Legacy of Gary Kildall:
The CP/M IEEE Milestone Dedication

Speakers:
Robert Huitt
Gordon Eubanks
Tom Rolander
David Laws
Howard E. Michel
Brian Halla
John Wharton
Brian Berg
Weilian Su
Scott Kildall
Bill Kampe

Recorded: April 25, 2014
Pacific Grove, California

Edited by David Laws

CHM Reference number: X7170.2014

EDITOR'S NOTE: Gary A. Kildall, an instructor in Computer Science at the Naval Postgraduate School in Monterey, CA and a software contractor to Intel Corporation, Santa Clara, CA demonstrated the first working prototype of CP/M (Control Program for Microcomputers) in Pacific Grove, CA in 1974. Together with his invention of the BIOS (Basic Input Output System), Kildall's operating system allowed a microprocessor-based computer to communicate with a disk drive storage unit and provided an important foundation for the personal computer revolution. Kildall and his wife Dorothy McEwen founded Digital Research Inc. (DRI) in 1976 to commercialize the software.

The following text is a transcription of a video recording of an event held at Pacific Grove City Hall on April 25, 2014 as part of the dedication of an Institute of Electrical and Electronic Engineers (IEEE) Milestone plaque to commemorate the "The CP/M Microcomputer Operating System, 1974." Some extraneous comments that do not add to the content have been omitted. A copy of the video is in the museum collection (Catalog number 102746908) under the title "Legacy of Gary Kildall: The CP/M IEEE Milestone Dedication." Brief biographies of the speakers, in order of first appearance, are:

Robert Huitt: Mayor Protem, City of Pacific Grove

Brian Berg: A member of the IEEE Santa Clara Valley History Committee, the AMW Organizing Committee, and president of Berg Software Design, a consulting organization.

Gordon Eubanks: Has an MS in Computer Science from the Naval Postgraduate School where Gary Kildall was his thesis adviser. He founded Complier Systems Inc. to commercialize the subject of his thesis, a BASIC language compiler for CP/M. After DRI acquired his company in 1981, he served as VP of Languages and Tools until joining Symantec in 1984 where he rose to CEO.

Brian Halla: Intel technical interface to DRI and friend of Gary Kildall for almost 20 years. Later he served as Executive Vice President at LSI Logic Corporation and CEO of National Semiconductor until he retired in 2009.

David Laws: Semiconductor curator at the Computer History Museum. He worked in Silicon Valley semiconductor companies, including Fairchild, AMD and Altera, in roles from engineer to CEO for more than 40 years.

Howard E. Michel: President-Elect of the IEEE. He holds a Ph.D. in Computer Science & Engineering from Wright State University (1999). He retired from the U.S. Air Force as an engineering manager after an 18-year career and is an associate professor of electrical and computer engineering at the University of Massachusetts Dartmouth.

Tom Rolander: A University of Washington graduate (’72 BS Civil Engineering, ’76 MS Electrical Engineering), he joined DRI as VP of Engineering in 1979 where he designed the multi-tasking (MP/M) and network (CP/NET) operating systems. He cofounded KnowledgeSet with Kildall in 1985 to create the first CD-ROM encyclopedia for Grolier.

John Wharton: Served as Intel’s technical liaison to DRI beginning in 1980 and as an independent consultant to the company from 1982 to 86. He is a Consultant/Analyst at Applications Research in Palo Alto and a member of the AMW Organizing Committee.

Scott Kildall: Son of Dorothy and Gary Kildall. He is a conceptual artist working with new technologies in a variety of media including video art, prints, sculpture and performance art.

Bill Kampe: Mayor of Pacific Grove. He spent 35 years with Hewlett-Packard Company and Agilent Technologies in senior engineering and management roles.

Robert Huitt: Good afternoon everyone. This is really weird. I'm used to being up here, but not in this capacity. My name is Robert Huitt. I'm not Bill Kampe. I'm filling in for the mayor, who is recovering from heart surgery, and recovering very well, by the way. And I expect that he will be at the 4 o'clock event, which happens to be right across the street from his house. So you can listen to the real mayor at that time. I'm very, very pleased to be able to welcome you to this very exciting and wonderful event, marking a milestone both for your industry and for our city. And it's kind of interesting, I see a lot of friends and neighbors out there, some people I didn't have any idea of your connection with Gary Kildall and DRI, but I guess that's what it means to say that this is a small world.

All I really want to say is, I hope you have a wonderful afternoon enjoying all of these events today. And when you have some time, I hope you'll stop in to one of our great shops and spend a little bit of money, so that we can stay solvent. But truly, enjoy your stay in Pacific Grove from wherever you're from, and I'm so tempted to say, ”If there any public comment we will give you three minutes.” I understand that Mr. Rolander, my good friend and neighbor, is wanting to find a seat so I'm going to let him have mine. Have a great time, and congratulations to all of you.

Brian Berg: Thank you very much Vice Mayor Huitt. My name is Brian Berg. I'm here representing IEEE and the Asilomar Microcomputer Workshop. It's a pleasure to be here. My background is, I was a chair of the local Santa Clara Valley section of the IEEE back in 2012, and I'm also the milestone coordinator for region six within IEEE. I've been involved with other milestones in the past. I'm pleased to be here for several reasons. First of all, I love history. IEEE milestones celebrate history by recognizing an achievement in technology and bringing it to the public's attention.

In addition, I've helped organize the Asilomar Microcomputer Workshop for 25 years now, and that workshop meant a lot to Gary Kildall. He attended most of those workshops during the years of 1975 through 1994. The last of those being just three months before he left this Earth. Like myself, Gary made many friends and business contacts by way of that annual event. And the 40th workshop concluded just two hours ago. Many of those in attendance at this dedication were at this year's workshop, and also many inventions that we now take for granted were first discussed in an off-the-record fashion at that gathering.

Just a few examples include some of the microprocessor architectures that are in common use today were first discussed at that workshop, and also they were inspired by other speakers at workshop. Also some of the architecture for the Silicon Graphics workstations was first discussed there. Even things like the Furby toy had its inspiration from that workshop. The creator of the Furby has been attending through this year. You wanna put that up here? [John Wharton holds up a Furby toy] So anyway, I found out that Furby is the second most popular toy name the world after Barbie, so a lot of that is due to the workshop.

In the spirit of the Home Brew Computer club, Asilomar is a gathering that's fostered friendships and collaborations. And so on behalf of the workshop, I salute the spirit that inspired Gary Kildall to create great things. I'm also pleased to be here because it's an honor to recognize Gary's technology inventions in what I feel is the ultimate fashion, and that's with an IEEE milestone. The fact is though, the milestone is not an award for Gary. The milestone is an echelon above that. It's a recognition of his inventions, and this recognition has been vetted by historians from around the world. This vetting process ensures that this recognition will be able to stand the test of time, and that will forever be seen as a foundation for that which comes after it. Just as Gary's inventions of CP/M and BIOS were created by his resting on the shoulders of those who came before him, the way in which others rest on Gary's shoulders will forever be documented in this indisputable fashion with this milestone.

I got to know the highly vetted process of getting a milestone approved when I was the champion for a milestone that honored the EEPROM and the way it paved the way for Flash memory. And that's a milestone that was dedicated two years ago at the Computer History Museum. I had the pleasure to work with SanDisk co-founder Eli Harari in that process. He's a holder of nearly 200 patents related to flash memory, and I got to look at many of the patents with him and to understand the process that went together to create that milestone, to vet that process, to show that that milestone would stand the test of time for what it represented. Because of that experience, I could very much appreciate the work that it took for David Laws to document the inventions of CP/M and BIOS, and to get this milestone approved by the IEEE history committee.

As such, I would like to invite up to the front here a few numbers of the IEEE. Ed Aoki, Chair of the Santa Clara Valley section, Weilian Su who's Chair of the Monterey Bay Subsection, Tom Coughlin, Region Six Director-elect, as well as Howard Michel, who's the IEEE President-elect. We would like to present to David Laws an award. If you could come down please David. So I'd like Weilian Su to present the award.

Weilian Su: I'm just going to read out what is on the award to David for all your hard work over the past many months that we've worked together on this. It says, the Institute of Electrical and Electronics Engineers, Santa Clara Valley section and Monterey Bay subsections are pleased to present this certificate of appreciation to David Laws, Semiconductor Curator Computer History Museum in recognition and appreciation of your efforts in being the champion of and organizing the dedications event for the IEEE Milestone titled The CP/M Microcomputer Operating System, 1974, April 25, 2014.

David Laws: I'm relatively new in town, and if you want to get to how a town works, and who all the important people are, have them put in an IEEE milestone. I made so many friends; it's been a wonderful experience.

