And the other, they spoke English.

So I signed up with the Berlitz School to learn some English, and I decided also to get the doctorate. So I talked with the [Heidelberg University], and I could have done it there. [Also at] Braunschweig [University of Technology], I remember they would have taken me on. And also, the [Johann Wolfgang] Goethe University in Frankfurt. I talked with them, and it looked like a possibility. But then I went to the library in Heidelberg. Again, just keep remembering that you're dealing with a very young person, okay? How do people like that think? So I said, "If I want to get a Ph.D., a doctorate, and if I want to learn English, I might as well do it in an English-speaking university. What the heck?" So what is the best English-speaking university in the world? Just like that.

So I went to the librarian in Heidelberg, the university librarian, and I said, you know, "Could you help me? What is the best English-speaking university in the world?"

He says, "Can we assume that it is in the U.S.?"

I don't know why, but I said, "Yes, you can." So we found a ranking of grad schools, and at that time, Berkeley was ranked number one. [. . .] And we even found a catalogue. And I saw that they have [both] chemistry and chemical engineering, et cetera, so I wrote to Professor [Gabor] Somorjai and asked him for advice. I didn't know him, but he had a Hungarian name, and I just assumed that he will understand what I am trying to do.

So he wrote me back instantly, and I still have his letter. [. . .] And he said that, you know, this is a very difficult school. "If you just want a quick Ph.D., you might want to pick an easier place. On the other hand, I do recommend that you try to get in here, because it makes a big difference in the U.S., what school you went to, at least at the beginning." So and he also said that, "You should also consider chemical engineering, because your training is somewhere between the two." **<T: 25 min>** We were basically halfway chemists and halfway chemical engineers, in American terms. And so I also contacted the chemical engineering department, and eventually, I decided to apply there. [The chairman of Chemical Engineering was Professor Charles Tobias, also a Hungarian emigre. He was very helpful in explaining how things worked at the university; how to choose a professor, the PhD curriculum. His advice helped me greatly with the transition].

So they wrote me back to say that they need proof of English proficiency. I said, "Oh, my God." [laughter] So I went back to the Berlitz School in Mannheim, and asked, "What do you think? How many [private] hours of English do I need to take to pass this test and show evidence at Berkeley that I possess enough English to be admitted to grad school?"

Well, if somebody asks that question here in the Berlitz School, they would, I guess, first ask, well, "How much English do you know? How much have you taken?" But we are in Germany. The answer was "*ein hundert*," one hundred. [laughter] So I signed up. There was no question. It doesn't take ninety-nine. It doesn't take one hundred one. It's one hundred. [laughter]

So they gave me this—they assigned me to a teacher. She was a long, tall blonde, California girl. And she lived with her boyfriend—her German boyfriend—in Mannheim. Okay. And so I started learning [to speak] English [from her]. I remember . . . we looked out the window, she pointed out the window, and said something about the weather, and I saw a bird flying there, and I thought that must mean the bird is flying there. So I didn't really understand spoken English at all. But she eventually pumped enough English into me that in Heidelberg, [in] the library, somebody from the American Consulate in Frankfurt, somebody came down to Heidelberg every once in a while to administer a test, after which then you could send the papers to the university you want to attend.

So I remember he pulled off a book from the shelf and asked me to read it. And I read it, read into it, and then he said, "Okay, let's discuss." I said, "Well, this is—" and it was Edgar Allan Poe, "The Raven." I said, "I cannot discuss this in any language. I'm an engineer [. . .]."

"Oh, you are an engineer." He searched around, pulled off another book. It was [Ernest M.] Hemingway, *For Whom the Bell Tolls*.

DOMUSH: Oh, wow.

HEGEDUS: So there is something in there—I should go back after all these years to dig this out—something in there where this is about the Spanish Civil War, and they were digging out some trucks from the mud or something, I vaguely remember. So I read that, and we discussed the matter, and I got a grade of "Fair." I was so proud. But much later, I found out that's, of course, the minimum passing grade. [laughter] But anyway, it was good enough for Berkeley. They knew that after three weeks, you know English. So they admitted me.

DOMUSH: Great.

HEGEDUS: So we arrived—you know, I said goodbye to Daimler Benz. And one thing I found out, which was very interesting, they showed me my personnel file in the HR department. They were very, very, really very nice people. And they showed me my file, and there was in it a report of a graphologist. It turns out, at that time, in Germany, you had to submit your bio handwritten. And they sent it to a graphologist, and this graphologist had some raving comments about me. And now I suddenly understood why they wanted to hire me on the spot. [laughter] **<T: 30 min>** Because the graphologist had such a raving review. He strongly recommended that they hire me.

DOMUSH: That's funny.

HEGEDUS: Very funny, huh?

DOMUSH: When you left Germany to go to the United States and to go to Berkeley, did you have it in mind that you would come back to Germany, perhaps come back to Daimler?

HEGEDUS: I was open, but on the other hand, you know, in the U.S., I was not a German citizen. I could have stayed [in Germany], of course. Eva was a German citizen, and I did get papers to stay. But I was hoping that I would like the U.S., and it turned out to be the case. I mean, this is a fantastic country, as you know very well, although you having been born and raised here have less opportunity to contrast it with anything else. But it was totally amazing. We arrived in the [. . .] last few days of September in 1968, in New York. Wow, right away in the middle of Manhattan. Eva had a relative who lived there.

So then we flew to California. And Vicky's [Vicky Marlow] sister's husband, my English teacher's sister's husband, was a grad student at Berkeley.

DOMUSH: Oh.

HEGEDUS: And so . . . it turned out. And so he came to pick us up.

DOMUSH: That's great.

HEGEDUS: And he had a Porsche 911. And to just tell you how we traveled, Eva, me, and all our luggage fit into that 911, which you know is a very tiny automobile. [laughter] So that was our possessions, arriving in the United States.

DOMUSH: Wow.

HEGEDUS: Yes. Well, to tell the truth, there was another suitcase which we mailed with a ship, which had glassware in it, and by the time it arrived several months later, all the glass was in shreds. So Eva wanted her glassware to be shipped, but it was all—

DOMUSH: Something it didn't make it.

HEGEDUS: —all broken. Yes.

DOMUSH: What were your—do you recall what your first impressions of Berkeley were? I mean, Berkeley at this time I think [was] very different than what Mannheim was like.

HEGEDUS: Yes, Berkeley had, at that time, eleven Nobel Prize winners.[7] And even today, you know, their alumni literature say that they have, I think, one more, the same or one more, Nobel Prize winners, than what the Russian nation has collected in their entire history, in all fields combined. It is a rather amazing place. At that time, all elements which followed uranium were discovered in Berkeley. And we knew that.

You'd see an old man standing in the sun, at the wall, leaning against the building, eyes closed. I asked a fellow student, "Who is he?"

[7] When Hegedus arrived at Berkeley, the following faculty members had been awarded Nobel Prizes: John H. Northrop (Chemistry, 1946), Wendell M. Stanley (Chemistry, 1946), William F. Giauque (Chemistry, 1949), Edwin M. McMillan (Chemistry, 1951), Glenn T. Seaborg (Chemistry, 1951), Owen Chamberlain (Physics, 1959), Emilio J. Segre (Physics, 1959), Donald A. Glaser (Physics, 1960), Melvin Calvin (Chemistry, 1961), Charles H. Townes (Physics, 1964), and Luis Alvarez (Physics, 1968).

“Oh, he’s Professor [William A.] Giauque. He got the Nobel Prize for approximating the absolute zero temperature.” You know? So it was just totally amazing to drop in there. And basically, everyone was just totally brilliant. So the first impression hit, “Oh, my God. I have never been in a place like this.”

The first class I took was from Professor [Robert P.] Merrill, Bob Merrill. He died, unfortunately, [since that] time. It was kinetics. So I found the place—that was my very first class. The classroom had one wall this way with a blackboard, and one wall that way, also with a blackboard. Bob Merrill was writing collision theory equations at high speed with his right hand, with the chalk, talking simultaneously, and using his left hand to make corrections [with the eraser]. And I didn’t understand anything. I totally could not relate to this. My English was not good enough, either. So I asked my left-hand neighbor, Clay [Clayton J.] Radke—he is now a famous professor, well-known professor, at Berkeley—but I asked him, I said, “Excuse me.”

He says, “What do you want?”

I said, “What class is this?”

And Clay Radke, if you know him, he responded, “*He-he-he-he*.” [laughter]

So Merrill turns around and says, “What’s going on there?”

And Clay said, “This guy doesn’t even know what class he’s in.” [laughter] So that’s how I started. We became good friends, of course. He’s a great guy.

So I’m jumping ahead a little bit, because when we arrived, I just missed the fall quarter, and I found—I didn’t have any idea about quarters or semesters or, you know nothing. So it turns out the winter quarter for which I was admitted started in January. [. . .] This was the first few days of October. So what do you do? Well, we had eight hundred twenty dollars. In German terms, that was [a small] fortune—[for German purchasing power] you can multiply [it] by five to eight in today’s terms, so like five thousand dollars, something like that. And so our friends said—we stayed with them for a few days—and they said, “You need a car.”

So okay, we had some money, so Pam [Drake, Vicky Marlow’s sister], drove us to Oakland [California]. The Oakland Broadway is where the cars are. As far as your eye can see, it’s automobiles, used car dealers. We had never seen anything like that. So we drove into one of them, and the salesman says, “How can I help you?”

I [said], “We would like to buy a car.”

He [said], “I thought so immediately.” [He was a smart aleck]. “So what kind of car would you like to buy?” And I said medium. He [said], “What is medium?”

I said, “I don’t know these cars, but there are small ones, big ones. [Medium is] somewhere in-between.”

"And how much money would you like to spend?"

I said well—discussed with Eva, "We have eight hundred twenty dollars. Let's keep twenty for harder times." [laughter] And so I said, "Eight hundred."

He said, "What an amazing coincidence! This car is exactly eight hundred dollars." [laughter]

I said, "Okay, we'll buy it." [laughter] So we did. We had some problems, because he added some sums to it, the tax, tag, license, this and that. I said, "No, I told you eight hundred dollars." We had to figure out how to get the sum to equal exactly eight hundred. [laughter] It was a Mercury Monterey. It was a four-hundred-fifty cubic inch [. . .] car, the size of a medium-sized European apartment. [laughter] With some fins. But we loved it. It had—being an engineer, I measured its mileage. It was 8.5 miles per gallon. But gasoline was seventeen cents per gallon at that time. Hamburgers were a quarter. Hotdogs were five cents. Different times.

So anyway, I went to Professor Somorjai, since you will see him, I have to tell Somorjai stories for you.[8] I told him I somehow have to find some work until January. So he called up Chevron [Corporation]. And **<T: 40 min>** they say, "Okay, come on out." So I came out [to nearby Richmond]. They immediately gave me a job. And a short while after, I made an invention, and filed for a patent.[9] And then they said, "Well, why don't you stay? Don't go anywhere."

But I said, "Oh no, I have to go to grad school." [laughter]

So we made it through those months. Eva also found a job. We went to an employment office. Lake Merritt in Oakland is a kind of circular lake, and around the lake are offices. And one of them was an employment office. So we went in there, and immediately they [found] her a job. And she started working . . . and came home crying every evening, [about] how rude Americans [are], how difficult it is, she needs a new job. It turns out it was a collection agency. [laughter] And with her broken English, she had to call people, causing them to pay up, and of course, they [were] not very cooperative.

[The] last little story about that period, we went to this Hungarian engineers' Christmas dance in San Francisco [California].

DOMUSH: In Berkeley?

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[8] Gabor Somorjai, interview by Hilary Domush, 30 January 2014 (Berkeley, California: University of California, Berkeley, Oral History Transcript In Process).

[9] L. Louis Hegedus and I. M. Whittemore, "Determination of Carbonyl Sulfide in Petroleum Gases: A New High-Sensitivity Method," *Preprints: General Papers*, Division of Petroleum Chemicals, Inc., American Chemical Society 14, no. 3 (1969): B181-B185.

HEGEDUS: San Francisco.

DOMUSH: Oh, in San Francisco.

HEGEDUS: And met [a nice] family, they just came from Australia, a Hungarian family. [He] worked at Bechtel [Corporation]. He worked at Bechtel as an engineer. Bechtel had something like nineteen thousand people at that time, and they were designing and building nuclear reactors. Okay? That was the period, you know, when the U.S. nuclear reactors were built. So this gentleman told Eva, "Why don't you come work with us?"

And Eva said—well, at that time, she only had a high school degree. Later on, she had a master's degree, and she became a city planner. But at that time, she said, "Well, how can I? What can I do there?"

He said, "Well, we'll teach you how to be a draftswoman." So she learned how to draw high-pressure steam piping diagrams for nuclear power plants. How about that? And right near is Limerick [Pennsylvania], the Limerick Power Plant [Limerick Generating Station]. She drew the steam piping diagrams for that.

DOMUSH: Wow.

HEGEDUS: So we [are now] in January [1969]. That's when school started. You become an American—in case you are interested, how long does it take to become an American? Two weeks.

DOMUSH: Two weeks? [laughter] I would have guessed longer, but two weeks?

HEGEDUS: Two weeks. After two weeks, you speak perfect broken English. So does everyone else around you, and you feel absolutely at home. And, it's just, you go out at midnight to buy a mattress. You know, there [were] twenty-four-hour mattress stores in California. [laughter] So you become an American in two weeks. Yes.

We needed a cactus. You drive around in California, there are all these beautiful cactuses along the road. So we stopped, dug up a cactus, and took it home, and later on, we learned that that is punished by . . . . [laughter] It's strictly prohibited. So we had the cactus. Then we needed a cat, so we found a cat. You get settled. Bought a mattress.

DOMUSH: Since it sounds like you both got settled into living in the United States pretty easily. It took two weeks . . .

HEGEDUS: Very quickly. Yes.

DOMUSH: . . . After the period of time where you're working at Chevron, once you were immersed in your classes, and you got used to fast, crazy writing of equations, how were the rest of the classes, and the rest of the lab work, and all of that?

