

Andrew Viterbi

Interview conducted by

Joel West, PhD

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SAN DIEGO TECHNOLOGY ARCHIVE



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Andrew Viterbi



Dr. Andrew J. Viterbi, Ph.D. serves as President of the Viterbi Group LLC and Co-founded it in 2000. Dr. Viterbi co-founded Continuous Computing Corp. and served as its Chief Technology Officer from July 1985 to July 1996. From July 1983 to April 1985, he served as the Senior Vice President and Chief Scientist of M/A-COM Inc. In July 1985, he co-founded QUALCOMM Inc., where Dr. Viterbi served as the Vice Chairman until 2000 and as the Chief Technical Officer until 1996. Under his leadership, QUALCOMM received international recognition for innovative technology in the areas of digital wireless communication systems and products based on Code Division Multiple Access (CDMA) technologies. From October 1968 to April 1985, he held various Executive positions at LINKABIT (M/A-COM LINKABIT after August 1980) and served as the President of the M/A-COM LINKABIT. In 1968, Dr. Viterbi Co-founded LINKABIT Corp., where he served as an Executive Vice President and later as the President in the early 1980's. Dr. Viterbi served as an Advisor at Avalon Ventures. He served as the Vice-Chairman of Continuous Computing Corp. since July 1985. During most of his period of service with LINKABIT, Dr. Viterbi served as the Vice-Chairman and a Director. He has been a Director of Link_A_Media Devices Corporation since August 2010. He serves as a Director of Continuous Computing Corp., Motorola Mobility Holdings, Inc., QUALCOMM Flarion Technologies, Inc., The International Engineering Consortium and Samsung Semiconductor Israel R&D Center Ltd. Dr. Viterbi serves as a Member of Advisory Board of JGV Growth Equity Fund, Provigent Inc., L.P, Impinj, Inc., Jerusalem Global Ventures I and Jerusalem Global Ventures. He serves as a Member of Scientific Advisory Board at NeuroVigil, Inc. He serves as a Member of the United States President's Information Technology Advisory Committee and Trustee of the University of Southern California and various other educational, scientific, and philanthropic institutions. He is a Trustee of Sanford-Burnham Medical Research Institute and Mathematical Sciences Research Institute. From 1963 to 1973, Dr. Viterbi served as a Professor at the University of California, Los Angeles, (UCLA) School of Engineering and Applied Science, where he did fundamental work in digital communication theory and wrote numerous research papers and two books,

for which he has received international recognition. Dr. Viterbi continued teaching on a part-time basis at the University of California, San Diego until 1994, where he is a Professor Emeritus. From 1957 to 1963, Dr. Viterbi was a Member of the Communications Research Section of the California Institute of Technology Jet Propulsion Laboratory. While there, he was one of the first communication engineers to recognize the potential of digital transmission techniques and propose them for space and satellite telecommunication systems. Dr. Viterbi has received numerous awards and recognition for his leadership and substantial contributions to communications theory and its industrial applications over the years. Dr. Viterbi is a Fellow of the IEEE, a Marconi Fellow, and a Member of United States National Academy of Engineering, the United States National Academy of Sciences, and the American Academy of Arts and Sciences. He has received honorary doctorates from universities in the United States, Canada, Italy, and Israel. Dr. Viterbi received a Ph.D. from the University of Southern California in 1962, an M.S. and B.S. degrees from the Massachusetts Institute of Technology.

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1 **VITERBI:** As I said, the first Viterbi decoder on a chip was done in the mid 80's at
2 Qualcomm, mid to late 80's. At Linkabit I know we worked very hard to make an MSI
3 chip with about 100 gates and that was somewhere between '72 and '75 and it almost
4 bankrupted the company.

5 **WEST:** Jerry Heller talked about this. You had a supplier problem.

6 **VITERBI:** Yeah several sequentially. There were several of them; more than one
7 flaked out on us. In any case that was an ACS, add compare select circuit which had
8 maybe a hundred transistors maybe a little more. That was the integration
9 technology of the early 70's.

10 **WEST:** What would it take to do the first Qualcomm chip? How many transistors are
11 we talking about there then?

