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LJC: First, maybe talk a little bit about your family, their personality, and something you have strong memory when you are in childhood. Tell your stories with more details.

LJC: 首先，可否谈谈您的家庭，家人的性格，以及您在童年时有深刻记忆的事情。请详细介绍一下您的故事。

LR: OK. Well, I grew up in Connecticut, within driving distance of New York City. My parents were both PhD chemists. My father ran the local **Dorr-Oliver** research lab. He was in charge of all the research for their operations for their company. And my mother was graduated from Yale, doing their PhD. But the time was such that she couldn't also take a job. It could have been inappropriate back then. So she took care of the Girl Scouts in the United Front and other volunteer activities, because she was a very high-energy woman. So somehow, as I look back, I see that there is a strong concept for us children (I have two sisters older than me) to all get great education and aim at a PhD themselves.

LR 好的。我在康涅狄格州长大，开车就能到纽约市。我的父母都是化学博士。我的父亲管理着当地的 **Dorr-Oliver** 研究实验室。他负责公司运作的所有研究工作。我母亲毕业于耶鲁大学，在那里攻读博士学位。但那个年代的奇怪之处是，她反而不能找到工作。可能是那时候不太合适。所以她在统一战线管理女童子军，还参加了其他志愿者活动，因为她是一个非常精力充沛的女人。所以不知为何，当我回顾过去时，我发现我们几个孩子（我有两个比我大的姐姐）都有强烈的概念，就是所有人都获得良好的教育，并且力争取得博士学位。

So my older sister went into education, so it wasn't actually useful to get a PhD. She has got a master's. Actually that was a problem for her because when she has master's in education, you have to be paid more. And if they don't want to pay more, they won't hire. So she had some problems in that way. But in any case, my second sister got her PhD in biology. She went to Tufts and I went to MIT about the last of her period in Tufts. So I was three years behind her. I went to MIT.

所以我的大姐姐接受了教育。但获得博士学位并不是很有用，所以她取得了硕士学位。实际上这对她来说是一个麻烦，因为当她拥有教育硕士学位时，就应该得到更多报酬。如果雇主不想支付更多，她们就不会被雇用。所以她就遇到了这类问题。但无论如何，我的二姐获得了生物学博士学位。她去了塔夫茨大学，而我在她即将读完大学的时候，去了麻省理工学院。所以我比她晚了三年。我去了麻省理工学院。

And actually going back to my childhood, I got interested also in all sorts of science. I did a lot of experiments of different kinds. A bit of Tesla coils for sparks; induction heating which people are now using for kitchen. I built a TV for the family out of the parts because TVs were just becoming available. And I built a lot of electronic equipment, radio systems, and other things. Just all sorts

of equipment. I didn't do much with chemistry, but I did make nitro-glycerine when I was in third grade, actually probably second grade. And, luckily, I didn't work too well. But later when I was in college, I worked fine. But besides playing with nitro-glycerine, I didn't do much chemistry. I actually had an accident when I was mixing a number of chemicals, and I sniffed it, and there was chlorine in it, and I had water in my lung. I had to get that treated.

童年时代，我对科学感兴趣。我做了很多不同种的实验。比如用特斯拉线圈做火花的大实验；还有感应加热，人们现在把它应用于厨房。我为家里制作了一台电视机，因为那时候电视刚刚上市。我制造了很多电子设备，无线电系统和其他物品。非常多种设备。我在化学方面做的并不多，但是在三年级的时候我确实制造过硝酸甘油，实际上可能是二年级的时候。而且幸运的是，我的努力并没有取得太好的效果。但后来当我上大学时，我干得很好。但除了硝酸甘油外，我并没有做太多的化学反应实验。实际上，当我混合一些化学物质时，我遇到了事故。我闻了闻化学试剂，那时它正在流，于是我的肺里进了水。

LJC: So you were pretty brave as a child.

LJC:小时候你很勇敢。

LR: Yes. My grades, my ranking was very high in academics. So I moved ahead, and did a lot of college courses in high school. I played the trombone for many years into college, and after that I gave it up. But I was second in the state as for trombone. The same was true of rifle shooting. I practiced rifle shooting and was also second in the state. (LJC: Really? Amazing!) So I did lots of things when I was in Connecticut.

LR: 是的。我的成绩和学术排名非常高。所以我再接再厉，在高中学习了很多大学课程。我演奏了好几年的长号，直到大学，之后我就放弃了。但我在长号比赛上排名第二。步枪射击也是如此。我练习步枪射击，也获得了州第二名。（LJC：真的吗？）所以我在康涅狄格州时，做了很多事情。

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LJC: I'm just curious. Dating back to the years when you were in kindergarten or even earlier, how did you get interested in science? You know, some kids like other stuff.

LJC: 我很好奇。在幼儿园或更早的时候，您是如何对科学产生兴趣的？毕竟有些孩子喜欢其他东西。

LR: Well, my father and mother were scientists, so I sort of grew into it. It was normal. In fact encouraged, I'm sure. But they gave me access to all sorts of materials and I used them. You know, they helped me get things to do experiment.

LR: 嗯，我父亲和母亲都是科学家，所以我有这方面爱好。这很正常。我很受他们的鼓舞，这是肯定的。他们让我得到了学习材料，我也利用了它们。他们帮我获得了做实验的材料。

LJC: So specifically, they brought the materials to home, or you have...

LJC: 具体来说，他们把材料带给了谁，或者你自己.....

LR: Oh, no, we bought electronic kits and other things which I could put together and used for **Matt** built-in solar scope, so I could see what I was doing. And other things like that. They just

provided that atmosphere and capabilities for me to try and learn about science. So outside of that, I did the other things like music. Because with the trombone I went to a music camp for the summer. Actually through that, I got asked to join a local symphony. In the neighboring town, there was a symphony orchestra that we played commercially. And I joined that for a number of years when I was in high school.

LR: 哦，不，我们买了电子工具包，里面有一些可以用来组装的零件。我做了一个太阳能望远镜，我知道我在做什么。我还做了其他类似的东西。家长只是为我提供了尝试和学习科学的氛围和能力。除此之外，我做了其他一些事情，比如音乐。因为会长号，我去了音乐夏令营，还被邀请加入当地的交响乐团。在邻近的城镇有一个交响乐团，我们会进行一些商业演奏。我在高中时，在那里待了很多年。

LJC: Oh, really? So you have the gift.

You talked about your parents, right? So what's their work and job, and how did they influence you? You talked they provided environment. Could you elaborate it, and tell us more details?

LJC: 哦，真的吗？所以您很有天赋。您谈到了您的父母，那么他们的工作是什么，他们是如何影响您的？您说他们提供了环境，是否能详细说明一下，并告诉我们更多细节？

LR: My father's company's lab was nearby. We could walk to it. So I could go see him there, and see what they were doing. It was large equipment like gold separation, and equipment in () solids work all sorts of big separators. So they built all that. He worked out the chemistry for all the reactions. My father had lots of patterns. And he was very high-ranking in his activity. So I was proud of him. He worked very... until he was 90, he still chopped the wood for the fireplace.

LR: 我父亲公司的实验室就在附近。我们可以走路过去。所以我可以去那里看他，看看他们在做什么。那里有大型分离设备，以及适用于各种大型分离器的设备。他们制造了这一切。他为所有反应提供化学支持。我的父亲能力很强。而且他在他参与的项目中职位都非常高。因此我为他感到骄傲。他工作非常.....直到他 90 岁，他仍然在努力工作。

LJC: So any story you think your father influenced you the most? For example, like Steve Jobs, he still remembered his father working on some furniture. That's the detail-oriented, rights? You know, caring about every detail when you make something. Is there any story?

LJC: 那么你认为您父亲对你的影响最大吗？例如，像史蒂夫乔布斯一样，他仍然记得他父亲在做一些家具。就是这些细节。做一件事时，总会关心每一个细节。在这方面有什么故事吗？

LR: I'm not sure about that. For a job to make money when I was in school, the head of his company had a farm where there were chicken houses. So they bought chickens, and I raised chickens for a few years, and sold the eggs to the market, and sold the chickens later. That worked well and I made money. He encouraged me to do things like that. He didn't push any particular science, because he actually hid all the chemicals so I couldn't make the nitroglycerin until I found them. But since he was a chemist, he had nitroglycerin accident. I sought around the house. So he had hidden. But I found them.

LR: 我不确定。在我上学期间有个赚钱的工作，他公司的负责人有一个养鸡的农场。他们买了鸡，我养了几年鸡，把鸡蛋拿到市场上卖，后来又卖掉了鸡。这很不错，我赚了钱。他鼓励我做类似的事情。他没有推动我接受任何特定的科学知识。相反，他们实际上把所有的

化学用品藏了起来，所以除非我找到它们，否则我都不能制造硝酸甘油。但由于他自己就是化学家，他经历过硝酸甘油事故。我会绕着房子寻找。他把东西藏了起来。但被我找到了。

LJC: So actually as a child, you not just learnt science from them, but also know the whole operation and the product development. Is that right?

LJC: 还是孩子的时候，您不仅从他们那里学习科学知识，而且还知道整个操作和产品开发。对吗？

00:09:51

LR: Yeah. I was very involved in doing my own experiments. And I saw what he was doing. But that wasn't in the house. He fixed everything, but he worked at his company largely. And my mother was very supportive as well. Certainly knowledgeable about medicines and everything else, because when they were in their PhD programs, they learned a lot more about medicine than most people. So even back then, we knew more about supplements and medicines than we do today, I mean, than most people did.

LR: 是的。我深度参与了实验。还看到了父亲在做什么。但那并不是在屋子里。他解决各种问题，但主要是在他的公司工作。而且我母亲也提供了大力支持。她在药物和其他各种领域都学识渊博，因为当他们参加博士课程时，他们比大多数人学到了更多关于医学的知识。所以即使在那时，和很多其他人相比，我们对补充品和药物也比大多数人知道的更多。

LJC: Is there any specific story you can remember about your mom, and maybe something related to how your mom coached you in important program?

LJC: 您有没有关于母亲的具体故事，比如她如何在课程中教育您？

LR: Well, let me give you one case. My mother was very involved in the Girl Scout. She ran the Girl Scout in the town. And because of that, they family was recruited to help build all the Girl Scout camps. So they would go up, my mother and father and my sisters, and work on putting together the Girl Scout camps. So we did a lot of that in the local camp. And there was another camp she built up later on actually when I went to college.

LR: 好吧，我确实有个例子。我的母亲深度参与了女童子军。她在镇上管理女童子军。因为这样，她的家人也被招募来帮助建设所有童子军营地。这样，我的母亲和父亲，以及我的姐姐们，也都过去了，并且努力组建女童子军营地。我们在当地的营地做了很多工作。其实当我上大学时，她还建立了另一个营地。

They needed a telephone system to string together all of their different sites on the camp. And so I built a small circuit board with transistorized telephone exchange. Probably the first when I built. There was all transistor. Because I had those parts in MIT, and all of the commercial exchanges were still relays. I had all relay equipment too, and I used that in school. But to do the camp, I just did it with transistors. And they were in stock at the camp. They had wires between the places. And they handled telephones, calling each other, which was great effective. And then I could call out on their other line. (LJC: Oh, really?)

他们需要一个电话系统将他们在营地的所有不同地点串连起来。为此我做了一个带有晶体管电话交换机的小型电路板。可能是我做的第一个。它们都是晶体管。我在麻省理工学院也有

相关的零配件，所有的商业交换机仍然采用继电器。我也有所有的继电器设备，我在学校里也使用过。但是在营地上，我只是用晶体管来做。他们营地有相关存货。不同的地点之间有电线连接。他们互相打电话，这非常有效。我也可以打电话给他们的另一条线路。（LJC：哦，是吗？）

So it was very interesting experiment, because no one had really done that before. And they made it available for the camp. So that was the kind of thing that went on. A lot of the work with the camp was just manual labor.

这是非常有趣的实验，因为之前没有人真的这么做过。他们把它提供给营地，这就是事情的经过。但其实营地的许多工作只是体力劳动而已。

LJC: So maybe the audience also want to know your family life? What is your family like when you were a kid? If people could watch it as a movie.

LJC：也许观众也想知道您的家庭生活。当您还是个孩子的时候，您的家人是什么样的？如果人们可以将其当作一部电影来欣赏的话。

LR: My family life as opposed to what I see today was more regular in a sense that we all sat down at the meals together. So my mother cooked. And my grandmother was there for a while. And she helped. Well, for breakfast, it was sort of depending on when we got up. We cooked on our own. But for dinner, we all sat down together, and talked about the day, talked about what was going on. So we were very close as a family. We stayed together.

LR：与我们今天看到的一些情况相反，我的家庭生活更加规律。家人都在一起吃饭。我妈妈负责做饭，我的祖母在那儿待过一段时间，她也帮忙。早餐取决于我们何时起床。我们自己做饭。但是在晚餐时，我们都坐在一起，谈论这一天的故事，谈论都发生了什么。我们作为一个家庭是非常亲密的，我们住在一起。

LJC: Were your grandparents live nearby in the same town?

LJC：您的祖父母住在同一个城镇附近吗？

00:14:28

LR: My grandmother, my father's mother, and father lived in ... where he grew up. So when he died, she moved in with us in the East Coast. And so she lived there for a number of more years with us. My other grandmother, and mother's father had died somewhat earlier. He was in Massachusetts. And my grandmother had a big house there. We went there and visited quite often. (LJC: Oh, really?) But they lived in Massachusetts. She never came down. We went up to see her.

LR：我的祖母，确切地说是我父亲的母亲，我奶奶，住在.....那是他长大的地方。因此，当他去世时，她和我们一起搬到了东海岸。她和我们在那里住了很多年。我的外公外婆早些时候去世了。他住在马萨诸塞州。我的祖母在那里有一所大房子。我们经常去那里参观。（LJC：哦，是吗？）但他们住在马萨诸塞州。她从来没有来过，都是我们去见她。

LJC: Who had more influence on your personality or character as a child?

LJC：孩童时期，谁对您的性格有更大的影响？

LR: Well, I'm sure my father and mother did. I don't know if they are different. My father clearly was a good influence on science, managing science and working at science as an activity. And my mother had tremendous amount of knowledge and energy. So I learned a lot from her. And I saw her as a very strong person. They both lived until they were above 90. So they lived great, longer than most people at that age.

LR: 嗯，我的父亲和母亲肯定都有影响。他们的影响不分轻重。我的父亲显然在科学、科学管理和从事科学工作等方面有很大的影响。而我母亲则拥有丰富的知识和充沛的精力。所以我从她身上也学到了很多。我认为她是一个非常坚强的人。他们都活到90岁以上。所以他们生活得很好，比那个时候的大多数人都活得长。

LJC: You talked about your father, rights? So anything specific that you think have biggest influence, No. 1 or 2, regarding hard-working, or creativity?

LJC: 您谈过您的父亲，那么您认为他在您的勤奋或创造力等方面是否有什么特别的影响。父亲和母亲，谁的影响最大？

LR: I can't say there was one thing that was stronger, because they both have strong influence. They both were very intelligent, and capable, and powerful and energetic people.

LR: 我不能说谁的影响更大，因为他们对我的影响都很大。他们都非常聪明，有能力，有能量，精力充沛。

LJC: Let's just compare your parents. It's more like the character of your father which influences your characters is hardworking, creativity or something like that.

LJC: 我们来比较一下您的父母吧。似乎您父亲在勤奋、创造力或类似的领域对您的影响更大？

LR: Both of them did that. Because my mother worked very hard too. Even though she wasn't allowed to take a job, she ran the Girl Scout, she ran the United Front. She was a cheer leader as well.

LR: 他们两个都对我影响很大。因为我母亲也非常努力。虽然她无法真正找工作，但她还是去为女童子军做贡献了，她管理着联合阵线。她也是一位拉拉队长。

LJC: It's a contribution to the community as well, leadership. Is the Girl Scout still going on very well today?

LJC: 这也是对社区的贡献，很有领导力。女童子军今天还在继续运作吗？

LR: I don't know much about how it is doing.

LR: 我不知道它现在的情况了。

LJC: But it's very popular in California. Right.

LJC: 但它在加利福尼亚很受欢迎，是吗？

LR: So she was very strong as well. I think both of them affected me similarly.

LR: 所以她也很强。我认为他们两个同样影响了我。

LJC: So it's long-lasting effects, not just specific events or specific moment that made you feel that you wanted to work on science. It's long-lasting influence right?

LJC: 这是持久的影响，不仅仅是特定事件或特定时刻让您觉得自己想要从事科学工作。对吗？

LR: Well, as far as the choice of science, my thinking is that chemistry is seen like an old head, an old technology just like mechanical. And I was looking for something new where I could make a real change, make a difference in the world, which actually I did (laughter). I was looking for that. So I went into electronics, because it seemed like the newest field. There I could get into. So I went into electrical engineering when I was 20. So I stayed with electronics and will get back to them. But I spent a lot of time working on... well, I thought about it, and decided how to pursue it. Actually I was admitted to Harvard, Yale, and MIT. I chose MIT because it was the electronics.

LR: 就科学的选择而言，我的想法是，化学看起来像一个老头，一个像机械一样的旧技术。我正在寻找新的东西，在那里我可以创造真正的变革，改变世界，实际上我也做到了（笑）。我也在寻找那种领域。所以我进入电子领域，因为它看起来是最新的领域。我可以深入其中。所以当我 20 岁的时候我就进入了电子工程领域。我那时一直留在电子领域，并还会回到这个领域。但是我花了很多时间研究.....好吧，我考虑过这个选项，并想好了如何去追求它。实际上我被哈佛大学、耶鲁大学和麻省理工学院同时录取了。最后我选择麻省理工学院是因为专业是电子学。

LJC: So you have your idea on what field you want to pursue already, right?

LJC: 所以您对自己追求的领域很有想法，对吧？

LR: Yeah. Well, when I was in high school, anyway, maybe before that.

LR: 是的。我在高中时就有了这种想法，也许在那之前。

00:19:36

LJC: We want to know more stories about anything very impressive when you were a child.

LJC: 我们想知道更多关于您小时候令人印象深刻的故事。

LR: I'm not sure. You know, as I said, I built the TVs, I built all sorts of things around the house.

LR: 我不太确定。正如刚才我说的，我做了电视，还在房子周围建造了各种各样的东西。

LJC: Maybe just how did you figure out that you wanted to build the TV, or what's the process you bought the material, made it, and the challenge in the process?

LJC: 也许可以谈谈您是怎么想出自己造电视的。或者您购买材料的过程是什么？制作过程以及在此过程中的挑战？

LR: Well, there was a kit, you could put the parts together. And I had other kits at that time that were for the solar scope and other pieces I needed. But it was a new thing, and we needed to try it. So it put it together, and built a cabinet, and built the TV.

LR: 嗯，我有一个工具包，可以将零件都放在一起。我当时还有其他套件，用于制造太阳能望远镜，还有我需要的其他部件。但这是一件新事物，我们需要的是尝试。所以我用工具

箱把零部件放在一起，并做了一个电视柜，然后制造了电视机。

LJC: But I'm just wondering, other than the kits, how did you know that theories on the electronic secrets?

LJC: 但我只是想知道，除了工具包之外，您是怎么知道相关电子理论的奥秘的？

LR: Well, in this case, the kit helped a lot. It told me what I had to put together. But I had to settle everything and put everything together. It gave me a good idea how it worked. Later on, when I was in high school, I got a job in the local TV repair shop. And I learned. I was the only one who understood transistors there. So I had to do any repairs on the transistor. But then I felt close to every place, tubes and TVs, and fix TVs when they were broken.

LR: 嗯，在这种情况下，那个工具包帮了很多忙。它提示我必须把那些零件组装在一起。但我必须解决所有相关问题，把所有零部件组装好。它让我清楚电视机是如何制造的。后来，我上高中时，我在当地的电视维修店找到了一份工作。我是那里唯一了解晶体管的人。所以我不得不承担起所有晶体管相关的修理工作。但后来我感觉每个项目都很类似，如电子管和电视，所以后来电视坏我也负责修理电视。

LJC: What was your parents', your father and mother's reaction when you told them you wanted to build a TV rather than asking them to buy a TV. You know, I can never imagine my daughter wants to make a TV for me.

LJC: 当您告诉父母，您要自己做一台电视，而不是去买的时候，他们是什么反应？我就无法想象我的女儿想要为我制作一台电视。

LR: Well, at that time, that was probably the most economic way to approach it to get a kit to build it. But I also wanted the experience. I mean, I was interested in doing those things, and seeing how they worked, and making sure I understood them.

LR: 在那个时候，用一个工具箱来自己做一台电视机，可能是拥有一台电视最经济的方式。我也想要这种体验的过程。我的意思是，我有兴趣做这件事，看看电视机是如何运作的，并确保我理解它们。

LJC: So when you made the proposal to your parents that I want to buy the kits, I want to ask for some money, what was their reaction?

LJC: 所以，当您向父母提出想买工具包，想要一些钱，他们的反应是什么？

LR: They helped me by buying it. They were quite cooperative. They loved to have me do things like that. They didn't watch TV much ever in their life. But it was down in the family room, and my sisters used it. And I used it for some. I didn't pay a lot of attention to TV, but I did watch a lot of movies back then. I don't watch any more.

LR: 他们帮我买了工具包。他们非常配合。他们喜欢让我做那样的事情。他俩一生中都没有看电视。但是在家庭活动室里，我的姐姐们看过，我自己也看过一些。我没有太多关注电视节目，但我当时看过不少电影。只是现在我不看了。

LJC: So you finished the TV and reset the TV in one time, or maybe you did the work...?

LJC: 所以您是一次性制造并重置了电视，还是分开来做的？



LR: Oh, it took weeks, roughly a month to build. Man, I had to go to school and do other things. So it was just a project that I worked on. There were all sorts of things like that. Probably I when I made the nitroglycerin and I went to school, the elementary school, as I say, it was like in second grade. And so I took some of it and put it on the rocks and pounded it with my friends with another rock. And it didn't explode, which was lucky. Later on, I learned that I had it at too high a temperature.

LR: 哦，我花了几个星期，大约一个月才完成。我不得不去学校做其他事情，这只是我工作的一个项目。我还有各种各样的事要做。比如当时我还制作硝酸甘油。那时我上小学，就像我刚才说的那样，那时还是二年级。我拿了一些，把它放在岩石上，然后和我的朋友用另一块石头敲打它。那时并没有发生爆炸，所以我们很幸运。后来，我了解到那时的温度太高了。

LJC: OK. Do you have a chemistry teacher?

LJC: 好的。您有化学老师吗？

LR: No, I had my father's books. (LJC: Oh, really?) I just grabbed his books and searched for what I wanted. He had plenty of materials. It was much more than most homes would have, since it was his business. In any case, there are more stories when I get to MIT. So maybe they want to move out of the childhood. I don't know.

LR: 不，我用的是我父亲的书。(LJC: 哦，真的吗?) 我拿起他的书，搜索我想要的内容。他有很多材料，这远远超过大多数家庭所拥有的，因为这是他的工作。当我到麻省理工学院后，还有更多的故事。也许童年部分差不多就这样了？您看呢？

LJC: We'd like to know more about the childhood then we move to your college life. So, other than your family, what about the environment on the town, maybe in the school? Which influenced you?