HEGEDUS: . . . You had to pick a thesis topic. So they had a list of subjects and professors. **<T: 45 min>** I just looked at them, and one of them, one of the topics was hydrogenolysis of cyclopropane. And I said, "Well, I understand hydrogenolysis and cyclopropane," and this is catalysis. And the professor, Professor [Eugene E.] Petersen, was very nice and friendly. So I signed up with him.

It turned out that the field which I got myself into is called chemical reaction engineering, which is a branch of chemical engineering. And that's where I spent, you know, my scientific career. That [became] my home base. And reaction engineering deals with, basically, applied catalysis, and reactor engineering, their mathematical description, and modeling of reactors.

That was another very interesting thing. I knew nothing about computer modeling. I never worked with computers. The Germans had, Daimler-Benz had a computer used for payroll and accounting. They had Hollerith cards. But we did not use it. As engineers, we used these mechanical calculators which you cranked with your hand. And slide rules, of course. And so I needed to very urgently learn computer programming, and Professor [Robert L.] Pigford had a seminar class for those of us stray foreigners who [didn't] Fortran. So he taught me. I joined [Pigford's] seminar class and learned Fortran very quickly. The second or third Fortran program I wrote, we published.[10] And in fact, that turned out to be one of the most frequently cited papers I wrote. It dealt with how to integrate chromatographic signals with a computer at that time. We used an orthogonal collocation technique.

So yes, the classes were hard, and very different from what I had ever seen, because if you didn't understand something, you couldn't do anything. In my previous life, if you didn't understand something, you still knew it. And you knew a lot of things which you didn't understand. But here, you understood a lot of things which you didn't know. So it was the inverse world. So I had to make this transition. Like, they would have an open book exam. Oh, what a wonderful thing! I got a pushcart, loaded it up with books, and it turns out that you don't have the remotest chance to look into any of them. [laughter] It's just complete nonsense to

[10] L. Louis. Hegedus and Eugene E. Petersen, "Integration of chromatographic signals by Digital Computers: An Approach for the Small Chromatographic Laboratory where Digital Computing Services are Available," *Journal of Chromatographic Science* 9 (1971): 551.

carry all those books in there. But you can make the transition. Also, the exams are all kind of solving puzzles. The European exams were—we had midterm-type [exams], and homework assignments, but the [final] exams were oral, verbal, you know. And here [at Berkeley], it was all in writing. But you get used to it. You survive eventually. I got royally scared, told Eva after a few months, “Brace yourself. We may not make it,” because it is just extraordinarily difficult.

But it turns out you—like I didn’t know much math, that type of math, applied math, specifically differential equations, which we needed to use to describe these reactors. And so what do you do? Well, you can surrender, I guess, or you can **<T: 50 min>** read yourself up on it. I ended up, . . . I would need to count, but probably published forty, fifty papers on that subject, eventually. So you survive, if you put your mind to it.

DOMUSH: Yes.

HEGEDUS: It was very interesting, though. Very interesting. All students were brilliant. The TAs . . . I remember an Iranian [student], Kambiz Milani was his name. He was a TA. I said, “How can somebody be so brilliant? My God.” You know? It was just totally incredible. I have never met anyone like him. Everyone was very smart. [. . .] So you kind of work yourself try to work yourself up as quickly as you can to a level where you don’t feel so out of place. And after a while, you start finding good results in your research. We published seven papers out of my dissertation, et cetera.[11] Did some very interesting things. So I got even my professor excited with certain things. I made Gene work through one night without sleeping, because he got so excited about something [I proposed].

DOMUSH: How was Petersen as an advisor? Was he someone that you interacted with regularly, or . . .

HEGEDUS: The best you can imagine. The best. The absolute best you can imagine. Extremely smart. Extremely smart, and obviously accomplished, but you had to earn his interest. Right? And some students he lost because, you know, you had to earn his interest. If you wanted to have a good thing going with Gene Petersen, you had to earn his interest, which not everyone managed to do. But he was just wonderful. He gave you tremendous room in what—I remember in, I think it must have been [. . .] Christmas, maybe ’69. I was sitting at home, and I was thinking, “What specifically should be the point of my dissertation?” Because he won’t tell you, won’t give you the idea. He had an area, a fund for a general topic. But how do you make a dissertation out of that, and how do you carve new material out of that? How do you carve out things which are publishable? He won’t tell you. [. . .]

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[11] L. Louis Hegedus, “An Experimental Theoretical Study for the Poisoning of Catalysts in a Single-Pellet Diffusion Reactor” (Ph.D. dissertation, University of California, Berkeley, 1972).

So I was sitting there, and I had this great idea. And that's what we worked on, and we [wrote] seven papers. So he gave you the opportunity of feeling that you were not told what to do, that it is truly a doctoral dissertation in the sense that you generated some new ideas. I'm eternally grateful to him. Yes. Eternally grateful. He was a wonderful [scientist], not to mention he was a very nice individual as well. Very lucky, again.

DOMUSH: Yes.

HEGEDUS: Very lucky.

DOMUSH: In addition to needing to learn Fortran, was there other instrumentation that you encountered during your research that you hadn't seen before, or you hadn't . . .

HEGEDUS: No, not that much. Well, of course, we built a computerized data acquisition system. At that time, they didn't really exist [or were very expensive]. So we worked with the electronics engineers to build a data acquisition system, which collected data from my reactor, which—the subject [of the research project] was catalyst poisoning, on which we wrote a book eventually, that book [pointing]. That's the first book on that subject, by the way.[12]

DOMUSH: Yes.

HEGEDUS: And so you **<T: 55 min>** couldn't shut down your reactor and start it. I slept on a folding bed. [laughter] And so you needed some device to collect your data, so you can go home.

DOMUSH: Yes.

HEGEDUS: So we built this very early data acquisition system. We still had slide rules at that time, and cranked [calculating] machines. The College of Chemistry had a computer. It was an SDS910. Since "SDS" turned out to be [an acronym for] one of those famous revolutionary groups [Students for a Democratic Society], they were some anarchists, the company named it, changed its name to XDS.[13] [laughter] It had a central core capacity of something like, I don't know, in the ks [kilobytes], maybe 50k or something like that so tt was very difficult to use it.

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[12] L. Louis Hegedus and R. W. McCabe, *Catalyst Poisoning*, Chemical Industries 17 (New York: Marcel Dekker, 1984).

[13] In 1969, Xerox Corporation bought the computer company Scientific Data Systems, SDS, and changed the name to Xerox Data Systems, XDS.

The [main] campus computer was [also] interesting. It was a CDC6400 with a central core capacity of 280k. Now think about that. What can you do with 280k today? And we had to solve, you know, non-linear coupled boundary value type differential equations with that. So it was an extremely difficult situation, because you were so severely limited by the computer. This computer [center] was in the basement of the physics building. There was a huge staff working on it. The—it was like a machine, okay? Air conditioned, and all the rest. Your cell phone [today] is vastly superior to it. [laughter] There's just no comparison. It's like light years superior to it.

DOMUSH: Yes.

HEGEDUS: The turnaround time was [about] ten hours at that time. We used punch cards. There was a punch card machine in the basement. You had to stand in line. You had your cards in boxes. The boxes were stacked on a cart. You had ten decks or so running. My binary decks were that long [approximately one foot]. And you had to punch in any new input, and stand in line, got your turn, and make sure you don't hold them up too much. And then you submitted the data. Turnaround time was about ten, [sometimes] twelve hours. Some people lived there; they slept in sleeping bags around.

One of the guys who worked there, a young undergraduate Hungarian [student], later on—who kind of worked in the computer center—became the famous Charles Simonyi. He [eventually] joined Microsoft [Corporation]. He was responsible for things like Word and Excel. And he was, I think, [one of] the first [paying] civilians [who] which went up [with] the Russian rocket to the Space Lab [International Space Station]. You can read all kinds of interesting things about him. He left Microsoft in the meantime. He's one of the famous computer [pioneers]. Yes.

So, you know, in the rain, you had to push your cart with all your expensive binary decks under an umbrella to the [computer] building. There was no display device. There was no CRT [cathode ray tube] screens [available]. We could only look at printouts. You stood in line to pick up your printouts, and if it was thin, then you knew it was [just] error messages. If it was [thick], "Wow, it ran!" [laughter] So while running the lab experiments, you also had to, in my case, [make plots of] the data, and compare them with the solutions of equations. It was great fun. It was great fun.

DOMUSH: Well, it's just about noon, and we said that we would stop for the day at noon.

HEGEDUS: Okay.

DOMUSH: So tomorrow morning we can **<T: 60 min>** finish up talking about anything else that we want to about your research and your time at Berkeley, and move on to your transition to the rest of your career, and of course, things like the catalytic converter.

HEGEDUS: Yes. Whatever. You drive it. You drive it in the sense that whatever you would like me to cover, I will do so.

DOMUSH: Great. Well, think that'll be a really good place to start. And then, like I said right before we got started, we can kind of end up by going out to lunch with Jody [A. Roberts], and talking a little bit more about the anniversary that's coming up.

HEGEDUS: Okay. Great.

DOMUSH: Great.

[END OF AUDIO, FILE 1.3]

[END OF INTERVIEW]

INTERVIEWEE: **L. Louis Hegedus**

INTERVIEWER: **Hilary Domush**
Jacqueline Boytim

LOCATION: **Chemical Heritage Foundation**
Philadelphia, Pennsylvania

DATE: **6 December 2013**

DOMUSH: Okay. Today is day two of the oral history. Again, I'm Hilary Domush, and with me is Jacqueline Boytim. And Dr. Hegedus was just about to give a brief summary of what we talked about yesterday.

HEGEDUS: Yes. So what I said yesterday is as follows. I've grown up in difficult times, in communist Hungary of the 1950s. Had wonderful and supporting parents and family, and had a strong and humanities-oriented high school education in Szolnok. I had an excellent university education in Budapest, very hard work. Looking back, it gave me a very strong background.

My first job in Hungary, process research. I enjoyed it very much. Then I was very fortunate to get to Germany, and found a great job at the car company which was at that time called Daimler-Benz. Now they are called Daimler-AG. And I was also even more fortunate to get admitted at Berkeley, and obtain a Ph.D. in chemical engineering in 1972 specializing in reaction engineering. So I believe we are at that point.

DOMUSH: We are.

HEGEDUS: Or are we still talking a little bit about Berkeley, or were . . .

DOMUSH: Well, I wanted to ask really quickly if there was anything else that you wanted to talk about at Berkeley. You mentioned that you had seven publications, that you got your research advisor really excited and really interested in what you were doing, and it sounded like your research . . .

HEGEDUS: And vice versa.

DOMUSH: Sorry?

HEGEDUS: And also vice versa.

DOMUSH: Yes. Yes.

HEGEDUS: Yes. We had great back and forth. Yes. Outstanding. I wanted to—perhaps [what] I could say about Berkeley is that you come out of there, you truly feel that you are at the leading edge of what you are doing. And you actually discover that not only do you feel so, but you actually are at the leading edge of what you are doing. So it gives you tremendous confidence, and you feel like you are able to tackle anything. And it was just a totally wonderful, wonderful experience. It's just a great place.

DOMUSH: That's wonderful. How did—oh, sorry. Before we leave Berkeley, one of the things that Jacqueline and I were interested in, around the time period that you're in Berkeley doing all this research, you know, getting kind of really settled in America, a lot of things are going on in Los Angeles [California] related to the [Los Angeles] Motor Vehicle Pollution Control Board. People are talking a lot about pollution. People are talking a lot about a lot of things at this time, protests about various things. But we were very curious about whether any of the talk about emissions and automobile exhaust, and pollution, any of that conversation that was taking place in L.A., was making its way to you up in Berkeley.

HEGEDUS: Great question. In fact, we had seminars, you know, [in] our research group, [with] Gene Petersen. We could select papers from the literature and discuss them with other students in the group. And amazingly, I did select some papers written by Shelef and Gandhi at Ford [Motor Company], Haren [S.] Gandhi and Mordecai Shelef. It was about NO_X [nitrogen oxides] emission control. And that—I'm sure it had some influence on my eventual selection of General Motors [Company] as my next station in life. Yes, there was a discussion about that [subject]. It was not a very strong thread yet at that time, but yes.

DOMUSH: Okay. So how did you make the transition to General Motors and to Michigan from Berkeley? How did that come about?

HEGEDUS: Well, first, you know, you look for jobs, and I was—that was a very difficult time in the U.S. for chemical engineering graduates, or in general. Nineteen seventy-two, spring of 1972, **<T: 05 min>** was not a boom year in the economy, so there were not so many jobs. But I was very lucky. I worked in catalysis, and catalysis, as you know, relates both to energy and also to the environment, so I had four excellent offers, and it was very difficult to decide.

DOMUSH: Can I ask where the other offers were?

HEGEDUS: Yes. [E.I.] DuPont [de Nemours & Company], Engelhard [Corporation], Union Carbide [Corporation], and General Motors [(GM)]. These were all top-notch companies. These were all outstanding opportunities. It was very difficult to decide. But [GM Research Laboratories in Warren, Michigan, sent their Technical Director, Basic and Applied Sciences,] to Berkeley to recruit. I was very impressed. They said that, you know, they have to put catalysts on millions and millions of cars. And I thought, "Oh, wow, this will be the largest application of catalysts on earth." [laughter] And being a reactor person, chemical reactor person, I said, "They want to manufacture millions of chemical reactors. Wow, this has never been done before." So I got very excited about the idea.

DOMUSH: Did you apply to or look to go back to Chevron, where you had worked for those couple of months?

HEGEDUS: Yes, I did, and we had a discussion, but it—somehow, the opening they would have had and what I was doing did not match very well at that time. Later on, I, of course had an opportunity to go back to Chevron, et cetera, but then I elected to stay [with GM]. But it's a great company also, by the way. Outstanding.

DOMUSH: So you get these four offers. The one at GM really sounds the most exciting.