12 **VITERBI:** Oh here?

13 **WEST:** No, for the Viterbi decoder on a chip.

14 **VITERBI:** On a single chip?

15 **WEST:** Yes.

16 **VITERBI:** Oh I could have told you that a few years ago. It was certainly less than a
17 million. I would think a few hundred thousand. But I don't have a firm feeling. But
18 compared to today's integration this is ridiculous.

19 **WEST:** But it's a factor of a thousand more complex than the chip you did at Linkabit
20 in the mid 70's.

21 **VITERBI:** Factor of a thousand.

22 **WEST:** You said a hundred transistors.

23 **VITERBI:** Well, yes, yes, yes. Well, I can just do a multiplication. That chip had to be
24 replicated 64 times plus all of the periphery, plus whatever else. So, it had to be at
25 least a thousand times, so you are right. It's in the hundreds of thousands definitely.

26 **WEST:** I am kind of starting from the 30's and going through roughly when you were
27 going to retire.

28 **VITERBI:** The 30's is when I was born.

29 **WEST:** Right. Bergamo.

30 **VITERBI:** I can show you my honorary citizenship out there. You read Italian. So,
31 yeah okay. I retired on March 9th the year 2000.

32 **WEST:** By the way, did you start the Viterbi Group before then or did you start it after
33 then?

34 **VITERBI:** I started it after then. Well, the Viterbi Group is what you see right here.

35 **WEST:** Right but Audrey went into business with you.

36 **VITERBI:** Audrey went into business with me. We actually rented this place I think
37 in May or June. Miss Fox joined us in July. We thought about it but we didn't do
38 anything until then.

39 **VITERBI:** On JPL NASA well I think my involvement...

40 **WEST:** I have some specific questions about that.

41 **VITERBI:** Well, I brought in Irwin and it was kind of a funny story. I don't know if
42 you got it.

43 **WEST:** Which is what?

44 **VITERBI:** Well, I met him in 1962...

45 **WEST:** Sixty-three at the National Electronics Conference.

46 **VITERBI:** That's correct.

47 **WEST:** Because you won an award for the 62 papers.

48 **VITERBI:** Right we won the best research paper and the best tutorial paper. I have
49 the research. Irwin said, "I've got a sabbatical coming up. I'm thinking of coming to
50 the west coast. Do you think JPL is a good place?" I said, "It's a great place." I don't
51 recall whether I said, "Send me the application I'll put it in," or whatever. But anyhow
52 I told him where to send it. It came and he got a rejection. So, then I went to see my
53 bosses' boss - Eb (for Eberhardt) Rehtin.

54 **WEST:** Right, I know the name.

55 **VITERBI:** Then he was probably an assistant laboratory director. No he was division
56 leader chief. I said, "Look he is a great guy, and MIT professor and you are turning
57 him down." So, that got turned around immediately. He came for a year. At that time
58 we had a space problem, so he spent a year in a trailer, an environmentally suitable
59 trailer but nevertheless a trailer.

60 **WEST:** In one thing you wrote you implied that you met Irwin when he did a job
61 interview at JPL in '59.

62 **VITERBI:** Actually we must have run into the hall without knowing each other at
63 MIT because I didn't leave until June of '57 with my Masters and he came after having
64 gotten his Bachelor's at Cornell in '56. So, for one-year we overlapped but we never
65 met. So, the first time we met was when he came to an interview at JPL and I guess it
66 was when he was getting his PhD I assume that was '59 yeah.

67 **WEST:** So you remember meeting him then?

68 **VITERBI:** Oh yeah definitely. I knew of him, his thesis or some other things. We
69 were pretty close to that MIT group.

70 **WEST:** But he said that he essentially didn't really get to know you until he came out
71 to JPL.

72 **VITERBI:** Oh sure. Except we had met in '62 and '63 we had chatted. But sure it
73 wasn't until—I had never been effectively in the same place. After that we worked
74 together to some degree. I was at this—at this point I was already, by the time he

75 came out I was at UCLA full-time. So, I consulted one-day a week, so I saw what he
76 was doing. As a matter of fact I just wrote a...

77 **WEST:** The 2006 IEEE Processing Study I have that one.