LJC: 我们想了解更多关于童年的信息，然后我们就开始聊大学生活。那么，除了您的家人，镇上的环境怎么样，学校的环境呢？哪个影响了您？

LR: OK, Well we lived two and a half miles out in the country from town. So it was it was not something where we could walk to town. And we could ride a bicycle, but it was a job. So my family usually drove us into town if we needed to go or the bus took us to school. I spent a lot of time in the countryside as a result. And with a friend who lived nearby, we went up and down the rivers. There were a lot of rivers nearby.

LR: 我们住在距离城镇 2.5 英里的乡村。所以我们不太方便走路到城里。我们可以骑自行车，但这也不容易。因此，如果我们需要去城里，就是父母开车带我们去，或者我们坐公共汽车。也因为如此，我在乡下度过了很多时光。当时和住在附近的一个朋友一起，在河边玩耍。那里附近有很多河流。

So we explored all of the tributaries and land, and spent time just running around the woods. One of the things I built was our pistol. It was started out as an air gun pistol, but I put on a new board and a new thing, and put twenty-two caliber bullets in it, and fixed it up so that it would work.

我们探索了所有的支流和附近的土地，并在树林里奔跑。我制作的另一个东西是我俩的手枪。

它最初是一把气枪，但是我装了一块新的板子，还有些新的小东西，并安装了 22 口径子弹，然后将它固定起来，这样就能用了。

And I connected it with an electronic solenoid. So when the electric eye I built would detect the groundhog, or, call it a groundhog. Things were buried into a hole. So I put the electric eye across the hole, and the pistol aimed at it. And so if he came out, he would get shot. It didn't hit. It didn't work. He avoided it. But in any case, it was it was not a very accurate pistol because the board was very poor.

我用一个螺线形电导管连接它。所以当我建造的电眼检测到土拨鼠时，它就会被埋在洞里。我把电眼穿过洞，用手枪瞄准它。如果土拨鼠钻出来，它就会被枪杀。可惜我们没有击中。这方法不管用。土拨鼠避开了陷阱。它不是一个非常精准的手枪，因为我们的材料用得不好。

LJC: OK. But it's very creative for kids. Yeah.

LJC: 好的。但这对孩子来说是非常有创意的事情了。

LR: And we had a rifle, so I practiced shooting in the backyard, but also at school. And as I said, I got very good at that.

LR: 我们还有一支步枪。我在自家后院练习射击，但也在学校练习。正如我所说，我非常擅长射击。

LJC: So it was considered as a sport, right? Rifle was considered as a sport that time? Did you mention that you have won a second place in rifle, right?

LJC: 射击也被认为是一项运动，对吗？那时候步枪被认为是一项运动吗？您刚才提到在步枪射击比赛中获得了第二名，对吧？

LR: It was recognized activity for the schools. And there was a statewide competition. Same with music, they had a statewide competition. So I did that too, as well as playing the symphony, lots of other things.

LR: 射击是学校公认的运动，，当时还有一场全州比赛。与音乐比赛相同，在全州范围内也进行了射击比赛。所以我也参加了，就像之前演奏交响乐一样，我还参加了很多其他的活动。

LJC: So as you see, playing the rifle, you need to be very focused, right, for practicing the game. Is there any similarity between rifle and maybe your project on the electronics?

LJC: 所以您看，玩步枪就需要非常专注，对吗？步枪和您的电子产品项目之间有什么相似之处吗？

LR: I wasn't particularly interested in rifles as an activity. But getting to be good at something like that was one of the options that I had at school. So I did. I mean, I had already practiced quite a bit at home, so I do pretty well. But the big heavy rifles that they used for the school were harder to handle than the light twenty two rifle.

LR: 其实我对步枪并不特别感兴趣。但这是我在学校的选修之一，我要做好。所以我去做了。毕竟我已经在家里有很多练习，所以我做得很好。但是学校的大型重型步枪比我的轻型 22 步枪更难把握。

Uh, so in any case, I did lots of different things. That's the main issue was raised quite widely. But my aim at school and in terms of most of my projects was an electronic.

不管怎样，我尝试了很多不同的事情。当时涉猎很广泛。但我在学校和大多数项目中的目标都是电子工程。

LJC: We also want to know what your personality was as a child. In general. More active and outgoing, or someone just like to stay at home, just do my project?

LJC: 我们也想知道你小时候的个性。一般来说，您是更加积极和外向，还是只想留在家里，只做自己的项目？

LR: Well, I didn't, I wasn't, I never have been outgoing, like making lots of friends and spending lots of time with friends. As I said, I spend a lot of time with a neighborhood boy walking in the woods. But it was what I did things. And in large part, I did my projects at home and at school, and played in the orchestra and did other things. But I wasn't widely active in making lots of friends. I was more concentrated on what I was doing.

LR: 我没有，我从来没有外向过。我并不喜欢结交很多朋友，花很多时间和朋友在一起。正如我所说，我花了很多时间和一个附近的男孩在森林里散步，但也仅此而已。很大程度上，我在家里和学校从事我的项目，还在管弦乐队演奏，也做了其他事情。但我并没有广泛、积极地结交很多朋友。我更专注于自己在做的事情。

LJC: But you did help on your mom's Girl Scout program, right?

LJC: 但您确实帮母亲完成了她的女童子军项目，对吗？

LR: Well, I worked with them at the camps, and then I saw what they needed in the case of the telephone exchange. But that was the main project I did. Otherwise it was mostly manual labor.

LR: 嗯，我在营地和他们一起工作，然后我注意到他们在电话交换机上有需求。但我也就做了这么一件事。其余的主要都是体力劳动。

LJC: What's your interaction with your sisters? Any stories?

LJC: 您和您姐姐们的互动是否也有一些？有这方面故事吗？

LR: Well, no, my sisters were older, three and seven years older. So my older sister, I didn't see too much because she was considerably older and then went off to school. And she went to Cornell at that point. And then my younger sister, I spent more time with. But the biggest thing I remember is she kept tickling me. It was annoying. But I didn't spend lots of time with them. The age difference was not conducive to it.

LR: 嗯，不，我姐姐年纪分别大了我三岁和七岁。所以我没有太多接触我大姐姐，因为她年纪大了很多，很早就去上学。那时她去了康奈尔大学。但我花了更多的时间和二姐在一起。我记得最深的是，她一直在挠我痒痒。这特别烦人。但我并没有花很多时间和她们在一起。可能是年龄差异比较大。

LJC: Also in this story, in the school, maybe regarding all the teachers or students, you know, or classmates, in elementary school or middle school?

LJC: 是否还有别的故事，比如在学校，包括小学和中学，和您的老师、同学们，是否也有故事？

LR: Well, I didn't have a lot of unique stories about school that I can think of. In seventh grade, I was in science class. And I was in since I was advanced, they had me doing some of the prep. And I was pushing a glass rod into something, and it broke and cut into my hand. So it was a big turmoil at the moment. The teachers were very supportive. They liked the fact that I was good at a lot of these things. And so they took advantage of that.

LR: 嗯，我没有很多关于学校的特别的故事，想不起来了。七年级的时候，我就进入了科学班。由于我学习超前，所以我能够进来。学校让我做了一些准备工作。那时候，我试图把一根玻璃棒插进什么东西，可是它断了，还并插入了我的手中。那在当时可是一场大动荡。老师们对我非常支持。他们很欣赏我，因为我有许多特长。他们也注意因材施教。

00:31:50

LJC: Which grade did you start the science classes, seventh grade or even earlier? Yeah.

LJC: 您从哪个年级开始上科学课？七年级还是更早？

LR: Seventh graders science. Yeah, that ran through the rest of our high school.

LR: 七年级科学。那门课一直贯穿了整个高中生涯。

LJC: So did you have any science project in elementary school? Maybe.

LJC: 您在小学期间有没有什么科学项目？

LR: Well, no, in elementary school, we didn't have a lot of projects. And when I was in sixth grade at home, I built an elevator in the big oak tree that was out. So I used a block and tackle to pull a great big crate up and down so I could go up to the branch and go down. So I use that. Unfortunately, I used a brass bolt to hold it to the rock, the block and tackle. It sheared one day when I was sitting in it, and broke. And I fell on my back inside the box on the ground, and broke my back. So I was in the hospital for a little while, and well, that got better and they put a cast on and everything. And so I miss the piece of sixth grade. But I was far enough ahead that they ignored it. In large part. There was no special projects in elementary school, and I didn't have any particular experience.

LR: 不，在小学，我们并没有很多项目。当在我家六年级时，我在屋外的大橡树上建了一个电梯。我使用了石块和滑车来上下拉一个大箱子，这样我就可以坐到树枝上，然后下来。我是这么使用的。不幸的是，由于我是用黄铜螺栓将它固定在岩石、石块和滑车上，有一天当我坐在里面时，它坏了。我仰面倒箱子里，摔在地上，摔断了背。后来我在医院待了一会儿，身体好转后，家人给这设备进行了加固。所以我错过了六年级的时光。但由于我的学习进度远远超过了别人，所以学校忽视了这点。在很大程度上，小学没有特别的项目，我没有任何特别的经历。

LJC: So even your school or in the town, there was no such a science club for kids?

LJC: 所以即使是你的学校或镇上，也没有一个适合孩子们的科学俱乐部？

LR: No, I don't think there were science classes. I did tons of science at home. But the school is mainly reading, writing and arithmetic.

LR: 不，没有什么科学课。我在家里做了大量的科学研究。但在学校主要都是阅读、写作和算术之类的课程。

LJC: So we just wonder where you worked on your project, in your house or garage? Did you have a dormitory in your home?

LJC: 我们想知道您在哪里操作项目，您的房子或车库等地方？您家里有宿舍吗？

LR: The basement was totally related to projects like that. So my father built, in the basement, his own table and wall of tools. He had electric grinders and sanders and all sorts of machines running on the next table. And then they had a lay to do woodworking.

LR: 主要是在地下室。我的父亲在地下室搭建了自己的桌子和工具墙。他有电动研磨机和磨砂机，边上的一张桌子上，还运行着各种机器。然后他还有个做木工的地方。

And so he had a lot of power tools to do things. And so I used those to my projects. And he and I built down another table for me to do my projects with some of that with chemistry, some of that was electronics, some of it was just mechanical pieces. One of the things he did was he collected old parts that were not useful anymore, middle parts. And so we had a large collection of piece parts that I could use to build something, or to fix something. And that's one of the things that they encouraged me to do is collect the parts so I could fix things.

他有很多电动工具来做这些实验。我也将这些设备用于我的项目。我俩做了另一张桌子，专门用来完成我的项目，包括一些化学的，电子学，还有机械方面的。他收集了一些用不上的旧零件、中间零件。因此我们有大量的零部件，我可以用它来做新东西，或修理一些东西。他们鼓励我做的一件事就是去收集零件，以便之后的制造工作。

LJC: So you know the different functions of the materials, right? How to make stuff. Did your father teach you how to operate the different tools?

LJC: 所以您知道这些材料的不同功能，对吧？包括如何制作东西。您父亲是否教过您如何操作不同的工具？

LR: Yeah. That was standard, and he had to make sure I knew how to do that. And so I did things like the tesla coil I wound on the lake, so that because it was huge amount of wire, tesla coil winding wire, for miles down the tube, which is about this long. So they did that on the lake because at least could let it turn while I was holding a wire to, and other things like that. But it was a well provisioned basement in terms of tooling.

LR: 是的。这是必须的，他必须确保我知道如何利用这些工具做事。因此我制作了一些东西，比如缠在湖边的特斯拉线圈，它需要用到大量的电线，沿着管线需要数英里长，大概这么长。他们是在湖上操作的，因为至少可以在我拿着电线时让它转动，以及其他类似的作业。在工具作业方，我家地下室的配置是一流的。

LJC: But I'm also wondering, how did you have the idea like tesla coil and induction heating, right? That wasn't popular at that time.

LJC: 但我也想知道，您是怎么想到特斯拉线圈和感应加热这样的实验的？毕竟在那时候知

道的人并不多。

LR: No. In fact, the induction heating, my father brought home some big capacitors from the lab that were left over. If I couple them with a coil, became tuned to sixty cycles, so that we had an oscillating circuit at sixty cycles to make the induction heating. And then I put that under my table and I could cook things on top or whatever. It was an experiment. We didn't keep it indefinitely.

LR: 没有。事实上，关于感应加热，我父亲从实验室带回了一些剩下的大电容器。如果我将它们与线圈耦合，调到 60 个感应圈，这样我们就有 60 个感应圈的振荡回路来进行感应加热。然后我把它放在我的桌子下面，就可以在桌子上或其他任何地方做饭。这是一个实验而已，我们没有无限期地保留这个装置。

LJC: But one thing concerning all those experiment is about, as you know, it's safety. Right? So the at this time, today, in school, most students are not performing those testing because of the safety concern. Right?

LJC: 但是关于所有这些实验的一件事是安全性，对吗？所以，现在在学校，大多数学生因为安全问题而没有进行这类实验，对吗？

LR: Well, he taught me pretty well how to be careful with safety. So I was well schooled in that. I don't think there was a problem in safety because of the fact that he supervised largely if I was doing anything that was dangerous. I mean that tesla coil isn't that dangerous. It can give you a burner that cause spark. But that's about it, and it can't kill you.

LR: 嗯，我爸爸教我如何注意安全，所以我受过良好的教育。我不认为安全性存在问题，因为如果我要做任何危险的事情，他会在很大程度上对我进行监督。我的意思是，特斯拉线圈其实不那么危险。它可能让一个燃烧器冒火花，但也仅此而已，不会对人造成致命伤害的。

LJC: I'm amazed that even if your father was a PhD in chemistry, he knew the equipment very well. Right?

LJC: 我很惊讶的是，即使您的父亲是化学博士，他对这些设备也非常了解。

LR: He was quite right. Yeah. His specialty was his chemistry. But outside of that he certainly was excellent at woodworking and fixing things. So he really fixed everything in the house, including the roof. Sometimes I had to help.

LR: 他说的很对。是啊，他的专长是化学。但除此之外，他也非常擅长木工和修理。他真的修好了房子里的一切，包括屋顶。有时我也不得不帮忙。

LJC: So were your elementary school and middle school in the same town, same neighbourhood?

LJC: 您的小学和中学是在同一个街区和同一个镇子吗？

LR: The schools were in town, two and a half miles away. So they were close. So that saved them driving or doing anything.

LR: 学校在 2.5 英里外的城镇。所以它们很接近。这样可以节省驾驶或做其它事情的时间。

LR: So before we move to college, any more story or anything impressive about your middle school life? Well, on this.

LR: 那么在我们聊大学之前，还有更多关于您中学生活的故事或任何令人印象深刻的事情吗？

LR: Well, I'm trying to cover anything I can remember. There were lots of projects, but I don't remember much more about them. You got almost no. It's too far over.

LR: 嗯，我试图提及任何我能记住的事。我做过很多项目，但不记得更多了。时间实在是太久了。

LJC: But your grade in middle school and high school? Your academic achievements.

LJC: 能否谈谈您在初中和高中的成绩？也就是您的学术成就。

LR: Oh, I did extremely well. They realized in the standardized tests that I was 99.99 percent. So I didn't have any problem in school as far as academics, and in high school, I did very well. So as I said I got accepted to all the colleges without any trouble.

LR: 哦，我成绩非常好。我在满分 100 的标准化考试中的成绩可以达到 99.99。因此，就学术而言，我在学校没有任何问题。而且在高中时，我也表现出色。所以正如我所说，我毫无困难地得到了所有大学的录取通知书。

LJC: You just said that you were very good in science and math, right? But how about writing, English or something like that?

LJC: 你刚才说你在科学和数学上非常好，对吗？但是写作、英语或类似的科目怎么样？

LR: I wasn't very interested in English and writing early on, but in high school there wasn't I got into. Because of my testing, they realized that I was belonged in advanced course. So they put me in a college grade, writing and reading, English course. And I wrote an award winning essay, something or other. That was actually in a national competition. I did extremely well because I got interested thing. But before that it wasn't very interesting, until it got to really where I could express some new thing and make something with it. So that changed the English around, and it was never my strong interest, but I got very good at it.

LR: 我对英语和写作不太感兴趣，但是在高中时我没有真正去学。由于我的测试成绩好，学校意识到我应该接受高级课程。所以他们让我上大学课程，包括写作、阅读，英语课程。后来我还写了一篇获奖文章，而且是在全国比赛中获奖。我做得非常好，因为我来了兴趣。但在此之前，这对我来说并不很有趣，直到写作真正能够表达一些新东西，并且我可以用它做出一些东西，这就改变了英语在我心目中的地位。虽然它从来都不是我最大的兴趣所在，但我也非常擅长。

LJC: At which grade did you make your mind, and decide to pursue the degree and consider your career, and want to study computer science?

LJC: 您在哪个年级做出决定，决定攻读计算机科学学位并考虑您的职业生涯？

LR: I didn't know about computers early on. I mean, I knew about whatever I read, but that wasn't much, because remember, this was in the forties before computers were even around. So what I was interested in is in electronics generally. And then, it wasn't until my senior year in college, the actual computer became available. And I'll tell you about that. But I didn't get interested in

computers, and really because there wasn't.

LR: 早前我并不知道电脑这东西。其实，我了解我读到过的任何学科，但那时关于计算机的文献并不多。记住，那是在四十年代，计算机还没有普及。所以我感兴趣的是电子产品。然后，直到我大学的高年级，计算机才算真正可用。我稍后会详说。但我并不是对计算机感兴趣，因为那时候真的没什么电脑。

LJC: So even in high school, you have never heard of the computer, right?

LJC: 所以即使在高中，您也从未听说过计算机，对吗？

LR: No, no, it wasn't something that was around in the forties. I mean if I read back I see that any act on a few machines were started in the later forties, but there just wasn't any public literature about it at all. I mean, I was all in this in back rooms in the schools.

LR: 对的，这不是四十年代会被大家知道的东西。我的意思是，如果回过头来看，人们在几台机器上进行的任何动作，都是在四十年代后期开始的，之前根本没有关于它的公开文献。我也是在学校的密室里边才真正接触了计算机。

LJC: But there was some like a calculating machine already, right?

LJC: 但是有些机器已经像计算机了，对吗？

LR: Calculators came out and I had an HP calculator. I don't know exactly when that came out, but whenever they started selling the HP calculators that let you do good things, then I got.

LR: 计算器问世了，我有一个惠普计算器。我不能确定是什么时候出来的，但每当商家开始销售有利于工作的惠普计算器时，我就会拿到。

LJC: Do you want a break before we moving?

LJC: 继续聊之前，您想休息一下吗？

LR: No.

LR: 没关系。

LJC: Let's move to your study in college.

LJC: 让我们聊聊您的大学生涯吧。

LR: So when I went to MIT, I first lived in the dorm, and I paid a lot of attention to the courses because I thought you had to do well. So I got all as without any trouble. As a result, they put all of the people, the thirty of us that had all as and did extremely well into a special class called 6B. Now, course 6 is the electrical engineering. 6A was industry-related, and 6B didn't exist before, but it was a new one where the head professors ran the classes. And we weren't expected to do extremely well. So this was a class went directly on to a masters rather than bothering with a bachelors. At the end of four years, we went to a five year, but a masters course really. And in the course of it, there were all sorts of projects that I could undertake. So I'll get back to that.

LR: 当我去麻省理工学院时，我是第一次住在宿舍里。我非常注意好好学习课程，因为我认为必须在学业上突出。所以我也没有遇到任何麻烦。结果，学校把我们三十个人，就是得到全 A 的表现极好的学生，全都安排在了一个叫做 6B 的特殊班级里。现在，课程 6 指代的



是电气工程。6A 与行业相关，之前没有 6B。这是一个新的、由高级教授经营的班级。而且学校并不指望我们能做到非常好。这是一个本硕连读的课程，不用纠结本科的毕业。在四年结束时，我们直接进入了第五年，是真正的硕士课程。在此过程中，我可以进行各种各样的项目。一会儿我还会谈到。

As I went to the school, I spent time with my friends in the dorm, and we did lots of things. One of them was that made nitroglycerin pack at home and brought it in. And we blew up things and around that were unarmful, wouldn't bother anybody.

我在学校时和朋友一起住在宿舍，我们做了很多事情。其中之一就是在家里制作了硝酸甘油，然后把它带到学校。而我们炸毁的东西都是无害的，不会打扰任何人。

One of the things that I did was fairly spectacular. My father brought home a lump of sodium about this size, of a huge amount of sodium, but metal and totally explodes when it hits water. So we took that and I wrapped it in all sorts of paper inside some kind of wrapping. And we went out on the ice in the middle of the Charles River in the middle of winter, drilled a hole in the ice, and dropped it through, and ran like mad back to the shore.

我做的一件事非常引人注目。我的父亲把一块这么大的钠块带回家，内含大量的钠，当它碰到水时会完全爆炸。所以我们将其包裹在各种纸张中。正值寒冬的时候，我们来到查尔斯河的冰面，在冰上钻了一个洞，把钠块扔进去，然后疯了一样跑回岸边。

And the device then, when the water suck through the all the paper, the sodium exploded, and made an explosion that essentially covered the whole Charles River. It was actually multi things, I mean, because it blew up a lot of pieces that were large, they hit the ice, they exploded again. So it actually spread about a mile and it was huge. It didn't hurt anything. We carefully placed it so it wouldn't hurt anything. And we weren't around by the time anybody realized it. So it was a huge success in that respect.

当水渗透进所有纸张时，钠爆炸了，这次爆炸基本上影响了整个查尔斯河。实际上，它有许多连锁反应。因为它炸出了许多大块的碎片，它们撞上了冰块，然后又爆炸了。所以它实际上传播了大约一英里，这是惊人的。它没有对任何东西造成伤害。我们小心翼翼地放置它，以免伤及无辜。而且当有人意识到爆炸时，我们早就消失了。从这点来看，我们也是挺成功的。

LJC: Did other people watch your experiment?

LJC: 其他人是否目睹了您的实验？

LR: My friends, the three or four of us. We didn't have any other people watching it because we were trying to be quiet.

LR: 我的朋友，一共有三四个人。当时没有其他人看，因为我们也试图保持安静。

LJC: But they have an explosion. It is difficult to be quiet.

LJC: 但钠爆炸了。很难做到安静。

00:46:39

LR: No, no. I mean, once the explosion happened, but we were off going ashore far away. So we were just watching. It's actually timed just well. We got out of there and it didn't hit anything. Actually there were boats along the edge, so and it missed those. That didn't get close to them.

LR: 不，不。我的意思是，一旦爆炸发生，我们已经到了很远的岸上。所以我们只是在看。实际上我们的时机掌握恰到好处。我们离开爆炸点，爆炸也没有造成伤害。实际上河边有船只，但爆炸没有炸到它们，甚至没有接近那些船只。

LJC: So what drove you and your father to do the experiment? It's just for fun or?

LJC: 那么是什么驱使您和您父亲去做实验呢？只是为了好玩还是？

LR: My father didn't know about that experiment. He brought this sodium home, and I hadn't done anything with it, I took it to school. But I also made the nitroglycerin he didn't know about that until I told them much later. But in any case, I made other things like sodium fulminate. My friend, one of my friends, it blew up and gave him burns. But, I didn't get hurt because I was careful. That's what you use for the explosive to set off the dynamite is the fulminate. So we needed some of that too. So the electric wire could trigger the dynamite. So the electricity triggers the fulminate, and the fulminate explodes. So that's of the dynamite.