HEGEDUS: Well, all of them were very exciting, and it was very difficult to decide. How can you turn down the DuPont Experimental Station's very elite engineering group? It was one of the premier jobs in my field on earth, if you wish. [laughter] So how can you turn that down? It was very difficult to make the decision. But finally, in the spirit of doing something amazing, I joined GM, and it turned out to be far beyond anything I could imagine even. Yes.

DOMUSH: So what was the transition to Michigan like? I mean, you mentioned that you needed your winter coat.

HEGEDUS: On the human side, you know, we had a two-seater British sports car, Triumph TR6. We drove it across the land; took about, I don't know, ten days or so, and arrived at around eleven p.m. [. . .] the first day of July or so, 1972. Eleven p.m. and change, coming from the west. There was a big sign: "Welcome to Detroit, 95 degrees." [laughter] At eleven o'clock p.m. It was very interesting.

We checked in in a hotel and went to the company the next day, et cetera. They were very friendly. The GM Tech Center [General Motors Technical Center] is glorious. You know, it was built by Eero Saarinen, the same [architect] who designed the Dulles Airport, Washington Dulles [International] Airport building. Glorious style. I was very impressed also by the people.

Regarding housing, the moving company [. . .] driver who took our furniture, the few pieces we had, **<T: 10 min>** said that, you know, "Remember what I'm telling you. In two months, you will start making arrangements to move back here." [laughter] So I told Eva, "We better have it nice." So we found a glorious high-rise building in St. Clair Shores [Michigan], on the border of Grosse Pointe, overlooking the Ford Estate. This was a gated community, and very expensive, and it was—the building was designed by I.M. Pei, the same person who designed the East [Building] of the National Gallery, and the pyramid in the Louvre [Museum].

DOMUSH: Yes.

HEGEDUS: You know? So it was a very high-class building, and we holed up there. I said, "We have to have it nice for a while, to make sure that we don't have any thoughts of going anywhere." [laughter] So that was—the transition turned out to be very nice. Soon you discovered that you have a very interesting and somewhat amazing job. Eventually, we had five thousand people on this project.

DOMUSH: Wow.

HEGEDUS: And eventually I was in charge of catalyst research. So it was just a very great experience.

DOMUSH: Now how when you first got there, what was it like in terms of kind of . . . . So you said when you first got to Daimler, you oversaw . . . I forgot how many people it was.

BOYTIM: Nine.

HEGEDUS: Nine.

DOMUSH: Nine technicians. How . . . what was it like when you got to GM? Were you overseeing a handful of people?

HEGEDUS: Well, I started as a bench researcher, so I had I think one or two technicians. And then I became a group leader, and they called it "supervisory research engineer." And I think it may have peaked by the time, in terms of direct reports, maybe in the twenties. But this was kind of forward research. We were the visible tip of the iceberg. We published our work. We participated in conferences, filed a whole bunch of patents, et cetera. We had basically, looking back, almost unlimited support. Essentially unlimited.

The reason is that by September 1, 1974, all these companies had to meet emissions standards mandated by the Clean Air Act.[14] And they were such enormous economic entities that they could not risk not being able to sell cars, or being delayed in selling cars, or perhaps being fined for not meeting standards. So they deployed, you know, exotic resources. The paper I gave you . . . where Jim [James J.] Gumbleton and I tried to summarize the effort, shows what effort was deployed there, in this.[15] It was one of the largest privately-funded civilian research efforts at that time, possibly the largest.

DOMUSH: So I was very curious about the nature of publishing and patents for your position, and you said that you guys were kind of the visible edge, the leading edge.

HEGEDUS: Yes. Yes.

DOMUSH: And so you were encouraged to be publishing, and encouraged to be publicly filing patents.

HEGEDUS: Yes. The company had, probably, at least two reasons. One is, you know, by participating in the scientific community, you gain an awareness of what is going on. You cannot isolate yourself from the technical [world]. The other one, as you know, that obviously, the company wanted to make sure it is well understood that they do everything humanly possible to meet the standards. So genuinely, the effort was kind of pretty extraordinary. **<T: 15 min>** Yes.

And the paper, which I don't have in front of me, lists numbers, how many cars were built, and how many catalyst combinations were run out of one hundred thousand miles, and how many people were involved, and how much money was spent. It was pretty extraordinary. [. . .] So anyway, it was a very large and very exciting project. It ranged from scientific work, catalysis, to reaction engineering.

We [did] a lot of math modeling. We had even a mathematics department, which helped us solving our differential equations. And lots of computer work. We had ceramists,

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[14] The Clean Air Amendments of 1970, Pub. L. No. 91-604, 84 Stat. 1676, 1970.
[15] L. Louis Hegedus and J. J. Gumbleton, "Catalysts, Computers, and Cars: A Growing Symbiosis," *CHEMTECH* 10 (1980): 630-47.

metallurgists. We had of course tremendous mechanical engineering capabilities in the company. And reams, and reams, and reams, and reams as far as your eye can see, engine dynamometers, running engines, testing catalysts. GM had a very good eye for hiring the best people from the top schools, and they went to Berkeley, Stanford [University], MIT [Massachusetts Institute of Technology], Caltech [California Institute of Technology], Princeton [University], et cetera, [University of] Wisconsin, and hired very good people. So the quality of [our] staff was absolutely first class.

It was very interesting. We had consultants, some of the top academics who worked with us, [such as Eugene E. Petersen, Rutherford Aris, and Michel Boudart]. And we worked late into the night. We worked Saturday, Sunday. I had a very patient wife. We were very excited, and also we were up against a deadline. And I—it's pretty obvious that the body of work which eventually qualified me to be elected in the NAE [National Academy of Engineering] was done at GM. I had great colleagues and coauthors, and it was just one of those rare opportunities in life, you know.

DOMUSH: [. . .] Before we started talking with the recorder on, we were talking a little bit about history of science, and in scientific papers, whether we should—whether it makes sense to cite what has influenced the author or what has influenced the field. And I'm curious, when you started at GM and when you started doing all of this research, how large was the body of historical scientific research on this topic? Was this something that was really new, that had to be kind of started from scratch? Or was there anything to work from?

HEGEDUS: Now catalysis, of course, has been around for a long time. And two things, perhaps, were brand new. One of them is, you know, that basically nobody has ever operated a catalyst under these conditions of extreme temperatures, and for a very long time under transient conditions. Chemical reactors normally operate at steady state. This thing had to cover a temperature range of room temperature to 650 [Celsius], and [space] velocities ranging from, you know, [from] idle to ridiculous. And one the other aspect was, nobody has ever designed reactors to operate at extremely high conversions for, **<T: 20 min>** in this case, one hundred thousand miles. So the technology simply had to be developed that didn't really exist, by far. This explains the extraordinary effort.

One interesting thought I heard at GM is that they talked with the established catalytic community, and basically, most of the—many of the experienced people, consultants, et cetera, said that this cannot be done. So there was a thought at GM, and they seem to have executed upon that, [that they should] hire some very smart, brand new guys who don't know that this cannot be done. [laughter] So there was an element of [truth to] this, and we really didn't know that this cannot be done. You put your mind to it. It was somewhat, looking back, very similar to some Silicon Valley-type of thinking, to do something amazing, and, essentially, seemingly impossible. But when you conclude it is possible, you go after it and get it done. There was that type of spirit at that time in the company.

DOMUSH: Was there—within GM and within the community that's working on this project—was there any competition between different groups at GM to promote certain catalysts or to . . .

HEGEDUS: Yes, there was.

DOMUSH: Or to think that their way was better or something?

HEGEDUS: There was a kind of a friendly competition. It was not uncoordinated, but there were several very strong groups. Of course, in the AC [Spark Plug] division at that time, Flint [Michigan], where all the practical work was done, you know they had done a lot of good thinking, especially, for example, in metallurgy and ceramics, but also in testing. How do you test? You had to test these catalysts somewhat in an accelerated way. You don't have a year or two to test each and every sample. So they were good at that.

GM had a very good advanced product engineering, [. . .] "vehicle people," who of course had to figure out the control systems. See, this is not only catalysts, and catalytic reactors, but electronics, and electronic controls, and sensor work. So there is much more to this than just the catalysts and the converter. The paper I gave you describes that properly, everything else that's involved. The control system was worked out by the engineering groups. Then, you know, you had to develop a sensor [. . .] for feedback control. And a lot of good work was done in the metallurgy department on that, and also in the physics department, and in the electronics engineering department at GM Research.

So many ancillary disciplines were involved in developing this technology. But the catalytic converter itself, as it consists, as it is composed of the catalyst and the reactor, that was us.

DOMUSH: Who were some of the people that you worked with to build . . . and create and develop that system?

HEGEDUS: The entire large, the entire system, or just the catalyst and the reactor?

DOMUSH: The catalyst and the reactor.

HEGEDUS: Yes. You see, I published with almost everyone in the group and in the department. So from my list of publications, you can see who they were. Here, standing on, kind of in flight, I am afraid to list names.

DOMUSH: Okay.

HEGEDUS: [The names of people who worked on this with me directly are listed in the references of my papers. It is a long list. There were others who worked with Richard L. Klimisch and Kathleen C. Taylor and they are listed in their references]. [. . .]

I published a lot of papers with a colleague called Se [H.] Oh, a Korean [researcher], brilliant person, and Jim [James C.] Cavendish, a mathematician. Jerry [Jack C.] Summers, preparative organometallic chemist. Others who did very significant work, and a good part before I even arrived at GM, was Dick [Richard L.] Klimisch and Kathy [Kathleen C.] Taylor, and both stayed with General Motors much longer than I did. And so there was a large group of people there, and Ken [Kenneth] Baron, I remember. [. . .]

DOMUSH: I was curious. One of the projects that I've been involved in here at CHF is a project related to women in chemistry. And so I was really interested in Kathleen Taylor's name and contributions the project. She comes up frequently if you look on line.

HEGEDUS: Oh, sure. [I would like to insert here that Kathy Taylor, a chemist, made [significant] contributions to the development of the catalytic converter, together with Dick Klimisch, also a chemist. Kathy was elected into the National Academy of Engineering. Both of them rose to high management positions at GM in the ensuing years.]

DOMUSH: And I was just wondering how, if you had any sense of how many women there were kind of working on research in catalytic converter at GM.

HEGEDUS: Well, Elaine [M.] Sloan, she was a technician, but she was a chemist, and I coauthored a paper with her.[16] It was mostly—there were others in other departments. In our department, we didn't have another woman [research scientist]. Basically, the environment was not entirely dissimilar from today. You just hire the best people you could find, and the—I cannot remember any consideration as to whether you are a boy or a girl. We just had to hire the best people available [at that time].

DOMUSH: Okay.

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[16] L. Louis Hegedus, C. C. Chang, D. J. McEwen, and E. M. Sloan, "Response of Catalyst Surface Concentrations to Forced Concentration Oscillations in the Gas Phase: The NO, CO, O_2 System over Pt-Alumina," *Industrial & Engineering Chemistry Fundamentals* 19 (1980): 367-73.

HEGEDUS: Yes. So at that time, perhaps, there may not have been so many women in the profession, either.

DOMUSH: Yes.

HEGEDUS: Much later, it—you know, in the French company, once we get there, we had many more women, because there simply appear to have been more [women scientists and engineers] available.

DOMUSH: Yes. You mentioned that in addition to the publishing, you were an active part of the scientific community, going to conferences and talking about your work. Was there any discussion with the other big car companies, with Ford and with Chrysler [Corporation]?

HEGEDUS: A very good question. At that time, there was this—

DOMUSH: Or with any of the international companies?

HEGEDUS: There was this antitrust law, or whatever it was.[17] It prohibited us from any discussion of our work with other companies. Of course, you presented papers. But you—we didn't really—we just followed the law, and did not have any conversations with these guys. And we met them at meetings, but we refrained from technical discussions. [laughter] We were proper and, you know, we were told not to bring the company into trouble by violating that law, and we didn't violate the law.

But we knew who they are, because they published. And we—there was somewhat of a little bit, too, in hindsight, kind of a mutual admiration. You know, for example, Ford people were outstanding, and I always looked at their work and said, "Wow." [. . .] And much later on, decades later, we were still good friends, and reminisce about [those] amazing times. Mordecai Shelef is still alive. He has of course retired. And Haren Gandhi has died in the meantime. [Both were elected into the National Academy of Engineering.]

But there was—the short **<T: 30 min>** answer is no, there was no discussion. And as a result, very interestingly, the very first technology which was commercialized was very

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[17] In 1969, the U.S. Department of Justice brought an antitrust suit against major American automakers and the Automobile Manufacturers Association for collusion to slow or prevent the development of pollution control devices for their vehicles. The suit was ultimately settled out of court with a consent decree, in which automakers promised not to conspire to withhold emission control technology. See *United States v. Automobile Mfrs. Assn Inc.; General Motors Corporation; Ford Motor Company; Chrysler Corporation; and American Motors Corporation*, 307 F. Supp. 617 (1969).

different between GM and Ford. GM looked at monoliths, which is a cordierite structure, magnesium aluminum silicate, which has a certain melting point, much lower than the melting point of aluminum oxide. You could not make aluminum [oxide] monoliths, for some reason or other, at that time. And the cordierite monoliths had their melting point below the adiabatic temperature, the max adiabatic temperature rise of the reaction mixture which you fed into the converter. So unless you have very good, very tight controls, you would melt it. So needless to say, we melted a whole bunch of monoliths. So the conclusion was, you know, that we will use pellets, at that time, because they are much more robust. So the GM converter was a pellet-type converter. You see it, a drawing of it in the paper. And the entire exhaust stream was passed through these pelleted converters.

Ford used, at that time, as I remember, a monolith on one side of the engine, and then nothing on the other side. You could tune your engine to run lean enough to have low enough emissions. There was a tradeoff. This was a very complicated subject, because you also have to have the car drivable. In addition to drivability, it has to have performance, has to have fuel economy, and has to meet emission economy. So that is four. You know, it's a four-dimensional space, and GM ended up at a different spot in this four-dimensional space than Ford, because we had not talked with each other.