Berg: Thank you. I'd also like to recognize some of the guests who are with us here in the audience. First of all, I'm very pleased that Ted Hoff, co-inventor of the microprocessor is here with us. Ted could you stand up please? Ted joined Intel in 1968 as employee number 12. He knew Gary Kildall well when Gary was developing the software that enabled Intel's microprocessors to power the personal computer revolution. Indeed, the citation of the plaque that will be unveiled this afternoon includes the following sentence, “Kildall's operating system allowed a microprocessor-based computer to communicate with the disk drive storage unit and provided an important foundation for the personal computer revolution.” These are powerful words indeed, and they show how this milestone represents a feat that is foundational to the consumer electronics revolution that is part of the daily lives of billions of people around the world.

Another co-inventor of the microprocessor who's here is Stan Mazor. Would Stan stand up please. Stan has been on the Asilomar Microcomputer Workshop committee with me since before I joined it. We also have Dick Ahrons the local milestone coordinator, who worked with David Laws in getting this milestone approved. Dick. We also have Paul Westling, IEEE publicity editor of the Bay Area. We're also pleased to have John Vardalis, senior historian of the IEEE History Center. I'm also pleased that we have, from the Naval Postgraduate School just down the street, Commander Staples, representing the Admiral's office. We also have Commander Martinson representing the electrical engineering department. And just to emphasize, they are here because Gary Kildall was at the Naval Postgraduate School, and much of his training and education and the inspiration for why we're all here today is because of the Naval Postgraduate School, so thank you very much gentlemen. I'm sure I missed many of you in the audience, and I apologize, but I thank you all for being here.

The IEEE is the world's largest professional association for the advancement of technology. It has over 400,000 members worldwide. IEEE has sections around the world and the Santa Clara and Monterey counties are part of the world's largest IEEE section, with about 13,000 members. We're pleased to have with us Howard Michel, who flew in from the east coast for this event. Howard is President-Elect of the IEEE. He's an associate professor at the University of Massachusetts at Dartmouth. His areas of interest include neural networks, artificial intelligence, sensor networks, and optical computing. He's a retired Air

Force officer, having served as a pilot, engineer, engineering manager, and satellite launch director, including overseeing two US commercial satellite launches from the People's Republic of China. Howard.

Howard Michel: Thank you Brian.

Berg: Certainly.

Michel: And so as Brian said, IEEE is the world's largest technical professional society. We have about 40,000 members in 184 countries. We run about 1,300 conferences every year. We have 18 of the top highly cited journals in our fields of interest. IEEE is about advancing technology for humanity, and recognizing those that have done so. So the IEEE established the milestone program in 1983, it's about 31 years. Two weeks ago past president Staecker dedicated the 138th milestone in Osaka, Japan. I get to dedicate the 139th here, and in a couple days, we have the 140th milestone going to be dedicated in Vancouver, Canada. It's truly a global program as you can see.

We recognize technical innovations and excellence for the benefit of humanity. It could be products, services, seminal papers, or patents. Some of the history of the milestones. We recognize an 18th Century milestone, Alessandro Volta's battery. 19th Century: the establishment of the transcontinental telegraph, the telephone, and Alexander Popov's work in wireless communication in Russia. 20th Century: ENIAC computer, the transistor, and liquid crystal displays. And so these are truly, truly important works. And we don't let any old event become a milestone. As Brian said, it's measured by the history committee. So first, it takes a local volunteer. So we have Dick Ahrons and David Laws that made the hard work of research, “Why was this significant?” But then they had to convince the history committee. And then the industry committee looked at it, as you said, not easily done. Right?

And then it goes to the IEEE board of directors, and every one of these milestones is approved, individually and directly by the IEEE board of directors. We take the program very seriously. The History Center actually in Stevens Tech-- if you ever get a chance to get back to New Jersey, we just moved the History Center to Stevens Tech, it used to be at Rutgers. I encourage you to take a look and see some of the history of our profession.

I'd like to say a little bit, a few words about this 139th milestone, and the significance as I see it. And I'm going to depart from my prepared notes a little bit. I want to take you back. The notes say, Gary did this work in 1973 and 1974. And I know I was an undergraduate student in 1973 and 1974. And we had a computer in the university. And you'd write your cards, punch cards, you'd bring them to the computer. Very few computers existed. They were these big things. And the companies that built these things, they wrote operating systems. And what was the purpose of the operating system then? [It] was to efficiently use the hardware. People were cheap.

And then people like Ted invented the microprocessor. But where would we be, if we just had the microprocessor. So a lot of technology went into this, and I think the key thing of this is, Gary saw we needed to have an operating system that is hardware agnostic. How did he do that? He came up with the BIOS, the concept of BIOS. So imagine IBM taking the 360 mainframe, and say, we're not going to build the operating system [just] for this mainframe, we're going to build something that anybody can use. Wasn't going to happen, right? So this truly was a revolution. I think this is the significance. And then, we talk about booting from a floppy disk. If you think back in 1973, '74, these mainframes had disks also, in 3,000, 4,000, $5,000 cabinets. And so we wanted to have something that was cheap and easy to use in a personal computer.

So the whole revolution started, I think, but it wouldn't have been what it is without this linchpin of the operating system that Gary invented. And so he did this in '73, '74 I guess was the first working prototype. '76 he incorporated Digital Research, Inc. released program version 1.3. And so the milestone we're going to dedicate later this afternoon is going to be at the headquarters, headquarters of the company from 1978 to 1991.

And I think the other thing that I saw in my research is talk about Gary and his work environment at DRI. It says Gary fostered a work environment in which good, creative people could set about the task of revolutionizing the world, and enjoying themselves in the process. I think that is the secret of innovation. To have good people, empower them, have them have fun doing these things, and see the great things happen. And we have a result of that, I think that's also part of Gary's truly innovative contribution. CP/M, Control Program for Microprocessors was the first commercial operating system to allow a microprocessor-based computer interface with a disk storage drive, as I said, the floppy disk. I remember when I was writing programs, we stored them on either punch cards or paper tape. So, floppy disk.

I think these things also created the atmosphere where hobbyists could generate and do things, and create innovations. I think that really is significant. I think we see that the whole technology came about from people, as we talked in the car ride home, taking a few pieces from the stock room, because the company wanted you playing with these things at home. Because there were things that were developed from that. And that was the environment that Gary had.

Another quote says, but perhaps Gary's most profound contribution was his first successful open system architecture. We talked about that. He built an operating system, he captured the essentials of what an operating system was, to allow it to use the hardware, but also in a user friendly way. On hardware agnostic platforms that you could then tailor an operating system to operate on different hardware. That's started the open system architecture revolution. Where would we be, if we didn't have that. All the competition that it forced, all innovation that it created. It's the spirit of the American way. And this was captured in this. So I'm pleased to be here to dedicate this milestone, and I turn it back to Brian Thank you.

Berg: Thank you very much Howard. I now have the pleasure of introducing you to the participants in a conversation that will enlighten you further about why we're all gathered here today. First we have Gordon Eubanks over here in the blue. Gordon received his master's in computer science from the Naval Postgraduate School just down the road, and Gary Kildall was his thesis adviser. Gordon founded a company to commercialize the subject of his thesis, a BASIC language compiler for CP/M, and that company was acquired by Gary's company. Tom Rolander to my left here, spent two years at Intel before joining fellow University of Washington alumnus Gary Kildall at Digital Research. Tom was VP of engineering before co-founding KnowledgeSet with Kildall in 1985. That was a company that created the first CD-ROM encyclopedia. Really the very first title that was significant for the CD-ROM revolution and the multimedia revolution that started in 1985.

I have a personal connection with Tom, which we discovered together some years ago at an Asilomar Workshop. Our parents knew each other, and we were both born abroad by way of that connection. Tom in Kenya, myself in Japan. In addition, the first girl I dated in college was Tom's sister. It's amazing. We found that out in the back of the Asilomar Workshop one evening.

In addition, David Laws directly to my left did the heavy lifting for this milestone. And that is more than just the 18 pounds of bronze that makes up that milestone plaque. Besides getting the milestone approved, his work included coordinating today's events, securing Digital Research documents and artifacts that are on display at the public library just a couple blocks from here. As well as setting up a successful Facebook page, and many other tasks, not to mention all of us here in this room today. David has held senior positions, including CEO, at a number of well-known companies, such as Fairchild, AMD, Altera and QuickLogic. I've known David for a few years by way of the Computer History Museum, where he is semiconductor curator. Without further ado, I now give you David Laws, Tom Rolander, and Gordon Eubanks

Laws: Well thank you Brian. I think you've used up my first three questions here. But we'll think of something to say. A bit on my background, I worked in Silicon Valley for about 40 years, in quite a number of capacities. And it was an exciting time. Transistors went from seven transistors on a chip, I think, when I first joined Fairchild and it was a challenge to do that. You could usually do it on Wednesdays but you couldn't do it on Thursdays. And by the time Ted Hoff got into the process of designing microprocessor chips, I think Ted put about 2,300 transistors on that first 4004 wafer. Today on a day in day out basis, many, manufacturers throughout the world are putting two billion transistors on chips that are not much bigger than the ones we started with back in the '60s. So it's been an exciting ride. Met a lot of fascinating people.