LR: 我父亲不知道那个实验。他把钠带回家，我什么也没干就把它带到了学校。我还做了他不知道的硝酸甘油，是后来我自己告诉他们的。总之我做了其他的事情，如雷酸钠。我的一个朋友在一次爆炸中被烧伤了。但是，我没有受伤，因为我很小心。人们就是用雷酸钠去引爆炸药的，所以我们也需要一些。电线可以用来触发炸药。所以呢，电会触发雷酸钠，然后雷酸钠爆炸。这就是炸药。

And we did things like that. I also wired the dormitory. Well, I didn't have to wire the dormitory. There are lots of wires. So I took advantage of those wires, and set up arrangements with my friends in various rooms to all have be able to use the outside line that I order to the room to make telephone calls.

我们还做了类似的事情。我给宿舍安装了电线。其实我没有必要安电线，宿舍有很多电线。我利用这些电线，和同学一起在各个寝室之间进行改装，这样我们就能利用我订的外线来打电话了。

LJC: It's actually something like the Internet, right? It was connected to the communication among the dorms. Right?

LJC: 它实际上就像是互联网，对吗？促进了宿舍之间的沟通。

RL: Right. And I also connected it to the MIT exchange as well as the dorm exchange, so that they could use the outside MIT exchange lines. There were phones occasionally in the halls. But they just put that in everybody's room if they wanted it. We quickly learned through MIT exchange to be able to call into the tie line network. So MIT was tied in with the Lincoln Labs and IBM, and lots of corporations throughout the world. I mean throughout the country, in the defense network.

RL: 是的。我还将它连接到了麻省理工学院的交换机以及宿舍交换机，这样他们就能使用学院交换机的外线。宿舍大厅里偶尔会有电话。但如果学生需要的话，学校还是会在每个房间安装电话。通过学院交换机，我们很快学会了如何给专用线路网打电话。麻省理工学院与林肯实验室和 IBM 以及全国各地的许多公司建立了联系，主要是在国防领域。

Lincoln Labs was MIT's lab, and it was in the defence industry. And it connected, it had tie lines to IBM. So as I learned the dialling, every extension possible, I mean, every three digit or two digit number, checked all of the two digit numbers to see if there was a tie line. If there was a tie line, I checked out calling somebody locally to see where they were. We're calling the operator, you know, finding out where I was and building a map of all of the tie line extensions.

林肯实验室是麻省理工学院的实验室，也是国防工业的实验室。它与 IBM 有专线联系。因此，当我学习拨号时，每个可能的扩展拨号，也就是每个三位数或两位数的号码，我都会检查，看看是否有专线。如果查到了专线号码，我就会检查当地的某个人，以找出他们在哪里。我们会打电话给运营商，找出自己的位置，并画出一个涵盖整个专线网络的地图。

I found if I went through Lincoln to IBM, there were two sites, one in Kingston. Two different sites. And they had a tie line between them. So if I went to the remote one in Kingston, and then took the tie line down to the other one, they thought I was in Kingston. So the operator would connect me with their New York tie line, city tie line. And I could then call my father's tie lines in New York City. And I could call free to my parents. And soon that got published in the student newspaper that there was this tie line potential to New York City. And too many people started using it, so it got cut off.

我发现从林肯实验室到 IBM 有两个站点，一个在金斯敦。那是两个不同的站点，它们之间有一条专线。因此，如果我去了较远的金斯敦，用专线打到另一个站点，那么他们会以为我在金斯敦。这样，运营商会将我与其的纽约专线连接，那可是城市线。接着，我就可以打我父亲在纽约市的电话了。用这个方法，我可以免费给我父母打电话。但这个方法很快就学生报上发表了，告诉大家有这种可以连接到纽约市的线路。后来太多人开始使用它，然后它就被切断了。

00:51:13

LJC: But if you make this change on the wire, did you get a permit from the office?

LJC: 但是如果你要改变线路，是不是要获得办公室的许可？

LR: No, we just went to the wiring what we choose. I mean, once you understood the system, it was easy to fix. I also worked in another one of the dorms to connect to what they could connect to. And actually, built the exchange from my parents' camp at the same time, and built the transistorized telephone exchange for their camp.

LR: 不，我们只用自己选择的接线。一旦你理解了电话系统，这就很容易搞定。我还在另一个宿舍这么干过，连接了他们的电话可以连接到的地方。实际上，我还同时建立了父母营地的交换机，并为他们的营地建立了晶体管电话交换机。

So I did lots of different activities when I was in my sophomore and junior year, because it was in the school and was relatively boring. It was very simple for me. And I did all sorts of activities. But then in my senior year, I started having lots of projects that were possible.

所以大二和大三的时候，我做了很多不同的活动，因为在学校里是相对无聊的。这些对我来说非常简单，我做了各种各样的活动。但到了大四的时候，我开始有很多项目。

And we built things. One of them, one of the professors wanted to see if he could create the largest magnetic field, and pulse. That was possible. That was in record. And so he collected a huge number of big capacitors, which filled the room like this, more or less.

我们投身创造。一位教授想知道他是否可以制造出最大的磁场和脉冲。那是可能的，也是有记录的。因此他收集了大量的大电容器，或多或少地充满了这样大小的房间。

And I built a really large power generator for high voltage electricity, with big power tubes that they had at MIT. And so it could generate, I think it was about ten thousand volts to charge all of the capacitors. And the room was totally locked with electronic locks that we built. So that nobody could get in the room when we charged it. And then, whatever, when we when we triggered, it would connect all of the power through one single loop coil. And that coil generated huge amount of magnetic energy. And that was what he was measuring. That's what he wanted. So a couple of other students and I built all of that, and tested it for him, and got it to where it ran the highest power to anybody.

我制造了一台用于高压电力的大型发电机，配备了从麻省理工学院拿来的大功率管。我认为对所有电容充电大约需要一万伏。这个房间完全用我们制造的电子锁锁着。因此，当我们充电时，没有人可以进入房间。然后，当我们打开开关时，它将通过一个单独的环形线圈充分通电。那个线圈产生了大量的磁能。这就是他所测量的，他想要的。我和另外两三名学生构建了所有设备，并为教授进行了测试，并尽量让它达到最大功率。

Another experiment that I did was to build an experiment where magnetic field that I created floated a steel ball, and in the middle of air and spun it, so that he could have extremely high rotational energy, because the magnetic field was rotating. And the ball rotated was a small ball about this big. But it rotated at extremely high speeds, much higher than you could if it had any bearings, because it was floating in air, and things like that.

我做的另一个实验是创造了一个在磁场上漂浮的钢球，使它漂浮在空气中，并使其旋转，这样他就可以具有极高的旋转能量，因为磁场是旋转的。旋转的球是一个大概这么大的小球。但是它以极高的速度旋转，比任何轴承要快得多，因为它漂浮在空气中。

And then in my senior year, they brought the TX-0 computer from Lincoln into the place. I also did one job on the IBM computer at MIT, which was punch cards, which I hated. And they had me connect a new type drive to the machine. So I did that. But, after that, I found the tx-0. And then I spent seven hundred hours on the TX-0 alone, the most time anybody had spent on a computer alone at that point, most likely in history. Because it was the first computer, it was the first transistor computer. And, as such, it was just like today's computers in terms of operation that was very effective.

然后在我大四的时候，他们把林肯实验室的 TX-0 电脑带到了这里。我还在麻省理工学院的 IBM 计算机上做了一份工作，就是打卡，我讨厌这份差使。他们让我将一种新型驱动器连接到机器上。我也这么做了。但是，在那之后，我发现了 TX-0。然后我独自在 TX-0 上花了 700 个小时，这可是当时人在电脑上度过的最长的时间，很可能是在历史上也是如此。因为它是第一台计算机，它是第一台晶体管计算机。而且，从操作的高效来看，它就像今天的计算机一样。

And I did a what's now very, very common, but was totally uncommon then was a neural net program to do AI, and recognized handwriting extremely efficiently. And I published that. So I was one of the first neural net programs that existed. Now everybody's doing it for the AI, but I did it back then. I then quit doing that when I finished my senior year, and started working at Lincoln Labs on the TX-2, which is the bigger machine that they built. And that was the machine I did a lot of my work on and started the Internet working and so on.

我还做了一个现在看非常非常普遍，但在当时十分不常见的事，就是做了一个神经网络程序来做人工智能，并且非常有效地识别手写。我发表了这个研究。所以它是最早的神经网络程序之一。现在每个人都在为人工智能做这种程序，但我当时就做到了。然后，当我大四结束的时候，我就放弃了这个方向，并开始在林肯实验室用 TX-2 工作，这是他们建造的更大的机器。也正是用这台机器，我做了许多工作，也开始了我的互联网工作等。

LJC: So I just wonder AI wasn't popular at that time. How did you have the idea?

LJC: 我想知道，AI 当时并不受欢迎。您是怎么想到这点的？

LR: You know. Well there was a strong AI program at MIT with Marvin Minsky. So he was pushing AI. I didn't mean I didn't do anything with Marvin generally except I knew him pretty well. And we talked, and I helped him in various cases. But AI was, it was clear that we could do something there. But I didn't want to spend all my time at it because it looked like it was in a very early stage. And it was really, I was looking for something where I could be in front.

LR: 麻省理工学院的马文·明斯基开设了一个强大的人工智能项目。他在推动 AI 的发展。我并不是说除了很了解他之外，我一直没跟马文做任何事情。我们聊了聊，并在各种案例为他提供帮助。但我们显然能在 AI 领域做点什么。只是我不想把所有的时间花在它上面，因为它看起来像是在很早期的阶段。事实上，我正在寻找可以让我走在前面的领域。

I was with a neural net, but I didn't follow through that and anyone, I didn't know whether that was the approach that would win or not at that point. I knew it worked well.

我确实研究过神经网络，但是我并没有从一而终。我并不知道这在当时是否是能让我脱颖而出的最好方法，我只知道它很有用。

LJC: At least you wrote some code for it.

LJC: 至少你为它写了一些代码。

LR: I wrote all the code, and did the whole thing. I didn't have any design to go from. I just built it to have, you know, an array of neural net. And it worked. I mean it worked very well for handwriting.

LR: 我写了所有的代码，做了整件事。当时没有任何可供我参考的设计。我建立它是为了拥有一系列神经网络。它也确实管用，识别手写的效果非常好。

LJC: Could you tell us what's your deepest motivation, or what drove you to work hard on all those projects? What's your goal?

LJC: 您能告诉我们，您心里最深的的动机是什么，或者说，是什么驱使您在所有这些项目上努力工作？您的目标是什么？

LR: I get very interested in in making something, understanding something and making it work, and creating something. And so it's only when I am creative that I get interested. And I did all of these things to be creative and challenge myself to learn. So at MIT I did all my courses. I actually didn't like the field theory part of electrical engineering, where we had to learn how to magnetic fields in space, and that sort of thing where we had to use differential equations. I wasn't interested in differential equations. I didn't find it that exciting, but I did like the computerized steps where I knew what the algorithm was and what I was doing.

LR: 我创造事物、理解事物、并使其发挥作用非常感兴趣。所以只有当我有创意时才会感兴趣。我做的所有这些事情，都是为了创造，并通过挑战自己来学习。所以在麻省理工学院，我完成了所有的课程。我实际上不喜欢电子工程领域的理论部分，我们必须学习如何在空间中使用磁场，必须学习需要微分方程的那些领域。我对微分方程不感兴趣，没觉得那令人兴奋，但我确实喜欢计算机化的步骤，在这里我知道算法是什么，以及我在做什么。

And so I learned the program very well, and I was extremely good at it. As soon as I went to Lincoln Labs, they just turned over the great big machine to me and said, build an operating system for us so that we can use it. I mean, they just built the machine that just finished. And it was slow. It was six micro seconds per cycle, compared to today's machines, which are huge compared to that. But given that it was all machine code, it was a much faster than a lot of things today. I mean much faster at that time.

所以我这个课程学得很好，而且我也非常擅长。我一去林肯实验室，他们就把这台大机器交给我，说，为我们建立一个操作系统吧，这样我们就可以用它了。他们其实刚刚建造了那台机器，而且速度很慢。每个周期只有 6 微秒，今天的机器和它比起来，算是相当庞大了。但鉴于它用的都是机器代码，它比现在的许多东西都快得多。我的意思是，在当时要快得多。

00:59:21

So I built the displays that we had one display on the big machine. And I designed that so that I could see 3D in motion. I could rotate objects. I could do all sorts of things that were in real time at that time with a slow machine. But the first thing I had to do is build the operating system. And they gave me a plug board to start with. And so I wrote commands onto the plugboard to load a paper tape. And on the paper tape, I wrote the commands to start building a sampler and a compiler, and the operating system, which was actually a time sharing system, because that's what I wanted.

所以我又做了显示器，我们在大机器上有一台显示器，是我设计的，通过它，我可以看到运动的 3D 物体。我还可以旋转物体。当时，我可以用很慢的机器做实时的各种事情。但我要做的第一件事就是构建操作系统。他们给了我一个插接板，我在插接板上写命令，加载在纸带上。在纸带上，我编写了构建采样器和编译器的命令，以及操作系统，它实际上是一个分时系统，因为这就是我想要的。

So I built an entire operating system from the ground up. (LJC: Amazing.) And all of the tools to run the tape drives which they built over time, and to run all the piece parts of the equipment, and to manage the assembly and compilation of code. So it was then all the other people that were there worked on it and used my tools.

我从头开始构建了一个完整的操作系统。（LJC：太棒了。）他们还逐渐制作了用来运行磁带驱动器的所有工具，这些工具还能用来运行设备的所有部件，并管理代码的汇编和编译。所以当时所有其他人都在为此工作，并使用我的工具。

I managed them generally. So just because I was there and I knew at all, I sort of wound up managing everybody. The person who was in charge of the lab who had built the computer left just about when I came. So I wound up being, even though I was just the staff member, staff associate to begin as a graduate student, I was wound up running everybody because there wasn't anyone who wanted to do.

那时基本都是我在管理他们。因为我在那里，而且我基本什么都知道，我可以说是在管理每个人。当我来的时候，实验室的头，就是建造电脑的那位刚好离开。所以尽管我只是工作人员，只是以毕业生的身份开始工作，但我最终还是负责管理每个人，因为也没有人愿意这样做。

LJC: This seems to be pretty much similar to your career in the up part, right? The manager of their program right? You've tried all the programs at school.

LJC：这似乎与您一直在高层的职业生涯颇为相似，对吧？总做项目经理。您已经在学校尝试了所有的项目。

LR: Yes. I've been the CEO of everything I've been involved in almost. So it's generally in order to make sure my ideas get done I have to sort of run them. In any case, the TX-2 activity was all involving. And I did my thesis there for three dimensional. Well, I did two theses. One was a master thesis, which was to reading photographs. But I built a scanner, which was an old facsimile machine, and read into the computer photographs. And this was the only source of photographs on digital tape. So Marvin Minsky at MIT asked me for copies of all of these, and I realized there was no way to get them to him.

LR：是的。我一直是我参与过的所有事情的 CEO。通常为了确保我的想法得以完成，我必须亲自运行它们。我充分参与了 TX-2 相关的活动。我在那里做了关于三维的论文，而且还写了两篇。一篇是硕士论文，关于照片读取。我制作了一台扫描仪，那是基于一台旧的传真机，然后用它把照片读入计算机。这是数字磁带上唯一的照片来源。麻省理工学院的马文·明斯基问我要了所有这些的副本，但我意识到没有办法将这些照片发送给他。

I had my machine. It was different than his machine. Even though they were related, I mean, he was on a TX, he was on a PDP-10, which was the commercial outgrowth of the TX-2, but it was different enough that you couldn't just move code. And so what I had to do was I had to build an interface for an IBM tape drive, and write my photographs under the IBM tape drive, and deliver it to him. So it took months to deliver the photographs to him.

我有我自己的机器。它与他的机器不同，即使它们存在一定关联性。他用的是（TX 计算机上，应系口误）PDP-10 机器，这是 TX-2 的商业化的产物。但它与 TX 机器不同，不能直接复制代码。所以我必须做的是，为 IBM 磁带驱动器构建一个接口，并将我的照片写在 IBM 磁带驱动器下，然后将其发给他。因此，我用了几个月的时间才将照片传给他。

And I have lots of photographs because I've taken photographs of lots of art in the museums. And people wanted to study whether they always had certain characteristics to the histogram of

intensity and color. So I could do those experiments with all of the photographs. I also was using the photographs to do my PhD thesis, which I'll come back to. But the first thing I did was to look at photographs and see if I could compress them so that they could be sent much fewer bits.

我有很多照片，因为我拍摄了很多博物馆的艺术品照片。人们想研究它们是否总是具有强度和颜色柱状图的某些特征，于是我用所有的照片做了实验。我还用这些照片来做我的博士论文，一会儿我会提到。但我做的第一件事就是看照片，看看我是否可以压缩它们，以便发送的时候图片大小能够小一些。

That program, what I decided to do was to build a pseudo random number generator, which was very small and efficient to generate a pseudo random code of about another, I don't know how many bits, six bits or four bits. That got added to the intensity level as you were recording the photograph, generating the base level. So instead of having... if you were only recording three bits of information, the third bit was being juggled back and forth. But the other bits that I was heading in pseudo random, and so all of the edges were smeared, and so there was no boundaries like you have in a normal photograph of here is the second bit and here's the third, I mean, with an edge. The edges are terrible for humans.

至于那个程序，我决定要做的是构建一个伪随机数发生器，它非常小，而且可以有效地生成伪随机数，我记不得有多少位了，大概六位或四位。当你记录照片时，它会增加强度级别，生成基本级别。所以如果你只记录三位信息，那么第三位就会来回晃动。但是我在伪随机数中加了其他位，因此所有的边缘都模糊了，所以不会有像在普通照片中那样的边界，一会儿两位，一会儿三位，而且有边缘。边缘对我们来说可不是什么好东西。

So I smeared them out with the pseudo random noise. And then when I was to use them on the computer, I ran the same pseudo random number generator over again, and unsmooth the energy, got rid of the extra energy. So the result was, you had a presentation that was looked like you know private code rather than a three bit code. And it was very high quality picture. That got patented by MIT and myself, and had government free license.

所以我用伪随机噪声抹去了它们，然后当我在计算机上使用它们时，我再次运行相同的伪随机数发生器，并让能量不平稳，摆脱了额外的能量。结果是，你得到的描述看起来是一个私有代码，而不是三位代码。这是非常高品质的画面。这项发明给麻省理工学院和我自己申请到了专利，并获得政府免费许可。

So the government used it for moon photographs that they returned. So that I went out to their contractor in Iowa, and helped them build hardware to do this. Because in those days it had to be all flip flops. So it was not an integrated circuit where you could run a programmer. And so this was just straight hardware to manage the bit management and the pseudo random sequence. And they used to send that to the moon, and they recorded all the photographs and send them back. And that's how they did the moon. They didn't have a patent free license, so nobody ever wound up using it as a patent in its twenty years for seventeen, whatever, because it was a long time ago. 政府将它用于从月球上拍到的照片。因此我去了他们位于爱荷华州的承包商，并帮助他们制造硬件。因为在当时必须得用触发电路，所以它不是一个可以运行程序员的集成电路。所以那只是进行位数管理和伪随机序列的直接硬件。他们曾经将它发送到月球，他们记录了所有照片并将其发回。这就是他们处理月球图片的方法。他们没有获得专利许可证，所以在那20年里，有17年都没人将其作为专利使用，但也因为那是在很久以前。



LJC: But it's still a very powerful technique that people can use. I mean, even if it's down at the sixth bit or seventh bit, it would improve things. Is there any other compression technology and image compression technology before your invention?

LJC: 但它仍然是人们可以使用的强大技术。即使它是六位或七位，也能改善工作。在您的发明之前是否还有其他压缩技术和图像压缩技术？

01:06:17

LR: Oh, yeah, people did various things, but they were much too expensive to use. And so when you looked at trying to do something economically for like the moon that you could build in hardware, that this was the only thing around. It actually did just as well as some of the more complicated processes. But people kept on building better and better compression, I mean, over time. So that was an ongoing activity. I didn't stay in that field. I then moved to the PhD thesis, which was to look at three-dimensional photographs of a table and chairs, and look at it as finding the edges.

LR: 哦，是的，人们做了各种各样的发明，但是使用起来太昂贵了。所以，如果人们要像刚才那个月球的例子一样，廉价地在获得能够处理图像的硬件，那么我的发明是当时唯一的选择。它实际上和一些更复杂的发明一样好。但是，随着时间的推移，人们不断发明出更好的压缩工具，这是一项持续的活动。我没有停留在那个领域。后来我开始做博士论文，那篇论文关于一张桌子和椅子的三维照片，旨在观察它们的照片，**就像要找到边缘**。

And that technique is now called the Roberts Cross. Its standard in the art that finds the edges of things. (LJC: It's important today.) I didn't realize that it was named and it was in all the textbooks until I talked to people much later. But that was an interesting story. I met this guy at a conference where people were getting awards and he came up and said he wanted to shake my hand and get to say hello. I said, well, you're talking about the Internet? No, no, no, no, it's the compression. It's the Roberts Cross and image management, which I didn't realize when that was in the textbooks that there were people learning at that page.

而这种技术现在被称为 Roberts Cross（罗伯特交叉）。它是这项艺术的标准，可以用来找到物体的边缘。（LJC：现在这很重要。）我没有意识到它被命名了，直到我很久以后与人交谈，才知道它已经出现在所有教科书中。这是一个有趣的故事。我在一个颁奖大会上遇到了这个人，他走过来说他想握手并打个招呼。我说，好吧，你在谈论互联网？他说，不，在讨论压缩，就是罗伯特交叉和图像管理。我压根没有意识到人们已经通过教科书来学习它了。

But in any case, my goal in the thesis was to show that there was various theories and they're all wrong about how you looked at 3D if you didn't have stereo. And you see a photograph and you recognize the 3D very well. You understand what's going on. But people were talking about all sorts of strange concepts that might be causing, that making that possible. And what I realized is as long as you recognize gravity, you were pretty much on the right track. It was floating in air. It was gravity-based.

但无论如何，我论文的目的是表明各种各样的理论都是不正确的，如果你没有立体照片，那么用这些理论来看 3D 是不行的。你只要看到一张这种照片，你就会很清楚 3D，就会了解整个过程。但人们正在谈论的是可能导致这种情况的各种奇怪概念。而我所意识到的是，只

要你注意到引力，你就几乎是在正确的轨道上了。物体漂浮在空中，它是以引力为基础的。

So what I did was I found the edges. I then mapped it so I could recognize that was a rectangle, had a certain projective angle. I worked out the projective geometry, which nobody had before as a four-dimensional transform. So I was a matrix transform in four dimensions to do the projective image. So now I can do that very fast on the computer, and find the map of basically a rectangle of any shape, and map it to the edges, same with the chair and the pieces with piece parts.

所以我做的就是去找到边缘，然后进行绘制，这样我就可以识别出它是一个矩形，具有一定的投影角度。我做出了投影几何体，以前没有人做这种四维变换。我是用一个四维矩阵转变来做投影图像。现在我可以在计算机上快速完成这个操作，并找到基本上任何形状的矩形的地图，并将其映射到边缘，这也适用于椅子和零部件。

And I put that all together, and then I could rotate it in 3D, and show you that I knew what it was in 3D by rotating it on the screen in any angle you want. So that thesis I used was the first in a long series of 3D display technology. And it's quoted all the time as the base reference for all that. 我把它们放在一起，然后用 3D 技术旋转它，并通过在屏幕上以任何你想要的角度旋转它，来向你展示我对它的了解程度。我使用的论文是一系列 3D 显示技术的第一篇。并且那篇论文作为这一技术的基础参考，一直被人引用。

01:09:52

LJC: Who is your PhD and master advisor?