78 **VITERBI:** No, no I wrote something. I don't think it would be online, although it
79 might be. I have it at home. It's the Emeriti newsletter.

80 **WEST:** I have that.

81 **VITERBI:** You have that. So, there I actually describe how he came to...

82 **WEST:** Yeah I read that.

83 **VITERBI:** How he came to UCSD and he turned down the UCSD offer initially.

84 **WEST:** Right he said that in one of his interviews. So, the puzzle I have in trying to
85 tell this story of the 50's and 60's, you write your textbook, your two textbooks, and I
86 have that and I understand where they come from.

87 **VITERBI:** Actually the second textbook with Omura didn't get published till '79 I
88 think. I left-my first textbook was '65, '65 or '66.

89 **WEST:** Seventy-three is the one with Omura.

90 **VITERBI:** No, '79. I can quickly find that.

91 **WEST:** Copyright is '66.

92 **VITERBI:** Sixty-six right. It was largely on much of what I had done at JPL but I was
93 at UCLA at this point. The next book was largely on the courses I taught at UCLA and
94 my research at UCLA and it started actually writing it in '71 or '72. But when I left
95 in '73 I enlisted Omura to help me, and he wrote the last two chapters. Let me see
96 and this has, it's in here somewhere, oh gosh, here it is copyright '79. Then the third
97 book, the CDMA book is '95.

98 **WEST:** Well, actually as long as we are on Jim Omura, did you participate in hiring
99 Jim Omura?

100 **VITERBI:** Yeah, at that time UCLA kind of had a very weird organization. There was
101 a very strong school and department. Actually initially there was a Dean L. M. K.

102 Boelter who ran everything. By the time I got there he was on his way to full
103 retirement that year in '63. But he still had control in some sense. In any case the
104 school and the department were really one, and everything else was divisions. So, I
105 was in the division of System Science, which consisted of communication control and
106 maybe some OR, operations research, and that sort of thing. So, there wasn't even a
107 chair, I don't even recall what its title was. The head of that division was an Indian
108 professor, Professor A. V. Balakrishnan. So, he really made the recommendation. I
109 was involved in interviewing him, and I was very positive on hiring him because he
110 was a student of my friend and actually somebody who had been in my group when I
111 was group supervisor at JPL, Tom Kailath who had since gone to Stanford and went
112 to Stanford in probably '62.

113 **WEST:** I have those tapes.

114 **VITERBI:** In this point Jim came to us in the mid 70's. I'm sorry not the mid '70's it
115 was the late 60's.

116 **WEST:** Tom Kailath you implied somewhere that you hired Tom Kailath at JPL.

117 **VITERBI:** No, I didn't hire him because at the time he was hired I wasn't group
118 supervisor but he wound up being in my group in '61 or so, or '62.

119 **WEST:** I have those tapes. I was actually looking at the JPL phonebooks yesterday.

120 **VITERBI:** I think he was hired in '60 because that is when he got his PhD.

121 **WEST:** What was the name of the group that you headed?

122 **VITERBI:** It was the Communications Research Group within the Communications
123 Research Section.

124 **WEST:** So, there was a group called Communications Research?

125 **VITERBI:** So I recall.

126 **WEST:** Later on in '63 Bob McEliece has an org chart that shows you consulting to
127 some group called I think Digital Communications, if I recall correctly. But that
128 might have been later.

129 **VITERBI:** I don't recall. I don't know. It could have been.

130 **WEST:** I'm still trying to find an org chart after your promotion because I've seen org
131 charts before your promotion.

132 **VITERBI:** What did it say—oh before my promotion it said Communications
133 Research Group didn't it?

134 **WEST:** I'm sorry I didn't bring that one.

135 **VITERBI:** The group leader when I was hired I was hired effectively by Eb Rechten
136 who was the section chief then. The group leader was Stan Lorens, Charles S. Lorens,
137 C. S. Lorens, L-o-r-e-n-s. He was the guy whose face was most visible on the Life
138 magazine article, Life magazine cover after Sputnik. Well, somewhat after Sputnik
139 when we launched Explorer I.