DOMUSH: Right. Were there considerations that you guys had to take into account regarding things like weight? Or, I would assume you couldn't be adding too much weight to a car, because that would affect its performance.

HEGEDUS: Well, at that time, cars were enormous. They were, some were the size of a kitchen in your house or something. [laughter] Remember that there were huge cars. But yes, weight is always an issue in automobiles. And we had to size it properly. I keep on referring to that paper. There is a picture there of one of the early experimental GM converters from the fifties, which is basically taking up the entire underbody of the vehicle. No, we were very careful in sizing it properly. The larger the converter, the higher conversion it gives, and the longer it lives. The smaller it is, you know the shorter its life is, and conversion is lower [as well], but it is lighter and cheaper. So you can see that this is what is called an optimization problem. After considering all these various variables, you end up with a size which was reasonable.

DOMUSH: Because of the antitrust issues, when you couldn't talk to Ford, you couldn't talk to Chrysler, how did the international car companies deal with these regulations? They were obviously also interested in selling cars in the United States. Did you talk to any of the international companies?

HEGEDUS: No, we did not. Not that I remember. Of course, we talked with the catalyst companies. And there was some kind of cross-pollination, I guess, through the fact that we did not make catalysts; Ford didn’t make catalysts; Chrysler didn’t make catalysts; Volkswagen didn’t make catalysts. [AB] Volvo at that time didn’t make . . . . The catalysts were made by catalyst companies, which sampled all the various different companies, of course. So maybe the catalyst company could see what Ford is doing, and what GM is doing, and what Volkswagen is doing, and what the Japanese are doing. So there was this, you know, orthogonal direction **<T: 35 min>** across the car companies and all the catalyst companies.

DOMUSH: So who are these catalyst companies? Who—where do you acquire the catalysts from?

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HEGEDUS: Well, they come from—in the paper, it shows you that there were something like [eighty-two] companies who originally submitted samples. And of course, it was shaken down eventually to UOP [Universal Oil Products], W.R. Grace and Company, Engelhard—as far—and Degussa [AG , Air Products and Chemicals, Inc.,] and Johnson Matthey [PLC]. I hope I didn’t leave out anyone, in terms of the noble metal-impregnated catalysts. And then Corning [Glass Works] made monoliths, and NGK [Spark Plugs, Inc.] in Japan made monoliths. And again, I hope I didn’t, in flight here, forget someone.

The noble metal aspect was very interesting. There was huge effort to try to avoid them, using them. When I interviewed with GM, it was in April ’72. They felt that they . . . at all costs, they want to use base metals. When I ended up on site in the first days of July ’72, they were all into noble metals. So how much noble metal to use? Well, the story is—I believe it’s also in our paper—GM called up Impala [Platinum], the South Africans. And they had a reef called the Merensky Reef, which was slanted, going down. It was—you should make sure you can correct these numbers.

DOMUSH: Of course.

HEGEDUS: I remember something like a mile deep at that time. And I remember something like the temperature down there was 61 degrees C. So it was a seam a foot or two wide, granite, and you had to mine something like twelve tons of granite for each troy ounce of noble metal which was platinum to palladium in a ratio of, I believe, five to two or five to three. We should look it up. And so the issue was—and you had to blow, of course, cold air down there, so people can survive. I think GM had to hire something like fifteen thousand, or the company had to hire fifteen thousand people to mine that reef. They had a town of something like forty-five thousand people. And it could be mined [only] at a certain pace. And that divided by, through the number of cars GM made worked out to be 0.05 troy ounces of a mixture of platinum and palladium, of the ratio of the Merensky Reef. So that’s what we ended up with. And so GM made a long-term contract, as I heard at that time, over the telephone. [laughter] Because of the hurry, you know.

DOMUSH: As you—as the years passed and the research kind of ramped up and got closer and closer to kind of the deadline, did you find any further difficulties obtaining these noble metals, or . . . ?

HEGEDUS: No. Not to my memory. But of course, platinum prices started out low.

DOMUSH: Right.

HEGEDUS: Because there was not so much use for platinum at that time. And now I think platinum is more expensive than gold. And so the car companies tried throughout this time period to reduce those metal loads. And that was done in a very brilliant way by making sure that you **<T: 40 min>** don't sinter the metals, that you anchored them to the support in rather sophisticated ways, so that the load—very significant reduction of . . . . I don't know where it is now, but I wouldn't be surprised if it is one-tenth of what we used, what we ended up using at that time.

DOMUSH: Do you have any . . .

BOYTIM: Maybe it would be nice to just have, for a general audience who might listen to this, your description of how the catalytic converter worked. I don't know. I suppose you might want to start with the two-way, if . . .

DOMUSH: No, I think that would be great.

HEGEDUS: Yes. It started out as an oxidation catalyst, of course, and one of the spectacularly interesting problems was that of course lubricating oils had phosphorus in them, and so the engine consumed some lubricant. You know, there's an oil consumption. And so you expose the catalyst to some phosphoric acid, in the vapor phase. And also, as the lead was removed from the gasoline, the entire distribution system was full of lead, so there was a period in which the lead level kept on coming down, coming down, but it was still there. You know, traces of lead. And the most peculiar thing is that these traces of—basically, these are lead halogen compounds in the gas phase—reacted with the phosphorus, phosphoric acid on the catalyst at the end, forming lead orthophosphate. And lead orthophosphate, in that . . . . You started out with a certain ratio of lead to phosphorus, and as the lead started to get depleted, that ratio migrated, in the phase diagram, to a point where you formed glasses. So suddenly, you glazed up the very outer micron or two of the catalyst. You plugged it up with lead orthophosphate. So some of the papers we wrote identified this problem, and tried to design catalyst pore structures to not to get plugged by lead orthophosphate.

And then, eventually, the lead was, over the years, swept out of the system, and people also figured out how to (a) reduce oil consumption, (b) reduce or eliminate phosphorus. So that is not such a major problem today. Probably not a problem, I would assume. And that also contributed to the company's ability to reduce noble metal levels. So originally, for durability purposes, we needed more noble metal as well.

Then as the emissions standards kept on getting tight, and eventually, we had to go to the three-way catalyst that operates at close to the stoichiometric point, and has the sensor electronic feedback, so it is now a computer-controlled reactor. It's extremely complicated for several reasons. On the long run, we have this transient of [catalyst] activity changing over time. In the shorter run, you drive the car, you know, you step on the gas, you take your foot off, so the catalyst operates in that transient. And even in the very short scale, the air-fuel ratio was dithering at roughly at the frequently of 1 hertz. So you are feeding the reactor with a 1 hertz frequency of oscillating the air-fuel ratio between two levels. And then all these [longer] transients on top. So this, mathematically speaking, this was an extremely interesting and very complicated engineering problem. How do you optimize such a . . . . Nobody has ever operated **<T: 45 min>** any chemical reactor anywhere near this level of complexity.

BOYTIM: Right.

HEGEDUS: Also, it's very interesting. You know, from a reactor design perspective, it is an entirely different thing to design one chemical reactor operating at some well-defined set of steady-state conditions. But to operate—to design reactors which are made in quantities of millions operated in this extremely complicated way.[laughter] This was—your earlier question was what was new. This was entirely—nobody has ever even imagined anything like that. So we really plowed a lot of new territory in reaction engineering, for example. The whole field, in my opinion, was significantly affected by the catalytic converter.

DOMUSH: How aware do you think the public was of this massive research effort that was being undertaken? I mean, the public was aware that cars were going to have to follow these emission standards, but do you think they had any sense that this . . .

HEGEDUS: I don't know. It's hard to . . . it's hard to answer this precisely. I remember I had many invitations to give seminars at universities, and occasionally we got interviewed by newspapers. I remember I gave a seminar at Notre Dame [University], and the *South Bend Tribune* came to interview me. And I was just a bench-level researcher at that time. I said, "Well, we are . . . .You know, we will . . . . Afraid to . . . .You know, you have to ask the company for permission to . . . ."

He says—a very clever. He was a very clever reporter. He says, “Well, you can say your own opinion, can’t you?”

So I said, “Sure I can.” [laughter] So I explained to him how the thing works, and basically, I reviewed my seminar, which was public anyway. So I didn’t really say anything different from what I was authorized to say at the seminar.

Well, two months later—see, there was no internet yet, and, apparently, General Motors read the newspapers slowly, but meticulously. Two months later, finally it popped up there, the *South Bend Tribune* interviewing General Motors’ scientist. So the title, big black title in the *South Bend Tribune*, [was something like, “Catalytic Converters Stink But Are Not Deadly, Claims General Motors Scientist.” [laughter]

DOMUSH: Wow.

HEGEDUS: So I—so somebody called me up, “What have you done, Louis?”

I said, “All I did is gave a seminar at . . . .” [laughter]

So yes, the public was probably aware of—there was huge public discussion about . . . . Obviously, the smog situation was very bad in some places, in most big cities. Everyone agreed that the lead—nobody wanted to have lead around. The counter forces were, you know, obviously a significant expense added to a car and at that time, a huge drop in fuel economy and driveability. Cars didn’t perform as well, and their fuel economy was very poor. So then much of the engineering effort was how to meet emission standards by making the car driveable and reducing cost and, regain some performance.

And look what’s happening now. You have cars with several hundred horsepower, **<T: 50 min>** amazing fuel economy. I sat on a commission of the National Academy [of Sciences], NRC [National Research Council], over the past [two years or so]. We finished our work in March, [2013], so the previous two-and-a-half years. The task was to write a report about vehicles and fuels for the year 2050.[18] So it was a large effort, fifteen, twenty people involved. And obviously, we reviewed carefully what is the technology of today. It’s astounding how much—you know, some of older persons who look back, what we had at the time versus today. It really is truly far beyond what we could imagine. It’s way beyond imagination. The emissions are extremely low today. Performance is fantastic, unimaginable. And it’s just tremendous what the synthesis of catalytic reactor technology and electronics has achieved.

And this paper, which I gave you, implies a synergy between catalysts and computers. And that was not our original title. I don’t remember what, we had some mundane title. And it

[18] National Research Council, *Transitions to Alternative Vehicles and Fuels* (Washington, D.C.: The National Academies Press, 2013).

was Ben [Benjamin J.] Luberoff, the editor of *CHEMTECH*, who somehow, he was somewhat of a visionary. [laughter] He kind of envisioned that the synergy will lead us into a domain which was far beyond what we [could] imagine at that time. I said, "Ben, don't change our title."

"Louis, I *am* the editor," he says. So finally, he changed the title. He changed also some figures, captions in it, not necessarily to the better, but anyway, it was—I give credit to Ben for visualizing what this combination of catalysts and computers can do.

DOMUSH: It's interesting when you say that, based on this task force, that you'd been doing all this research and work to understand what the current state of the technology is, and how amazing it is, how low the emissions are, and how performance is so good. On the other hand, you know, you'll read these articles about people who don't necessarily have the same engineering or scientific background, but are concerned about the environmental aspect related to automobile emissions and gasoline use, and things like that. And the question always is, "Well, why can't it just be better? Shouldn't cars be getting better miles per gallon, and performing better? Shouldn't there be even lower emissions?" And of course, many of the people asking these questions, like I said, don't have an engineering background, don't have a scientific background. How do you explain to someone that we have made great strides? If we're going to drive cars, we have made really amazing strides?

HEGEDUS: Yes, we have. But, you know, it does not justify stopping progress. I think there is an unbroken slope here. When you look at the future, if you look into the report which our committee produced, you will see further astounding progress. So we haven't stopped here. It's not so that we should tell the public, "We are done. We have done great work. Everything is fine," and we stop progress. I think this will go on, and on, and on.

The problem is much less significant now, the environmental problem, but it's an infinite task. There are certain things which you . . . you don't stop. And you just want to balance—this has three dimensions. I gave you a book [which] we recently wrote about the U.S. energy future, and you can see that the problem is three-dimensional.[19] It is technology, economics, and the societal domain. And the societal domain really is the **<T: 55 min>** so-called sufficient condition in Boolean logic. The necessary conditions are technology and economics. If something doesn't work thermodynamically, forget about societal concerns, you know? [laughter] You cannot beat the laws of thermodynamics. The second one is the economic, another necessary condition. If you cannot pay for it, it doesn't exist. To be realistic, you have to make sure that you can pay for something.

But the societal condition, is the so-called sufficient condition, which—that means it ultimately determines what will happen. Right? And so all these three are moving forward.

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[19] L. Louis Hegedus and D. S. Temple, *Viewing America's Energy Future in Three Dimensions* (Research Triangle Park, North Carolina: RTI Press, 2011).

Society's considerations keep on changing and advancing, and become more sophisticated, more stringent, et cetera. The economy is always there. Economic conditions are always there. We just have to make sure that we can actually pay for what we want to do. And as I mentioned earlier, technology keeps on advancing. We have hybrids which recover a part of the inertial [energy] wasted. We have plug-in hybrids, which bring in some component of electric drive.

And then, of course, look at the Tesla. Wow, wow, amazing, you know. You can drive three hundred miles or two hundred fifty to three hundred miles, depending on how you measure the cycles, on electricity, at three cents per mile. And the car does not spread pollution around. The pollution control can be done at the power plant. Furthermore, the internal combustion engine operates on a thermodynamic cycle, called Carnot cycle. A very significant portion of the energy [of the gasoline] goes into your cooling system, or is blown through the exhaust. The Carnot cycle has serious limitations at the temperatures at which materials used for engines can work. It could be vastly improved if you somehow could make ceramic engines, but how would you lubricate that?

The power plant, you know, modern [electric] power plants, gas turbines are not operated by the Carnot cycle, but by the Brayton cycle. It [has] a much higher efficiency. So you can see that you burn less fuel, control the emissions centrally, and they use electricity in vehicles, not spreading the pollution around. So you can see the future, again. And that [electric vehicles]will be another humongous improvement, not only in the environment, not only in the [reduced] use of hydrocarbons, but also in performance.