LJC: 谁是您的博士和硕士生导师？

LR: Peter Elias was the primary adviser. Claude Shannon was one of my advisors, and Bob XX was the other. So all very senior. And Shannon was very interesting, and he took me to his house and showed me his unique bicycles and TV and all sorts of things that he played with. He played with all sorts of things at home.

LR: Peter Elias 是主导师。Claude Shannon 是导师之一，还有一位是 Bob XX。他们都非常资深。Shannon 很有意思，他带我到他的家里，向我展示了他独特的自行车和电视，以及其它玩意儿。他在家里玩各种各样的东西。

LJC: What's their advisory style? They were more like teaching you every step, or just give you all the ideas?

LJC: 他们的指导风格是什么样的？他们更像是手把手地教您，还是只是给各种点子？

LR: No, no. They don't teach me anything. I talked to them about what I was doing, and I made sure I was on a path that was recognizable as a PhD thesis that had the right, but had a theory that was proven. Something that was creating, that was actually so far advanced compared to anything else of that age. Another friend of mine, Ivan Sutherland, who was working at MIT at the lab, but at the time. And I took that 3D program and he built a big thing that came down from the ceiling and held a head-mounted display. We put a small display on. And I had already built sonic generators that there were four on the display that received any ultrasonic sound, and then one on one. So the one could be found in three space very easily. And so we put those ones on the

head-mounted display. And so we knew where the head was and what position in space and so on.  
LR: 不，不。他们不教我任何东西。我跟他们谈过我在做什么，并且确保我走的是一条可以被认为是正确的博士论文的道路，但得有一个被证明正确的理论。论文需要有创造性，而且要与那个时代的任何其他东西相比具有先进的。我的另一位朋友 Ivan Sutherland，他在麻省理工学院的实验室工作。我接下了那个 3D 项目，他制作了一个大物件，从天花板上挂了一个头戴式显示器。我们还放了一个小显示屏。而我已经制作了声波发生器，这样显示器上就有四个接收任何超声波声音的装置，然后把它们一对一。这样就可以很容易地在三个空间中找到它。我们将这些放在头戴式显示器里，然后就可以知道头部在哪里，以及它在空间里的位置等等。

01:11:39

And we could then display, and you could look around and see everything. So it was actually a very... You could look at a 3D image that I had or whatever and look at it from any point of view you want when you're moving your head. And that was the head-mounted display virtual reality. It was way early, so early that I then decided this was a dead end for me, because basically about twenty years before anybody would make that cheap enough to be used. I had all this expensive equipment, but nobody could do it in their own lab. I mean, who just was too much?

接着，我们就可以进行展示了，你可以环顾四周看看一切。它实际上是一个非常.....你可以看到我拥有的 3D 图像或者别的，并且当你移动头部时，从你想要的任何视角看它。这就是头戴式显示器虚拟现实。做出这个时候实在是太早了，早到我甚至认定这对我来说是一个死胡同，因为差不多二十年后，这样的装置才能便宜到足以让普通人使用。我拥有足够的昂贵设备，但很少人能在他们自己的实验室里做到这一点，确实太贵了。

So I said, okay, I'm not dealing with the display technology mean with the picture processing anymore. In 1964, I met with Doctor Licklider at a conference. And he was running Arpanet at the time, running the information processing program. And I just left, and Ivan was running it then. I don't know for sure. But in any case he met with me and we were talking between sessions at the conference about what was next. And he said well, really have to get these computers connected together. And I had this story I told you about the photographs moving them to MIT's lab. And it was so hard to move data between these different machines that I realized how important it was to connect the computers together, and build a network of some kind.

所以我说，好吧，我不再研究显示技术与图像处理的方法了。1964 年，我在一次会议上与 Licklider 博士会面。当时他正在运作 Arpanet，也就是信息处理程序。然后我们就分开了。那时候运作这个项目的是 Ivan，好像是。但无论如何，他遇到了我，我们在会议间隙谈了谈未来。他说得很好，真的要把计算机联系在一起。刚才我说过在学院实验室发送图片的故事，在不同的机器之间移动数据非常困难。我意识到将计算机连接在一起并构建某种网络是多么的重要。

LJC: At that time, is that impossible, or is there still a way to move the pictures among the machine, but it's just a copy, or it's download or something?

LJC: 当时，这是肯定不可能，还是仍然有办法在机器之间传送图片？比如复制粘贴，或者是下载等方法？

LR: If you're going to keep them in digital form, you got to move the data. You either have to have tape or disk or something that's compatible between the two. So these are easy now, but they weren't then. And disk was unique built for your computer. And the IBM tape was about the only common media. So I had to go to the IBM tape to move the data. You couldn't move it by wire because we didn't have any communication technology.

LR: 如果你打算以数字形式保存它们, 你就必须移动数据。你必须拥有磁带或磁盘, 或两者之间兼容的东西。这些现在很容易, 但在当时并非如此。磁盘是专为个人计算机而制造的。IBM 磁带是唯一的常见媒体。所以我不得不用 IBM 磁带来进行数据移动。当时无法通过线路传输数据, 因为我们没有任何通信技术。

LJC: Even wire is not possible.

LJC: 连线都不行。

LR: Well it was not. People dialled in to the time sharing computer at MIT at that time, but that was about the most you could do was have just a standard single user dial and typewriter. But what I wanted to do was it, so the computers could talk to each other and move data at high speed, and connect people all over the world to the computers.

LR: 嗯, 是的。当时人们给麻省理工学院的分时计算机拨号, 但只有一个标准的单用户拨号和打字机, 你最多也就只能做这么多了。但我就想这么做, 这样计算机就可以相互通信, 并高速传输数据, 并将世界各地的人们通过计算机连接在一起。

01:14:39

LJC: Okay, can you talk a little bit more about your discussion on the conference? You might have the idea of the connecting the machine for a long time. But the what's your discussion in the conference about the connecting the machine?

LJC: 好的, 您能谈谈您在会议间隙的讨论吗? 您可能一直都想把计算机联网。但是您在会议上谈论的计算机联网, 都讨论了什么?

LR: In the conference, I didn't present at the conference. I mean I'm not sure exactly what you're asking.

LR: 我没有出席会议。其实我不确定您想问的是什么方面。

LJC: It's about Licklider. What's your discussion with Licklider on the necessity of connecting machine?

LJC: 是关于 Licklider 的。您与 Licklider 关于连接计算机必要性的讨论, 其内容是什么?

LR: What's Licklider? Is that about my advisors?

LR: 什么是 Licklider? 您指的是我的导师吗?

LJC: Not advisor. It's more about the conference you talked about.

LJC: 不止是导师。我想问的是您刚才谈到的那次会议。

LR: The conference was unrelated. The conference was just a standard information theory

conference, one on technology. I just was meeting in the lobby with Licklider. And we were talking about the future. So it was a small private conversation. And that was the key to say here is an idea. And I decided very quickly that there was an idea where I could be first, where I could do something that was different, to make this happen. So I started working on the concept.

LR: 会议没有太大的关系。那场会议只是一个普通的信息理论会议，一个关于技术的会议。我只是和 Licklider 在大厅见面，我们谈论了未来。所以这只是一个小小的私人谈话，其实关键在于我们的想法。我很快就决定我可以在一个领域成为第一，可以做一些与众不同的事情。我要实现这个目标，所以就开始研究这个概念。

Ivan took over, took position at Alpha. And so I asked him for a contract to have some money to do this, to do an experiment on it. I then did the experiment to get program the whole code to do a specified protocol between two computers, one on the west coast and one on the east coast went between us and SDC. And I designed the experiment so that we could learn what we needed to learn about the air control and everything else that we needed to bypass noise on the line.

Ivan 接下了 Alpha 的位置。我让他签一份合同，来给实验筹集资金。然后我做了一个实验，写了一整套代码，在两台计算机之间做一个指定的协议。这两台计算机一台在西海岸，一台在东海岸，在我们和 SDC 之间。我设计了这个实验，以便我们可以了解我们需要学习的空气控制，以及为了减少线路上的噪音所需的一切工作。

And that dictated the size of the packet. Because if you had the packet too big, you lose. Back then, communications channels had huge brush noise because of relay clicks. So in every exchange, when a relay went, it would give an electric impulse to some other line that went through. And that would destroy the packet. So you had to have relatively short packets, which wound up to be around 1 thousand bits. That could get the most data through with the highest data rate, because you have to repeat them if they lost.

这也决定了数据包的大小。因为如果你的数据包太大，你就肯定出问题。当时，由于继电器点击，通信渠道产生了巨大的刷子般的噪音。因此，在每次交换中，当一个继电器发生时，它会给通过的其他线路带来电力冲击。这会破坏数据包。所以你必须拥有相对较小的数据包，最多可达千位。这样可以通过最高的数据速率获得最多的数据。因为如果数据丢失，你就必须重复操作。

LJC: Can you recall your lobby discussion with Licklider? How long did it take?

LJC: 您能回忆一下您与 Licklider 的大厅讨论吗？它花了多长时间？

LR: Our conversation took twenty minutes.

LR: 我们的谈话花了二十分钟。

LJC: Which year?

LJC: 是在哪一年？

LR: 1964. It was before I did the experiments in 1965, and then I did the experiments to prove that. Well, we could talk to each other, but the communication channel as a dial up telephone line was hopeless. It was much too slow, took forever to set up. You send data one fifteen to the time, and the rest of the time, except the one fifteenth, you are waiting for the next thing to happen.

Computers send it first.

LR: 1964 年。那是在我 1965 年进行实验之前，然后我做了实验来证明这个想法。我们可以互相交谈，但作为拨号电话线的通信渠道是很糟糕的，速度太慢了，花了很长时间才建立起来。比如你在一点十五分发送数据，然后剩下的时间，你除了等待还是等待。计算机首先发送它。

LJC: You had the problem before already. Right?

LJC: 你以前遇到过这个问题对吗？

LR: So what I realized was that there was a huge gain that we have over a dedicated line, a few used packets, and send packets and use shared transmission line between many different projects. So the concept was you would have lots of people sharing a big line, but their packets would be mixed. Because otherwise you couldn't use the line, and then you were paying for all those transmission capacity, and you weren't using it.

LR: 我意识到我们有专用线路，一些使用过的数据包，并以此发送数据包，并在许多不同的项目之间使用共享传输线。这个概念就是，会有很多人分享一条大线，但他们的数据包会混在一起。因为如果不这样，你就无法使用该线路。结果你为所有这些传输容量付费，却没有使用它。

So that was the basic impact of the early Arpanet. As I went to Arpanet and started building it, I got drafted into Arpanet.

这就是早期阿帕网络的基本影响。当我致力于阿帕网络并开始建造它时，我就深陷其中了。

LJC: Yeah, obviously you had the difficulties before you had some idea. How did Licklider say?

LJC: 是的，显然您在有创意之前也遇到了不少困难，那么 Licklider 是怎么说的？

LR: He just said there was a problem. What he did not say was how to do it. He just knew there was a problem. One of the computers we talked to each other.

LR: 他刚才说有问题，他没说的是要怎么做。他只是知道有问题。我们谈论的问题之一就是计算机。

LJC: Was the problem from his project, or was the problem he observed an industry problem?

LJC: 这是他自己项目的问题，还是他观察到的一个行业性的问题？

LR: He observed it as an industry problem. He was running the upper program in time-sharing and computer technology. But nobody was working on it. He just saw that there was an issue, and he mentioned it in this meeting. That was about it. It was a very short conversation.

LR: 他认为这是一个行业性问题。他在分时和计算机技术方面都是在运作高端项目。可是当时没人在做这个。他只是看出了问题，并且在那次会议上提到了这个问题。仅此而已。我们那次的谈话非常短暂。

1:20:00

F: “互联网”这个思想的源头，是不是他这个……？

Who came up with the idea of “internet”? He or ...?

LJC: what was, how do you think, what was the source of the ... to build the internet, yeah, among the machine? That, did it come from Licklider or...?

LJC:在机器间搭建互联网，这个想法的源头是谁？是利克莱德吗？

LR: I don't exactly \*\*. I said, what he said was an issue how do you build... somebody got to build the network that connect the computers. (LJC: oh, yeah, yeah.) That was it. He just know there was a problem. He wrote papers about the fact that it would be nice to have (LJC: oh, nice to have, yeah.) intergalactic network. But he didn't know how to do it. He got no... He gave no insight into how to do it, just that it needed to be done.

LR:我不这么认为。我前面说了，Licklider 只是提出了一个问题，要怎么搭建……（LJC：哦，对，对。）他知道这个问题，仅此而已。他写的论文只是说明了有了星际互联网的话，一切会多美好（LJC：哦，多美好，对）。但他不知道要怎么搭建。他没有……至于到底要怎么做，他没给出任何深刻见解，他只是说要把这个搭建好。

LJC: This is everything, right?

LJC:他做的就是这些，对吗？

LR: That use packets was my idea. (LJC: oh, oh.) Because otherwise, I realized how little we used the lines when computers were \*\*. Because it was all burst. (LJC: OK.) It was a very small amount of time. So, in the experiment, I proved what the issues were, and what we needed to do, and that we had to build a new network with packet switches. (LJC: yeah, yeah.) Because circuit switching was not supported (LJC: yeah, yeah.) under any circumstances. It was much too slow and too unreliable. (LJC: OK.) And so it was my experiments to prove what we needed to do. (LJC: OK.) And packet switching is the core of everything on the internet. I get back in the protocols and... and TCP/IP—another issues, which we should go over. But the issue at that time was how do you build a network that would let these communicate. (LJC: oh, oh.) And, to do that, we had to have packet switching. And packet switching is the underlying basis of all of the technologies.

LR:采用数据包是我的想法（LJC：哦，哦。）。因为，如果不用数据包的话，我们对于的使用率其实很低。都是突发模式，时间很短。我的实验验证了问题所在，验证了我们要做些什么，也验证了我们必须搭建以包交换为基础的互联网。（LJC：对对。）电路交换不受支持。（LJC：对对。）它太慢了，太不可靠。（LJC：对。）交换是互联网上所有事物的核心，而网际协议和 TCP/IP 协议族——这是我们需要探讨另一方面的问题。但当时的问题在于，你该如何搭建一个可以让这些相连的网络。（LJC：哦，哦。）要搭建这样的网络，我们需要包交换。包交换是所有技术得以实现的根本。

LJC: So packet switching is that... in your proposal for the funding already or it's after the funding you figured out that...

LJC:所以，你在申请专款的文书中已经提到了包交换？还是说，是在申请到专款之后，你想

到要.....

LR: No, it was...it was... the funding was to explore packets—sending data between two computers.

LR:不是，是.....是.....这笔专款是用来研究数据包的，研究如何在两台电脑间传输数据。

LJC: OK, yeah.

LJC:好的。

LR: And I use packets because obviously because it was no way to send long blocks. (LJC: yeah, yeah.) And you had to send short pieces. So I had some check on some small packets. That was just my idea. That wasn't part of the design or anything else. That was just what I needed to do to make it work. (LJC: OK.) And, and so, that was my idea. The idea of building a switch to the network is what I concluded what we had to do. Because you couldn't you use the circuit switching.

LR:我用数据包，因为没法传送很长的区块。你只能发送消息碎片。所以我研究了一些小数据包。这只是我的想法，不是设计的一部分，也和别的东西无关。（LJC：好的。）是我为了让搭建物联网所要做的事。这是我的想法。关于我们要做些什么，我总结出来的结论是，要互联网中搭建包交换。

F: 因为，因为，也有人说，就说这个.....Licklider 也应该被称为“互联网之父”，就是他，他应该怎么看？他认为这个，这个说法合适吗？

F: Licklider is also known as the “Father of the Internet” by some people. How does he feel about that? Does he think Licklider should share the title?

LJC: So, so, so that... also, I think some people uh... consider that Licklider is one of the Father of Internet, yeah. How do you think about it?

LJC:我想，有些人会把 Licklider 称作“互联网之父”。你对这个说法怎么看？

LR: Well, he, he had the concept that said you needed it. But he didn't have any... he ain't doing it. So I consider him the source of the idea.

LR:嗯，他的理念就是告诉所有人，我们需要互联网。但他没有任何.....他什么也没做。我认为他是这个理念的源头。

LJC: Oh... OK. Idea, the source

LJC:哦，好的，

LR: Source of the problem. Not the idea, but the problem.

LR:他是第一个提出问题，不是提出“互联网”的想法的。

LJC: Source of the problem. You had the problem too in your project before, right?

LJC:他是第一个提出问题的人。你在之前的项目中也遇到过这个问题，对吗？

LR: I realized the problem that I didn't concentrate on in building a network yet. He said, get a



network some kind, whatever, I don't have, but get them connected somehow, which I did.

LR:我意识到这个问题了，但在搭建互联网的过程中，我并没有关注于这个问题。他说，不管怎么样都要搭建互联网，我不知道怎么搭，可你们就是要把它们都连接起来。把它们连接起来的人是我。

1:23:34

F:他跟他交往多吗？谈谈他对 Licklider 的印象，是怎么一个？

F:Did he have much contact with Licklider? What's his comment on Licklider?

LJC: do you have much interaction with Licklider? And what's your impression...

LJC:您和 Licklider 接触的多吗？您对他的印象……

LR: No, I only met with him couple of times. I met him at conferences. I met him once on my team. He was, he was not involved in the project. He just mentioned his idea. As you know, he's probably written a couple of papers about the, the, the, um, what he called as... I mentioned before... Intergalactic Network that he thought was important. (LJC: um.) But again, no idea of how to do it. Nothing to do with packet switching. Just the fact that we needed something to connect the machine. Everything up till then was direct lines that just were running all the time from one place to one place. Sage had some of that. And the time sharing machine had dial-up. So that was all not packet switching. That was all just characters over the line.

LR:不，我只是见过他几次。我在一些会上见过他。他来看我的项目的时候，我见过他，他没有参与这项目，只是提到了一些想法。他大概写了不少论文，是关于他所谓的……我前面提到过，关于星际互联网的，他觉得星际互联网很重要。（LJC：嗯。）但他还是不知道要怎么做。他的理念也和包交换没关系。他只是论述了我们需要连接机器这一事实。当时所有的连接都是直线结构，从一个地方运输到另一个地方。Sage 有一些这样的系统。当时的分时是拨号接入的。这些都不是包交换。只是传输线上的字符。

F:还是先回到大学生吧，就是他那时候除了工作之外，他的生活，生活爱好是怎么一个状况，就是大学期间？

F:Let's go back to his college life. How was his college life and his hobbies outside of work?

LJC:这就是回过去了？

LJC:So, we'll get back to the topic in the beginning?

F:对对，回头。互联网因为有很多问题可以再……现在就回到这个大学期间

F:Yeah, get back to the topic in the beginning since we can ask him the questions about the internet later. Now let's focus on his college life.

LJC:在大学的的生活？

LJC:His life in college?

F: 对对对，他的生活状况。有什么比较有意思的影响他，哪些人，包括哪些老师对他影响比较深刻。因为那个时候，MIT 这个，计算机最出名都在里面。这个先来聊聊。

F: Yes, his life. Interesting things that had influence on him. People, including his professor, who

impressed him. A lot of famous computer scientist were from MIT. Let's talk about his college life first.

LJC: OK. Dr. Fang want to be back a little bit. He also want question on the college. Basically, and we also know that MIT, right, is very famous, play a big role in internet, history of internet, yeah. We just want to know the education system and research system in MIT, you know, about the... from your life and experience in MIT, what... how MIT could be a... such, you know, a important university in history of the internet?

LJC:好的。方博士想回到前面的话题。他想聊聊你的大学生活。我们知道 MIT 是非常有名的，它在互联网和互联网历史上发挥了巨大作用。我们想通过你在 MIT 的生活和经验，了解 MIT 的教育体系和科研体系。MIT 是如何成为互联网史上举足轻重的高校的？

LR: Well, it was all, it was all due to the fact that...um...several of us started there. Lick [Licklider] did, and I did, and um... actually... um... one of the people I hired later was... from there. Basically, it was, it was, it was just...happens there. We were there. They were early involved in computers. That was the thing... (LJC: ah, yeah, yeah). Not only uh... I mean the Lincoln Lab activity started building these computers, TX-0 and TX-2. Those are basically where all of the expertise came for training me and... enabled us to move on to packet switching.

LR:那是因为我们几个都是从哪里走出来的。Licklider 是 MIT 的，我是 MIT 的，我之后聘请的某个人也是来自 MIT 的。互联网的大事件是在 MIT 发生的。我们在那里。MIT 很早就开始有电脑了。林肯实验室开始造电脑，有 TX-0, TX-2。许多来自 MIT 的专家教育了我，让我们有能力研究包交换。

1:26:54

F: 那他的这个大学生活是，就是工作之外的生活是怎么样的？

F: How was his college life...his life outside of work?

LJC: Dr. Fang question about the life at the MIT, other than our research, yeah, your project.

LJC:方博士想了解 MIT 的校园生活，除了您研究和项目之外的生活。

LR: well, MIT was a very... had a very open capability in terms of their courses. You didn't need to do the homework if you didn't feel you needed to so long as you passed all the test. And, that was a great game for me because I was smart enough to learn the stuff and not have to do most of the homework. So that helps tremendously, and it was very open for new ideas and professors talking to you. (LJC: oh.) So, it was, it was quite cooperative in that respect. But it had all these computers capabilities which were important to build this packet. And um... I think the environment was extremely conducive.

LR:嗯，MIT 非常……有非常开放的课程体制。如果你觉得没必要做作业，你就可以不用做，只要考试合格就行。对我来说，这是个极好的教育政策。因为我很聪明，可以自己学东西，不需要做许多功课。这点让我获益颇多。MIT 对于新观点也很包容。教授们会与你侃侃而谈。（LJC: 哦。）从这方面来说，MIT 的师生们是互相促进。MIT 有许多，这对于搭建数据包是十分重要的。我觉得 MIT 的氛围是对科研是非常友好的的。

LJC: Helpful, supportive, right? Very supportive. How do you get involved into your project? Or you propose your idea or maybe professor have some project on...

LJC:对学生有帮助,支持学生发展,对吗? 非常支持学生。你是如何参与到你的项目中的呢? 是你自己申请的项目, 还是教授本来有项目.....

LR: No, I proposed all my own ideas. The professors... supported it and said, "as long as you prove a theory, do what academically... they make you academically appropriate to be a PhD". (LJC: chuckle) Uh... and it was... it was actually more than that. But in any case, it was... My paper on 3D graphics is the base of all activities. Every day it gets more and more citations. Since all of the reports... I have paper that I wrote on doing radio packet management when I was at the ARPA and every day I get new citations, readings because that was the basic paper in show how to use the radio waves to pass effectively with reasonable efficiency. (LJC: Oh.) And so that paper is in the field my graphic paper in 3D was very seminal because it created the four-dimensional transform which has been used ever since to do projective display. Doing a projective thing is very hard to do it. All the time and when I did it, there was only old German text I had to translate to learn about projective geometry. Basically, nothing was written in the States at that time. I did the first paper on how to do projective displays... in that thesis. So, I mean, I had to solve a lot of my own problems (LJC: chuckle) but basically the professors were quite supportive but they didn't tell me what to do. (LJC: ok.). They didn't.