And after I retired, I somehow stumbled into the Computer History Museum, I don't remember how that happened. Spent some time there as a docent, and then we started up a group called the Semiconductor Special Interest Group {SIG}, of which the gentleman in the back in the blue shirt, Doug {Fairbairn], followed me in one of my roles there as Director of that activity. The role that the special interest groups

play at the museum is to help collect, preserve, and present the stories of the pioneers of the important chips that help build the modern world we live in, for better or for worse.

And I became peripherally involved in a couple of milestone projects, the disk drive down in downtown San Jose, and the big project that Dick [Ahrons] worked on for the planar transistor that went into Mountain View, where Jean Hoerni came up with the process that we basically still use today to manufacture chips. And then when Dick was looking for some more feathers to put in his cap, there's a lot of these milestones on the east coast, big power stations and stuff like that, but there aren't many out here so, we're going to fix that Howard, right? Good.

Michel: Yes we are.

Laws: I said “I think there was something interesting going on just up the street from where I now live in Pacific Grove. why don't I go check it out for you?” aAong the way I met Tom Rolander, and other people in town, and learned the story of Gary Kildall's development of CP/M back in the early '70s. Started writing up a proposal, and I thought, well I can wash my hands now, and someone else will take over. Guess what. That didn't happen. I'm glad you're all here today. We have visitors from many different parts of both the industry and culture and the world. And one name I would like to mention, who didn't get any introductions is Ed Lazowska. Ed, if you could wave your hand here.

Ed's a big time professor up at the University of Washington in Computer Science [The Bill & Melinda Gates Chair in Computer Science & Engineering]. We appreciate you coming down for the day. Good to see you Ed. I don't think this is the place to try to repeat the story of Gary Kildall. I think most of you are familiar with it, you've heard the dates. He developed the technology back in 1973 or so. Struggled with hardware to actually make it work, recruited another friend from the University of Washington, John Torode, who actually made the physical connection between the floppy disk and the microcomputer development system that had been loaned to him by Intel. And sometime in 1974, they managed to get it to get it to work. We haven't figured out the exact date yet, it was sometime in the fall. I spoke to John, and he just remembers that he and his wife went back to work in Chicago in the October, so sometime before October 1974 is the best date we can pin down.

Gary continued teaching at the Naval Postgraduate School and began to sell it as almost a pass time. Established a company in 1976 and had a thriving company here in Pacific Grove by the late 1970s and early 1980s. Tremendous number of innovations. A lot of fascinating people went through the company, quite a few of them here with us today. And two of them that I would like to talk to in a couple of minutes to get some background and some insight into what what is the real legacy of Gary Kildall, and how did he contribute to help to establish the foundations of the digital age that we all live in today.

Tom I think you probably met Gary before Gordon did, that was at college right?

Tom Rolander: That was in college.

Laws: Tell us a little bit about your background, How you became interested in the topic.

Rolander: I went to the University of Washington. Go Dogs, right Ed? One night I was in the electrical engineering department, and was heading toward an engineering career. I was working at Fluke Manufacturing, they built digital volt meters, and they actually put me through grad school. Well in 1972 in the summer, it was August, I came into the computer science lab late one evening. It was probably about 2:00 am in the morning. Sitting there doing my work, and in comes a guy with cutoffs on, freckles on his face, and he pulls out a leather briefcase, opens it up, and he plugs in a ASR 33 in there. Some of you know what that is, it's a Teletype. And he plugged it in and he had a computer. I went absolutely nuts. I wanted to know where he got it. Apparently he got it from Ted Hoff over here. I wanted to find out how I could get involved in that. And that was the beginning of my friendship with Gary.

Laws: And you studied at the University of Washington?

Rolander: So I studied at the University of Washington. I completed my master's in EE and I got recruited by Intel. So I came to Intel in late '75, and joined them for a few years. I worked on initially hardware. I was part of the SBC [Single Board Computer] team. And then moved into software. Worked on RMX 80, which is their multitasking executive. And during that time, of course I ran into Gary again. Because Gary was writing the PL/M compiler, which was the high level language for us to use on the microprocessors. And I was one of his test subjects, and one of his critics on PL/M. And so I went through that QA [Quality Assurance] process. And he kept recruiting me, wanted me to come down to Pacific Grove. And I said, no, I'm having a good time here at Intel, I'm not really interested, I have no idea where Pacific Grove is.

Laws: Tell us a bit more of that story in a minute. Gordon, you also had an interesting interaction with Gary I believe in the early days at Naval Postgraduate School.

Eubanks: We did, but most of that we can't talk about here. That's for sure. We know. So, I was a Naval officer, nuclear submarine officer, and they sent me to get a masters in computer science at NPS in 1975. And Gary's reputation at the school was the toughest guy, toughest thesis person. So I went to his office and said, I want to do a thesis with you. He, of course, said he was too busy. I said, I've checked, you have no thesis students. True story. And so finally he agreed, as long as I did something with these microprocessors.

And I'd worked for IBM for awhile during school and stuff, so I thought all computers were big, the bigger the better. So I agreed to work on this with Gary, and did a thesis on [a BASIC interpreter] There were three of these wire-wound boards, I believe. I think John Torode had one, and there were two others. One

of them in the lab at the Postgraduate school. These were just millions of blue wires and the disk controller. There was one diagram of it, which was close to what was wired on the board. [It] did not have any of the fixes that were necessary reflected in the diagram. It managed to stay together. And the floppy, the eight inch floppy, was given by Intel. It was one of the floppies used for endurance testing. So [that] tells you how good these floppies really were, or maybe it was Shugart [Associates]. -- Anyway someone endurance tested it and then Gary got it. So I worked with him there.

And I just want to say that the thing that Gary did-- there's a lot of things Gary did-- but the one thing that I think doesn't get nearly enough recognition is he wrote PL/M. I mean this was a mind boggling idea. He wrote it by the way in Fortran, that is mind boggling in itself. He was in the true Edison heritage, he was a true inventor. I mean he really did inventive and remarkable things. Anyway, PL/M doesn't get mentioned. I guess that's because this is about CP/M. But without PL/M there would have been no CP/M. I really believe that's true. We argue how much was written in PL/M but anyway.

Laws: Interesting insight. I understand that the topic that he wanted you to work on, something about a word processor and you chose not to choose that one. There was an interesting story there.

Eubanks: One of the many times I should've listened to Gary. He said, well why don't you write a word processor for microprocessors. I couldn't see the value of that, because UNIX had “ed”, right? And even had one that would format, and as long as you backed up enough that when it crashed you could recover. But yeah, he thought that would be a great opportunity, I wish I had listened to him.

Laws: And instead you, what was your thesis?

Eubanks: I wrote a BASIC interpreter called BASIC-E and then I converted it into a commercial product called CBASIC. This was a long time ago. I still have the source code, if anyone's interested. It was all written in PLM.

Rolander: You could donate it to the Computer History Museum.

Eubanks: I tried, they didn't want it.

Rolander: You've got an in right here.

Laws: You didn't speak to the right people.

Eubanks: I also one of the first Osbornes, There were Osbornes made with metal cases.

Laws: That might be special. I know the museum has several Osbornes, but I don't think we've got many with metal cases. Tom, tell me about your recruitment process.

Rolander: The recruiting. Gary was a truly unique recruiter. I had known him, at that point, for I guess about six or seven years. He'd been calling me a number of times to come down and join him. And I finally got to the place where I realized, OK it's time to go down, at least have a look, and maybe Gary would leave me alone if I just came down. So I came down to Pacific Grove. Well actually, what happened then was, Gary said, OK great you're going to come down to see us, well can you start on Monday. I said, no, I really want a proper interview. So I came down on a Friday afternoon, and it was one of those chamber of commerce days. Just beautiful. I came in to Monterey, this is before the aquarium was here. Drove along the waterfront, oh my god. My thinking is, you mean I can live in Pacific Grove and write software? That was a pretty good opener.

So I came into the Victorian, you're going to see it's where the plaque is. Gary's office was in the second floor in the front corner. He had the master bedroom up in that corner, and that was where his desk and his computers were. So I came up to his desk, and on top of his desk was an airplane model. I was kind of curious about that, because I looked at it and I said, so what's with the Cherokee 180, and he says, oh are you a pilot, and I said of course. And he said, ah, are you current in type? Which means, could I get in that airplane right now and fly it legally with my license, and I said, of course. At that point he said, well let's go.