I urge you to go and test drive a Tesla. In various malls, like King of Prussia Mall, they have a Tesla shop. Yes, it is an expensive car, but they are planning cheaper cars. The thing out accelerates anything. The electric motor has its rated torque, full rated torque, at 0 RPM. Its torque is not RPM-sensitive. At any speed you drive that car and step on the gas pedal, it's like a rocket. It is just totally amazing, having no emissions, either. Having only three cents per mile energy consumed. The efficiency of an electric motor is in the nineties. Efficiency of an internal combustion engine is, depending on what you include and exclude, but certainly not more than twenty-some percent. Right? So you can see enormous room left for progress. So don't imply that society should . . . . [laughter] It's fantastic, what will happen. And these guys also made a beautiful, beautiful car. It's just totally glorious. So that's technology for you. You know, very impressive. **<T: 60 min>**

DOMUSH: I guess, stepping back again to talk a little bit more about some of the things at GM, you mentioned yesterday that the book that you wrote on catalyst poisoning was really the first book published on the subject.

HEGEDUS: Yes.

DOMUSH: And I was curious if you could talk a little bit more about why you felt that book needed to be written, why a book, say, as opposed to just paper publications? Why was that topic so . . .

HEGEDUS: Well, there are books on various different subjects. You could ask the same question about any book.

DOMUSH: I could. [laughter]

HEGEDUS: And the answer would be the same. If something has never been covered by a book, it might justify a book. If some field has progressed in some significant way, it is helpful and useful to summarize it. Catalyst poisoning progressed enormously as a result of this monumental issue of how to make the catalytic converter survive the conditions at which it had to operate. So massive amounts of lead and phosphorus were passed through it in time, and the catalyst had to operate for one hundred thousand miles. You had to figure out how to design catalysts for that, involving geometries, like, you know, we published papers on the shape of the channels of the cordierite monolith, or metal monoliths. And published papers about the pore structure of the support, published papers about how do you manage the spatial distribution of the noble metals. Where do you put the platinum, the palladium, the rhodium, for three-way catalysis? We didn't even mention rhodium so far. And all this happened in a very short time period, and a very large number of people worked on it.

DOMUSH: Yes.

HEGEDUS: So I thought that—I was kind of stunned that no book existed so far. So I was invited to a conference in [Antwerp, Belgium], and at that time . . . to talk about catalyst poisoning. So at that occasion, we wrote a paper. It turned out to be a longer paper than we expected, so the publisher said, "Why don't you write a book?" So we extended [it into a book].

Writing a book is a very difficult task, if you have ever attempted it. My entire office was covered with paper. [laughter] There was no internet at that time. There was really no computerized—well, sorry, the GM library had excellent search capabilities. And so they were very helpful. But it was still a monumental task to write that book, oh, my God. I took a big break after that, before I got into the next one. But that's why we wrote it. You know, a huge advance in certain time period. We thought it useful to document it.

DOMUSH: Well, certainly if you have more to talk about, about the catalytic converter, we should do that, but it's about 10:20 [a.m.] and it seems like a good time to get some more coffee, take a break.

HEGEDUS: Okay.

DOMUSH: But like I said, if you have more to talk about, certainly . . .

HEGEDUS: Well, it's endless, so I could talk about it for,until dinnertime.

DOMUSH: Well, I guess, I guess since we, since we won't be talking about the catalytic converter till dinnertime, is there anything important about it and about your time at GM that we missed, that we need to make sure that we have?

HEGEDUS: I just want to maybe summarize it, to say that it was extremely lucky and fortunate, I feel, to have been involved with such a major development. The catalytic converter influenced life in the whole world now. It is one of the greatest technical successes of chemical [technology] ever. It certainly should go **<T: 65 min>** into history. The ACS [American Chemical Society] recently published, you know, at the occasion of . . . I think it was their hundredth anniversary, a timeline of significant contributions of chemistry to humanity, and they failed to mention the catalytic converter [. . .].[20] So the anniversary of the catalytic converter, fortieth anniversary, will come on September 1, 2014, and the Chemical Heritage Foundation has an opportunity to step up and deal with it.

DOMUSH: Well, I think we'll certainly be talking about what we can be doing at CHF, but let's take a minute to take a break, and then we'll get back into what happened next.

HEGEDUS: Okay.

[END OF AUDIO, FILE 2.1]

DOMUSH: Okay. Back on after a quick break. So one of the things that I wanted to talk about next was what made you want to leave GM? I mean, you talked about these great colleagues. You talked about all the support that you had for research, all the excitement and interest that you and the company had for the projects that you were working on. But you left and went somewhere else.

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[20] American Chemical Society, "National Historic Chemical Landmarks: Timeline," available at http://www.acs.org/content/acs/en/education/whatischemistry/landmarks/landmarks-timeline.html (accessed on 23 March 2015).

HEGEDUS: Well, you know, there are the famous stages of technology: inception, [. . .] growth, [and] maturation. And once this technology started to get mature, GM is a car company at the end, and I was a catalyst and reactor person. So obviously, I— since we published so much, and our names started to become known, companies call you up and try to recruit you. And finally, one of the suppliers of General Motors, W.R. Grace, approached me to become director of some part of their central research, which looked like a good step forward, an opening, you know, new territory for me in the chemical industry. Of course, they dealt with many more products and technologies than just auto exhaust catalysts. So that turned out to be a—eventually, it became an irresistible idea. [laughter] And so we moved to the Washington, D.C. area. Central research of W.R. Grace was, and still is, in Columbia, Maryland. So we bought a house in what was called North Bethesda [Maryland]. It's between Rockville [Maryland] and Bethesda, a wonderful part of the world. Of course, D.C. is a great city, one of the best in the world, perhaps, in my opinion. And so I started my new life there.

DOMUSH: Now were your daughters already born by the time you moved?

HEGEDUS: Caroline [Hegedus Borncamp] was born in Detroit, and Monica was born in Silver Spring, Maryland, the hospital there. We, as I said, lived in North Bethesda at that time. Monica eventually became a doctor, M.D., and Caroline became a lawyer. So we produced two professionals. They none of them wanted to follow my footsteps to become the next-generation chemical engineers.

BOYTIM: Right.

DOMUSH: Yes. It would have been third generation.

HEGEDUS: Yes, it would have been interesting, but they are doing fine.

DOMUSH: So when you made the transition to Grace, as you said, you're going to become director of one of their areas of specialty research. This was your first time really in the chemical industry as opposed to the automotive industry?

HEGEDUS: Not necessarily. My very first job in Hungary was [in] chemical process research.

DOMUSH: Yes. You're right. I misspoke.

HEGEDUS: So I just, eventually, after a huge circle, ended up—came back to the chemical industry. [laughter]

DOMUSH: Did you find that it was a difficult transition, kind of, intellectually, or from a chemical engineering, reaction process standpoint?

HEGEDUS: No. I got very excited, because they had so many problems brand new to me, and reaction engineering really has not yet fully penetrated the chemical industry at that time yet. So you felt, again, like some sort of a missionary, in some way. Of course, running a large research department, et cetera, you are not a reaction engineer anymore, you know. But I still managed to publish. I kind of feel that I grew into management, and eventually to executive positions, by working my way through **<T: 05 min>** the ranks. I did not bypass anything, you know. I started at the bench, and kind of did my work up, and up, and up. But at Grace, I continued publishing with some friends there, for a while, at least.

The transition was very interesting, from many different angles. You get exposed to many different technical and research problems at the same time. At GM, we had this one enormous problem, and all of us worked on the same problem, towards the same goal. So we had this monumental, monolithic project, if you wish. And at Grace, we had like fifty or a hundred. These companies have—you know, it's just like DuPont or Dow. Grace also had hundreds and hundreds, if not thousands, of products, plants all over the place, issues, problems, challenges, opportunities. So as you get into a management position in companies like that, it is like every five minutes something amazing happens. [laughter] If you can recognize it and appreciate it. So it was another fantastic world to drop into. It was very interesting.

DOMUSH: What were some of the exciting problems and issues that you were working on?

HEGEDUS: Well, the name, my title was Director of Inorganic Research, but basically, the departments who reported to me at that time worked in catalysis. Grace was the world's largest manufacturer of catalysts, the Grace Davison Company. And electrochemistry, Grace was the world's largest manufacturer of lead acid battery separators. [Construction products was another significant research department under my direction].

We were some of the very early people working on lithium batteries. We worked on the first lithium batteries for pocket telephones, for example. And another department which I had to build was ceramics, technical ceramics. That was composed of electronic ceramics and structural ceramics. In the catalyst area, of course, we worked, [in part], on emission control. That was my kind of link; it was the bridge for me, but also, you know, petroleum conversion and chemicals, hydroprocessing. We did a lot of work, and patents, and published in hydroprocessing, oil refining, basically, for the oil industry.

I guess this answers your question in a concise way. But again, there are just so many amazing projects in a company like that. You travel all over the world. It's a very cooperative industry in the sense that, literally, nobody can do something alone. So you have suppliers, and you have customers, and you are part of a value chain, and the value chain begins with some sort of raw material or ends with some sort of a very complicated product or gizmo, whatever it is. And in between, there are stages, and companies are lined up, and they are receiving technology and products from the left that do something with them, and passing it on to the right. And you do this dozens and dozens of different times, all at the same time. [laughter] So it is completely amazing to be in a management position in an industry like that.

And I appreciate your question. It's a very, very good question, because it allows me to kind of realize or verbalize the enormous difference between everyone working on one thing versus everyone—or not everyone, but many, many people working on completely different things.

DOMUSH: Right.

HEGEDUS: So **<T: 10 min>** very—in that sense, the transition was also very interesting.

DOMUSH: You spoke about how, while you were at GM, you had a large number of colleagues, people that you published with, people that you worked with and collaborated with, people that you had friendly competition with internally. When you made the transition to Grace, when people are working on these sometimes vastly different projects, even if they are catalysis-related, did you find that there was a similar level of, maybe, informal collaboration, since they were different projects, but friendliness and collegiality? Or was it just different?

HEGEDUS: Well, people tried to help each other, but, you know, they had so many different projects that people had to deal with their responsibilities, make sure that their project is being tended to. And it was less competition between groups, but trying to help each other. Trying to make sure that the technologies somewhat synergized in the company.

DOMUSH: I guess another comparison question to your time at GM: you said that you were kind of on the leading edge, the physical edge of the research. And so you were encouraged to publish. You were encouraged to go to conferences. Was it similar at Grace? Did they want you to publish, want you to be part of the scientific community?

HEGEDUS: Doing scientific work and publishing is necessary in every industry. Again, for making sure that you're part of the technical community, so you know where is the leading edge, and make sure that you are close to it. Also, there is another element in that industry. You have to demonstrate to your customers that you have depth of technology. You know, there is enormous risk in technology transfer, and if you deal with a company, or organization, or person who has some demonstrated depth, I think the business benefits greatly from that. So that aspect was more emphasized in the type of environment at Grace than at General Motors. [At GM], we really didn't need to convince our customers that we know the pore size distribution of our catalyst. The customer just needed to know that we can control emissions and certify cars at GM. At Grace, when you deal with your, both with your suppliers and customers, you want to deal with established, known [technical and business] entities who know what they're doing, and who know what they're doing, and vice versa. So this element is also significant, the business aspect of publishing [our] work.

You have to draw a balance. The objective is not to go out and spend your time as an outdoor cat, [but] as an indoor cat, you eventually will fail, so you have to balance between being basically an indoor cat or go outside sufficiently, you know? [laughter] So that's what—a that's an optimization problem, basically. And some companies do it very well. DuPont is one of them, for example. And Grace at that time did it very well.

DOMUSH: One of the things that you did publish during your time at Grace was a book called *Catalyst Design: Progress and Perspectives*, is one of the ones that you brought for Jacqueline and [me] yesterday.[21]

HEGEDUS: Yes.

DOMUSH: I was particularly curious about this book, and there's another one that I don't have the title of in front of me, where your coeditor was Professor [Alexis T.] Bell from UC Berkeley. And there's an additional list of people who helped edit a catalyst design book.[22] And I was curious, what was your relationship, or really, if any, to some of these academic professors, or was it just something that these were people that you were friends with?

HEGEDUS: It's a two-dimensional thing. That book, *Catalyst Design*, was my idea, and I just [invited] **<T: 15 min>** the best people, whom I considered to be the best in the world in that subject at that time. And it so happened that most of them were good friends as well, because we knew each other's work very well. The circumstances of that book were very interesting. We decided to write such a book, and so we all holed up in Carmel, California. For a weekend, you know. And [talked] it over and decided how are we going to do it, who will write what. There's

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[21] L. Louis Hegedus, ed., *Catalyst Design: Progress and Perspectives* (New York: Wiley, 1987).
[22] A. T. Bell and L. L. Hegedus, *Catalysis Under Transient Conditions*, ACS Symposium Series 178 (Washington, D.C.: American Chemical Society, 1982).

a picture in the book of the group. I would say these were [some of] the best people in the world at that time, in my humble estimation. And some,most of them are still alive. You know, Professor [Rutherford] Aris died, and five years ago, I had the honor of giving a talk at the AIChE [American Institute of Chemical Engineers] meeting in his memory. I had the opportunity to reminisce about our collaboration. We wrote some papers together at that time.[23]

DOMUSH: In the book where it talks about kind of the weekend that you guys spent in Carmel, you know, figuring out who would write what, it said that you kind of initially had the idea for this book at a couple of different AIChE meetings.

HEGEDUS: It was Professor Boudart who, Michel Boudart who added the subtitle, "Progress and Perspectives." And I said, "Michel, the longer the title of the book, the more insecurity you are communicating. And secondly, "progress and perspectives" implies that this is some sort of a symposium, compendium, you know. It's not what we have done, and why do you want to have such . . . ?"

"Louis, we still cannot design catalysts."

I said, "Michel, if we could, we wouldn't need to write the book." [laughter] So we had this friendly bantering. But eventually, we accepted his idea to kind of soften the [title]. I said, "Michel, we can design, you know, people can design fabulous automobile engines without really being able to fully comprehend combustion." Right? It cannot—chemical reactions of that complexity cannot be modeled. The kinetics are too complicated, et cetera, but we can design engines. So I said, "The same way we don't understand everything about catalysts, but we can design catalysts very well, thank you, at some level, and then we push that level."