LR:不, 这些想法都是我自己提出的。教授们.....很支持我的想法, 跟我说: "只要你能证明某个理论, 你的学术成果就能称得上是一位博士生了"。(LJC: 笑) 但其实, 这比他们说的要难得多。我写过一篇关于三维计算机图形的论文, 这篇论文是之后所有科研活动的基础。每天, 我都会在这篇论文里加入新的引用。在 ARPA 工作的时候, 我写过关于封包无线电管理的论文。我每天都会在这篇论文里加入新的引用, 在参考文献里加入新的书名。因为这篇论文是研究电波如何高效传递信息的基石。(LJC: 哦。)。我那篇三维计算机图形的论文, 对于我后期的研究很有帮助, 因为它首次提出了四维变换, 而四维变换之后被用于射影研究。要做关于射影几何方面的研究是很难的。当时, 我学射影几何的时候, 只有古德语的文献, 我只能把它们翻译成英语来学射影几何。当时, 美国没有射影几何的相关文献。但我写了第一篇关于射影研究的论文。我的意思是, 我得自己解决自己的问题。(LJC: 笑) 但总的来说, 教授们很支持我, 虽然他们没告诉我怎么做。(LJC: 好的。) 他们没说。

LJC: but they, they provide resource whatever you want, just student want...

LJC:但他们提供了资源, 满足了学生的需要.....

LR: what they tried to make sure was that I was on the right track as well as academic papers.

(LJC: OK)

LR:他们只需要确认我没跑偏, 我的学术论文有进展就行了。(LJC: 好的。)

F:问一下他工作之外的日常生活, 大概是什么样, 什么一个状况?

F: How was his life outside of work?

LJC: How about your daily college life? Maybe little bit...

LJC:您的日常校园生活是什么样的? 能不能分享一下.....

LR: in, in terms of high school, in high school, I dated one girl, but not very much. And in college I didn't date long really. Um... I was too busy. (LJC: laugh) and I finished my mas... my P... my undergraduate and I got married, and, to a local girl. And um...

LR:读高中的时候, 我和一个女孩谈过恋爱, 但我们俩也不怎么热络。大学的时候, 我的每段恋情都持续得不长。因为我太忙了。(LJC: 大笑) 我读完之后本科学后, 和一个当地的女孩结婚了。

F: 哪一年?

F: Which year?

LJC: Which year?

LJC:您哪一年结婚的呢?

LR: When it was in 59. And, and later on I got divorced but that was a mistake. (LJC: laugh) it was, it was... the first time I actually was able to date anybody seriously. (LJC: chuckle)

LR:是在 1959 年。之后, 我离婚了, 但那是个错误。(LJC: 大笑) 那是, 那是我第一次认真真地和别人谈恋爱。

F: 她也是 MIT 的吗?

F: Is she from MIT either?

LJC: Is your... did your first... is, is ex-wife studied at well...

LJC:您的.....您的第一任.....您的前妻也是.....

LR: She went to the University of \*\*... Had, had bachelors and lived with me after that.

LR:她是\*\*大学的, 拿到学士学位后, 就和我同居了。

1:31:34

F:那他, 这个他关心政治啊, 文学啊, 这种爱好有什么?

F: Does he love politics or literature? What are his hobbies?

LJC: So, what's your hobby? Do you like the literature or the... anything else, like the social, events? Other than... what do you care about other than research?

LJC:你有什么兴趣爱好吗? 你喜欢文学, 或是别的什么吗, 像社交的? 除了.....除了科研, 你还有其他爱好吗?

LR: Oh... (LJC: laugh) at school? (LJC: yeah, school.) Not much. As I said, I did a lot of things like putting the sodium... (LJC: laugh) and using the nitroglycerin and the dorms and wandering in the dorms other things like that. Building... exchange... I built a phone exchange for the dorm as well. But in any case, I learnt how to do a lot of things. But, but, MIT was... started to get more involved as I moved on since my thesis. So I was involved and busy with that.

LR:哦.....(LJC: 大笑) 在学校的时候吗?(LJC: 对, 学校。)没什么爱好。我前面说了, 我做了很多类似把钠放进..., 使用硝酸甘油, 在宿舍里暴走这样的事。搭建.....我在宿舍里

搭了一个电信交换机。但不管怎么说，我学会了做很多事。完成论文后，我很投入科研，也忙着做科研。

F: 那时候，因为 MIT 有很多这个很著名的人嘛，包括 Minsky 呀，就是这些人。他对这些人有什么印象？

F: A lot of famous people, like Minsky, were from MIT. Does he have any memories of those people?

LJC: also that there are many famous people in MIT, like Minsky or other people... Licklider, and (F: 苏斯兰德) Sussland. So do you have interaction with people in that time?

LJC:麻省理工学院有许多知名人物，比如明斯基，还有其他人.....Licklider，还有（F: 苏斯兰德）苏斯兰德。当时，你和这些人交往过吗？

LR: I interacted with those that were related to what I was doing. I interacted with Minsky in his group. (LJC: ah.) When I went to ARPA later on, I funded those groups. So I got more involved then because I was managing the funding for a while of (LJC: ah, ah, ok.) project on AI, all of the AI in the world actually, in the US. So I funded for Marvin. (LJC: oh really?) So I funded a Carnegie group and a MIT group and a Stanford McKersie group. McKersie was in MIT when I was there. So, he moved to Stanford. And so I was involved in a lot of project and in fact one of the project that I started was speech recognition (LJC: oh.) with all these group cuz I knew you could go a lot further than people to really put together syntax and semantics and all the other issues. Semantics was key uh... to speech recognition. If you could sort of understand what they were talking about, it helps tremendously. (LJC: oh, amazing.) And so, speech recognition took a big step back then. (LJC: OK) But those are things I funded well when I was in ARPA. I was involved in project from all around computer science. Anybody who had a project came to me. (LJC: laugh) So, so, that was, that was, the kind of thing that I did mostly. When I went to ARPA, I spent a lot of time designing ARPANET because there is tremendous amount of uh... unknown uh... technologies that I had to discover in terms of the typology of the network and how you got the optimal throughput at minimum cost for a network. (LJC: um.) So I spent a lot of time on the theory of typology and I ordered did everything else building a network even though I contracted the actual building of the packet switch after specifying to should be working and I did that turned out to group near MIT at BBM. But... there was, there was, um...well, I'm not sure where... (LJC: laugh)

LR:我与和我所做的事相关的人交往。我去参观过明斯基的团队，和他交流过。（LJC: 啊。）我去 ARPA 之后，资助了这些团队。后来，我更深入他们的团队，因为我管理的是 AI 项目的资金（LJC: 啊，啊，好的。），全世界的 AI 项目，全美国的 AI 项目。我资助过马文。（LJC: 哦，是吗？）我资助过卡内基 梅隆大学的一个团队，一个麻省理工的团队，斯坦福的麦克西的团队。我在 MIT 的时候，麦克西也在。他之后去了斯坦福。我参与了很多项目。实际上，我自己也开始做“项目”，那就是在各个小组里进行言语识别（LJC: 哦。）。因为我相信，如果你理解对方所说的话的句法和语义，你可以走得更远。语义是语言识别的关键。如果你能理解他们在说些什么，这会对你有极大的帮助。（LJC: 哦，真棒。）当时，要在他们中做到言语识别是很不容易的。（LJC: 对。）但我在 ARPA 的时候，这些项目在我的资助下发展得不错。我参与了计算机科学领域内所有的项目。任何人只要想做项目，都会来找我。（LJC: 大笑）这是我当时做的最多事。我在 ARPA 时，花了许多时间 ARPANET，

因为整个过程中遇到了许多亟待我去发现的未知技术，有关于网络拓扑的，有关于如何使用最低成本达到网络最大吞吐量的。（LJC：嗯。）因此，我花了很多时间研究拓扑学，做了所有和搭建网络相关的事。虽然我承担着搭建包交换的职责，但在明确了要怎么做之后，我和 MIT 附近，在 BBM 的一个小组一起做了。但.....我不确定，那个小组到底在哪里。

1:35:27

F: 我是想这本是就是，一般大众也能更多地了解他。所以还是要讲讲，除了工作之外，再讲一些他生活中比较有意思的事情。

F: I suppose the book is aimed at helping ordinary readers get to know him better. So, could he share more about some interesting things in his life other than his work?

LR: Let me come back to the issue of packet switching. Basically, what I did was I started packet switching to create the first network that did that. And it was designed with a protocol which I... besides hiring Kleinrock to run at the test lab at UCLA, I got a group of graduate students together to design the basic protocols that was used over the network. The network control protocol, NCP. This protocol basically reserves spots for packets in the network ahead of time so when you send a packet, you knew there was space and then switch for it. And, ah, therefore we didn't lose packets... um... except for noise, which we retrace locally in lines immediately. So the next stage some checked the packets and got retransmission rather than waiting for the entire thing while TCP does. So, so, it was, deliberate reliable data to the final end station. So, you didn't have to use TCP or something else. Um... and then I started... then I, I left ARPA in '73 and um, started Telenet, which was the X.25 protocols was this standard for the world the next couple decade. So about twenty years, Telenet and X.25 were primary packet switching capability in the world. I built that equipment uh, uh... so that the UK and Canada and other people they started building the world network. Other people built their own equipment. But eventually a lot of them came from Telenet and that eventually went public and sold that to GTE later on. Um... the, the, the thing about that was it also manage to keep copies of packets and make sure that we have reliable communication so there was no need to have TCP on top of it. It actually was basically reliable all the time cuz it makes sure you have space and switches. Today... but then when I left ARPA, uh...um, Bob Kahn [Robert Kahn] and Vint Cerf took over and brought \*\* in, who was one of the people the original committee. But, um, Vint decided that was good enough and we didn't need to do **air control** at all. Just having the network trying send it through and then have user trying to resend it. It didn't work. That technology has worked for uh... for uh... well, it started in 83 and is, is still used today as the primary protocol in the network. But TCP has the problem that it runs at certain speed because you're waiting for the round trip before you can send anything else. So it's totally dependent on distance. And that, that is keeping the speed down is what we needed in 1990 not 2018. And so, today, you try to send a big file, you can only get 100 megabits. That's maximum you can get. We should be able to get gigabits, um, per second because, um, because the network is running at 100 gigabits. So why are we working at 100 megabits? So I still have a problem what we did back then because it's, it's... um... it's restricted the speed in moving big files tremendously. That's becoming critical. (LJC: um.) So, the project I'm working on now is basically that to fix it up. But I don't want to get into that.

LR:我想回到前面关于包交换的话题。我所做的是搭建了一个使用包交换的网络。这个网络

是通过一个网际协议设计的，我聘请了克兰洛克在 UCL 的实验室运行这个协议，还请了一群研究生一起研究用于这个网络的基本协议，也就是网络控制协议。这种协议可以为数据包预留空间。所以，你发送数据的时候，你知道是有空间的，也有交换器的。这样，我们不会在传输中丢失数据包，声音是例外，我们需要在传输中立刻追踪声音。因此，下一个阶段，只要核查好数据包，将它重发就好了，不用像 TCP 一样一直等着。因此，到终点站的时候，信息也是完整无缺的。你不必使用 TCP 或是其他的东西。1973 年我离开 ARPA，创建 Telenet，后来的 X.25 协议是全世界通用的网络标准。在后来的二十年，Telenet 和 X.25 都世界上包交换水准最高的技术公司。我搭建了这些设备。英国，加拿大，还有其他地方的人也开始搭建网络。其他人也搭建他们自己的设备。但说到底，很多设备都是基于 Telenet 的。Telenet 最终上市，被 GTE 收购了。问题的关键是，这个系统可以保留数据包的副本，确保我们沟通无阻。因此，不需要加上 TCP。它一直很可靠，因为它确保你有足够的空间能够交换。我离开 ARPA 后，鲍勃·卡恩和文顿·瑟夫接管了这些项目，他们还招了\*\*——这位是原来组委会的成员。但 Vint 认为 TCP 已经够好了，完全不需要 air control。只要让网络把东西发过去，让用户把东西再发出去就可以了。这压根没用。这个技术沿用了……嗯，它是 1983 年开始被使用的，一直用到现在，是互联网主要的协议。但 TCP 有一个问题，那就是它运转有固定的速度。因为你发掉一样东西后，得等它转一圈回来之后，才能发别的东西。因此，它完全受到距离的影响。我们在 1990 年可以减速，但现在 2018 年。到现在，如果我们要发大文件的话，你只能发 100 兆比特的。这是最大值了。但我们应该做到每秒是吉比特，因为现在的网络的速度是 100 吉比特的。为什么我们还非得用 100 兆比特传信息呢？对于过去做的一些研究，我还是持反对态度。因为它极大程度限制了传送大文件的速度。这个问题变得很关键。（LJC：嗯。）因此，我现在在做的项目就是要解决这个问题。但我不想就此讨论太多。

LJC: yeah, yeah. laugh

LJC:对对。大笑

LR: But there is a problem that continue throughout history. And I worked various...new programs in various companies...

LR:有个问题时到现在都没解决的。我在不同公司，参与不同的项目……

LJC: ok, yeah, yeah.

LJC:好，对对。

1:40:21

LJC: The speed can be further improved, right, significantly, right?

LJC:传输速度可以大幅提高，是吗？

LR: Oh, we can get 50 times what we get today.

LR:可以提高到今天的 50 倍。

LJC: Um um um um... Without the change infrastructure how?

LJC:不改动基础设备的话，怎么做到呢？

LR: Without replacing the routers in the user's computer, we have to do something else. (LJC: oh, oh, ok) We can't change the infrastructure that seriously. (LJC: um, um.) It has to be a relatively modest change. I've looking for the way to do that. That's what I'm working on.

LR:不能不替换用户电脑里的路由器，所以我们得想别的办法。（LJC：哦，好，好。）我们不能大幅改动设备的基础结构。（LJC：嗯嗯。）必须是相对较小的改动。我一直在想办法解决这个问题。这就是我现在在做的事。

LJC: The packet switch is the foundation of the internet, right? How do you think about the contribution of the other country, like European. Especially, there are some report like the Donald Davies (LR: oh, yeah)

LJC:包交换是互联网的基础。你对于其他国家对此做出的贡献有什么看法，比如欧洲国家？尤其是像唐纳德 戴维斯.....（LR：哦，是的。）

LR: There were two projects in Donald Davies'... National Physical Laboratory. If you read carefully what Donald Davies when he died, he...published paper was wrong about Kleinrock. Kleinrock had something that I did in the packets. He just didn't them call packets because there was no such word then. I picked up the word from Donald Davies when I was at the conference in '67, and I decided that was a good word because it was an English word for \*\*. So I picked up that word from there but at that time, when I had already designed the network, and designed the packet switch, and um... we actually got it running, he was still thinking about the problem in building a small switch in his lab. He couldn't get funding for anything else.

LR:唐纳德 戴维斯所在英国国家物理实验室的有两个项目。如果你仔细读他去世前发表的论文，你会发现他对克兰洛克的评价是错误的。克兰洛克对于数据包是有贡献的。他只是没用“packet”这个名字称呼而已，因为当时还没这个词。我是在 1967 年的学会上，受唐纳德 戴维斯的启发，采用了这个词。我觉得这个词不错，因为它是\*\*的英语词。所以，我选了它。当时我已经设计好了网络，也设计好了包交换器，实际上，它们已经在运作了。但戴维斯当时还在想怎么在他的实验室里造一个小交换器。他没法拿到资金支持。

LJC: actually you just adopted the name but you have worked on going on already.

LJC:其实你只是借用了这个名称，但实际上你的项目研究已经有了进展了。

LR: Oh yeah. It was all, uh, all built. It was just a question I needed to name. But for the thing, which we were calling a message. The message was too big, (LJC: message, oh.) a piece of message. It's hard work to come up a way with for a piece of message. It had to be chopped into pieces. Uh... in any case, He was unrested in the problem and he heard me talk at MIT once. He's written on his papers. he went there for a visit. He learnt about the kind of work I was doing. And he went back and started working on it. But, they didn't get very far before I finished. It was, um, a contemporary effort, but a little bit later. He didn't actually discover anything new because I'd already done it. Chuckle. But in any case, Paul Baran's paper, become much more involved because people read that and say, well, it was...my project was to help defence nuclear attack. Because that was Paul was thinking. He was saying I wanted to build a packet network which we all called today. He really didn't, uh... he worked at that in '64. At the same time, Kleinrock had written his thesis and published it. So actually Kleinrock was well first in terms of the concept...um, what you need to do, what the theory was for queuing and anything else. But Paul



actually more or less the same time, was writing you should do build it first. The problem is he didn't have a design. He just, uh... talked about it. And that wasn't even available to me until... after I designed the network. So, it didn't contribute actually to what I was doing. But I had no intention worrying about it as something that was standing nuclear attack. But it needed to be reliable. So, I mean, it had to be reliable cuz it had to be connected at least. We already had that reliability. Outside of that, I didn't believe nuclear was an... an issue. But um... Steve Lukasik who was running ARPA, a good friend of mine who after um left ... so when he presented it at the congress he may have used that theory because it was useful.

LR:它已经造好了。我只是要澄清一下这个问题。还有一样东西,我们当时管它叫信息。信息太大了。(LJC:信息,哦。)一条信息。要传输一大条信息是很难得,必须要把它变成碎片。戴维斯对这个问题很困惑,他有一次在 MIT 听到我谈论这个问题,就来 MIT 参观了一下。了解到我在做什么项目后,他回去后也开始着手做项目。但我做好之后,他们都没什么进展。他没发现任何新的东西,因为我已经搭建好了网络。笑。还有保罗·巴兰的论文,也让他参与到这个话题中。因为人们读了他的论文后,说我的项目是为核战争说话。因为保罗就是这么想到。他说我想搭建一个包交换网络,这个说法我们现在都在用了。他其实没有什么.....他 1964 年在那里工作。与此同时,克拉洛克已经写好了他的毕业论文,也发表了。所以,实际上,克兰洛克是第一个想出这个概念的人,也是第一个谈了我们要做什么,排队论是什么。保罗当时大概在写论文说明你应该先搭建网络这一观点。但问题是,他自己没有设计出网络。他只是在谈论这个话题而已。他的论文我在设计完网络后才看到。因此,对我也没什么帮助。我也不担心它是不是支持和战争。我只想让它变成可靠的网络。它一定要可靠,至少要把电脑连起来。我们后来就达到了信息传输的可靠性。除此之外的事情,我并不认为核是个问题。史蒂夫·卢卡西克当时是管理 ARPA,他是我的好朋友。他在议会上展示我们的成果的时候,可能还用了我的理论,因为我的理论很有用。

LJC: laugh. public to understand the importance of technology. So...

LJC:大众理解技术的重要性。

1:45:04

F: 从他的角度来说,就是这三个人, Kleinrock 啦, Paul Barran 啊, Davies, 就是.....这个.....那都不应该有贡献, 是吧?

F: So, he doesn't think that the other three people, Kleinrock, Paul Baran, Davies had contributed to packet switching, does he?

LJC: From your perspective, Bob Kl-... Bob... Davies, right (F: 不是那个, 那个谁.....Kleinrock) Kleinrock (F: 戴维斯.....这三个人, 是不是对包交换都有贡献) From your perspective, like the Kleinrock, Kleinrock, Bob Baran, and Davies... they also make some contribution to the paget switching, right?

LJC:在您看来, Bob Kl-.....Bob.....戴维斯, 对吧(F: no, and Kleinrock) 克兰洛克(F: Davies... Did three of them made contribution to packet switching?) 克兰洛克、巴兰和戴维斯.....他们也对包交换做出了一些贡献, 是吧?

LR: who?

LR:你说谁?

LJC: The...Kleinrock, Kleinrock.

LJC:克兰罗克, 克兰罗克。

LR: Kleinrock?

LR:克兰罗克。

LJC: ah, yeah. Baran and Davies.

LJC:对。还有巴兰和戴维斯。

LR: No. Barber and David uh uh uh... (LJC: Baran) Barber and the UK group (LJC: ah, yeah.) included Barber and, and... (LJC: Davies, yeah.) and Davies. Basically they wind up making no contribution of their own. They were working at it at the same time and a little later. But they couldn't get any funding and they didn't ever do an experiment that made (LJC: Oh, oh, oh.) any changes at all. And, I don't know, um, I didn't depend on their research. (LJC: ah, yeah, yeah.) I got the work from... (LJC: ah...) the packet.

LR:鲍勃和戴维斯, 呃.....鲍勃和英国的科研小组 (LJC: 啊, 对。) 包括鲍勃和, 和..... (LJC: 戴维斯, 对。) 戴维斯。他们最后没做什么贡献。他们是同时或者稍后在研究这个项目的。但他们没拿到资金支持, 他们没做出有建设性成果的实验。 (LJC: 哦哦哦。) 我也不清楚, 我自己并没有参考他们的实验。 (LJC: 啊, 对对。) 我是通过研究数据包完成项目的。

F: 六七年代的会议对他影响有多大?

F:What influence did the conference in '67 have on you?

LJC: how do you think that... what's the... how much the importance are... are the influence of the '67 conference to you, your project, or to you, to you?

LJC:您认为, 1967 年的学会对您和您的项目有什么影响?

LR: '67... uh...

LR:1967 年.....嗯.....

F: 就是这个, 这个词, 这个这个词.....

F: The coinage. That coinage...

LJC: Is that ACM conference? What's conference? '67, the conference on the...

LJC:是计算机协会举办的学会吗? 是什么学会? 1967 年的学会, 关于.....

LR: well, when we, when we, uh... in '67, the first... the only meeting that I can remember is our PI meeting where I presented what I wanted to do with all of the other ARPA contractors. They were all basically being paid for by ARPA but I was responsible for their funding. And I presented what I wanted to do. And um, the um, and the conference basically uh... was Clark suggested doing ... Actually in cab, he suggested to me doing the, um, switches in a separate computer, a small computer, which was a good idea. Um, I uh, I had done it already on the TX-2 and STC

machine as the piece of operating system. But that was complicated because you had to do it differently on every computer. Well as doing separate machine made it a single project good, which was good. And, so, that idea was very valuable. Wes [Wesley] was my... was person who used to run the lab. When he left... at Lincoln, he ran that Lincoln Project, so I knew him. Um... so that conference, I got the feedback from most of the people, you know, at the ARPA meeting that I told have to sign up for the network. They didn't like that. Because that was going to use their computers for somebody else. (LJC: chuckle) And they didn't want to lose computers. Turns out they got more computers due to the speed and time zones cuz everybody could share computers. So it worked out much better. I have projected that we would save money on computers because of the network. When I grew up that finally after doing whole project it turns out that I had... um, um... made very substantial cut in the amount of computers that I had to buy. (Um...) so I'd say, much more money than we spend on the network. That was one of the things that happened at the conference. I don't think that was '70 ... (F: 就是他听到“包交换”那个词的那个会议。) It was a conference in Gatlinburg (LJC: yeah, yeah). That was the one where I got the word packet from (LJC: Don... Don...) one of the participants (LJC: yeah). It was ... (LJC: the colleague of the ...Donald Davies?)