So, we got out of the office. We went down to his Porsche, drove out to the airport, climbed in the airplane, he put a hood on. You see, Gary had just got his instrument rating a few weeks before I came down there, and I was his safety pilot. You have to fly every, an hour a month, several approaches to keep current. And so, that I think was how I really got the job, was I was Gary's safety pilot. Today in cars we call them carpool dummies, in flying we call them safety pilots. So that's how I got started, and in fact I did start working for Gary the next week.

Laws: Unique interview Tom. Gordon, when did you first become aware of CP/M? What was your idea about it, was this going to be a useful thing?

Eubanks: Well I first heard about it when Gary said there's a computer you're going to use to write your thesis. Gary also taught an operating system class where he actually passed out the source code and we studied CP/M in great detail. And I've looked for these notes, I can't seem to find them, where I have all my own code. But anyway, so that's how I first heard about it. It's hard to go back to 1976 and realize the incredible feeling of the power of being able to sit there at your own computer, and put in a disk and boot it up and see that a prompt. I guess that's what some of these drugs do. I've only heard. But I think, I really think that changed my life, to see that. So I mean it really was incredibly impactful. Because you're at the Postgraduate School where they had these almost armed guards [for the mainframe computer],

and you only got so many submissions a day, and rules and regulations and a bunch other BS, and here you had your own computer. Very amazing.

Laws: Did you have any sense that it would be useful beyond engineering in those days?

Eubanks: Sure, I mean I think everyone who was involved there really saw this as something that had tremendous future. I spent a lot of time arguing with Gary about this, about whether or not this should be commercial, whether there was a real market.

Laws: Was Gary convinced that there was?

Eubanks: I think Gary was convinced there was. I mean he tried it, and it certainly was very successful. Changing-the-world ideas, they're not really obvious. I mean the first microprocessor, I'm in awe to be in the same room with someone who did that. I mean, there must have been skeptics when someone said we're going to put hundreds of transistors on a single piece of silicon. It's those kind of things, so Gary was one of those people.

Laws: Tom, when you joined Digital Research what was your first assignment? Was it a new generation of the operating system?

Rolander: Yeah, when Gary recruited me and brought me down to Digital Research, I think it illustrates one of the things that Gary did, at least to me as a mentor. And what I credit Gary with was being actually an architect. Gary always wanted to look at the big picture. So when I look back at the process of CP/M, Gary was convinced it was going to grow into higher, more powerful processors. Those were going to lead themselves to multi-tasking, to multi-programming, and also to networking. So when Gary was designing the architecture of that system, he wanted to make sure that each piece was going in the right direction.

And the way he explained it to me was that, at an early stage, when you're making decisions if you're doing a fairly small project, there becomes some sort of arbitrary decisions that you make. And it's almost a coin toss in some cases, what sort algorithm to use, or et cetera. And what he did is, he said, what you need to do is make that decision based on where you're going, and it's no longer an arbitrary decision, because it gets you closer to that ultimate goal. So that was one of the things that I learned from Gary in mentoring. So he brought me on to actually be the architect and creator of his multitasking system, and then later his networking system, with a token ring network at that time.

And the element that he really watched carefully during that was, how I designed and worked with the BIOS level. So in the multitasking world, we have something called an EXIOS, extended IO system. And

that had to deal with differences in interrupt architecture, differences in the way the timer worked. And so, I had to come up with a method to generalize, to make those elements general, so they could work on anybody's computer. And the same thing when we got to networking. We had to work with token ring, and then as Ethernetevolved, to work with that. So we had to then build that layer between the hardware and the software in a way that was agnostic. So that was part of Gary's tutoring or mentoring.

Laws: The other day when we were trying to identify some of the most critically important aspects of CP/M, we mentioned BIOS a number of times, but Gordon you came up with something that-- I'm a transistor guy, not sure I understand this, but—"dynamic relocation" of the OS. Can you tell us what that is and why it was important?

Eubanks: I think Tom and I kind of disagree on this. I think BIOSs were already in use on mainframes and minicomputers because people knew they had to improve the hardware and they needed a smooth interface. We can disagree, they're both very important. But what Gary did that was-- sorry to keep saying mind boggling. But I remember the day at the school he came bouncing into the lab and he said, I have figured out how to relocate. He took advantage of the fact that the only byte was always going to be the high order byte. And so he created a bitmap. And what this meant was, it didn't matter how much memory the computer had, the operating system could always be moved into the high memory. Therefore, you could commercialize this-- this is really nerdy stuff-- but you could commercialize it on machines of different amounts of memory.

Which was really, if you think about it, you couldn't be selling a 64K CP/M and a 47K CP/M. It'd just be ridiculous to have a hard compile in the addresses. So Gary figured this out one night, probably in the middle of the night thinking about some coding thing, and this really made CP/M possible to commercialize. I really think that without that relocation it would have been a very tough problem. To get people to buy it, it'd seem complicated to them, and if you added more memory you'd have to go get a different operating system. Did that make sense?

Laws: I think I understood the first three words.

Eubanks: Intel, for reasons I don't understand, had the bytes reversed, right, for the memory addresses. But they were always in the same place, so you could relocate it on a 256 byte boundary, to be precise. You could therefore always relocate it with just a bitmap of where those-- never mind.

Laws: Certainly the most eloquent explanation I've ever had of dynamic relocation. Wonderful, thank you.

Eubanks: I barely graduated.

Rolander: Do I get a rebuttal?

Laws: Well, yes you do get to rebut. You want to tell us the importance of BIOS?

Rolander: I think it's actually more than the BIOS, because Gary's operating system, or environment, was layered. You had the physical IO system, you had then the basic disk operating system, and above that you had something we affectionately called the TPA, which was the Transient Program Area. That's where the word processing and spreadsheets and other applications went, or were running. Remember back to the silk boxes that came out with PCs. There'd be a silk box for your word processor, and a silk box for your spreadsheet, and whatever. Well could you imagine if you had to have a different box for each different piece of hardware, each different computer that was out there?

That was really the state before that time, and I think what Gary did is he enabled people to have that scaling that they could sit there and prepare one software box that could run on all those machines. That I think was the truly unique contribution. And all of that was built on these two layers, the layer of the BIOS, which separated the hardware, and then the layer, what we call the BDOS, which were the operating system calls that the application program would make. In fact, we got really irate at Digital Research if people made calls all the way from the application down to the BIOS. That was a no-no, you know that was a problem. That meant, for us, that those applications could not be ported necessarily from machine to machine. That was, I believe, the real BIOS contribution.

Laws: You described Gary's approach to designing a new architecture or a new product to me the other day. Tell us about the fine drawings the he used to produce.

Rolander: I mentioned earlier that Gary liked to approach a problem as an architect. When I look at what CP/M's accomplishment was, and it really was an architecture, it was an open system architecture. In fact, he did too good a job. He made it easy to copy CP/M, because he provided the architecture of the interface. These are the operating system calls from the application program, these are the parameters to pass. And so that was something that could be replicated, because he did a really good job with that architecture. So that was the way when he did that design.

Laws: And then he did these big drawings.

Rolander: So, OK, the drawings. I just wish I had them, I have one small one that's down here [on display] in the Pacific Grove library, I only kept a copy of one of them. Those of you that worked with computers in the early days, remember the big 12 by 18 sheets, with sprockets holes on them, printer paper. Gary would take a whole bunch of those sheets, lay them on a big table. He had at one point a door blank sitting on saw horses that gave him enough working room. And he would draw the most

beautiful pictures of his data structures. And he would stare at it. He would sit there and stare at it for hours, and get unhappy with it, rearrange it a little bit. But he did absolutely beautiful drawings.

And when he finished that, when he had the picture and was convinced those data structures were now correct, he would go into just an unbelievable manic coding mode. He would just go for as many as 20 hours a day, I'm sure his kids appreciate it, Scott and Christie, that he was just gone during these periods of time. On a couple of those occasions, when he'd get something running the first time, which could be in the middle of night. And all you who have written software have seen that, for example, that the first time it comes up on the screen, you've got to tell somebody. My wife Lori will tell you that I had a couple of those calls in the middle of the night, LOGO was one example, XLT 86 was another, where he got it running the first time, and he had to have somebody see it. So it didn't matter what time it was, he'd call me, I'd have to come over and see it running.

Laws: So Gordon, you wrote this CBASIC program and you had your own business selling this, and tell me how you came to join DRI.

Eubanks: Well they bought my company.

Laws: Best way. Didn't even require an interview, right?

Eubanks: I had a lot of equity and I wanted to see what this was all about. So, no, I was still in the Navy most of this time, and my mother ran the company down in Sierra Madre, California. Once the IBM PC scenario was clear to Digital Research, in my great fortune, great, great fortune, Gary decided he ought to buy us because we were a language company and Microsoft had gotten a lot of progress on the operating system front. So, is that what you're asking? Anyway Gary called and I came out and I was eager to come to Pacific Grove, because I've been here at NPS, so I loved this area.