So it was a very interesting weekend, very interesting weekend. Michel had to step out for the wedding of his friend, Professor [Carl] Djerassi, at Stanford, and then he came back. [laughter]

DOMUSH: Well, I'm glad that the wedding didn't interrupt too much. One of the other things that happened during your time at Grace is that you were one of the recipients of an R&D 100 award for some work related to asbestos abatement technology.

HEGEDUS: Oh, yes. Right.

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[23] S. H. Oh, L. Louis Hegedus, and R. Aris, "Temperature Gradients in Porous Catalyst Pellets," *Industrial & Chemical Engineering Fundamentals* 17 (1978): 309-13; L. L. Hegedus, R. K. Herz, S. H. Oh, and R. Aris, "Effect of Catalyst Loading on the Simultaneous Reactions of NO, CO, and O_2," *Journal of Catalysis* 57 (1979): 513-515; B. K. Cho, L. Louis Hegedus, and R. Aris, "Discrete Cell Model of Pore-Mouth Poisoning of Fixed-Bed Reactors," *AIChE Journal* 29 (1983): 289-97.

DOMUSH: And I was wondering if you could talk a little bit about that.

HEGEDUS: Asbestos. Okay. That's a very interesting subject. We—you know, many, many years before, Grace sold some products which contained some asbestos, and also had an asbestos, had a mine which mined a mineral which contained some low-level asbestos. And I'm trying to be careful not to comment on a legal situation improperly or inaccurately. But the bottom line is that Grace started to have enormous number of lawsuits. The legal aspects of asbestos flared up. And so we decided to look into trying to **<T: 20 min>** understand asbestos. This was building materials, construction materials, insulation systems.

And we, you know, at research, didn't know much about asbestos, so we started to read up on it. And we discovered that asbestos actually is being treated as a material which exists forever, which cannot be eliminated. You can encapsulate it. You can store it. You can—but it remains asbestos forever. So [we] said, "Well, can we convert asbestos into some harmless material?" Well, [after] some research we discovered that—and this has been published—that you can develop a chemical brew which you spray onto these asbestos fire-proofing things, and convert the asbestos basically by unzipping the asbestos filamentous structure into an amorphous structure.[24] The chemical composition of asbestos is harmless. It's magnesium, silica, alumina, whatever, but its structural form is the one which is problematic, because it—some types of asbestos, not all, which penetrate the lung, stay there. Some other forms of asbestos actually get dissolved in bodily fluids relatively easily. So we discovered that we can spray asbestos with this chemical—it was diluted phosphoric acid with some catalyst in it—and eliminate it.

So we got very excited, went to the EPA [United States Environmental Protection Agency], and asked them to help us [by joining] the project. Went to the DOE [United States Department of Energy], and they gave us a couple million dollars. And we worked with the Brookhaven National Lab [Laboratory], and basically developed a process and demonstrated it on a bank building, actually, that we can eliminate the asbestos. So that has the potential to reduce the costs of, and consequences of, asbestos abatement, because you don't necessarily have to have a negative pressure tent. You know, part of the expense is to dress people in moon suits and put them into these tents, which have to be evacuated, so that as you are scraping off the asbestos, that the dust doesn't escape.

DOMUSH: Right.

HEGEDUS: So that was well-received, and we received this award for it. Yes.

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[24] J. Block, L. Petrakis, L. E. Dolhert, D. F. Myers, L. Louis Hegedus, R. P. Webster, and L. E. Kukacka, "A Novel Approach for the in-situ Chemical Elimination of Chrysotile from Asbestos-Containing Fireproofing Materials," *Environmental Science & Technology* 34 (2000): 2293-2298

DOMUSH: Yes. How long was that timeframe? How long was that research project that you were working on?

HEGEDUS: It was in the last two years of my stay with W.R. Grace. It went on for perhaps another couple of years in the implementation stage. One of the interesting aspects of that work was that we had to teach ourselves about asbestos and all the problems related to it, so we assembled a group, and we really assigned tasks for lecturing to each other. [laughter] And it worked out excellent. For a moment, nobody was a manager or a subordinate or anything. We just divided up the subject and taught each other. We couldn't read everything ourselves. So it was very interesting. It was great fun. There were some lasting friendships, for example, at Brookhaven as a result of that.

DOMUSH: Did you have any opportunity to continue any of the work on automotive exhaust and related catalysts? I mean, you mentioned that—

HEGEDUS: At Grace?

DOMUSH: Yes. You mentioned that of course Grace is producing catalysts for this.

HEGEDUS: Yes. We worked on metal monoliths, for example. We worked on ceramic monoliths. We worked with pellets. We **<T: 25 min>** worked with impregnation strategies. So some of the papers you'll find in my publications were written at Grace.

But, you know, I gradually kind of had to fade out, as more and more people reported to me. I had to tend to business more and more rather than [doing] research. Eventually, you develop a form of management, which I call asymmetric. That means you are involved in certain things, and not necessarily are you involved with other things. Just make sure they are in good hands, and that you are dealing with them, but aren't participating in them. So you participate in certain things personally. I've always done that, all the way through up to my retirement. I've always participated in something at the working level. So I never abandoned being a researcher. But you participate in a smaller and smaller fraction of what [reports to] you, of course.

DOMUSH: As you said a little while ago that you really felt like you worked your way up from being a bench chemist into management. And you didn't ever have to kind of jump into something. But did you ever have anyone that offered advice or mentorship about some of these types of things, about how to manage different people, different projects, when you still do want to be involved in some things?

HEGEDUS: This is a very good question, again. Two things I can mention in this regard. One of them is that in all of these companies, there is quite significant management training going on. And if you select the right venues for that, and the right contacts, connections, services, they are extremely helpful and useful. And I guess the trick is to somehow keep the charlatans out of your company. There are a bunch of charlatans as well. But there are outstanding people who can help you a great deal.

And the other thing I can mention is I had one—I always benefited from, not always, but mostly, benefited, having good, interesting people who I reported to. And you do tend, consciously and unconsciously both, [to] follow people whom you appreciate or admire or like. And so in that regard, for example, at W.R. Grace, [F.] Peter Boer was [my boss and] a fellow member of the NAE. I learned a lot from Peter. He's an extremely interesting thinker, in management, and I learned a lot from him. It's not that I do exactly what he did or said, but many conversations I had with him open up your mind, opened up my mind to think about certain things in certain ways. And I always liked his style, and I liked his way of thinking. So looking back, I was influenced by him, for example, as well.

In every company, there are always people whom you like very much, who you like their style, like the way they work. So you kind of develop your own [management style] over the years, but you remember those who influence you.

DOMUSH: Did you then participate in any sort of mentoring of managers or supervisors who were below you?

HEGEDUS: Oh, yes, absolutely. And it's very interesting to look back now, how many people I hired or worked with whom I still have contact. I don't want to mention names, but one of **<T: 30 min>** the people, for example, one of the guys I hired many, many years ago, has recently been named the chief technical officer of one of the world's largest companies. And he wrote me an email, and he says, "Louis, I never learned more from anyone than from you."

DOMUSH: Wow.

HEGEDUS: So I [responded], "Wow, you made my day." [laughter]

DOMUSH: What a wonderful compliment.

HEGEDUS: So, you know, yes, you pass it on, and you try to help people and influence—I'll give you another example. One very talented fellow, he was a postdoc. I don't want to mention names [. . .] hired at Grace. And, boy, he was difficult to deal with. I don't know, just [a] complicated guy. [. . .] He didn't report to me [directly], he reported somewhere in the chain. And so I called him in, and I said, "Look, you're a very smart guy, but you are arguing with your boss. And let me inform you that I agree with you, but cannot act upon it, the way you behave. You are disrespectful, and the way you behave, you literally prevent us, okay, from acting upon the points you are raising, which I happen to agree with it. So if we deal with them, we have to go around you." Right?

So I told him, you know, "We have this lady in the personnel department, Barbara, and if you agree, you should be 'Barbara-ized.'" [laughter] "That means talk it over with her. Okay?" And he did, and took it . . . he is now the president of a large company.

DOMUSH: Wow.

HEGEDUS: Right? And eternally he is very thankful that we Barbara-ized him. [laughter] Because he just didn't realize what he's doing

DOMUSH: Right.

HEGEDUS: Okay? So Yes, you can help people. Yes. Yes. You can Barbara-ize them.

DOMUSH: While you were working at Grace, you were also involved in some external things. You were a consulting editor for the journal for AIChE. You were involved with the Council for Chemical Research [CCR]. How did some of those things develop? How did they . . . how much time did they take up, I guess, compared to . . .

HEGEDUS: Not much. Not much. You try to be efficient. CCR was and is a very significant interface involving the chemical industry, the chemically-oriented academia, and the government labs. And, you know, you meet people who run research and development in other companies. So you can easily visualize the business significance of

DOMUSH: [sneeze] Excuse me.

HEGEDUS: *Gesundheit*—business significance of [being able to] pick up the phone and talk to anyone in your industry, [. . .] your peers in other companies, who, otherwise, how would you get to them? And vice versa.

And also government labs. More, and more, and more, as you know, forward researching is being funded by the government. So this way, you meet and become friendly with a whole bunch of people in that domain. Not to mention heads of departments, deans, chairmen, et cetera, for recruiting purposes. When Berkeley, [in one particular year] the recruiting center, was—you know, they said they don't have any slots left. And the dean, Jud [C. Judson] King was there at that time, says, "Come on, Louis, use my office." So I did. You know, so why? Because you know these people and CCR is one of the significant opportunities for that. [Of course, in this particular case, I knew Professor King from my graduate student times at Berkeley]. And the other one you mentioned was what?

DOMUSH: You were a consultant editor for the *Journal for AIChE*.

HEGEDUS: Oh, the *Journal*? I was on various editorial boards. *I&EC Research* [*Industrial & Engineering Chemistry Research*], *AIChE Journal*, and a couple of catalyst journals. The *Ullman's Encyclopedia*, et cetera. None of this is heavily **<T: 35 min>** work-oriented, but you want to, again, share your views. For example, [at our advisory board meeting, the question was raised], "Why do we call our magazine *C&E News*, *Chemical & Engineering News*? Should we pick another name [. . .]?"

I said, well, it's not really a name. It's a brand. You know, be very careful. [laughter] Everyone knows what it is. And it is a fantastic magazine. So you are tinkering not with the name of your magazine, potentially, but the brand which has a hundred-year history, and they completely [agreed]. So you can give advice in three minutes. It's not time-consuming. That was your question.

DOMUSH: Yes.

HEGEDUS: You know, but they need input. And not—it's not that they wanted to change the name. It is just the issue came up: should we? And I said, "Don't, because you destroy your brand. Whatever its name, it doesn't matter anymore, because it's a brand." You know, [. . .] Apple [Inc.], should we change the name Apple? Well, you know, I mean, it's a brand. It's not a fruit. Everyone knows what is Apple, the same way everyone knows what is *C&E News*, no matter how you call it, because it is a brand. Yes. So that's the significance in trying to help others. The [other] journals, same way. I did do a lot of reviews of publications. You try to maybe help with the review process, and you do it mostly at home. You hole up with a cup of coffee.

DOMUSH: So how did you decide that it was time to leave Grace and take another position?

HEGEDUS: Well, Grace, you know, started to run into [legal] problems with this asbestos lawsuit. As we speak, they are still in bankruptcy protection—doing very well under protection from these lawsuits.[25] Some big fund . . . I don't know all the details precisely, but some big fund has been established to cover expenses, and the company is very successful right now. But at that time, the company kept on selling off businesses, et cetera, et cetera, and many operations and positions, businesses, started to get eliminated.

The company Elf Aquitaine [SA] was the largest French oil company at the time, and it had a chemical business called Elf Atochem. Elf Atochem had quite significant operations in North America involving many manufacturing facilities in numerous states, et cetera, and a research lab in King of Prussia, [Pennsylvania], of, at that time, maybe close to three hundred people.

A headhunter was hired, a recruiting agency was hired, to find somebody to replace Mike [Michael M.] Besso, who was running the research for the company in North America, because he was retiring. And so I interviewed with this gentleman from the agency, called Boyden. And we liked each other very much. You know, former military, and as a pilot, I can understand military people immediately, because in both piloting and the military, you speak very directly. [laughter] So we had a great meeting. And I interviewed. I **<T: 40 min>** came to see the company in Paris [France], and I was very impressed with them.

I don't want to mention names, but some other companies also were interested, and I had some very interesting conversations with others. But I—it's not appropriate to list them for the record.

But anyway, I had great impressions, and a lot of fun in Paris. Eva was very excited. "Oh, my God. Oh, my God." Our family likes the French. Francophiles. Both of our daughters learned French at school. Eva learned French. [. . .] The opportunity was very interesting, and so I decided to join them.

It started in June, on June 1, '96, with a one-month full immersion at the Berlitz School in the French language. Now please consider that I have already been inoculated with Latin, [. . .] then of course [my] mother tongue, Hungarian, [then Russian in high school], then having lived and worked in Germany, then, you know, come to the U.S. and learned English on top of German, which was positioned on top of Hungarian. So when you start stacking up billiard balls on top of each other. [laughter] You can—how many languages and grammatical structures, and words, and expressions [. . .] can you retain in your head and instantly recall? [laughter] [. . .]

[25] W. R. Grace has come out of bankruptcy protection since this interview.

Most of us, having had Latin and English [know or recognize] many French words even though some of them are *faux amis*, which means [the] same word meaning different things [in the two languages]. But after one month, I realized that this is a very significant task. After one month in Berlitz School, three teachers, eight hours a day, every day, right? So it's not only full immersion, but I would rename it full exhaustion. [laughter] It's totally exhausting. And after that month, you develop this safe and secure feeling that you can recognize the French language. Whenever it is spoken, you know it is French. [laughter] But beyond that, you discover another element of the situation, and that is that there is no such thing as broken French. Broken English is a world language, as we discussed already.Billions of people are speaking broken English, and it's well-accepted. That's fine. But broken French, that's not really a language. So you either know French or you don't. It is somewhat digital. [. . .] I bought two books, for example. The title of one of them is *Irregular French Verbs: Volume I*. And you can guess the second book, *Volume II*. [. . .] [laughter]

And the other funny thing, I asked one of our business presidents, Bill [William M.] Kraus, great guy there, I said, "Bill, how do you guys deal with the language?"