LR: 1967 年的会，我能想起来的只有我们的项目负责人会。我在会上给所有的 ARPA 的合约人展示我要做什么。这些合约人都是拿 ARPA 的钱的。我要对他们的项目资金负责。我演示了我想做什么。会议基本是.....克拉克建议.....其实是在出租车上，他建议我在没有连接的电脑上尝试交换机，一个小一点的电脑。这是个很好的想法。我在 TX-2 和 STC 机器上装过交换机，它是运作系统的一部分。但克拉克提出的想法更难，因为每台电脑要有不同的安装方式。在独立的机器上做交换器的项目可以算得上是另一个新项目的，这非常好。他的想法很有价值。韦斯[韦斯利]是管理实验室的人。他在林肯实验室时，管理林肯项目。所以我认识他。在那次会议上，我得到了大部分人的反馈。在 ARPA 的会议上，我提出要启动互联网的项目时，他们都不喜欢这个想法。因为项目期间，可能要用他们的电脑。(LJC: 笑) 他们不想失去电脑。但结果，因为速度和时区，他们拿到了更多的电脑。因为每个人都可以共享电脑了。项目的成果好很多。我曾推断，等网络建成后，我们可以节省电脑的开支。等我整个项目完成后，结果证明我大福减少了需要购入的电脑的开支。节省的钱比我们想投入的成本还多。这是在会议上发生的一件事。但我觉得这不是 1970 年的会议.....(F: the conference where he picked up the word “packet”) 是在盖林伯格的会议。(LJC: 对，对。) 在这个会议上，我发现了“数据包”这个词，是 (LJC: 唐.....唐.....) 其中一位与会专家给我的灵感。(LJC: 对) 他是..... (LJC: 是唐纳德 戴维斯的同事吗?)

LR: No, he wasn't there.

LR:不，他不在场。

1:49:30

LJC: oh, he wasn't there. He's a colleague. He's a colleague.

LJC:哦，戴维斯不在场。是他的同事，是他的同事

LR: one of his colleagues. I forgot his name.

LR:他的一个同事。我记不起来他的名字了。

LJC: I think the name is...

LJC:我记得他的名字是.....

LR: Scantlebury.

LR:斯坎特伯里。

LJC: is Scanbir...something...

LJC:是斯坎伯什么什么.....

LR: Scantlebury.

LR:斯坎特伯里。

LJC: yeah.

LJC:对。

LR: yeah, He, he, um... also suggested that... I was looking for the higher speed lines I can find because that was critical and he said, he told me that there was a 50 kilobit modem that existed, that AT&D had. I took, I think was 9 telephone lines. But it was available under \*\* so I can buy the lines very cheaply. So, I looked into it. The cost was better than 9.6 kilobit modem. So I, I, I went to the 50 kilobit lines. I just hadn't heard of that capability. So he mentioned that.

LR:对，他还建议我.....我当时在找速度更快的线，因为我很挑剔。他告诉我，AT&T有一个5万比特的调制解调器。我拿了.....我记得是9跟电话线。但它是\*\*，所以价格很便宜。所以，我稍做研究。它的价格比9600比特的调制解调器要便宜。所以我买了5万比特的。我之前没听说过这个。是他告诉我的。

F: 他们两个单独聊过吗？

F:Did you have any private conversations?

LJC: You... how do you talk with that...with him? How did you talk... you talked like after the session or...?

LJC:你们是会议之后聊的，还是.....？

LR: After the session.

LR:会议之后。

LJC: After the session...Oh.

LJC:会议之后。

LR: Yeah, yeah. I presented my paper and he presented his. But the, but the conversation was after the session.

LR:我展示了我的论文，他展示了他的论文。但我们的对话是在会议之后。

LJC: OK... How long did you, did you talked, yeah?

LJC:你们聊了多久？

LR: Oh, probably 20 minutes or something. Not very long.

LR:大概二十分钟左右。不是很久。

LJC: Not very long. OK.

LJC:不是很久，好的。

LR: I mean, they hadn't done any experiment yet. They tried to put together a switch. They hadn't gone very far yet. But he knew those two things for me.

LR:他们当时还没做实验。他们想要搭建交换器。但没什么进展。但他给我提了两个很好的建议。

F: 这几个，这四个“互联网之父”之间，就是他们的这个，Kleinrock，他什么时候认识的？交往过程啊，包括……怎么做评价？

F: When did he first met the other three Fathers of the Internet, like Kleinrock? How did he get to know them and... what are his comments on them?

LJC: people think that we have four Fathers of the Internet. Kleinrock, and then... other few...

LJC:通常人们认为“互联网之父”有四位。有克兰洛克，还有其他……

LR: basically, that was from the... uh... uh... award that National Academy of Engineering gave for the um... um... it was the award they gave to the four of us. They were attempting to duplicate the Nobel Prize but they didn't duplicate the money (LJC: laugh). The Nobel Prize, which, you may go back one step, which was um... that little poster down there. The one's from Ericsson is actually the little Nobel Prize (LJC: OK.) because what happened in, in terms of Nobel... Nobel um... wrote as will, you can't have math as a subject. (LJC: oh, yeah.) Because his wife's boyfriend was a mathematician. (LJC: OK) and he didn't want the mathematician that was the Spanish word saying there, which is pretty like the Nobel Prize in the way it's organized. But in any case, the actual award is run by the National Academy of Sweden. It's given by the King. The words are presented exactly like the Nobel Prize (LJC: laugh) done by the same committee and in the same conditions. But they had to be funded separately. Because of the problem with uh...Nobel's will. (LJC: yeah.) so, Ericsson funded communication award, which would have been illegal under Nobel. You can't do it. And so I believe that, actually it shouldn't be call little Nobel. (LJC: laugh) Because basically it's the same. (OK) It's just they wouldn't allow Nobel... group to do it.

LR:这个说法其实是来源于……美国国家工程院颁的奖……我们四个人都拿到了这个奖。工程院的人想要复制诺贝尔奖，但他们复制不了诺贝尔奖的奖金额。（LJC：大笑）诺贝尔奖是，往后退一步，你们看下面那张小海报。这是爱立信奖发的，爱立信奖其实被称作“小诺贝尔奖”。（LJC：好的。）因为诺贝尔立了遗嘱，诺贝尔奖不许有数学学科。（LJC：哦，是的。）因为他老婆的男朋友是数学家。（LJC：对）海报上面的西班牙语就是“数学家”的意思。爱立信奖和诺贝尔奖的评审方式很像。评审是由瑞典学院组织的。奖是由国王颁发的。颁奖词就和诺贝尔奖一样，都是由同一个评审委员会，在同样的情况下写的。但是两个奖必须有不同的专项资金，这和，嗯，诺贝尔的遗嘱有关。（LJC：对。）因此，爱立信就拨款给通信奖设立专项奖金，如果是用诺贝尔的名号的话，就是犯法的。你不能这么做。另外，

我坚信，这个奖不该被叫做“小诺贝尔”。（LJC：大笑）因为它其实和诺贝尔奖是一样的。只是他们不允许诺贝尔奖的组委会颁奖给数学家。

1:53:38

F: 让他讲讲他们四个人之间的这个， 这个.....关系.....

F: Could he talk about how he got along with the other three?

LR: so, basically the National Academy of Engineering in the States wanted to have some similar prize. They created the award that...uh... gave to the four of us. And it was Kleinrock and I back then because the other people hadn't been involved. He did the theory and I did the network. And he did a lot of the theory and his thing and didn't test them. (LJC: ah...) Um... so basically we worked together throughout the project...

LR:本质上说，美国国家工程院也想要有这样的奖项，所以就创立了这个奖，之后颁发给我们四个。我认识克兰洛克，因为另外两位并没有参与我们的项目。克兰洛克做理论研究，我搭互联网。他做了很多理论研究，但没验证。（LJC：啊。）嗯.....所以我们两个是一起参与到项目中的。

F:他们两个最早什么时候认识，就是 Kleinrock?

F: When did he know Kleinrock?

LJC: When, when do you know that... the Kleinrock, yeah?

LJC:您是什么时候认识克兰洛克的?

LR: I knew him at the graduate school. We shared and office. laugh

LR:读研究生的时候认识他的。我俩共用一个办公室。大笑

F: Which year?

F:哪一年?

LJC: Both are graduate student... you both are graduate school?

LJC:您二位当时都是研究生吗?

LR: We were both in graduate school at same time doing our PhD. (F: 哪年啊，是哪年啊?) So we shared the office for...

LR:我们都是研究生，同期攻读博士学位。所以我们共用一个办公室，用了.....

LJC: Which year?

LJC:哪一年?

LR: well...this...'59 to '60... uh... well... '63. And at '64 or '-5, '63 to '65, we were at Lincoln Lab together. (LJC: oh) So we worked together a lot. And, and he'd written a book, which, in '64, which covered all of this. And the book was um... had most of theories like queuing theory and whether we would lose packets before storing packets for a very long \*\*, for we would run out of

space. But he computed the limits for what you could, he could prove that it was viable, that we wouldn't lose it. As I said once, when I didn't know the theory, I wouldn't have taken a chance. I mean, I could have designed it and done it, which I did. But I wouldn't have taken the chance to ARPA and undertaken as a full-blown project of building a millions-of-dollar network if I didn't know if it's gonna work.

LR:1959 年到 1960 年，不，是 63 年。1964 到 1965，不，1963 到 1965 年，我们成了林肯实验室的同事。（LJC：哦。）我们常常在一起工作。他还写了本书，书里讲到了这些事。这本书里还有许多理论，比如排队论，比如在长途包交换是否会空间不足，导致数据包遗失。他推算出传输的极限，证明了包交换是行得通的，证明了数据包不会遗失。我以前说过，克兰洛克没推算出的话，我是不会冒险的。我的意思是，我可以设计它，完成它，我也确实完成了这个项目。但如果我不确定 ARPA 的项目会成功的话，我不会冒险去那里，参与到一个完备的项目中，去搭建一个价值百万美金的网络的。

LJC: it seems that you two are so close. Did you also discuss... Maybe even he can know that whether those ideas or theories practical, yeah?

LJC:看样子，您二位关系非常好。您是否和他讨论过.....或者，他是否知道这些想法、理论是否切实可行呢？

LR: well, he wasn't... he, he wasn't into building it or designing it. But he designed a lot of the theories on how you should, what you should do, what you needed to do in terms of queueing, in terms of topology, in terms of everything. So he had a lot of the ideas behind it, behind the fact that it should work. But not any way to, not any proof of activity. He couldn't do that. Because that wasn't his specialty. His specialty was queueing theory. Queueing theory is, is... He's one of the masters on that.

LR:嗯，他做不到.....他不喜欢造东西，不喜欢设计东西。但他创立了很多理论，在排队论、拓扑学等各方面，指导你怎么做，该做什么，需要做什么。项目背后有很多他的理论支撑，理论证明项目是可行的。但他没有办法验证。他验证不了。因为这不是他的专长。他的专长是排队论。排队论是.....他是排队论的几大专家之一。

1:56:23

F: 那时候，他们两个人关系怎么样呢？除了工作之外。

F: How did he get along with Kleinrock outside of work?

LJC: Do you get along well?

LJC:您和克兰洛克相处得好吗？

LR: Oh, we get along great.

LR:噢，我们相处得好极了。

LJC: Great, ok, yeah.

LJC:好极了。

LJC: What's your-...what his personality? Any story, yeah?

LJC:他性格如何? 你们之间有没有发生什么故事?

LR: We went to Las Vegas quite often cuz I developed a counting theory. He was using Thorp theory, which was a very difficult counting theory for blackjack to make it ... (LJC: laugh). I developed my own theory by a lot of math to compute the optimal strategy. And the optimal strategy was to count up and down. (LJC: OK) That's what used today largely in... in trying to beat blackjack. Uh... we went to Las Vegas quite often together and I probably won over 10 thousand dollars during that period. We often won quite well because they hadn't got to know how to protect against it. (LJC: ah, ok) Now, they use two mini decks and get two mixed up. You can't do it very well.

LR:我们经常去拉斯维加斯, 因为我设计了一种算法。他常用的是索普理论, 这是一种难度很高的算法, 在二十一点中.....我运用许多数学原理, 设计了我自己的算法, 来推算出最优策略。最优策略就是要累加累减。(LJC: 好。)这套理论在今天的二十一点中也广泛使用。嗯.....我们常去拉斯维加斯, 那段时间, 我大概赢了一万美金。我们常赢, 因为当时赌场不知道要禁止我们这种方式。(LJC: 啊, 是的。)现在, 他们会用两幅迷你拍, 还把它们混着用。推算起来很难。

LJC: OK... laugh

LJC:好.....大笑

F: 能赢钱吗?

F: Did you win?

LJC: You both win or it's just...?

LJC:你们都赢钱, 还是.....?

LR: we both won.

我俩都赢过钱。

LJC: We both win.

LJC:我们都赢钱。

LR: We basically uprated as a team to share because that was the safer way. Because if it was high and one was low, it got equalized. But we both did it. And he used my system because it was far better than his system. (LJC: laugh)

LR:当我们组成一个团队的时候, 我们的赢面最大。因为这是更保险的做法。如果一方牌面大, 一方牌面小的话, 那就扯平了。但我们都赢过。他还用我的算法, 因为我的算法比他的好用太多。(LJC: 大笑)

F: 能不能再讲得更具体点? 就他, 他们是坐飞机过去, 那大概怎么一个过程呢?

F: Could he share more detail about the Las Vegas story with us? If they travelled there by plane, how was the flight?

1:57:56



LJC: Did you drive to Las Vegas, or fly...?

LJC:你们是开车去拉斯维加斯的，还是坐飞机？

LR: No, he might drive, I don't know. He was in LA so it's easy ... (LJC: oh, oh, LA is, is, yeah.). I was in the East Coast, so I had to fly. (LJC: OK, OK) Anyway, it... one time I had also built a... a device to sit in my pocket that had a quartz crystal later that had accurate time base. if it's tie-clipped and I touched it, it would start to count and then it would um... give me a shock when it went off. So it was totally unnoticeable to the casino. And I watched the luck wheel and I realized that you can the, the, the ball... if you can project all where it's gonna be within half, you're gonna win. Because I have to bet on numbers around where it's going to land. It doesn't have to win every time but you'll better off by the factor 2 or 4, if you can get approximate where it's going to land and you can't. So what I did is I timed the ball from when it passed the certain double zero to where it went around so many times. That gave me its \*\*. I know the DXL ration from previous experiment. (CHUCKLE) And so I could predict where it's going to land versus double zero and I could bet on those things that were there. So what happened is it started failing. I built it out of standard transistor integrated circuit. So they started failing in heat the cuz it was very hot in my pocket then. (LJC: laugh) and I couldn't get it to work that well to give me a little shock because it started failing. So it didn't ever work too well. I proved that it was working and I got it calibrated. It was failing too much. So we went to another casino. And... um, I, I, I, I had a recorder in my hand that would record the sound of the wheel cuz what I wanted to do was to improve it, to work off the sound of the wheel which was Doppler sound shift. Different shift in sound when it goes around. I didn't have to measure it, that the sound would do it. So I was recording the sound of the wheel. Meanwhile, Leonard was playing the game aside of me and I was playing nothing much. I was betting on similar things. While I was recording and so the croupier basically said, "What's wrong with your hand" "well, I bring" "you wanna lose it. Laugh. And so we left. Laugh. He was winning. That was giving them a problem. He was winning by luck but he was winning. So the experiment stopped. I stopped working. I didn't even build this system after that.

LR:不，他可能是开车过去的，我不确定。他住在洛杉矶，洛杉矶过去很方便。我住在东海岸，我只能坐飞机去。（LJC：好的，好的。）有一次，我做了一个小机器，可以藏在我的口袋里的，机器里有石英石，有很精准的计时机制。它关得很紧，如果我碰它的话，它会开始计时，计时结束就会电我一下。赌场里没人会发现它。我观察幸运转盘。我发现，如果你可以推算出球会落到哪里，你就能赢。因为我要把赌注押在它可能会停留的数字的附近。也不用每次都赢。只要你可以估测到它会停到哪里。但你做不到。所以，但小球通过双0的时候，我开始让我的机器计时。这样我就可以知道它的\*\*。通过之前的实验，我知道DXL的概率。（LJC：笑）这样，我就可以推测出它会停在双0的哪一边。我可以把赌注押在那一边的数字上。但之后，这个机器失灵了。它是用标准的晶体管集成电路做的。一热就失灵，因为我口袋里很热。（LJC：笑）我没法让它正常运作，它也没法电我一下，因为它失灵了。这个小机器不是很有用。之后，我验证了它是有效的，我把它校准了。但它还是有很多次都失灵了。之后，我们去了另一家赌场。我手里拿着录音机，用来录转盘的声音的，因为我想改进我的小机器，来假冒转盘的声音，因为转盘的声音体现了多普勒效应，每次转声音都不一样。我自己不用计算，声音会计算。于是，我就去录转盘的声音。伦纳德当时在赌钱，我什么都没赌，我每次都押在类似的东西上。我录音的时候，赌台的管理员说：“你的手是怎

么回事？”“我\*\*”“你是不是不想要了？”于是，我们离开了那家赌场。他在赢钱。这给赌场造成了麻烦。他赢钱是运气好，但赢了就是赢了。之后，实验终止，我不再研究它了，之后再也没有制造过类似的系统。

F: 去过几次啊？

F: How many times have you been to Las Vegas?

LJC: How many times did you went to Las Vegas?

LJC:您去过拉斯维加斯几次？

LR: Oh, I don't know, many times. We went there every so often. And, and I was traveling quite a bit on work. So might stop there.

LR:噢，我记不清了，许多次。我们经常去那里。我也经常出差，有时候会到那里去一下。

LJC: What motivate to there... you want to test your theory or...?

LJC:是什么促使您去那里的呢？您想验证您的理论，还是.....？

LR: Oh, I just wanted to get the money. (LJC: laugh)

LR:哦，我只想赢钱。（LJC：大笑）

LR: I won like ten thousand dollars.

LR:我赢了大概一万美金。

2:01:41

LJC: It's, it's a huge money at that time.

LJC:这在当时是一大笔钱吧。

LR: Yeah.

LR:没错。

LJC: Ten thousand, right?

LJC:一万块，对吧？

F: 每次都能赢吗？

F: Did you win every time?

LJC: Do you win every time? Or It's just... is there lose some time? Your theory or...

LJC:您每次都能赢吗？还是说偶尔也会输呢？

LR: Well I won virtually every time. I mean not every bet. But the theory is that basically you have a percentage of advantage. So you never lose very much. Because if they're dealing with it with numbers of deck you can handle, with that counting system like I can handle two decks or even four decks, where four decks were making it very difficult. Um... and he switched to my

system because in four decks he could use this system, which was the one that was published. So, I, I, I started the hi-lo system which is primarily used today. But it, it was very effective back then. Nowadays, it's not.

LR:我差不多每次去都能赢。不是说我没把都赢。我的理论依据是，你会有一定的赢面，所以你不会输太多。因为打牌的话，他们用几副牌，你就要算几副牌。用我的算法，我可以同时算两副，甚至四副牌。算四副牌难度就很高了。他用我的算法，是因为我的算法可以算四副牌。这个算法后来我还发表了。今天人们一直在用的“高牌低牌”机制就是我开创的。当时，这套算法很有效，现在就不行了。

LJC: ok...

LJC:

F: 他们两个谁水平更高啊？

F: Which of you were better at counting?

LJC:他讲是他的这个吧，因为他赢得更多。

LJC: According to him, he was better because he won more often.

F: 他们两个性格，就在相处中，他们两个性格还是挺不一样的。

F: He has quite different personality from Kleinrock.

LJC: How about the different in personality? Did you and Kleinrock... uh... yeah...

LJC:你们的性格有什么不同之处吗？

LJC: Personality... just in life or...

LJC:性格，就是生活中的.....

LR: We, we did a lot of things together. We, we, we were both doing the same theories for radio networks sorts of things. So we corresponded quite a bit. Again, he was working on a lab for me, measuring the network.

LR:我们合作过很多事。我们，我们，我们都研究相同的理论，关于电台网之类的事情。所以，我们挺合拍的。他在实验室里为我工作，测量网络。

LJC: how is the personal character like...?

LJC:性格怎么样，比如说.....

LR: Well, we got along extremely well when we were still there.

LR:我们相处得特别好。

LJC: Oh, yeah. Laugh.

LJC:噢，好的。

F: 两个家庭之间也有很多.....熟悉吗？

F: What about their families?

LJC: Do also your does your two families know that...

LJC:您的家庭和他的家庭.....

LR: No, they are not. I don't know they've met. I've met his family in his... kind of the worst thing. But since then, I don't know both...

LR:不，不熟悉，他们没见过。我见过他的家人，是在他的.....这简直是最糟糕的事。自那以后，我就没见过他的家人。

F: 就是有没有一些两个人交往中还有些比较有意思的故事，能分享一下？

F: Could you share with us more interesting stories about your friendship?

LJC: Are there interesting stories?

LJC:还有有趣的故事吗？

LR: No, I don't have a lot more there. That was the main thing we did outside of our normal life

(LJC: laugh)

LR:没有，有趣的故事不多。去赌场是我们除了日常科研外，做的主要的事儿。（LJC: 大笑）

F: 跟另外两个

F: How is his relationship with the other two?

LR: But there were four of us and Barber the National Academy and that basically was me and uh... Lin and Bob Kahn and Vint Cerf. When I left ARPA, I turned it over to Bob Kahn, who I had hired at the mean time. He originally worked in BBN. Couldn't get along with Frank Cahouet so he wanted to come to ARPA and I hired him to ARPA. He was very smart and very capable. He, um, took over the later on after I left. Although Licklider came back for a short time to help me out cuz I had to get out of there. Um and so he, he took over later on. And he hired Vint Cerf in the 80s and they did TCP/IP protocol. Um, and, and Vint was primarily known for the TCP/IP. Bob, Bob he ran the office there. He was uh... very involved in getting the protocol TCP/IP standardized for DOD, and therefore, required for DoD if you're buying a computer, you have to have an interface. Well that required everybody to have an interface to TCP/IP, which was a critical step in getting it to be approved instead of some other protocols. So it was a big fight at that time. So I claim he was very involved and get it to be a worldwide standard because he got DOD did.

LR:美国国家工程院把奖办给了四个人。一开始是我和克兰洛克，还有鲍勃和文顿·瑟夫。我离开 ARPA 时，把项目交给鲍勃接管。他一开始是在 BBN 工作但他和弗兰克·卡韦关系不好。他想来 ARPA，我就把他招进来了。他很聪明，能力也很强。我离开后，他之后接管了项目，虽然期间利克莱德也来帮过我，但时间不长，他来帮我交接项目的。所以，鲍勃后来接手的。之后，八十年代的时候，他聘用了文顿·瑟夫，二人一起研究 TCP/IP 协议。文顿是因为 TCP/IP 为人所知的。鲍勃当时是管理办事处的。他参与了 TCP/IP 协议对 DoD 的标准化项目，也就是说，要用 DoD 的话，买了电脑，你需要还需要连系装置。他要求所有人都备好和 TCP/IP 对接的连系装置，这是让 TCP/IP 通过审核的重要步骤。当时可以说是

TCP/IP 和其他协议的一场乱战。我认为，他在这个项目的参与度很高，他也将它变成了全球通用的网络标准，就像 DoD 一样。

2:06:03

F: 所以后面两个人，就他们在做互联网的过程中，这个一开始不认识？

F: He didn't know Bob and Vint at the beginning, did he?

LJC: DO you don't know the other two people when you at the very beginning, right?