Laws: And you stayed couple of years at DRI?

Eubanks: Exactly two years. And then went up to Silicon Valley and got involved with what ended up to be a company called Symantec, which probably most people haven't heard of, but you've heard of Norton. We bought Norton in 1990, the company, not Peter.

Laws: Tom, you also went on to found another company?

Rolander: Yeah I went on. This morning I was, for a while, at the Asilomar Microcomputer Workshop. And Carl Helmers was there, he was the publisher of BYTE magazine, those of you that are nerds will remember that magazine.

Berg: I think, is Carl here?

Rolander: There's Carl.

Berg: Can you stand up?

Rolander: Yeah. One thing I reflected on is that Gary passed away in 1994. And Scott and Christy asked me to lead the memorial service for him, which was held at the Naval Postgraduate School. And as I thought that through, I needed some kind of prop to bring with me. And I thought about a floppy disk, or maybe bringing a little one of the CP/M computers along, and I finally settled on BYTE Magazine.

They had a headliner that said, “Computers, the world's greatest toys”. And I really resonated with that because one of the things that I think I learned from Gary is this what technologists do is, they will always have the latest toys. It gets the mind going, it gets your juices flowing to develop something new. Gary had the first Walkman that came to town. In fact he got the Walkman, he had one of those double ear buds, and I ran around the track with him in Pacific Grove because we had to try it out, listening to his music, which was some Western music..

And another example here, is when the first CD player came out, the Discman, he heard about it, and it was only available in Japan. Well he got our friend to ship him one from Japan, and I remember the evening he got that, and he brought me over to his house, sat down and looked, and then he says, Tom, this is optical storage, you're going to fit hundreds of megabytes on this piece of plastic that's going to be replicated cheaper than a cassette tape. Because a lot of manufacturing cost is time. And when you have to dub a tape, it has to run through, I don't care how quickly, it still takes time to dub that tape. So with the CD it's the stamping process, so it was cheap from day one. This was a publishing media. He said, Tom we've got to get into this business. So it was toys, it was that kind of new idea. He always had the next newest thing. And he knew toys.

Eubanks: If I could add a couple things. Gary as I said, was an inventor, he was inventive, he did things. His Ph.D. thesis proved that global flow analysis converges. Now, you'd have to know what that meant, if you do I feel sorry for you. This is a fundamental idea in computer science. And I took a course, a summer course once from a guy named Dhamdhere. And they talked about optimization for like a week and then they put a slide up and said, “Kildall's Method,” this is the real story. Anyway, so he did, that I

mean that's something that no one ever thinks about. And before CD ROMs, the laser disks. Remember those?

Rolander: Pioneering video disks

Eubanks: If anyone needs any, I have like 50 movies on laser disk. At least. At a good price. But, he took those laser disks and he did that thing, what was it called?

Rolander: He had a Chyron character generator and a BVH.

Eubanks: What was the name of it, it was-- the guy in Carmel, the guy from the Monkees--

Rolander: Michael Nesmith.

Eubanks: He was constantly seeing new technology. Brian-- I don't want to take your thunder, are you going to talk about this?

Halla: It's all been said.

Eubanks: It gets lost in all this stuff about IBM and all these other things. I think his thesis was very cool.

Laws: Maybe we need a copy of that too.

Rolander: So, I was going to say after the CD-ROM, and we sold that business [KnowledgeSet], Gary then started a company, Prometheus Light and Sound, and he was into connected devices within the home. Which is of course what Google and Nest is about at this point, I think the reason for their acquisition. So he was consistently 10, maybe 20 years ahead, of, in many cases, the commercial viability of a lot of those technologies.

Laws: At this point there are cards out on the seats. If you have a question you'd like to ask any member of the panel, if you could write the question on that, we will collect those when the next two speakers are finished.

Berg: I wanted to say a couple more words here. There's been some talk with regard to CD-ROM and optical storage. I got into optical storage in the mid '80s writing device drivers and working with those

devices. And that's actually how I came to Asilomar. I'd given a talk on write-once optical storage, and somebody heard me, and they invited me to come to Asilomar, and the rest is history. So I've got that connection with CDs, so it's kind of funny that we're talking about optical storage. And if you think back in the mid '80s, that was before people were using the internet, or widely using the Internet I should say. And so the big thing was to widely distribute lots of data, such as multimedia data, CD-ROM was the medium. So there's the optical disks, the video disks that were also discussed, but CD-ROM was what really made it. So, Gary Kildall was on the leading edge of that, and very much recognized it as Tom just said. So I just wanted to say that's just one other avenue in which Gary Kildall made an impact. So I think that's pretty cool stuff.

I'd now like to recognize a couple people I didn't mention earlier. Both Kristen and Scott Kildall, Gary's kids are here. Would you mind standing up please? Whatever kids, sorry, children whatever--

Scott Kildall: Son and daughter.

Berg: Son and daughter, that's better, thank you. Let's see, I believe are there any other Kildalls in the house.

Kristin Kildall: My children are outside. They didn't last.

Berg: And by any chance, is Lee Felsenstein in the audience? Did he come along? I guess not. I mentioned earlier [he was founder of] the Homebrew Computer Club, he was at the Asilomar Workshop, and just wanted to recognize him if possible. So we've got a couple more gentlemen to give some thoughts here. We have Brian Halla over here on the left. Brain was Intel's interface to Gary Kildall when Gary first worked as a microprocessor software consultant at Intel. Brian also served as executive VP at LSI Logic, as well as CEO at National Semiconductor. Brian.

Brian Halla: Thank you Brian. I was watching CNBC yesterday and they have this deal going to celebrate their anniversary where they recognize the 25 most influential and transformative people on the planet. And yesterday was the chairman of HTC, Cher Wang. And I thought, Gary should be at the top of the list. And not just for CP/M, but for all of the things that have already been mentioned. And by the way I talked to Doug back there with the cameras and Dave that the Computer History Museum needs to have a Gary Kildall section right at the start of microprocessor-based computing. If you feel that way, send in letters. I absolutely believe that. Also we sent word to the mayor that we need to have a banner across Lighthouse, just like the one they have in Reno that says “The Biggest Little City” that needs to say, “Home of Gary Kildall, the Father of the Interconnected Universe.”

By the way it's great to see Ted and Stan here, it sure does bring back a lot of memories. I joined Intel in '75, and one of my first products in the late '70s was a floppy disk system that we were getting ready to release. And they told me about Gary, and said that Gary had offered CP/M in exchange for a floppy disk-based development system. And we said, well we didn't say it, but the engineers said that we've got ISIS, and that's going to hang the moon out there. So we turned down Gary, but gave him the development system anyway. My wife and I went down there to present it to him, and one thing led to another. Gary and I became fast friends, and I got to know Gary had an incredible sense of humor. As it's already been said, he was the gadget guy. Everything [that] came out, he was the first one to have it. First time I ever saw on of these brick phones was when my phone rang and I picked it up, and he says, Brian it's Gary, look out your window. And he was the first guy to have one of these cassette-based cameras instead of the thing you hang around your waist.

I remember Gary and I went to one of my daughter's volley ball games in his Lamborghini, and a mass of students came and huddled around the car and one of the students asked if he was Donald Trump. Gary, because he had a beautiful place right across the street from Pebble Beach, decided he was going to take up the game of golf. So I gave him a set of my hand me down golf clubs. And he called me the night after his first venture with golf, and he said, Brian these clubs don't work. I said, you know Gary we've all felt that way from time to time. I said, why don't you just have a couple lessons and get out and practice. And he says, no they don't work, he says they're right handed clubs and I'm left handed.

All right, I don't know if Ted and Stan remember this, but there were some pretty dark days at Intel. Tom was in the SBC [Single Board Computer] group. I remember there was a time when the only design we could talk about was an SBC design with an 8086,that was for an automated chicken plucking factory. And they would literally hang the chicken by his little feet, and they'd take him around a conveyor belt and chop off his head first, and then dip the body in a bucket of lye to get the feathers off. There was a bug, I don't know if it was in our program or their program, where they skipped the step where they chopped off his little head. We had another design that was a traffic light controller. But fundamentally, this was before the PC. There was a marketing guy for the 8086 by the name of Dane Elliott.

Berg: He's in the room.

Halla: Where's Dane?

Berg: Would you stand up please?

Halla: Dynamite. Dane was the best presenter I ever saw, and knew more about the X86 architecture than anybody. I remember we got, in the factory we got a TWX. I look around, and a lot of you will remember the TWX. Dane sent a TWX in, and I remember these words because it sent a chill throughout

Intel. And the words were, I've been out in the field for two weeks now, we're not only losing some of the designs to Motorola, we're losing all of the designs to Motorola. Did I get that right Dane?