140 **WEST:** Is that the one that they put on cover of the Viterbi School magazine?

141 **VITERBI:** Yeah I think so. One of those. It was that series of photographs. I'm not
142 sure that was the one that actually made it to Life or there was another one that made
143 it to Life.

144 **WEST:** Yeah because I looked in the old issue of Life and I didn't see the one of you
145 holding the paper tape.

146 **VITERBI:** No, I think the one in Life you see the back of my head. They fudged it a
147 little bit. They got it from the same source, the same photographer. But that is exactly
148 right.

149 **WEST:** So, the question that I couldn't answer was, you're at MIT. Do you take any
150 information theory courses at MIT?

151 **VITERBI:** I took a course which was based on Norbert Wiener's work by his disciple
152 whose name was Yuk Wing Lee.

153 **WEST:** I think he was Jacob's Masters advisor.

154 **VITERBI:** It's possible. I don't recall. Anyway it was a wonderful course. It was called
155 Statistical Communication Theory, but it didn't—it did a lot, it brought forth the
156 theory of random processes which is central to all of this. It didn't really get into
157 entropy and things of that nature. I was only there for one-year past the Bachelors, so
158 I didn't get a chance to take the Fano course which was outstanding and very difficult

159 because he was writing the book. He wrote a very important book in 1960. It
160 published in 1960. But after I came to JPL, and at USC there really wasn't any great
161 strength in information theory, I studied that book very thoroughly and that is where
162 I got my start really in understanding information theory and coding. So, basically I
163 learned it on my own and had a lot of incentive and fun kinds of things I was doing.

164 **WEST:** How did you actually even know you were sitting here at USC and there are
165 no advisors?

166 **VITERBI:** No, no Greg Young was not a bad guy. He understood random processes.
167 He understood Markov processes and the so-called Fokker-Planck equation quite
168 well. That was his thesis as I recall. The thing about Greg he was a bright guy he was
169 disorganized. He spent three-days a week, he spent roughly half time, and he was
170 roughly half-time at USC. He taught four courses, something ridiculous like that, plus
171 he liked to go play pool and have a beer. Half of the time I'd have to go with him to
172 the beer joint on the edge of campus to explain to him what I was doing. He was
173 bright enough. He did not influence my thesis at all. What I was doing at JPL
174 influenced it a lot. And there are a couple of guys, and I would say primarily I would
175 cite Lloyd Welch who is now a professor at USC as being a great supporter, a great
176 mentor, a great guy I could go with a problem that was half baked and he would
177 point me to the right mathematics and to some extent Sol Golomb he is a very close
178 friend. But he was more into number theory and things like that, than signal
179 processing.

180 **WEST:** You said one of them...

181 **VITERBI:** And then there was a couple of other colleagues that were quite good and
182 also working in our group.

183 **WEST:** You said I think it was Welch that taught you the math that you needed.

184 **VITERBI:** Well, I took math courses at USC, but he was, he is a very bright
185 mathematician.

186 **WEST:** You mentioned you had Fano as a mentor, but you didn't actually have Fano
187 for a class.

188 **VITERBI:** Yes, I did. I did as an undergraduate. I took Electromagnetic Theory,
189 Electrostatics or whatever it was, a junior course from him. I knew him socially, not

190 really socially but I mean he was from my same very narrow ethnic group so he had
191 been to our home.

192 **WEST:** Jewish Italians from Boston.

193 **VITERBI:** Exactly. In fact not only Jewish Italian but his father who was a famous
194 mathematician. I think his name was Ugo Fano, or maybe that was his brother, I
195 don't know. It's a very distinguished family. The father was a mathematician in fact
196 there is a Fano Theorem named for him at the University of Turin when my father
197 was studying medicine there at the turn of the century, literally the turn of the
198 century, and he had two sons both of whom are, actually one just passed away, he
199 was at the National Bureau of Standards, I think in Washington, the National Bureau
200 of Science, and he was a Physicist, and Roberto, or Bob who was the younger son, but
201 the most interesting thing was that both my father and I think Fano's father were
202 actually born in Mantova [Mantua in English]. So, it was a small Jewish ghetto until
203 1848 I think. It spawned a lot of musicians, spawned a lot of very interesting people.
204 But it so happened that both Fano, although he was born in Turin because his father
205 by then was a professor of Mathematics at the University of Turin. But his roots are in
206 Mantua as are mine.