LJC:你一开始不认识另外两个人吧？

LR: Well, Bob I've known ever since I started the project cuz he was working at BBN. And, and, then, I met Vint when I was working on the first project. But uh... and Vint and I had never been entirely close because he keeps on trying to downplay the packet net and make it all responsible for what he did with TCP, which has been a big problem over time. But that's... you know, we coexist, fine. (LJC: chuckle)

LR:我做项目的时候就认识鲍勃了，因为他当时在 BBN 工作。之后，我在做第一个项目的时候，认识了文顿。但我和他关系一般，因为他一直在贬低包数据网络，还把他在做 TCP 的时候遇到的问题都归结在包数据网络上，这是我们之间长久以来的大问题。但.....我们和平共存。(LJC: 笑)

F: 那跟他们两个的关系，交往不是太深是吧？

F: So he didn't have a close relationship with either of them, did he?

LR: In my mind, packet switching is the key... and TCP is a protocol. (Protocol, yeah, yeah) And today, we switching to IPv4, v6, and so but still TCP is involved. TCP is workable. But you got to change the network. Someone just have more intelligence in my mind.

LR:在我看来，包交换是关键，而 TCP 只是数据传输的协议。如今，我们用的是 IPv4、IPv6，虽然 TCP 仍被使用，它也是可行的，但要用它还得改变网络。

LJC: So for the other two people, you don't have much interaction other than...

LJC:你和另外两个人之间没有什么交往.....

LR: No, we are not, we are not ever involved. Because they... uh... Bod worked for me for many years, for couple of years. But we don't have a lot in common because of the argument that has been since created.

LR:没什么交往，我们关系并不亲密。但因为之后产生的分歧，我们意见相左。

LJC: Yeah, yeah. Laugh. Understand, yeah.

LJC:是的，我理解。

F: 就是说，就是说这个.....就说，为什么互联网会在 1969 年，六九年当时的一些社会背景讲一讲。

F: Why the year 1969 became the big year of the internet? What was the social background of

1969?

LJC: More people make contribution to internet. Most people think 1967 is basically the year of internet, right? Yeah... so, what's the social background, technology, the project base that you think '69 is the year of internet?

LJC:越来越多的人为互联网的发展做出贡献。大多数人认为，1967 年是互联网之年。当时的社会背景，技术是怎样的，为什么 1969 年会成为互联网之年？

LJC: 1969 is the year, the born of internet.

LJC: 1969 年是互联网蓬勃发展的一年。

LR: Yeah. In '67 I started the project and got the group in funding. But Taylor claims that he went to Herzfeld and got a million dollars approved. That may be true but it didn't help at all because you have to write a program plan and put in the total amount for project, which is what I did. Um... when I went there, Bob got me hired. I mean he forced it by getting Licklider to call Lincoln Lab and make me come and had Lincoln Lab convinced me to go because otherwise they couldn't affect Lincoln's budget. (LJC: laugh)

LR:是的。1967 年我开始了我的项目，也开始寻求资金支持。但泰勒宣称他找赫兹菲尔德要了一百万美金。可能是真的吧，但这也对项目没有什么帮助，因为你要写项目规划，要把项目预算写进去，这些是我做的事。我过去之后，鲍勃强行聘用了我。他让利克莱德打电话给林肯实验室打电话喊我过来，让林肯实验室说服我到他那儿去，因为我不去的话，他们就会干预实验室的资金预算。（LJC：笑）

2:09:09

LJC: Other than you know...do you... other than you live in the Boston right, you want to move to DC, right?

LJC:你住在波士顿，但你想搬去华盛顿市，对吧？

LR: Well, I didn't particularly care about the move. What I cared about was going into the management. (LJC: oh...) I didn't want to go into the management. I wanted to be more of a researcher. (LJC: oh...) And... that was... not my strength. I mean, not my only strength. And so, it turns out that the management was great. (LJC: OK...) I've been doing it ever since. (LJC: laugh) Get more people work on my theory. I mean I love more strengthen and getting my things done.

LR:我不太在乎搬去哪儿。我担心的事要我加入管理层。（LJC：噢。）我当时不想进管理层。我想做科研。（LJC：噢。）那不是我的强项。现在看来，那不是我唯一的强项，因为我发现做管理层也很好。（LJC：好。）自那以后，我就一直做高管。（LJC：大笑）让更多的人研究我的理论。我喜欢更多的强项，也喜欢完成我的项目。

LJC: Yeah... but, but still you make the...

LJC:嗯.....但您还是.....

LR: I wouldn't... I rejected this request (LJC: yeah.) for five times. (LJC: OK.) I wouldn't go.

Until Herzfeld called Lincoln and got him to talk me into it cuz he said they will take care of you... if you don't like it, you can come back (LJC: oh.) you have the job and we'll keep paying you until they pay you...blah blah blah. But on top of that, he wanted to make it happen because the funding was at stake. (LJC: laugh.)

LR:我并没有.....我拒绝了他的要求 (LJC: 好。) 整整五次。(LJC: 好的。) 我不想去。后来赫兹菲尔德打电话到林肯, 让他说服我, 因为他说他们会照顾你的; 如果你不喜欢那里, 你还可以回来的; (LJC: 噢。) 在他们给你发工资前, 我们会保留你的工作, 付你工资..... 等等, 等等。但归根结底, 他想让我去, 因为他的项目资金岌岌可危。(LJC: 大笑)

LJC: But you think that, you think that... do you think that's opportunity, that's the bigger project, right?

LJC:您认为这是个机遇吗, 这是个更大的项目, 不是吗?

LR: I didn't think it so much of an opportunity as a change of... to management. And, and it turned out to be great. (LJC: yeah, yeah.) But people did come to me with their problems, their project, their things. I knew I would go to bed very easily. I could filter all of the research and I could manage all of the research...extremely well. So, that turned out to be quite productive. (yeah, yeah) As well as I get the network built, which I did. (LJC: chuckle) '67 was the first time I presented it in the conference and to my group. (Um) And then um... I wrote the... material got to go out to build the equipment. And student group started working on protocol. And I did all of the topology and the design and rest of um... buying the net lines... rest of the network.

LR:

LR: 我当时不觉得改做高管是个机遇, 但做下来感觉还不错。(LJC: 嗯嗯) 人们会来找我解决问题, 找我投资项目, 会因为各种各样的事儿找我。我知道自己可以安心入眠了, 因为我做主可以筛选所有的科研, 可以管理所有的科研...还管理得特别好。所以, 效率非常高。

(LJC: 对对) 我做管理和我搭建网络一样都干得很好 (LJC: 笑)。1967年, 我第一次在学会里把这个项目展示给我的小组看。(LJC: 对) 他们, 嗯...我写了相关材料, 说明了不需要搭建设备。学生小组开始研究协议。我做了所有的拓扑研究, 所有设计, 和其余所有事儿...购置网线...所有关于网络的事儿。

LJC: How do you think the critical factors that you can get the funding, yeah, get the project approved, yeah for the fifty million?

LJC:你觉得能成功获得资金支持, 让项目通过审批, 拿到五千万的关键因素是什么?

LR: Well, it wasn't hard because the, the, the concept for the military is extremely attractive to have a network connected to their stuff. (LJC: oh...) So, ARPA had no problem funding it. They thought it was great. And it was. I mean, it's one of the best things that have been ever done.

LR:这不难, 因为对于军方来说, 在他们的系统里搭建网络, 这个想法是很吸引人的。(LJC: 噢。) 所以, ARPA 申请资金支持的过程很顺利。军方觉得这个想法很好。这确实很好。这是我做过的最棒的事情之一。

LJC: How do you make them to... to believe you can do it, yeah?

LJC:你如何让他们相信你能完成这个项目呢?

LR: Everybody was telling them I was good. That's why... (LJC: oh... laugh) I had done their

experiments to show that I could do it. So, that wasn't the problem. I mean, I... that's why they hired me.

LR:所有人都告诉他们我很厉害。这就是为什么..... (LJC: 噢.....大笑) 我给他们做过实验, 来证明我可以完成项目。因此, 让他们相信我, 这并不是难题。他们就是知道我厉害才雇佣我的。

2:12:08

F: 再问一下, 他跟 Bob Taylor 两个人关系, 就当时那个同事之间.....就是那个, 他一开始 Bob Taylor 是主的嘛, 他是协助他的嘛, 他们两个那时候相处怎么样?

F: I would like to ask about his relationship with Bob Taylor when they worked together. Taylor was the director and he was assisting him. How was their relationship back then?

LJC: How, how do you... how did you get along with Bob Taylor?

LJC:你和鲍勃·泰勒相处得好吗?

LR: Well, Bob Taylor was in the office. After I left, he could really run the office very well. But he uh...was left in charges as deputies before I left ARPA. So he became a director. And... he needed help in computer science obviously because he wasn't a computer scientist. So when they brought me in, they made me the chief scientist so that I ran the program. And he worked on the political things and interacting with military in Vietnam and other places. (LJC: oh...) So he actually went to the front and worked on computer stuff in Vietnam and other places. So he was, he was involved in that in couple years and then he left. Um... because it wasn't his thing really. But he, but he was, he had been realized working with was important to do the network. And he got me hired by pushing (LJC: laugh).

LR:鲍勃·泰勒是在他们的办事处的。他把办事处管理得井井有条。我离开 ARPA 之前, 他是副职。之后, 他成了主管。但他电脑科学很差, 因为他不是电脑科学家。所以他们让我加入, 还让我担任首席科学家, 让我来负责项目。他专攻政府有关的事情, 去越南或其他地方和军方沟通。(LJC: 噢。)他是真的去越南和其他地方, 上过前线, 做一些电脑方面的工作。他在这方面工作了几年, 然后离职了。因为, 这不是他的特长。(LJC: 大笑)

F:那他们两个人合作的怎么样呢?

F: Did you work together well?

LR: And, and Bob was very bitter later on in life. Because he didn't get the recognition that he thought he deserved by getting me hired. Seems to me that wasn't major issue cuz I that too (LJC: chuckle). But anyway, Bob was very upset about it later in his life.

LR:鲍勃后半生挺不满的。因为他觉得让 ARPA 成功雇佣我是件值得被认可的事, 但他没得到他认为自己应得的认可。但不管怎么说, 鲍勃之后对此都很愤恨。

LJC: In the two years, you worked together, how do you think about...

LJC:你们一起工作了两年, 你是如何.....

LR: Oh, we got together fine. (LJC: fine.) I helped him even with his personal life because he was



a flirt with all of the women. (LJC: oh... laugh)

LR:噢，我们关系很好。(LJC: 关系很好。)我在私下里也帮过他，因为他处处和女人调情。(LJC: 噢.....大笑)

F: 因为一般来说，目前的故事就是说，是 Licklider 有这个概念，有这个思想，然后就是说，包括 Taylor，就是想到，就最早的互联网的起源啊，是他想把办公室里面的这个系统连接在一起。然后就是他来把这个事情变成现实。是不是应该这样？

F: The story about the internet generally starts with Licklider, who had the concept, the idea. And he (and even Taylor) wanted to connect all the systems in the office and he did that. Is that the true story?

LJC: So I think that some people, especially people will believe that internet is an idea is from Lick...uh...Licklider. And they selected the overall idea or the constructive from Bob Taylor, regarding the one-million-dollar fund, and your solution...

LJC:我想许多人都会觉得互联网的概念是利克莱德先有的。然后，因为鲍勃泰勒申请的一百万美金的资金，他们从鲍勃 泰勒的方案里选出建设性的看法，然后你解决了.....

LR: No. Bob is hardly important (LJC: oh, hardly.) knew Licklider that should get done but he thought it was important but he didn't know how to do it. He just knew that he had to get me hired (LJC: ok, ok) I mean, on the project, he didn't contribute anything really.

LR:不是这样的。鲍勃其实不怎么重要。(LJC: 噢，不怎么重要。)他知道互联网很重要，但他不知道怎么搭建。他只知道他要雇佣我。(LJC: 好的，好的。)在这个项目上，鲍勃真的没做什么贡献。

2:15:12

LJC: Oh... ok, ok. Is

LJC:

LR: Well, he was there the office. He knew he had to get help. So he did, I mean... and, and they got me.

LR:他当时是管理办事处的。他清楚他得找帮手。他去找了。然后他们找到了我。

F: 就是说，当时他的房间里不是有三套系统，他想把这个连起来嘛？

F: It is said that there were three systems in his office and he wanted to connect them all.

LJC: Bob Taylor had three group...or three systems. He want to link everything together.

LJC:鲍勃泰勒房间里有三组.....三套系统。他想把所有系统连接起来。

LR: Oh, that was. There wasn't until I was in the office. And, and we got information on it. But from the various projects, then we put in computers when I talk to various groups that by email once we got email going. And so, we, we actually, the problems he saw, like the thing you mentioned. But that was what he knew that there was problems. No solution. And he did of course. We got email. And I wrote the email. I mean, part of the project was to build a file-transfer

mechanism by name, and they did... that they did was to build the basic IO. And once they did that, I realized that it was too complicated to use. So I wrote a email handler which outlook today. Program that Allow you to see resend file

LR: 哦，是那个。我去办事处前，他那儿是没有的。我们得到了许多关于这方面的信息。通过不同的项目，我们接入电脑。电子邮件成功后，我和几个小组用邮件沟通。所以，他看到了那个问题，正如你说的。但他只是知道有这个问题而已。没有解决方案。他发现了问题。我们有了电子邮件。我写邮件。项目的目标之一就是搭建显示文件名的文件传输机制，他们做的是搭建了基本的 IO。他们弄好之后，我发现做出来的东西太复杂了。所以我写了代码还制作邮件处理器，做出来的东西很像今天的 outlook 邮箱。这个程序可以让你去阅读，去多次发送邮件。

F: 他觉得互联网诞生在 69 年是一个偶然还是.....

F: Does he think the internet was invented in 1960 just by happenstance, or...?

LR: Once we did that, email became extremely valuable and the main business. Everybody use it cuz he wanted be able to communicate with more of the world. So, it was, it was mandated actually in ARPA.

LR: 我们成功后，电子邮件变得极富价值，也成为了我们的主要商业服务。每个人都用它，因为大家都想和这个世界沟通。电子邮件其实是由 ARPA 托管的。

LJC: In your view, you have named very few important people in the internet. What's your...

LJC:在您看来，您提到了一些互联网界的重要任务。您的.....

LR: The four that primarily involved. Kleinrock and me working on theory, making it happen and building it. And Bob contributed a lot to help building . and also took over, getting it to be a standard in the world.

LR:最开始投入到互联网研究的四个人。克兰洛克和我一起研究理论，真正实现、搭建了互联网。鲍勃在搭建\*\*中帮了很多忙，还接管了\*\*，把它变成了举世通用的标准。

LJC: you agree with that. The four most important...

LJC:所以你认同你们四位是最重要的.....

LR: yeah.

LR:是的。

LJC: ok.

LJC:好。

02:18:07

LR: I mean there are other people like pastel. Others who contributed a lot but they didn't help build it. So much make it happen. To become a worldwide standard took what the foremost did.

LR:当然还有其他像我们一样的人，他们也为互联网做出了巨大贡献。但他们并没有促进搭建互联网，没有让它称为现实。要让它成为全世界通用的标准，需要最杰出的人才。

F: 那就像这个法国的互联网之父，在这个的贡献呢？

F: What about the “Father of the Internet” in the France. Did he contribute to it?

LJC: How about the, the... what's the name? How about Pouzin in France?

LJC:那法国的普赞呢？

LR: Pouzin in France was um... He didn't do anything before I started standardizing X.25 (um-hum). Um... he uh... realized that there was a um... issue in his mind. I was pushing for a protocol that was relatively complete, so that with X-29 and X.25, you could specify what a carrier would need in order to offer the service. In other words, he would have a standard that interface to dial in and communicate with a computer. And the standard for X.25 communicate between computers. And... I knew that since I had been building Telenet and I had already built ARPANET that you had to have a standard on how to do that. What was unsolved working on the standard was that it would be nice to have uh... more flexibility than and and just be able to send messages protocol. All you had to do was be able to move packets. Well, was that wouldn't work because carriers couldn't offer service. There was no way if the there was just random packets network just packets protocol. And so, we. And later on, he tried to do that. But it never succeeded because it was no way to do that. You had to have a standard that somebody could deploy X.25 in the long run. Very quickly, getting standardized. First actually was like I said. So, he wasn't building anything at that time. He was just arguing that you should be able to do that with, with um... random protocols. Everybody had their own protocol. To me was... certainly for a carrier, impossible and without a carrier by themselves sufficient. Develop different possibilities but that didn't sound...

LR: 法国的普赞是……在我开始着手将 X.25 标准化前，他什么都没干（LJC：嗯嗯）。当时，他意识到，嗯，他有一个想法。我当时力图搭建一个相对完整的协议，有这个协议后，通过 X-29 和 X.25，你就能弄清楚运营商需要哪些东西才能提供服务。也就是说，他要有一个标准，才能在通过连接装置事先拨号，实现与另一台电脑的对接。X.25 所需要的标准，用以在不同电脑之间对接。自从我创建 Telenet 以来，从我成功搭建 ARPANET 后，我就认识到，你需要一个标准，来实现电脑间的对接沟通。在探索这个标准的过程中，有个悬而未决的问题，那就是，如果能实现机动性与灵活性，那可比只能发发信息要强很多。而你要做的，就是移动数据包。但，如果运营商不提供服务的话，那就行不通。如果就是随机的数据包网络，只是数据包协议，那就没办法解决这个问题。因此，我们……之后，他尝试去解决这个问题。但是他没成功，因为他的办法是行不通。你必需要有个协议，这样别人才能长时间使用 X.25。他只是声称：你用随机协议，应该可以攻克这一难题。每个人都有自己的协议。对我来说，对运营商而言，这是不可能的，没有协议，仅靠随机数据包也是不够的。普赞也是提供了一种可能，但这种可能听上去……

LJC: How do you think of the born of the internet, you know... if without you, like the four people, do you think internet will still be born or in later time? Or...

LJC:你是如何看待互联网的诞生的？如果没有你和其他三位的话，互联网还会在这个时候诞生吗？还是会晚点呢？

2:21:12

LR: I think in three years later.

LR:我觉得要晚三年。

LJC: Three years.

LJC:3年。

LR: Because Davies would continue working on that in England and maybe get funding someday. But not from the government because they needed to have a standard before they were doing anything. And they did as soon as I got X.25. They were involved. (Ok) But um... he couldn't get them to move at all. Because it was no standard. Carriers like VT won't upgrade without standard. Um, the same is true I had to have a standard which I created very early by '65. I, I, I created it because he wouldn't have a chance to be (ok). Um and so, basically, uh... you had to work that way in order to get it to operate.

LR:如果没有我们的话，戴维斯会在英国继续研究，也许有一天会拿到资助。但拿到政府资金是不可能的，因为政府给钱之前，需要他们先研究出一个标准。他们也做到了，与此同时，我搭建除了 X.25。（好的。）但.....他没法让它运作，因为他们做出来的东西算不上是标准。像电视这样的运营设备，如果没有标准的话，是不会升级的。我也需要一个标准，但我在 1965 年就一定成功研究出了。我研究出了标准，他却没有（好的）。本质上，你得想办法让它运作。

LJC: How do you think about the government role in the internet, you know, in the born of the internet, you know?

LJC:您如何看到在互联网的诞生中，政府所起到的作用？

02:22:10

LR: The government (LJC: yeah yeah). There was no involvement in DoD, as I said, after I finished the ARPANET. I wanted to turn it over to somebody to run and I asked AT&T if they would just take it for free and then charge everybody, including the government, but build it, communication service. They said no. They didn't want to take the free gift and make it into a business. Um... because they didn't like packet switching. (LJC: laugh) They thought it was going to fall on the floor. But, in any case, um... so I, I went to Strasbourg at the FCC. Um... and I asked him what to do because I couldn't get... I mean, AT&T was the only possibility generally at that point. And he said, "no, no, you can start your carrier. We just did that with MCI and, and... you can start a new carrier to do this." So, I did. I created the RFP for getting the carrier licensed and we got that, the thing. I started with Telenet as soon as we got approved.

LR:政府（LJC：对对）。我前面说了，我完成 ARPANET 之后，他们并没有参与 DOD。我想把它转交给某人去运营。我问 AT&T 是否愿意免费接手，然后向所有人收费，包括政府，当然他们要先搭建运营的服务平台。他们不愿意。他们不想要免费的礼物，也不想用它赚钱。因为他们不喜欢包交换。（LJC；大笑）他们觉得包交换成功不了。之后，我去找联邦通信委员会的斯塔伯格。我肯定他来接受，因为我没法让.....AT&T 是当时唯一可能会接受的公司。他说：“不，不，你可以自己创建运营平台。造 MCI 的时候，我们就是这么做的。你可以搭建一个完全的运营平台来实现它。”我就这么做了。我搭建了 RFP，以便让我的运营平台通过审核，它之后的确通过了审核。一过审，我就立刻着手创立 Telenet。

LJC: how do you think about your personal, you know, achievement, maybe, feel 3 to 5... also involve so many projects.

LJC:您如何看到您的个人成就呢？

2:23:36

LR: I, I, I, I built many companies since all based on some sort of technology or related to it. One of them... I mean, I took on after that, after I left, after I sold the company to GTE. DHL offered me to be president because they wanted the electronic capabilities for tracing and tracking and making their business work. And so they hired me. I was president for a year, which was our agreement and I would start the electronics part, which I did. And, and... I was CEO of that as well. And, and I then ran electronics part, which was NetExpress, for many years, did all their tracing and tracking and started a new project to do facsimile transmission worldwide so they could pick it up locally and deliver it with Group 4 technology and... fax, which never took off. I created it, I mean Canon came in as an investor in that. And eventually, um... it proved that Group 3 was good enough that everybody in DHL back-talked the project because it wasn't worthwhile anymore. But NetExpress was already operating worldwide. And we operated that for many years and to move facsimile from local call to not have to call a courier, for example. And Canon started a company in Japan. We are all interacted so people could send fax really cheaply. And I said it was Group 4 because I could transform through...between 3 and 4, which I did. The result was that, but then we sold all out. Meanwhile I created a group that built X.25 ATM switch. So that...I did that for another company. I then took over own project then after I built it. I had a company. I sold that to um...\*\* and \*\*turned into \*\*later. And when they had this offer, they closed down anything that was unprofitable, trying to get out of being taken over. And I took the people and started a company working with flows other than just addresses. Um... much more efficient. A company build that today but couldn't get there even with a lot of funding. So it is... it just didn't have enough uh... to compete with Cisco and other people. So I left in the middle of that because I knew they were gonna fail, because they were pursuing small amount of machine and I started my own company which did a much better job. Then, we have the failure of internet funding. Internet funding got lost along with that company. So I quit working on companies at that point and did some consulting until I started this company.