"Oh," he says, "of course, all the French people speak good English, so that is not an issue at all, but occasionally, you encounter a French document." And he says that you, knowing English, and even some Spanish, you can kind of figure out, more or less understand what is in it by reading it. He says, "The one thing you have to be very careful about, and that it is very difficult sometimes to determine whether what is written there is what we want to do, or is it what we want to avoid at all costs."

DOMUSH: An important distinction.

HEGEDUS: That means that they are—the point is that the language is so polite.

DOMUSH: Oh. **<T: 45 min>**

HEGEDUS: So polite, that you really have to pay attention when you deal with French texts. Or, you know, if you speak French, [. . .] it is a very polite language, somewhat indirect. It relies on your intellect to comprehend what the heck are we dealing with here. [. . .] [laughter]

Overall, [. . .] it was a wonderful experience. And that is—you know, managing an American research lab under French [ownership was] a very interesting experience, because the French [business] culture is an engineering culture. It is somewhat Cartesian, very precise, very accurate, very knowledge- and information-based. And, of course, the American [business] culture is more adventurous, more enterprising. You know, the idea is to act before 100 percent of the information is available, to take what we call risks, and balance risk and reward, et cetera, et cetera, so a combination of the two is very interesting and very enjoyable.

DOMUSH: Now let me just ask a question. Maybe I missed this when you said this a minute ago.

HEGEDUS: Okay.

DOMUSH: Were you at the King of Prussia site, or were you based in Paris?

HEGEDUS: King of Prussia.

DOMUSH: Okay.

HEGEDUS: King of Prussia. But we traveled a lot, back and forth, which is a wonderful experience on its own.

DOMUSH: Yes.

HEGEDUS: Of course, you go there and have long, long meetings, but they were all interesting. People with interesting. You meet very interesting people in Paris. [. . .] I mentioned to you yesterday that I feel I was always very lucky in transitions, and this was just another kind of wonderfully fortunate move. A great one.

DOMUSH: Now were Caroline and Monica still living at home when you guys moved?

HEGEDUS: Monica, yes, she was in high school, and Caroline was already at [the] Pepperdine Law School [Pepperdine University School of Law].

DOMUSH: Oh, okay. [. . .] And then she stayed in Southern California?

HEGEDUS: Yes, she—well, she married another lawyer there, a wonderful person, who is very successful as a partner in a [. . .] large law firm. He's number three in a big law firm.

DOMUSH: Oh, wow.

HEGEDUS: So Tom [Thomas Borncamp] is not movable. [laughter] Caroline wants to come back, but I think they just cannot give up a position like that.

DOMUSH: Yes. Yes. So when you would travel to Paris on some of these business trips, would you ever have an opportunity to stay in Paris a little bit longer and see some of the sights, or perhaps stay in Europe and do some traveling?

HEGEDUS: Oh, yes. Yes. You go and see the *châteaux* and [. . .] look around [in]Paris. Eva came with me often. Caroline spent a semester at [La] Sorbonne [University of Paris]. And [she] worked part time in the company in Paris. So yes, you see the sights, sample the food, and it's great.

DOMUSH: Did you have an opportunity to go back to Hungary at any of these times?

HEGEDUS: Yes. The first time we went back was in '78. [. . .] That was thirteen years after I left. Some Hungarians went back and they reported that nothing happened to them, so I contacted the State Department [United States Department of State], and asked them. You know, by then we were American citizens. And the State Department responded that our relationships with Hungary are good, and we see no reason why you should not go. So we went, and indeed, nothing happened. So that was of course amazing, to see your parents again. Except that we saw our parents before, of course. We met them in Vienna before.

DOMUSH: So you had been able to see them?

HEGEDUS: Yes. Yes. My father came out to California. **<T: 50 min>** My mother came out to Germany when I was in Germany. So we met them several times. I hadn't seen my brother for thirteen years, so . . .

DOMUSH: Oh, wow.

HEGEDUS: Yes. [. . .] So we went back. It was very interesting, nostalgic. Any trip like this has three dimensions, three aspects, three stages. It's nice to go, nice to be there, nice to come home. So our home is here now, because this is where we spent most of our lives, our children, bought a house, whatever, and our career. But it's nice to go to Europe, and it's always a pleasure.

DOMUSH: Now do Caroline and Monica speak Hungarian?

HEGEDUS: Yes, they do.

DOMUSH: Good.

HEGEDUS: Yes, they do. I am somewhat amazed by that, but yes. [laughter] Because it's a very complicated language, but we spoke to them in Hungarian. Eva and I spoke a mixture of the two. When it got serious, we switched to English.

DOMUSH: [. . .] Can they write it as well? [. . .]

HEGEDUS: No.

DOMUSH: Yes. My husband, like I said, is from India, and so he can speak his native language, but he moved when he was nine years old, and has, other than kind of writing the alphabet and his name and the numbers, he has no recollection of how to read it or write it.

HEGEDUS: Which is peculiar, because Hungarian is a phonetic language. That means you—it's WYSIWYG, the way you speak is the way you write and read. It's very simple. It's just like German. And English, of course, is not phonetic. It's a very complicated thing. You need to have a third dimension, how do you actually write down something? [laughter]

DOMUSH: Right.

HEGEDUS: But they didn't learn it [in Hungarian]. It's too complicated, perhaps, for them.

DOMUSH: Yes. Well, that's nice, though, that they can speak it. That's very nice.

HEGEDUS: Yes. They do.

DOMUSH: In addition to traveling to Paris, and being immersed in French, what were some of the research projects that you were involved in overseeing?

HEGEDUS: I ran this research lab, and let me open this [curriculum vitae] up for a second. I was senior vice president, research and development, started as a vice president, and eventually got promoted to senior vice president. The company had many, many different products and product lines, maybe ten thousand different products.

And the name was also changed, first when Elf Aquitaine and Total [SA] merged into TotalFinaElf. Elf was Elf Aquitaine. Fina [PetroFina] was the national oil company of Belgium, which Total had acquired. So it became TotalFinaElf, and the chemical branch was then named Atofina. And then we just simplified the name to Total for the mother company. Total found themselves to have more chemical activities going on than in their judgment an oil company—than what they would like to have. So they formed [a new] company, Arkema [SA], which was about an eight-billion-dollar chemical company, and was spun out as an independent company. So we then became Arkema. And I was then—you know, I basically did the same thing in the same research center, in the same office, but as the business has evolved, and the name has changed.

So what have we done? The company is a major manufacturer of thiochemicals, largest in the world, actually, fluorochemicals, **<T: 55 min>** fluoropolymers, a whole bunch of other performance polymers, and other, a wide variety of pretty complicated performance, fine, and commodity chemicals. [Also] hydrogen peroxide, one of the largest manufacturers of hydrogen peroxide, I believe number two in the world. Organic peroxides. Components for lithium batteries.

DOMUSH: Now again, when you were managing this research laboratory and the research site, were you employing the, how did you phrase it, the asymmetric management?

HEGEDUS: Yes.

DOMUSH: Was that again your style?

HEGEDUS: But I had more—you know, I didn't necessarily write papers anymore or something like that, but I dealt more, was more personally involved with some projects than others. For example, I was very close to the fuel cell research. I was very close to some electronic chemicals research activity. I was very close to some specialty polymer work, several projects. While in some areas I was less directly involved [in person], of course, my duty required to make sure, know what they are doing, doing the right thing, and all the rest and that their work is properly coordinated on a global basis. The company had several research labs in France: Normandy, Paris, Lyon, and then the foothills of the Pyrenees, Pau. And Japan, and now China, and of course the U.S. So in a job like this, you also have to make sure you know what's going on in the world, and that it is coordinated.

DOMUSH: Were you doing any traveling to Asia, or just when you would travel, would it be to Europe?

HEGEDUS: Yes. We basically had operations at that time in Japan, so I traveled to the Japanese operation. And I was in Hong Kong. But mostly, Paris, mostly France, and mostly the French labs, I would say, all the French labs.

DOMUSH: I was curious if you could comment at all—you mentioned a couple of different times how important modeling has been to some of the different catalyst projects and some of the other projects you've been involved in—and I was curious if you could comment about advances in computers, or advances in instrumentation that have allowed that modeling to, I would imagine, to improve.

HEGEDUS: Yes. This is a very good questions as well, very interesting. Throughout my active career in reaction engineering, we were always limited by the computer, and it was a never-ending struggle to simplify our equations so that the computers can handle them. And now, as I understand from my friends in the field, that they are now more—which is the proper way of operating—limited and controlled by their own ideas, rather than by their ability to [solve their equations with the computer].

So it must be a very exciting world now, you know, because computing has advanced exponentially. At our time, in Berkeley, the central core capacity of the CDC6400 computer, the one and only in the middle of [the]campus, was 280k. Now what can you do with 280k? We are talking about gigabytes now. [laughter] So you had to write computer programs which somehow could solve your differential equations [with] such very meager computing capability. At GM, [it was the] IBM 350, you know, and more sophisticated mathematical tools, orthogonal collocation, et cetera. We had a math department, who were very good at helping us. **<T: 60 min>** But by now it must be amazing to do reaction engineering.

In some ways, reaction engineering is now not such a very big deal. In my time, that was the adventurous, the exotic end of chemical engineering. We were the heroes of the day, right? It's probably not the case anymore. I believe that the materials people, like nanotechnology, et cetera, people who make materials today are probably more the heroes than the people who can figure out how to model a reactor. I don't put them down. I'm just saying that computing has advanced so amazingly that it's no longer [such] limiting factor.

DOMUSH: Well and I wonder how much that also changes some of the education. People obviously still need the strong math skills, but they don't necessarily need to . . .

HEGEDUS: Yes. You now have MATLAB. You know, you can actually use software. In our times, we had to write a whole bunch of Fortran programs. And we had punch cards, and we had tapes with holes in them. At Berkeley, at the Student Center, you had these endless, endless back and forth loops of your tape on the ground, you know. And then you had this machine which took it—*rat-tat-ta-ta, rat-tat-ta-ta*—took your tape slowly, and feeding it into the computer. It was a different world. It was exciting, obviously, for us, at that time. But today, [research interest is] more materials oriented so that the curriculum has changed, and also, there is much more biology and biochemistry and biomechanical aspects. Chemical engineering has changed, as it should. Things should progress. [. . .] Some [academic] departments added [a new] dimension to their name, [chemical and biomedical engineering]. So much of what we did was process oriented, and much of—a good portion of the education today is product oriented. I think a combination of the two is what you want, and probably that's what is being done at the top schools, anyway.

DOMUSH: What are your thoughts on some of the future work that we can hopefully look forward to related to catalysis or catalysis design? I mean, you mentioned earlier when you were talking about the book that you guys planned out and then wrote when you were in Carmel, that we can design, at that time, we could design certain things, and hopefully, we can design better. What are your . . .

HEGEDUS: Yes. You could, relatively early, design in an engineering sense, reactors which are in the scale of meters, catalysts which are on the scale of centimeters, catalyst pore structures which are on the scale of nanometers. But we still cannot design the reaction itself on a surface. It is still extremely complicated and computationally extremely intensive. So probably the leading edge, I would assume, is how to model chemical catalytic reactions on complex surfaces. The problem in catalysis is that it is not necessarily [an effect of] simple composition on the surface. When you look at industrially suitable catalysts, they contain a quite amazing fraction of the periodic table. [laughter]

So it eventually, like in all fields, I propose to you, **<T: 65 min>** you are operating at the empirical edge. Okay? You take whatever structured information is available, but if you don't push it to the empirical edge, you are really not making use of all your capabilities. So catalysis also has its empirical edge, which is being pushed forward, and I think that that empirical edge is trying to understand reactions taking place on extremely complicated surfaces, [surfaces] which themselves keep on changing with the reactor conditions, feed conditions, temperature, et cetera, so there is a level of complexity in catalysis left which guarantees [room for] huge further progress.

A counterpoint to that is very funny. I read the autobiography of Eugene Wigner, another Hungarian, [who] went to the same school, although briefly, when in Hungary, where I went, the Technical University.[26] His father was the chief engineer or director [. . .] of a leather tanning company, and he says in his book that he resolved to become a chemical engineer and advance the field of leather tanning. But after a while, he realized, when he looked into it, that we can make perfectly good shoes without understanding how leather is being tanned. [laughter] So he decided to become a physicist, and as you know, eventually won the Nobel Prize.[27] I don't think this is the case in catalysis. I just want to make sure. We cannot really make what you would call perfectly good catalysts because, why is that so? We always want to make better and better catalysts. So the Eugene Wigner analogy, in this case, doesn't apply. [laughter]

DOMUSH: Do you think that—I mean, obviously, we talked at length about how—related to the catalytic converter and automotive exhaust and vehicle performance, the progress is in, I think you phrased it as an unbroken slope, that progress will continue, and there's so much more that we can do.

HEGEDUS: Eventually, transportation will be electrified. That's the bottom line. Eventually.

DOMUSH: Where do you think that the next exciting projects like the catalytic converter are going to be? I mean, what . . .

HEGEDUS: They already are. Batteries, lithium batteries.

DOMUSH: Lithium batteries?

HEGEDUS: Or advanced batteries. One maddening property of electricity is it's very difficult to carry it around. So I think that's the, right now, the hot area. And there is good amount of catalysis involved in that as well.

DOMUSH: Do you think that the research projects being undertaken on lithium batteries and related, kind of, next generation batteries, will rival the technical undertaking and manpower that was employed to create and implement . . .