Dane Elliott: Pretty close.

Halla: And that was a shock wave. And Intel rallied the troops. We got all the marketing guys and the thinkers in the cafeteria and came up with-- we divided into teams. But ultimately the thought process was, what do we have that Motorola doesn't have. And that of course became, we have software. Intel has software. Intel has Gary Kildall. And so we came out with the theme of the Crush, the now famous Crush program, 1980, was the software crisis. And the software crisis was, I mean, I can hardly say this without chuckling, but that there was going to be such a proliferation of microprocessors that the university system would not be able to graduate enough software programmers to keep up with all the platforms. Therefore, it was important that people stick with one platform, where the supplier, Intel, was dedicated to making that software live from generation to generation. And of course they did that. I think it's no surprise, or no secret, that Intel did survive. But that was Gary.

Of course a PC came out of that design campaign as well, it wasn't because of the design campaign, but it was being developed in Boca Raton along with the Motorola based PC at the same time. And we sent an awful lot of guys to Tahiti as winners of that contest, because all of them claimed PC designs. There were about 200 PC clone makers. That, is something that I remember when I wrote the rebuttal to the [Gary Kildall] obit in the San Jose Mercury, one of the people that sent me a letter thanking me for doing that was Andy Grove. Intel clearly owed a lot to Gary Kildall, - maybe even the company. And of course, we've already talked about KnowledgeSet, Gary's optical disk [company], and I think in addition to the Grolier's Encyclopedia, didn't he also put the [Boeing aircraft] 747 maintenance manual--

Rolander: Yeah, and the 757 and 767, the first maintenance manuals.

Halla: And that's something nobody knows about Gary Kildall, maybe not his kids, one time I was over at his house. He says Brian, you've got to come downstairs to see this, and we go down. He's got a VAX 11/780 running in his house. And he says, someday computers will generate animation. And he shows me the demo of a Coke bottle spinning around that is being generated by the computer. When I asked him about that several months later, he said he sold it to a little company called Pixar.

So one of the things we did at Intel was this thing called a wild card, and this was my last group at Intel. It's a PCXT on a credit card form factor using flip-chip and an epoxy blob over the chips so we didn't have to package them. It had a CMOS 8088 there we got from OKI [Electric Company] and a 2010 combo chip from Faraday that had an 8087 [Intel] math coprocessor socket. The whole company fell in love with it, except for Andy Grove. But Gary fell in love with it. And one night, my wife and I were at a party at Gary's house, I think Tom Bruce was there as well. And Gary says, you've got to come see this. He had taken

the PCXT on a credit card with the belief that some day phones would be as smart as PCs, and he built the world's first smartphone. So Gary wasn't just a visionary and a dreamer, he was also a doer. He made everything that he believed in happen. Which is, to me, amazing.

I think about it, the first microcontroller assembler, high level language, microprocessor OS, the CD-ROM, computer animation, a smartphone, Gary was a pioneer, he was a hero. I think he was a clear winner. I think he was the father of the connected universe, and I hope all of us with high tech hearts will remember Gary forever.

Laws: Just before John speaks, we would like to collect the question cards if anybody has them.

John Wharton: Hello, my name is John Wharton.

Berg: Can I introduce you? I just wanted to say a couple words about John before he spoke. John served as Intel's technical liaison to Digital Research in 1980 to '81, and was a contractor to them in '82 to '86. He co-authored several technical papers with Gary Kildall. I met John when I first attended the Asilomar workshop in 1987. He accepted my offer to join the organizing committee in '88. As program chair for the workshop, John is the man who does the magic, who turns all the talk proposals into a coherent program for each year's workshop. And that's no easy task. So I'm proud to introduce my friend, John Wharton.

Wharton: As to the [Asilomar] programs, engineers like solving puzzles, and the more difficult the puzzle, the more fun it is to solve. And trying to find 30 unrelated presentations and make it look like it was part of a planned program is a lot of fun. Oh look, these three all relate to things with the letter B in the product name. There's been a lot of discussion of the fact that Gary had been a professor at the Naval Postgraduate School, that he had taught such and such, always in the past tense, as though that had been a job that held at one point in his career. The thing that always struck me about Gary, his entire life he was immersed in academia, from the time of a child. The story of what happened before he rose to prominence is not told very often.

His grandfather, Harold, had been a navigator and a Merchant Marine, sailing back and forth from, I think Tacoma to Hong Kong. When he decided to settle down, he formed a navigation college, which turned into a sailing college, nautical college. As that grew, his son, Joseph I believe, joined in and became one of the faculty members. And Gary, as he was growing up then, was in a family where his father and his grandfather were both instructors at an institution of higher learning. He helped out when he could. In high school he was sometimes given the advanced mathematics classes to teach, and was always struck that Naval officers are sitting in their chairs learning from me how to do these advanced mathematical things. But the idea of being able to present information and sharing information and letting information out was something that he had learned from the very start of his life.

So when he got out of high school, went to college, got the bachelor's degree I think in math and computer science. Stayed on, and the first time the University of Washington offered a Ph.D. degree in computer science, Gary was part of that class. As has been mentioned, he was very much into that world, writing the very early compilers, and some of the theoretical optimization techniques that are being used to this day.

But he also had a chance, working there, to learn a whole lot about different types of computers, different architectures. Mainframes were the only thing that was available then, but what makes this mainframe different from that mainframe? How do you move software between them, in what ways are they the same, where are the differences that you need to watch out for? Because if you want to write software and run it on five different computers, you don't want to have to start from scratch five times.

And part of this architecture thing of seeing where you were headed before you started even the first step meant that each of those programs could be written in such a way that moving it to another platform later on, if that became necessary, would be trivial. All the things that needed to be changed were defined up front. You could make some minor changes, run it through a machine, and now you'd have tripled the power of the software you developed, because now it could run on any machine in campus. That was absolutely not typical of the time. It used to be that whatever software you ran had to be purchased from IBM or from Control Data, or from some other company, and there was no prayer of ever getting it to run on anything else. But he carried that sensibility into the development of CP/M.

People talk about CP/M as a product. I always saw it as an educational tool. It was almost as though that was something he was developing in order to use in his classes. It was mentioned that source code was circulated to the students to learn how it had been written. My first exposure to him-- there's been a lot of discussion of this computer conference at the Asilomar grounds. When I was in grad school I came out to California to interview for a start up company that was about six years old at the time called Intel.

My parents just prayed I wouldn't take that job, because no company that small could ever last. Because they wanted me to go to Texas and work for TI instead, but whatever. As it happens, on my interview trip, the person who spotted me and interviewed me and demanded that I stay around and talk to other people, was Tom Rolander. So he's literally the oldest person in the state, the longest person I've ever known.

But I did join Intel. I had been working about two years and later one day Stan Mazor advised me that we're going to a computer conference next week at the Asilomar conference grounds. And I followed along, and went to the conference. There were a couple of presentations he wanted me to give. But during one of the sessions, something grabbed my arm and said, comie with me. I looked up, and it was Tom Rolander pulling me out of the room. It wasn't a request or an advisory, it was just a here's what's happening John. And he dragged me down to the building at 801 Lighthouse, I'm sorry, he took me to the building which was the DRI headquarters, introduced me to Gary. And we probably spent two hours, and

what Gary was doing was basically giving me a computer science lecture on the potential of microcomputers. I had worked at Intel for some years, I knew what these things were, and he opened my eyes. Because he was looking so far out beyond anything that Intel had conceived.

Normally when a new technology comes along, if you're designing the first car, you go at it step by step, and you keep improving the car, improving the car, and problems may arise later. The thing that Gary had going for him was that, since he had gone through a full formal academic program, since he had a Ph.D. in computer science, since he had taught at the Postgraduate School, he had the sense of where this new industry was headed. Intel didn't know that.

It's not clear Intel knew that the chips they were selling were even computer chips, From their perspective, they were things like digital scales and traffic light controllers. In computer science, the formal education, you learn that there's a fundamental theorem that any machine that has this bare minimum set of capabilities-- the computer scientist Alan Turing hypothesized this area. If you can do just a handful of instructions, like addition, and clearing, and a conditional branch, and loading and storing data or something, any computer with that bare minimum could do anything, including simulate the operation of any other computer you could divine.

And if you could simulate the other operation, then that could run any code that had been written for any of those other computers. And so what he was always intrigued by the possibility of growing a market for the product, getting the simple chips that were extremely primitive, and getting them to run very, very sophisticated software. When he had been working at the University of Washington, he was the person behind the counter who you submit your box of punch cards to. The routine back then was that you would punch up some card, spend hours getting it straight, give this box to some priest behind the curtain. The priest would carry them away, and by morning when you went in, it might be sitting out with a long list of errors and things that you have to fix. So it's going to take you another two days before you could submit that.