LR:我创立了许多公司，这些公司都是急于某些科技，或是与之相关的。其中一家公司.....我把它卖给了 GTE。DHL 让我做他们的董事长，因为他们希望建立查单追踪的电子功能，让他们的事业有效可行。因此，他们雇了我。根据协议，我要做一年的董事长，要开创电子部门，我确实也开创了。我还是电子部门的首席执行官。我之后创立了自己的电子运输，就是 NetExpress，运营了许多年，承包了 DHL 所有的查单追踪业务。后来，我开始做关于全球传真通信的项目。通过 Group 4 传真技术，他们可以在当地收集传真，再把它发出去，但 Group 4 并未得以实现。我创立了这个项目，佳能是这个项目的投资人。但最终，事实证明，Group 3 已经很好用了。所以 DHL 的人开始反对我的项目，因为不值得研发下去了。但 NetExpress 已经在全球范围内开展运营了。所以，我们使用它已经使用了很久，让传真业务从本地拨号到发送，到不需要联系联络人就能发传真。佳能在日本创立了自己的公司。我们都是利益相关的，所以用户可以花很少的钱发传真。我提到 Group 4，因为我可以在 3 和 4 之间自由切换。后来，我们把它卖掉了。同时，我创建了 X.25 ATM 转换。我是帮另一家公司

司创建的。但创建完后，我便接管了这一项目。我开了一家公司。我把它卖给了\*\*，\*\*之后成为了\*\*。

拿到这个售价后，他们就关闭那些不赚钱的部门，以防被公司被人接管。我接管了那里的人员，开办了新公司，处理信息序列，而不是一个个地址。这样高效多了。但这家公司的后期资金不足，无法和思科等企业抗衡。所以，我中途离开了，因为我知道他们不会成功，以为他们小机器。我开办了我自己的公司，我的公司比它强很多。但我们后来遇到了资金支持不足的问题。资金没了，公司也没了。所以，我那是不要在开公司了。我做了一阵子咨询，然后才开了现在这家公司。

2:27:29

F: 就是他成功，就是物联网能够提前三年诞生，他总结一下这些主要的经验在哪里。

F: The internet was brought to us by him 3 years earlier that it would have been without me. What contributed to his success?

LJC:提早三年，就是他们的这个.....

LJC:3 years earlier, you mean their...

F: 对，对。

F: Yeah, yeah.

LJC: So in summary, what do you think about the critical factor that in order you, you maybe feel people could make a significant contribution to the internet, make it like happened three years early, right?

LJC:总结来说，你觉得互联网提前三年诞生的关键要素是什么？

LR: Three years, it's a guess. It could have been much longer if nobody funded it. (LJC: yeah, yeah.) So, I, I, I'm just saying that would have put in England... (LJC: yeah, yeah) um... So the question was what?

LR:三年是我的猜测。要是没人资助的话，可能会更久。（LJC：对对。）我就说说，英格兰.....你刚问了什么？

LJC: What are critical factor just you feel, father of the internet, right so that...

LJC:作为互联网之父，你觉得关键要素是什么？

LR: ...finding somebody with knowledge, go and make it happen, just like any startup. Because of the funding, so I didn't get any equity (LJC: laugh). But it was... it was the same thing as a startup. You have to have a lot of confidence in your idea and you have to have a lot of knowledge about it. And get uh, uh, everything done.

LR:找到有相关知识的人才，实现自己的想法。和所有新公司一样。因为有别人的资金支持，我没有任何股权。（LJC：大笑）但这就和运营新公司一样。你必须要对自己的想法有信心，你不需要懂很多相关的知识，做好所有事的。

LJC: Timing... maybe the support either from government or society, capital were important as well, right?

LJC:时机.....还有来自政府、社会 and 资本的支持，对吧？

LR: Yeah, get the funding. That's one of my problems that a lot of companies have. Getting the funding, right? Funding is always difficult to ask for the new idea.

LR:没错，要拿到资金支持。这是我遇到的困难之一，也是许多公司都遇到过的问题。要拿到资金，对吧？很难说服别人给新想法投入资金。

LJC: Have you tried to get the funding from private sector when you propose the idea? Just wondering...

LJC:您是否尝试过想私企申请资金支持呢？我只是单纯好奇.....

LR: Well, companies that I started have done both ways. I mean I got fundings from DHL, Canon. I got funding from venture capitals in other cases.

LR:我创立的公司向政府部门和私企都申请股资金。我拿到过 DHL、佳能的资金支持。我也拿到过风投的资金。

LJC: For internet people don't understand internet. It's 90s right. It's '60^

LJC:但当时是六十年代，人们还不是很懂互联网.....

LR: Well, I think the government was critical.

LR:我觉得当时的政府非常严苛。

LJC: Critical, right? Yeah, yeah. It's very critical. The government support those idea so...

LJC:严苛？好，好，政府很严苛。政府支持这些想法.....

LR: Well, as I said, it turned out, in order to make this work, you have to have a standard or, or... have a protocol be accepted. I did that for X.25 by getting X.25 standardized by TCP/IP. And that made all the carrier support it while as DoD finally forced the issue, in terms of TCP/IP and the ARPANET technology. So, it basically, you have to find a um...a mechanism where you're on the lead, on not only the technology but something that allows people to interact with it. (LJC: um, um, um, um, um, um, um...) Standard or some sort of things.

LR:正如我说过的，要成功的话，你得要有一个网络标准，要有一为人所认可的协议。X.25成功了，因为我通过 TCP/IP 把它标准化了。这样，所有的运营商才会支持它。DoD 也最终解决了网际协议和 ARPANET 技术方面的问题。所以，根本上说，你需要找到一个机制，你不仅要在技术层面上做主，也要让搭建让其他人可以和它交互的东西。（LJC：嗯嗯嗯嗯嗯。）那就是要有标准，或是类似的。

2:30:52

F: 他，他，他这个整个生活的轨迹，就是这个 55 年应该到 MIT 是吧？67 年在波士顿，然后，这个 6 年应该在 DC 吧？然后他离开以后，是在哪一个城市啊，大概，大概他生活的轨迹是怎么样的？

F: He was at MIT in '55 and moved to Boston in '67. He spent 6 years in DC, right. But after he left DC, where did he live?

LJC: Dr. Fang asked about your city of life you have been... you have been with... so before '64, you are at MIT for 12 years, right? This is...

LJC:方博士想知道您在哪些城市生活过。在 1964 年之前,您在麻省理工待了 12 年.....

LR: '59.

LR:是 1959 年。

LJC: Oh, '59, '59.

LJC:哦,五九年,五九年。

LR: '59 to... well, to '60... I don't remember (LJC: OK).

LR:五九年到六零.....我也记不清了。(LJC: 好)

LJC: Dr Fang, how about DC?

LJC: 那华盛顿市呢?

LJC: DC... You have been '67 to '73, right? Six years? Six actually.

LJC:华盛顿市.....1967 年到 1973 年的时候,您在那里,是吗?一共六年?

LR: '67 to '73... yeah whatever. Six years generally, I think generally six years in ARPA was plenty. (LJC: chuckle) Because it's got to have turn over or it won't work...

LR:1967 年到 1973 年.....好吧,无所谓。应该是六年吧,我觉得六年在 ARPA 足够了。(LJC: 笑)因为六年了,这个要么成功,要么失败。

LJC: So after '73, you are at the... Telenet, right? Which city is Telenet, yeah?

LJC: 1973 年之后,你在 Telenet, 是吧? Telenet 在哪座城市呢?

LR: Telenet started in Washington DC (LJC: oh.) because we needed data lines and bid date center there for the 50 kilobit lines. And then we moved to Western Virginia.

LR:Telenet 一开始在华盛顿市(LJC: 噢。)因为我们需要数据线。后来,我们搬去了西弗吉尼亚。

LJC: Oh, Virginia, Virginia. Western Virginia.

LJC:哦,弗吉尼亚,弗吉尼亚。西弗吉尼亚

F: 待到哪一年呢?

F: He was in Western Virginia until which year?

LJC: '83, right? Uh, uh, uh, uh... '80, right?

LJC:1983 年,对吧? 呃呃呃.....1980 年?

LR: No.

LR:不。



LJC: You are at 1980. You are at Telenet, right?

LJC:1980 年，您在 Telenet，对吗？

LR: no, I started '83. '73 to (F: '80) '80...

LR:不，Telenet 是 1983 年.....1973 年到（F：1980 年）1980 年。

LJC: So after '80 where are you?

LJC:1980 年后，您去了哪里？

LR: I went to DHL for a year... (LJC: oh) to run. DHL I put the airline in place (LJC: laugh), deliver all the packages, just like, sort of like \*\* express.

LR:我在 DHL 待了一年.....（LJC：哦。）管理 DHL。我把他们的空运管理得井井有条，所有的包裹都安全送达，就像，有点像\*\*速运。

2:33:03

LJC: Where was DHL at that time? Which city?

LJC:DHL 当时在哪里？哪座城市？

LR: DHL was a startup at that time. But it had a good worldwide... it had strengthened all the worldwide. It was... didn't a domestic position. I created domestic network, airline in order to compete with Federal Express cuz if we were losing a day domestically we lost on the international side. So we needed to keep the domestic. So my strategy was charged distance after keep the plane full ... and don't buy planes every year because that's what kill you. (LJC: laugh) Um... I let the salesmen just fill the plane a pricing control. They could discount a little bit or adjust the price to fill the plane. But if they got too much traffic, we would have to buy a bigger plane. That would be a very hard step. (LJC: OK) so we did that and that worked great.

LR: DHL 当时是家新公司。但它有很好的国际业务。只是国内领域还为拓宽。我创建了国内网络、空运，用以和联邦快递竞争。因为如果我们在国内业务上失利，我们会失常我们在国际业务上的份额。所以我们要争取国内业务。我的策略是装满飞机，按距离计价，不要每年都买新飞机，因为那会把你搞垮的。（LJC：大笑）我让销售人员装满飞机，让他们有些调整价格的权利。他们可以给别人一点折扣，可以调整价格，从而把飞机装满。但如果运载量太大的话，我们就得买一架大飞机了。这是很困难的。（LJC：好的）。我们按照我的策略运营，效果不错。

F: 到西部是哪一年啊？

F: When did you go to the West Coast?

LJC: Which year did you move to the west coast?

LJC:到西部是哪一年啊？

LR: I moved down there in '84.

LR:我是 1984 年过去的。

LJC: Oh, '84.

LJC:哦,1984年。

LR: I mean, after finishing and selling it GTE, they moved me into cooperate to run all of the data networking for PBX activity. And I did that for couple a year. And they hired me into DHL.

LR:我把 Telenet 卖给 GTE 之后,他们和我合资,让我管理网络电话交换的数据网络。我做了几年,然后被 DHL 雇用了。

LJC: Ah, DHL... which city?

LJC:啊, DHL 是在哪座城市?

LR: city was right here, in\*\*. Right in this area.

LR:就在这里,在\*\*。就在这个地方。

F:他这个.....生活这么多城市,大概有什么感受啊?

F: How does he like all the cities where he's lived?

LJC: In the comments about the city... live about the environment...

LJC:请评价您所居住的城市。

LR: Well, I love the area. It's a beautiful climate. Not bad it has earthquake (LJC: laugh). It's not that bad.

LR:我很喜欢这个地方。气候很好。有地震这点不太好。(LJC:大笑)也不算太差。

LJC: other than weather, how about the neighbourhood, the industry...surely, Silicon Valley is a high tech valley so...

LJC:除了天气以外,周围的人啊,工业啊.....硅谷毕竟是个高科技园区.....

LR: Silicon Valley for me is ideal because it has all people. You can hire good engineers very easily. And it has all of the support facilities, like fabbing and silicon and everything else. So it's easy to get things built. It's easy to get people. (LJC: um...) So, it's a great environment. Living environment is expensive.

LR:在我看来,硅谷是非常理想的。因为它里面有许多相关的专家,很快就能招到优秀的工程师。硅谷里的相关设备也很完善,有芯片制造,有硅,什么都有。所以在硅谷,要搭建东西是很方便的。要招人也是很容易的。(LJC:嗯。)所以,硅谷的环境很好。但生活成本很高。

F: 所以他的,你看他的,做研究,到项目,到创业,这三个不同的角色,他自己觉得他哪方面最适合这个?

F: He was a researcher, project manager and entrepreneur. Which one among the roles does he find himself most suitable for?

LJC: Yeah so that you have different face in life. One is you research in the school, right? And

also you managed the project at ARPA, right? And later, you become management of company, or CEO, president of company. So, which... what's your comment of your career? How do you feel about the three roles?

LJC:您在生活中是个多面手。您在学校做研究。您还在 ARPA 做项目管理。之后，您还做公司的高管，首席执行官，董事长。您是如何评价你的职业生涯的呢？您是如何看待这些角色的？

LR: Well actually, I, I, I like running the company to start with because that means the strategic decisions has to be related to the project. Um... have to be right. And in some of the case the VCs—venture capitals, brought in other CEOs and CTOs. That's uh... generally a disaster. Because the person they bring in don't know the technology and don't know the issues and in one very bad case they came in... and almost every bad case happened. They put me back as CEO in some cases because nobody else could do it. It's basically the problem with the venture community. If...um...my strength is computing and technologies, then I shouldn't be running (LJC: companies, yeah). But it actually works much better to start with. Later on, probably I'd rather be CTO or something else.

LR:我更愿意通过管理公司来管理项目，这意味着你所做的战略决策都必须和项目有关。这些决策必须是正确的。有些情况里，风投会招其他首席执行官和首席技术官。那基本都是灾难。因为他们招进来的人不懂技术，也不知道问题所在。我遇到过极坏的情况是，这些人进了项目组，之后能发生的糟糕的事都发生了。他们让我做回首席执行官，因为其他人干不了。这是整个风投圈的问题。如果我擅长的事推算和技术，那我就不该管理..... (LJC: 公司)。但通过运营公司来管理项目确实效果不错。以后，我宁愿做首席技术官。

2:37:20

LJC: Ah, ok, ok.

LJC:啊，好的，好的。

F: 如果这个.....

F: If...

LR: I mean I had...

LR:我已经.....

F: 因为我们想，如果要写本书的好，当然还是需要更丰富，网上查到资料还是非常有限的。就是这个.....需要到时候提供资料，就是他，就是他希望这本书哪些重要的事情应该突出。

F: If we want to write book about him, we need more information. and what we've found on the internet is not enough. We would be more than happy if he could provide us with some information. Also, is there anything he wants to highlight in the book?

LJC: If we want to write the biography for you, we need more data but the data on the internet is very limited. Also maybe, the author need to know more about surely first thing is research but the author know more a little bit more about the life, hobby, yeah.

LJC:如果我们要为您写传记的话，需要更多的资料。但网上的资料有限。作者首先需要了解

您的科研，另外，作者也需要了解您的生活，爱好。

LR: we've covered enough. (LJC: laugh)

LR:我们都聊到了。(LJC:大笑)

F:他有什么建议，就是出版这本书应该怎么写。

F: Does he have any suggestion concerning how the book should be written?

LJC: First if you interested for us to write the biography. If yes, how do you think the biography should be?

LJC:首先，您是否想让我们给您写传记？如果您感兴趣，请问你觉得这本传记应该是怎么样的？

LR: the project I undertake at the moment is too much work. Laugh.

LR:我现在自己手头上的项目已经耗费掉我不少功夫了。大笑

LJC: Surely, but they can... you know...

LJC:作者团队可以.....

LR: It will be difficult for your team...

LR:那你们的团队写起来会很困难.....

LJC: Not difficult. Because they write something for other people already.

LJC:不难的。他们也给别人写过东西。

F: 我觉得这个对，我觉得他们有这么大贡献，应该有，有一本传记。

F: I think the idea of writing a biography for them is great. They made such great contribution and they deserve a biography.

LR: I don't wanna spend more time. (LJC: ah... ok.) It's, it's it'd be nice to have, but I just don't know...

LR:我不想在你们的项目上花太多时间。(LJC: 啊，O 好的。) 有一本传记还是很好的，但我不知道.....

LJC: we don't need much time from you. Rather than, first, we need your consent, your approval, right, for the biography. Second thing is...

LJC:我们不需要您投入太多时间。首先，我们需要征得您的同意才能写传记。第二.....

F: 我觉得我们就是隔个几个月再过来跟他谈一次。能够谈个，谈个 10 个小时以上，我们已经谈了一半了，五个小时了。

F: I think we can have another interview with him for more than 10 hours several months later. Actually half of the work was done since we've talked for five hours already.

LJC: 对对

LJC: Yeah, yeah.

F: 可能在未来还要再谈个两次。

F: Maybe two interviews in the future.

LJC: they maybe after this interview, so they may try to think about how to write the biography, yeah. They may need one or two interview later maybe few months later. Do you think that's ok?

LJC:这次采访结束后，他们会去构思该怎么写传记。他们可能会在几个月后找您进行一到两次采访。您可以接受吗？

LR: Maybe, what do you need from me?

LR:可能吧。你们需要我提供什么？

LJC: 他说，你需要什么东西啊？

LJC:He asked what you needed.

F:我下一次会把提纲.....

F: I'll send him the outline by the next interview...

LJC:They may have the outline of the biography...you know, something missing, anything to add.

LJC:他们可能会有传记的提纲。比如，有没有什么遗漏的，要加些什么东西。

LR: no, what I mean is that is there any monetary effect for...

LR:不，我是说，有没有什么金钱.....

LJC: 它这个有没有什么钱需要？

LJC: Do you need his money to run the project?

F: 不需要。

F: No, we don't.

LJC: no, no, no. No monetary effect, definitely no. we tried to.....

LJC:不不不，不需要您的资金，完全不需要。我们想要.....

F: 就是我们觉得有必要.....

F: We just feel the necessity to...

LJC: we think you're such... you are founder, you are founder of the internet. We want people know, young generation know your contribution. How do you, especially idea, how do you... become so successful, right? On the funding, we don't need any funding. We fully support everything, so...

LJC:在我们看来，您是“互联网之父”。我们希望大众，年轻一代能了解您的贡献，你的思想，您是如何成功的。关于项目资金，我们不需要您的资金。我们的项目已经得到了全额支持。

LR: Would it be in English or Chinese?

LR:传记是英文的还是中文的？

F: 先是中文，然后我希望再是英文。

F: We'll publish the Chinese version first and then the English one.

LJC: It will be Chinese version first then...

LJC:先是中文版再是.....

F:明年能把中文出出来。后年再把英文出出来。

F: We'll publish the Chinese version next year and the English one the year after next year.

LJC: Maybe tomorr... next year, we will have a Chinese version first and the year after, we have an English version, yeah. But anyway, even in the Chinese version, we try to translate and get your approval on every wording.

LJC:大概明年，我们会出中文版，后年出英文版。但就算是中文版，我们也会把它翻译成英文，确保字字句句得到您的许可，我们才会出版。

LR: Well, it's... it's certainly impossible. I don't want to give any pressure if I'm going. (LJC: laugh)

LR:这也不现实。如果我加入的话，我也不想给你们太多压力。（LJC：大笑）

LJC: Surely we don't want to take your time. Any suggestion on you or your biography? Which area do you want to be more focused on?

LJC:我们不会占用您太多时间。关于专辑怎么写，您有什么建议吗？您希望突出哪部分？

F:包括我们可以反映一些他认为比价.....

F: We can also write about that he thinks is...

LR: I don't have anything...we just discussed. I gave you all. (LJC: laugh) I mean, I have done the similar work in many year.

LR:我没有其他的.....我们刚讨论完，我把我知道的都告诉你们了。（LJC：大笑）。许多年来，我的工作都是类似的。

2:41:45

LJC: In many area... oh.

LJC:在许多领域.....噢。

LR: Uh... yeah and graphics, 3D graphics and the network (LJC: ah...) Many networkers and including...

LR:我做过三维计算机图形方面的工作，网络方面的工作（LJC:啊。）许多网络方面的专家，包括.....

LJC: For this book, do you recommend us to interview few more of your friends or any more

people? You know that maybe...

LJC:如果写这本书的话，您建议我们再去采访您的朋友或是其他人吗？

LR: Well, I don't know. If you need to, you can. That's not my problem. (LJC: laugh) Kleinrock is the best one to...

LR:我也不知道。如果你们需要的话，你们可以去采访。克兰洛克是最佳.....

F:我跟他约的这个是六月份

F: I had an appointment with him in June.

LR: You have to arrange that.

LR:但你们要事先和他约好。

LJC: Dr. Fang had tried to interview... have interviewed Kleinrock one time already. He maybe interview him another time in this June.

LJC:方博士要采访.....已经采访过克兰洛克了。他这个六月份还会采访他一次。

LR: Yeah.

LR:好。

F:已经和他说好了。

F: I've made the appointment with him for the interview in June.

LJC: Yeah, they have make appointment already. It's great you are good friends. (LJC: laugh)

LJC:他们已经约好了。你们是好朋友，这真是太好了。（LJC：大笑）

F:有没有可能他.....

F: Could he...

LR: You get very different stories from others and then... as they keep trying to change the history. They don't need to. They did their thing.

LR:如果你们采访其他的人话，会听到截然不同的故事，因为他们总试图改变历史。但他们没必要这么做。他们做过的事，就是做过了。

LJC: Yeah. Laugh. Agree, agree, yeah... because I used to be... we are used to be engineer or work on stuff so that we try to maybe more the fact base, yeah... based on fact so... And could you also... I think, I think for the biography, sometimes we need the... other than wording, some people need this... maybe some photo other data, yeah so...

LJC:是的。大笑。我同意，是的.....因为我以前是.....我们都是工程师，我们是建造东西的，所以我们尽力做到基于事实说话。另外，您能否.....我觉得要写传记的话，除了文字以外，一些人还想看图片，或其他信息.....

LR: there is some photos that I have. Not many.

LR:我有些照片，但不是很多。

LJC: Not many.

LJC:不是很多。

LR: I have a picture of me at the TX-0 when I was doing the pattern recognition. Have a few photos of mine. But one thing I didn't do much is take a lot of photos.

LR:我有张照片，是我在 TX-0 拍的，当时我在做模式识别。还有一些我自己照片。我有件事不常做，那就是拍很多照片。

LJC:Laugh. You are too busy.

LJC:大笑。您太忙了。

F:以前的，以前的这些.....

F: The old...

LR: Should have done more.

LR:我以前应该多拍拍照。

LJC: How do we get the photo? In any way, could you... We just...

LJC:我们怎么能拿到这些照片呢？

LR: I'll just have them emailed.

LR:我发邮件给你们。

F:下半年有时间，我们希望，可能就是，基于前面.....

F: If he has time in later this year, we hope that based on...

LR: There aren't many.

LR:照片不多。

LJC:So maybe, 下半年, we are write the outline of the biography. They ask do you have any time in the later of this year. So they will give...

LJC:采访结束后，他们会构思传记大纲。您下半年有空吗？他们想.....

LR: I'm here. I am not going anywhere. There is no particular... time.

LR:我就在这儿，我不去别的地方。没有什么特别的.....时间。

LJC: Ok, ok, yeah.

LJC:好的，好的。

F:对，我觉得可能还是，我下次来啊，还是要多听他人生中一些精彩的故事。更多故事，因为我希望这本书是就是大众，普通大众他能够了解的，理解他的这个贡献。就面向大众的，普通大众的，它不是面向专业，行业的。你跟他说一下，面向大众的，所以可能需要更多故事。



F: The next time I come to interview, I may need more about his interesting life stories. More stories. Because the book is intended for the ordinary readers to get to know him and his contribution. It isn't for the pros, for the industry. So, please tell him that more stories is needed in writing a book for ordinary readers.

LJC: Yeah, Dr. Fang mentioned this book is, actually is for the public, right? Average audience. We try to make it not so technique-driven, make people understand the story behind it. That's why we try to need more stories.

LJC:方博士提到说，这本书是给公众看的。普通读者。我们希望这本书的知识性、技术性少一点，让读者能了解知识和技术背后的故事。所以我们需要更多的故事。

LR: Yes, yes, I understand. But you dragged out most of the things I can tell you.

LR:是的，是的，我理解。但你把我能说的大部分都已经问出来了。

LJC: Laugh.

LJC:大笑

LJC: It's very encouraging to hear the story and the history about the, the, the internet. Doctor thanks so much for taking time.

LJC:能听到您的故事，听到互联网的历史，是非常鼓舞人心的。方博士感谢您抽出时间来参与我们的采访。