207 **WEST:** Well, Bob Fano came actually was invited to your parent's house when you
208 were at Boston Latin to give you advice on where you should go to college.

209 **VITERBI:** I'm sure they did that. I remember him coming several times. I don't
210 remember the particular advice. But probably my mother in particular would have
211 done that.

212 **WEST:** Why do you say that?

213 **VITERBI:** Mothers especially are always pushing.

214 **WEST:** But it sounds like from the stories that you were already set on MIT long
215 before you met Bob Fano.

216 **VITERBI:** I think so yeah. By the time I was in Latin school yeah I think so.

217 **WEST:** How did you know Fano's book if you didn't take...?

218 **VITERBI:** Well, we were doing communications research and MIT was a bit of a
219 mother church. As a matter of fact there were three books that came out that year in
220 1960, one was Peterson's coding Error Correcting Codes, one was Fano, and I'm trying
221 to think what the third one was. It was lesser interest to me obviously. I thought error
222 correction and error bounds and that sort of thing was really fascinating. It's gone
223 somewhat out of style for a variety of reasons which you can go into. But it was a very
224 elegant piece of applied mathematics. He had done a lot of things before that. Among
225 them was the matched filter. He didn't invent it, but he played a very important role.
226 If it hadn't been for Shannon, it would have been Fano Information Theory. Because
227 he independently and almost at the same time came up with the source coding
228 theories, theorems. In fact some people call it Shannon-Fano Coding. I think on the
229 noisy coding which is the more difficult thing that was Shannon. But Fano's
230 [sequential decoding] algorithm was very-very elegant. It wasn't the first one. The
231 first one was Wozencraft. But he cleaned it up a lot. In fact it was funny, the way
232 Irwin spoke, this was many years ago, coming from New England and all, and he
233 pronounced Fano in a way that it sounded like final. So, some people thought it was
234 the Final algorithm, the end all.

235 **WEST:** Well, the other thing is you mentioned today you called it the mother church.
236 In an interview you called it the mother church. Why do you say the mother church
237 and not the temple, not the shrine?

238 **VITERBI:** It's the American terminology.

239 **WEST:** I thought it was because you lived in Back Bay next to Mary Baker Eddy's
240 Church.

241 **VITERBI:** Yeah, I was just there. I took my grandson to see the Mapparium. Do you
242 know the Mapparium?

243 **WEST:** No.

244 **VITERBI:** Oh that is the real attraction of the Christian Scientist Monitor. There is
245 this great cathedral on Massachusetts Avenue, the corner of Huntington. But there is
246 the Christian Scientist Monitor Headquarters. I don't know that they really do the
247 editing there anymore. But it's a very classical building. But you go in and there is a
248 map of the world that you walk into. In other words you are looking at it from the
249 inside. It was built in 1934 or so. And it's all glass, glass panels and you have all of the

250 countries of the world. But rather than looking at it from the outside like you do a
251 globe you are inside. It's called a Mapparium. It's still one of the attractions of Boston.
252 If you pick-up any travel book you'll find it. Anyhow that is irrelevant to the...

253 **WEST:** To why you called it the mother church.

254 **VITERBI:** No, I use that term because that is sort of where it all began to a large
255 extent. Shannon actually and Bell Labs did it first. But you could write several books
256 and I'm sure they've been written about Shannon left in '56, maybe even '55, because I
257 was standing in line to be inducted into Tau Beta Pi the engineering honor society
258 and right in front of me was Claude Shannon. It was an honorary—he was being
259 given an honorary Tau Beta Pi membership as a faculty member and he was just
260 standing in line, and along came one of the club officers, society officers and said,
261 “Professor Shannon you shouldn't be standing here.” He's so modest. I only saw
262 Shannon twice once was in '56 and the other time was at the Information Theory
263 Symposium in Brighton, England in 1985 when he was already starting to suffer from
264 Alzheimer's but was still very lucid yet. So, Bell Labs in some sense was the original
265 but he had moved to MIT. There was Fano. There was Norbert Wiener. There was
266 Yuk Wing Lee, lesser figure. There were a number of others Wozencraft, Elias, later
267 Bob Gallager. So, really it was an era. It was a golden era.