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[26] A. Szanton, *The Recollections of Eugene P. Wigner as Told to Andrew Szanton* (New York: Plenum Press, 1992).
[27] Wigner was awarded half of the 1963 Nobel Prize in Physics for his contributions to the theory of the atomic nucleus and the elementary particles, particularly through the discovery and application of fundamental symmetry principles.

HEGEDUS: It's taking place. Very good question, again. It is taking place differently, because now companies, you know, the laws have changed, and companies can talk to each other and collaborate. And they are using the model of the electronics industry, where there is a humongous infrastructure, where each element is talking with every other element. It's hugely interactive. How do you develop, you know, a computer chip? No one company does anything [alone]. There's an enormous infrastructure [in] place, and battery research benefits from that same type of mode of operation, so various different aspects [of the problem] are handled by different companies [who cooperate in various ways].

And others, of course, are integrating those technologies and making batteries. There is a lot of engineering involved, beyond, you know, chemistry. For example, the big breakthrough with Tesla has been the **<T: 70 min>** idea of reticulating that enormous, what is it? Eighty-five kilowatt-hour energy, not into one battery, or [a] battery consisting of large cells, but in its first manifestation, into something like 6,837 Panasonic computer battery cells.

[The cells are] individually accessible. You know their charge. You know their temperature. You know their condition. If one of them runs away, the computer can turn them on and off. This allowed them to have a level of control over this enormous amount of energy, to operate safely. They had some fires, as you read in the press, but they relate to the car apparently riding [too low]. There are three settings for its height over the road: high, medium, and low. And when you had the low setting—and I tried this when I test drove—it's very close to the road, and it hits some solid whatever, debris on the road, and it punctured. So they are going to not let people lower the car that [far]. [laughter]

DOMUSH: Yes.

HEGEDUS: But other than that, you know, that's the real breakthrough there, the reticulation of the battery into tiny controllable elements. That's engineering brilliance. So there's breakthroughs occurring in so many different scales. All at once.

DOMUSH: Yes. Of course, when we've talked about your time at GM, you mentioned not only the antitrust laws that prevented you from talking to your counterparts at Ford and Chrysler and so on, but we also talked about the Clean Air Act and the regulations that were forcing this work to take place.

HEGEDUS: Yes.

DOMUSH: And then you talked about just very briefly when you were doing some work with the Council on Chemical Research, you said that this, Council on Chemical Research, is really the interface between industry, academia, and government laboratories. And I was wondering if you had any further thoughts based on your experience at CCR, or your experience from your time at GM, about the interplay of government regulation and scientific chemical engineering breakthroughs and innovations.

HEGEDUS: Yes. Obviously, some technical advances are driven by the customer, and some advances are driven by regulation. And the catalytic converter was driven by, initially by regulation, and then later on, I think there was a good element of customer expectation. I think the customer . . . There is a dimension to the customers who are green. For example, my younger daughter is. She demands, you know, green technology. She would pay for it; she would only use it; she would recycle. [. . .] So the number of, the fraction of society who are that way is growing. Therefore, we cannot say that the automobile technologies are solely driven by government regulations. I think it's a mixture of government regulations and customer demand and desire.

Superimposed upon this are, of course, purely customer-driven things, like performance, fuel economy, driveability, reliability, [cost], et cetera. Customers don't buy a car which, for example, is unreliable, which requires a lot of repair. So it's a very complex conundrum of all these things which drive technology. But I would say that emission control, and now also fuel economy, are being significantly driven by regulation. That means [that[regulation, you know, sets something **<T: 75 min>** which gives you a line you cannot cross. You have to meet the regulation. But you can do it in so many different ways, at so many different costs and performance levels, that, of course, customer issues come in immediately. [. . .]

Also, regulations, you know, it's interesting, too. To put the same challenge in front of, simultaneously in front of the entire industry and all companies, and then the race is who can do it better. Yes. So it's still very competitive.

DOMUSH: Yes. During one of my oral history interviews with a woman who's a civil engineer at UC [University of California] Davis, we had a conversation about the difference between scientists who can choose to work on more fundamental, basic research, or more applied research. And she said that she feels that, as an engineer, even if it's on the more basic, fundamental side, everything that she does has to have an application. It has to be something for society. And our conversation kind of led us down a path of wondering in some ways who has, kind of, the easier task. And we were going back and forth about whether or not engineers have a more challenging and interesting tasks in front of them, because they often have to work within restraints. They have ideas. They have research projects. They have goals. But they have constraints.

And, you know, again, coming back to the catalytic converter, we were talking about we still had to maintain performance. You still had to maintain weight issues. You couldn't double the weight of the vehicle. It had to fit on the car. You still had to have decent gas mileage, and of course, you had to make sure that the catalytic converter actually worked in conditions that the car would drive in.

HEGEDUS: Exactly. Yes. Yes.

DOMUSH: And I'm just curious a little bit, throughout the course of your career and education, what your thoughts are on kind of engineering versus some of your colleagues who maybe have not been engineers and just been chemists, scientists, whatever it is, that's not an engineer, and how you think about some of these working within constraints.

HEGEDUS: Very interesting question, again. Basically, in industry, it kind of washes out. After five years, you don't know whether you are a chemist or an engineer. You work on problems. And you just have different backgrounds; you know different things. As an engineer, [eventually] you learn more chemistry, and as a chemist, you start to comprehend some of the physical aspects of what you are doing. [laughter] And it turns out that a whole bunch of engineers think [. . .] as if they were chemists, and a whole bunch of chemists think [. . .] as if they were engineers. And after a while, you really have to ask, "Is he a chemist or an engineer?" [laughter] It's really problem-oriented more than discipline-oriented. It's your ability to integrate a wide variety of demands, and a wide variety of technologies and techniques in your head, and try to make progress.

Another interesting comparison is academic and industrial work. The *I&EC Research* magazine, Don [Donald R.] Paul, you know, he says, "Louis, could you write an essay for our"—I believe it was their seventy-fifth anniversary. So I wrote an essay, and it's on their home page.[28] And the essay tries to compare success in academic life and industrial life.

I say, "How do you get judged in academia? You deal with problems." You [are tested with solving problems]. You know that the problem has a solution. You know that that solution can be generated in the time allotted to you, **<T: 80 min>** that all the tools required for that solution have been taught to you and are available, are at your disposal. So you are being judged by solving [that] problem. [. . .]

There is a complete inversion in industry. Quite often, you don't know that you have a problem. [laughter] And major credit goes to the one that discovers that we have a problem. I say the next kind of—there's hierarchically lower and lower levels of [challenges] in industry. The next one is: what is [the problem]? [laughter] The next one is, [. . .] can we solve it? Does it have a solution? The next one, is it worth solving? Is it too expensive or [is it economic to solve it]? The next one is, how do you solve it? And [in some situations], the lowest level of intellectual accomplishment [may end up] actually solving it. So I said this inversion totally

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[28] L. Louis Hegedus, "Industrial and Engineering Chemistry," 2008, http://pubs.acs.org/page/iecred/anniversary/100/hegedus.html (accessed on 11 June 2015).

mesmerizes people coming out of school, because they became star students by dealing with the inverse of actual life. And so they are fascinated by discovering this inversion in hierarchy. So I wrote this essay for them.

So that's another comparison, and maybe orthogonal to your question, which is, you know, applied or basic work. Or chemists or chemical engineers. In real life, in industry, the problems are so complicated, and it is basically impossible to imagine that you have a deterministic solution to many of them because to collect all the information necessary to generate a deterministic, up front outcome is often not possible. So you just simply take risks of [making approximations], basically.

So a certain fraction of your projects [will] fail, and you have to live with that, because you can't afford lowering the challenge to the level at which all of your projects [. . .] succeed. So it's very interesting. This is another optimization problem, right? You can fail with all projects, or you can fail with none of them, and you can see both of [these approaches] will lead to disaster. Because if all your projects fail, you are in very big trouble. If all your projects succeed, you're really not taking—making use of your opportunities. You are lowering the level at which you operate, so you cannot compete with anyone. So that's another management optimization problem. At what risk level are we operating our R&D? It's an interesting challenge for industry.

DOMUSH: Well, we've spend the last little while talking about kind of some big-picture questions, and something that you said makes me want to step back and ask a more specific question. You mentioned something about being able to speak with military people and piloting.

HEGEDUS: Yes.

DOMUSH: And I was wondering if we missed something about military experience or piloting experience.

HEGEDUS: I have no military experience, but I have thirty, oh my God, thirty-five years' experience in flying airplanes.

DOMUSH: Wow.

HEGEDUS: That's a great hobby. Great hobby. Yes. And when you—that's an interesting world. [. . .] It's the inverse of research, you know. [In flying] you really try to eliminate all risk, and you try to basically eliminate any creativity whatsoever. [laughter] So it's a very nice form of recreation for a researcher, to enter a different world for a few hours. There you have to be very precise, very accurate, very clear, and deterministic. You don't do anything there without knowing, with absolute [certainty], the outcome of it. You don't experiment flying an airplane.

DOMUSH: **<T: 85 min>** Do you have any questions before we . . .

BOYTIM: I don't think so.

DOMUSH: Well, then, it's just about noon, and at the end of an interview, I mean, same as with every oral history I've ever done, we could sit and talk for many, many, many more hours.

HEGEDUS: Yes.

DOMUSH: But is there anything big that we missed, or anything that you would like to say before we finish?

HEGEDUS: Well, one thing we didn't cover is my life after retirement. So in one minute: after I have retired [from Arkema as senior vice president for research and development], I of course did not pull the plug from all intellectual activity. So I consulted with some interesting companies and interesting organizations. I was on the advisory board of a lithium battery company [SEEO, Inc.]. And I spent roughly seven years consulting with the Research Triangle Institute, RTI, on various interesting things.

DOMUSH: Where you're now a distinguished visiting fellow?

HEGEDUS: Well, that contract—I was, you know, still on contract, fundamentally. The contract is over now. Yes. I'm still talking with them about various different things. But that visiting fellowship has a beginning and an end.

The other thing I want to mention is my work with the National Academy. I sat on this very interesting, exciting, and labor-intensive project on trying to figure out vehicles and fuels for 2050, which was very exciting. And so, in retirement, you still can maintain intellectual activity, and I enjoy it very much.

DOMUSH: The work that you mentioned with National Academy, how often do you meet with people? How does that work? Do you go . . . ?

HEGEDUS: Oh, this was a very labor-intensive project. I sat on several of [National Academies committees] over the years, you know, I even chaired the committee on critical chemical technologies. I gave you the book we wrote on it.[29]

But this [latest] one was extremely labor-intensive in that we did a lot of modeling work, a [number] of economists, engineers, scientists, and policy people were assembled for this effort. So we did a lot of work. My job was primarily, I was more or less responsible for natural gas as a fuel for vehicles. So I dug deep into that subject, and produced appropriate verbiage for the committee. It was a very interesting activity.

DOMUSH: And yet, though natural gas was your part to research, a couple minutes ago you said that the future of the automotive fleet really is, one day, electrification?

HEGEDUS: Yes. But how do you make electricity? You use natural gas. The power plants are switching to more and more natural gas. It produces tremendously less pollution, it requires much less capital, and it's much more flexible. You can turn it on and off easily. So it's a tremendously impressive chain of technologies, all starting with natural gas. Of course, we shouldn't ignore coal. I'm not saying that we shouldn't use coal. We [. . .] cannot yet stop using coal. But the electric vehicle will very significantly benefit from our discovery of [more] natural gas.

Basically, it's technology-driven as you know. We knew all the time that we have all that shale gas. We didn't think that it can be extracted economically. But I believe it was in June [2009]—I can look up the exact date—of 2010, that the [Potential] Gas Committee, which declares the natural gas resources of the country every **<T: 90 min>** two years, decided at their meeting to upgrade the U.S. natural gas resources, in one step, by 39 percent. The impact of that news release, which I reference, and I can—for the purposes of the written document about this discussion, I can look up the exact date—that date changed the world.[30]

DOMUSH: Yes.

HEGEDUS: Because they made a one-time announcement of a jump of 39 percent, by declaring the combination of horizontal drilling and hydraulic fracturing to be economically feasible. And imagine the impact of this on the financial world, on banks, on land ownership, on stocks, on everything. And all this happened in one day. The technology, of course, evolved

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[29] National Research Council, *Critical Technologies: The Role of Chemistry and Chemical Engineering* (Washington, DC: The National Academies Press, 1992).

[30] Colorado School of Mines, "Potential Gas Committee Reports Unprecedented Increase in Magnitude of U.S. Natural Gas Resource Base," news release, 18 June 2009, http://www.mines.edu/Potential-Gas-Committee-reports-unprecedented-increase-in-magnitude-of-U.S.-natural-gas-resource-base (accessed on 11 June 2015).

over years, et cetera. It was [already] there. It was being practiced at some [. . .] level. But, you know, once you unleash the funds, then you unleash a feeding frenzy. So that’s what happened. And that will obviously produce, eventually, clean electricity, which will of course, hopefully [be used, in part], for transportation.

So that’s how you break the blood-brain boundary between natural gas and vehicles, because currently very little natural gas is used [in automobile transportation]. There are other ways to use natural gas. I want to be very fair and correct. That is compressed natural gas and liquefied natural gas, and that is being done. It is growing. It is primarily currently being used by large vehicles, but it has its own complexities, refueling stations, et cetera. So you can use it in different ways.

Another way, [as] our report says, of course, you can convert natural gas into various fuels. You can make methanol out of it, or you can make gasoline [or diesel fuel or even hydrogen] out of it. So all these are technologies which are there. They have various features, pros and cons. And that’s what the report deals with in great detail. But eventually, long-term, we don’t exactly know when, because it depends on the battery work, [. . .] electric cars [will come]. Drive a Tesla. You will see what I mean. [laughter]

HEGEDUS: Yes.

DOMUSH: Well, perhaps that’s a time for us to end, and thank you so much for all of your time.

BOYTIM: This was wonderful.

HEGEDUS: Yes. I thank you. Very good questions, and I enjoyed it.

DOMUSH: Good. We’re very glad.

[END OF AUDIO, FILE 2.2]

[END OF INTERVIEW]

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