Gary was the person that got the boxes, and what he'd like to do is, any night when there wasn't like a terrible backlog, he'd put out a sign that said, machine down for maintenance. And then spend the rest of the night playing at the console. That made the university's mainframe computer be his personal computer to play with and experiment with, and discover just how productive somebody could be if they weren't breaking their work into discontinuous sections. If you could run a program, see the bug, change that, and proceed, and keep doing this iteratively, it was tremendously productive, and tremendously empowering, and tremendous fun. Except you can't do that, because not every citizen can own an $8 million IBM mainframe.

When the first Intel microprocessor came out, what he saw was that, with the right software, there's nothing this thing can't do. Applying the Turing theorem. It might take a lot longer to do it, if you're running a whole IBM mainframe and you front run a program, it might end within half a second. OK so it might

take four minutes or 15 minutes to finish, if you have a very, very slow processor, but that's still an interactive process that makes people a lot more productive than they would have been otherwise.

So part of that was, his view, he already knew what the destination was, what the Promised Land was. He had been using these computers, very sophisticated machines to do very sophisticated things. And then when the Intel chip came out, what he saw was that this will grow to become that stuff, and the important thing is that we do it in steps, knowing what our target is instead of just experimenting and trying things one step at a time.

The time that Tom Rolander grabbed me from the workshop and brought me back to 801 Lighthouse, introduced me to Gary. I didn't know quite what was going on, but Gary basically launched into a lecture about this potential and what could happen, and here's what the software has to be, and here's what the first generation will be, and here's what the second generation will be. And then we're going to have to worry about multi-programming, and at some point remote connectivity is going to be important, so then we have networked operating systems, but they all have to run the same software, because you don't want to have to write new editors when you go from being this one thing on your desktop to something that's running on another system halfway across the country. And they'll become affordable, you can put multiple computers together, you can get them to cooperate, you can get them to communicate, you can get them to share memory, you can get them to pass messages back and forth, and run multiple tasks.

I mean it was just this weird vision. I had never heard anything like that. Within Intel, the company that was making the chips, nobody knew that's where the industry was headed. So what was fun then was sitting back, as he was teaching me about these things he'd occasionally grab a reference manual and give it to me and say, there's a lot more here, he'd grab an 8.5 inch floppy disk and say, here that's the utility, here's the operating system. A real corporation doesn't give stuff away to strangers. They make their stuff by selling. But he was trying to share with me, I guess Tom told him, I don't know what Tom told him. It seemed like what he was trying to do was, he enjoyed teaching so much, that I was a bright young pupil that he wanted to bring up to speed. He maybe knew that I was at Intel, maybe he figured the more disciples there were carrying in the message though the back doors, the sooner Intel would get the message.

But I walked away with an armful of hundreds of dollars worth of software and documentation and disks, not quite knowing why. But as I went home and started reading all this stuff it was just fascinating. Because mostly, when you get computer software, the user's manual tells you how to do things, here are the commands, here's the result.

Gary's user's manuals always included philosophy. Here's what we're trying to do, Here's how it works, here are the data structures, here's why they have to be the way they are, here's how they're going to be adapted, here's the process that goes on in opening a disk file. Teaching a lecture, a textbook, on how to

do what it is that he did. And by the way, here's what he did, which you can use as a reference. But don't stop there, here's how you change it.

There's been discussion of this BIOS and what it made remarkable. In the old world of mainframe computers, if you bought a computer mainframe from IBM or from Control Data or any other vendor, what you would get is an integrated package. They would deliver it, hook it up, install it, set in the cooling systems, give you all the software you needed. And that was it, you were at their mercy. If you needed something else you would have to buy something else from them. Gary's view was that, when we went from being large systems sold as a unit to individual chips being sold as a piece, there's no reason why people should be constrained by what some other manufacturer thought to offer them. So his goal was to think that any computer built using this particular processor or another processor like it, should be able to run all the software in the world at a minimum effort.

So towards that end, what this BIOS thing did, the basic IO system, was take a very complicated operating system, and make sure that all of the IO operations conducted throughout the whole application, the utilities, everything funneled down to a very small number of entry points. I think there may be 13 routines, things like here's how you read a character from a keyboard, here's how you write a character to a display, here's how you specify a sector on a disk drive, here's how you read that sector into memory, here's how you write that sector in memory. And he would explain the work, and he would show here's the source code we developed and do all that, and here's what was produced when that was assembled into the binary code.

And here's how those binary locations are laid out on sectors 13 and 14. And here's what you'll see in terms of all the hex values. And say you're trying to build a computer or change a computer and you're using a different mechanism for doing the output, then you have to change these two routines. And here's how you change them, you read in the sector, you poke and some slightly different values, you write it back out again.

You now have a fully customized machine, which won't do everything quite yet, but will boot up the operating system, and it will run the edit utilities. So from there, now you can make additional changes to the other routines to do disk reads and writes and bootstrap yourself up to the point where-- Well that was a lot of fun for me to do, I got very interested. I arranged to become the liaison to the company. And it just made sure, not just the people knew what was going on, but it also made the industry a whole lot more competitive, because computer manufacturers could change the components they were using, to the fastest, most efficient things at each step. And instantly bring with them years and years of application programs made by hundreds and hundreds of vendors. And the whole system would move seamlessly from one generation to the next.

Berg: Thank you very much John, that was extremely enlightening.

Laws: I thought we were going to get a demo of the Furby though.

Berg: We'd have to put the batteries back in.

Laws: Maybe later. OK. We have a few questions up here. When did Apple create the first Apple OS and how did it differ from CP/M? Gordon, can you answer this one for us?

Eubanks: I'm not sure, exactly, but it was contemporary with CP/M. And the difference between the Apple II and the operating system and CP/M was, CP/M was a disk operating system, and Apple was really focused on sequential devices like tape. I don't believe that in that period there were disk drives that originally were the Apple II '79 right?

Berg: '77. They did an upgrade for the Apple II, it had a board with a floppy disk controller. Which actually, was very interesting because the original ones had about 47 chips, and thanks to Steve Wozniak it went down to about five chips, because of the fancy software he wrote to run those five chips. Pretty amazing actually. That's actually part of the substantiation for the Apple II milestone that will be dedicated in about a year.

Eubanks: But it was originally tape.

Berg: It was originally tape.

Eubanks: I mean I think the vision though of CP/M was the disk operating system, the random access, it fundamentally changes what kind of software you can develop and what you can use it for. Again it wasn't something that hadn't been done in big computers, but it was a real milestone to do it with an 8080. When we talk about 8086s, there weren't any ‘86s in these days. These were 8080s that addressed 64K, fairly slow.

Laws: OK, hopefully a short answer to the question here about the issue of “Why didn't DRI immediately sue Microsoft for copyright infringement?” I think Tom can cover that first.

Rolander: Yeah, Digital Research didn't have a patent on CP/M. We copyrighted the API for the product. And at that point in time, nobody had taken to court an API lawsuit. So that was very complex at that point. I think from Gary's perspective, he was not litigious. He was more looking to the future. He was more interested in multitasking, moving on to the next generation. So he was less concerned about that interface and protecting it from, and pursuing a lawsuit.

Eubanks: They also had a legal agreement with IBM, if we remember.

Rolander: That was part of it.

Eubanks: He went to New York and the agreement was that IBM would release the computer with no operating system, but the user could buy whichever one they wanted. Right, there were three of them. And of course, all the applications ran on Microsoft's operating system, but--

Rolander: And one other minor difference, and that was, CP/M was priced at $260, and PC DOS at $40. So they let the market speak.

Wharton: Let me interrupt. I bought a PC, and of course every case I know of, they threw in the operating system for free. It's a $40 value that we're giving to you for nothing at all.

Eubanks: And it was always DOS.

Laws: Made it an easy sell.

Wharton: And I'm sorry for interrupting you. If you prefer to spend $260 for CP/M, we do have that in our warehouses, fill out one of these forms, pre-pay, we'll send it on to the office. We usually send these out every month or so. In the meantime, here's a free copy of MS DOS, get started now, start developing software, do what you want. By the time you get the software you need, you'll be two months into this, and it will never make sense for you to suddenly stop and start from scratch, because you got what you needed and had started.

Laws: Another question, wasn't the first name control program slash monitor? And I think that was correct, it was later changed to microcomputer. Make it more obvious what the applications were. How many companies did Gary start? I think we listed about five different companies?

Rolander: Digital Research, Acti-Venture became KnowledgeSet, and Prometheus Light and Sound, so three.

Eubanks: The first name of Digital Research was actually Intergalactic Digital Research, a piece of trivia most of you probably know.