268 **WEST:** Forney somewhere is quoted as saying that he arrived at MIT in the golden
269 stage...

270 **VITERBI:** Exactly and Dave the two most brilliant graduate students there are Dave
271 Forney and Elwyn Berlekamp. Elwyn was actually Shannon's student I think. Where
272 Dave was Bob Fano's, was Gallager's student. But Gallager's book which is the classic
273 today, even with a lot of things going out of style but still his 1965 book I think. It
274 started out being Fano and Gallager. It was a rewrite of Fano's book but then Bob
275 went so far beyond and I'm sure Bob Fano was so gracious they agreed that he should
276 be the sole author.

277 **WEST:** That is what Bob Fano said that in fact...

278 **VITERBI:** Fano is a remarkable guy, not because of the closeness. We are not really
279 that close. He's older. He is about 18 or 20-years older than I. Well, not quite 20. Well,
280 I take it back. He must be in his mid-80's so he is only about 15-years older than I.

281 There is that, also he was my professor, and also, and I was enough of a European and
282 perhaps he was too that we put professors on a pedestal.

283 **WEST:** Right.

284 **VITERBI:** But I know he has very fond—he's fond of me, and what I've accomplished.
285 I have a great deal of respect for him. As I say he's very modest. He did not get all of
286 the credit he deserved. Have I drawn you off?

287 **WEST:** Probably.

288 **VITERBI:** Sorry about that.

289 **WEST:** Sort of going back to this issue of self-taught information theory, so I've read
290 your...

291 **VITERBI:** In Gallager's paper of 1965 before the book came out, I had it in note form
292 probably in '64 when I was teaching the Information Theory course for the first time.
293 That gave me a real boost because he had a much more elegant way of presenting the
294 fundamental theorem than either Shannon or Fano. Shannon never really went all of
295 the way. He guided you. He had existence proves and things like that. Elias had put
296 some more bones on it, flesh on the bones.

297 **WEST:** Elias or...?

298 **VITERBI:** Elias, Peter Elias and Fano even more so. And then Gallager came along
299 and Gallager had the most elegant presentation. So, that really gave me a boost and I
300 was teaching that when I started playing with the algorithm. I was also trying to teach
301 sequential decoding, both Wozencraft and Fano decoding. And it was difficult to
302 teach. So, then I started playing with these other ideas. I came up with this—the
303 algorithm was nothing more than a step in the proof.

304 **WEST:** Now when you say teach was that 286B?

305 **VITERBI:** Yes.

306 **WEST:** Not the undergraduate course?

307 **VITERBI:** No. I taught 186B. I taught that out of Abramson's book, which was a neat
308 little book. It's out of print which is a shame. It had all of the source coding or

309 noiseless coding nicely done. Then it had a very nice undergraduate presentation not
310 the full story but the full flavor of noisy coding. So, I taught that in 186B and in 286B I
311 went into Fano and then into Gallager and then beyond.

312 **WEST:** Was 286B what you wrote your textbook for?

313 **VITERBI:** I would say yes. Then I continued it—very funny I taught it for about eight
314 or ten-years at UCLA and then I taught the same course for about 19-years at UCSD
315 but it morphed. It went from being purely theoretical to the CDMA book. I didn't
316 give up any of the rigor but it was much more applied. And by the time I taught that I
317 stopped teaching the proof of the Shannon Theory.

318 **WEST:** Was that because people didn't want to hear it or because you thought there
319 was more stuff that you wanted to cover instead?

320 **VITERBI:** More stuff that I wanted to cover instead, and people probably didn't want
321 to hear it. They wanted to hear all about wireless and how you do it for cellular
322 phones.

323 **WEST:** So, I'm reading your work, your early JPL work, your orthogonal coding stuff.
324 Other than quoting Shannon I don't really see a lot—I don't see a lot of quotes of the
325 MIT School really until your Viterbi Decoding paper. You know in your '67 paper you
326 quote Elias, Fano, Wozencraft and Gallager.