Laws: And for me, can you tell us about software plans in CHM and where CP/M would fit? Specifically, about CP/M I don't know, I'm a chip guy, not a software guy. But there is a very big exhibit in development this is due to open when they finish fund raising for it. It's called Make Software, and it's going to be about, Doug about a $7 million or $8 million exhibit. With some of the fundamental applications of software and how they work in our lives. I know Photoshop is one of the examples that'll be used. So I think we're about out of time. Are we out of rain yet? No, it's still raining.

Berg: It's lightening up, it's lighter than it was at least.

Laws: I've got one other thought. If we have a few more minutes here, Scott do you have your words with you right now? Maybe, in case some of you can't make it down to the plaque because of the rain, Scott Kildall has a few words that he's prepared to speak there. Maybe it's a good time to hear them now.

[INTERPOSING VOICES]

Scott Kildall: So you're going to have to imagine that we're outside in front of the milestone, and you guys are standing around a circle and I'm not sitting here on the podium with everyone else. So this is more of a formal speech, but one thing that struck me is that there's been so much amazing stuff I've learned today about the history from Gordon and John and Tom that I never knew from talking to my dad or reading his memoirs. So, it's been personally really amazing. I'd also encourage you guys to take some active roles in Wikipedia. Seriously, I've looked at his Wikipedia page many times, and a lot of this stuff's not in there, and it should be.

My sister and I co-wrote the speech and we'd like to thank everyone for coming out here in person today to celebrate the dedication of the milestone. And I'm going to get a little bit emotional at a few points, so forgive me, for our dad. And a special thanks to Tom Rolander, who's been a longtime family friend, and David Laws who's been incredible, and everyone at IEEE, who I've just met today, to do the legwork to honor Gary's legacy.

It's just an amazing experience to be back in the small town where we've grown up. I have many childhood memories of the eight inch floppy disks, terminal computers, and the family of Digital Research employees. And I grew up in Digital Research when I was seven, eight years old, and being surrounded by these machines. And it was just incredible to be there. We didn't know the significance at this time, but my dad and our mother Dorothy McEwen who was his cohort in making Digital Research a reality, and providing this amazing business atmosphere for his employees. This milestone, like every IEEE milestone honors the inventor, a rare type of human. This is the person who creates something original, rather than just finding something and marketing it, and finding the work of others that way. And this is someone who brings a new technology to share with the world, as Gary's case is driven by the spirit of creation, rather than that of profit.

With the dedication of this milestone, and everyone that has ever preceded it, I think we have the opportunity today to redefine what success really means. Success means embracing invention. Gary saw what didn't yet exist, and worked so very hard to make this vision happen. In 1974 as we all know here, people thought of the computers as toys. Or they hadn't even heard of computers. They thought of them as these giant things ensconced in private companies. And when he wrote CP/M, he envisioned this world where everyone would have a personal computer, and now we have them on our desks, our laptops, in our pockets, and this is only the beginning.

Success means sharing ideas. Gary, he would often sit down with a pen and paper, and I didn't even know that story about him laying out this door frame like style with the giant diagrams. But I do remember the doodles that he always had, and he was always telling me, a seven-year-old kid, and diagramming things like the concept of infinity to like a seven-year-old kid. And he would share these ideas, no matter what the cost. And he'd always want to start a lively conversation about coding or the CD-ROM with just about anyone. I think Gary today would've been a huge supporter of today's open source culture. That was just his nature.

Success also means doing what you love. And Gary just loved his work. [He made his joy of ideas infectious to others. And I think there's a lot of people here, former Digital Research employees, can I see hands up? Yeah, many of whom now stand before us, maybe a little older, maybe a little grayer. And that experience just changed so many lives. I mean, provided products that help millions and millions, but all those people, all those Digital Research employees I see here today. 40 years later, after the invention of CP/M, 20 years later after his death, and all those people have carried that legacy of Gary and his creative juices-- I'm totally going off script right now-- into the future.

I think many of us are just privileged to work with, or be related to, or to know Gary and his work, either personally or professionally. And I just hope that we can embrace this other type of definition of success. That we recognize, support, and embody this definition of what success means, loving your work, being creative, and sharing it with others. And I can't help but think of how proud Gary was, our dad, of that moment in 1974-- and this was, I think we point to that pivotal moment as something that he wrote about, with assistance of John Torode, who provided the hardware engineering-- Gary transferred the CP/M program, and he wrote this in a simulator, it was all simulated software, from a paper tape onto a floppy disk, and it worked the first time. I mean, that was just amazing, that he actually made this happen the first time. And at that moment, that the computer talked to the world, via floppy disk, which in my mind is the very birthplace of the personal computer. Thank you.

[INTERPOSING VOICES]

Berg: So I'm going to distribute [small glass] replicas of the IEEE milestone plaque to our speakers today, including to Scott and Kristin. If they could come up here for those as well.

Laws: They're sort of alphabetical. I think.

Wharton: We got the Bs over at this end.

Rolander: The last one.

Berg: Thank you. Thank you very much. Is that David?

Laws: Thank you. What a surprise.

Berg: And Tom.

Rolander: Thank you.

Berg: Absolutely.

Rolander: Woah.

Berg: So these are glass plaques with the words that are on the bronze milestone plaque that's at 801 Lighthouse.

[INTERPOSING VOICES]

Berg: We also have one for Weilian Su And also for John. Thank you everybody.

[EDITOR'S NOTE: THE VIDEO NOW MOVES TO THE EXTERIOR OF A VICTORIAN RESIDENCE AT 801 LIGHTHOUSE AVENUE, THE FORMER HEADQUARTERS OF DRI, FOR THE UNVEILING OF THE PLAQUE. IT IS RAINING HEAVILY AND SOME OF THE COMMENTARY WAS NOT CAUGHT BY THE MICROPHONE.]

Bill Kampe: I'm so delighted to see everyone here for this recognition. Such historic contribution to the computer industry, made right here in Pacific Grove by Digital Research, Gary Kildall, and a very significant team of people who participated in making it happen. I'm joined, and I believe you've probably met, our mayor pro tem, Robert Huitt. I just have tell you my latest personal story, got a new computer two days ago, discovered I'm going to have to go out and upgrade the BIOS.

And it's bringing me flashes to my earlier days in the computer industry when I spent a lot of time tracing interrupts through assembly code, and what it did in the BIOS. But anyway, a lot of great things have happened here. It's had a profound effect on the evolution of the computer industry. And I will turn it back at this point to David Laws.

Kildall: It's been so amazing. I think most of you or a lot of you were at the presentation earlier today, and either in person or on video, and it was just amazing to hear Gordon, Tom, David, John Wharton, all those people who were talking about Gary's significant contributions and contextualizing them in a way that even I, his son, who had access to his memoirs, and who talked to him many times before he passed away, didn't know. And it's so touching that many, many people flew in from all over the place. And once again I'd like to do a big thanks to all the DRI employees who came out today and were part of that great time.

And one lasting legacy that all of us here, in person, and all the people whose lives that Gary touched, we know that Gary passed away younger than he should have, and he didn't get all the recognition in the industry that he should have, but he's getting the recognition today that he should. And that legacy that we all know here person, that we're experiencing today and now, we're going to carry through in our lives to the people that we touch. Thank you very much.

Rolander: I'm Tom Rolander, and I worked here at Digital Research in this building right here. And my office was up in the back corner up there, and we had a fantastic time by the way in this building. Just what I could say is, that this is something that Gary would truly appreciate, would be this kind of celebration, because it's one among friends. He was a very collegial person, and very social, and he had that social and warm aspect of him, and he also was an incredible inventor. So we're here today to celebrate his invention that will be unveiled here on the sidewalk. Thank you.

Michel: So I want to remind everybody, as I often say, engineers literally invent the world that we live in, engineers and computer scientists. And IEEE likes to recognize the top engineers and computer scientists, and so this is 139th milestone for IEEE, for something that has really changed the world we live in. Thanks Gary.

[EDITOR'S NOTE: LAWS AND MICHEL MOVE TO THE PLAQUE SITE, WHICH IS COVERED WITH A BOX DECORATED WITH COMPUTER PUNCHED TAPE AND A FLOPPY DISK.]

Laws: Just cut the tape there.

Unknown Speaker: Floppy disk on top?

Michel: It is.

Laws: [Holds up a length of punched tape] This is the way it was done before floppy disks. And Howard is going to read the inscription on the tape.

Michel: [Reads message punched into the computer tape] This may have been one of the most exciting days of my life, except of course when I visited Niagara Falls one day.

[LAUGHTER]

Laws: That was a favorite expression of Gary's that he wrote in his description of his feelings immediately after he completed and booted up CP/M for the first time.

Unknown Speaker: How appropriate it's raining. It's Niagara Falls.