327 **VITERBI:** Yeah, but that first paper at JPL the orthogonal coding was written
328 probably in 1960 and I didn't know that much information theory at the time. I knew
329 enough to talk about entropy and things like that, and capacity of course but I didn't
330 have the full flavor of it all. As it turned out, there were people even in my group that
331 said well, it's just a limiting case and so forth. But it was sort of the first time that it
332 had been applied in a somewhat practical way. In fact it became a mainstay not in the
333 first spacecraft but in the second generation.

334 **WEST:** I have the dates on all of that. But I guess that was what I was trying to get
335 at...

336 **VITERBI:** The term bio-orthogonal that I coined. It just seemed like a natural, it was
337 an obvious thing.

338 **WEST:** But it was essentially a flavor of Reed Mueller coding.

339 **VITERBI:** As it turned out yeah, that's correct.

340 **WEST:** I guess the point I was trying to get at is in reading your work, I haven't
341 looked at '65 and '66 stuff, but certainly in the JPL stuff before you graduate you are
342 not really quoting, citing, immersing yourself in the MIT stuff, it doesn't seem to
343 come until...

344 **VITERBI:** No, I was doing mostly phase lock loops. I was doing communication
345 circuits. It's the first book essentially.

346 **WEST:** Right.

347 **VITERBI:** One-way of putting it in 1960 there was a huge gap between theory and
348 practice. Practice was filled, not vacuum tubes but it was plain old analog radios and
349 very more than that. We were just scratching the surface of digital and even the
350 digital engineers didn't understand channel capacity, and now it's in every system. It
351 took a long time. It took over four-years. Well, not quite. That was part of my
352 education, and my growing up. Another thing that I often cite is that the Gaussian
353 Channel was almost ignored. There was some interest. The MIT, I'm not talking
354 about the information theory crowd so much but more generally people like Jerry
355 Wiesner who later became president was in the earlier days was head of RLE. They
356 believe that just plain old Gaussian noise was not enough to describe this very messy
357 channel. They talked about the fading channels and they really didn't understand
358 fading channels like we do today. Even there, there was a dichotomy. They didn't feel
359 that information theory could work in the very messy channels. They were doing
360 tropospheric proration ionospheric and so forth.

361 **WEST:** Well, a number of people remarked that it is fortunate that space so
362 naturally...

363 **VITERBI:** Exactly, that is exactly the point that I was going to make. You've heard it
364 before then by others as well is that the space channel was perfect as a Gaussian noise
365 Channel. In fact we were getting these big antennas and lots of equipment we were
366 able to get the thermal noise temperature down so that was all there was and it was a
367 perfect Gaussian Channel so we were able to push the theory that already established
368 into this channel and now even though there are is multi-path and all of that it all
369 comes down ultimately once you clean up the first stages of the equalization and so
370 forth it comes down to the Gaussian Channel. There was space then that really made

371 us aware that was the last frontier if you will, the one where the theory would actually
372 apply. We were able to get planetary ranges doubled by using this.

373 **WEST:** Well, I know you are tight for time, if you don't mind there were a couple of
374 ambiguities in sort of your early biography that I was trying to get at. Bob Fano said I
375 could just read your biography not realizing that most people don't read Italian.

376 **VITERBI:** It's an Italian biography. So he read it.

377 **WEST:** I actually typed in sentences in on Google Translator.

378 **VITERBI:** That went way beyond. This is the original.

379 **WEST:** This is you meeting your wife.

380 **VITERBI:** Well this fellow he is very flowery. He writes for Italians. It's all accurate.
381 Do you want me to translate it for you?

382 **WEST:** No, no just to clarify. Who is the cousin that is mentioned?

383 **VITERBI:** His name is Alberto Finzi. On a Saturday morning a cousin, Alberto Finzi
384 invites him to the temple or a synagogue for the Bar Mitzvah of a 13-year-old Italian
385 boy.

386 **WEST:** Yes, I got that. But is Finzi on your mother's side then?

387 **VITERBI:** It's on my mother's side yeah except for my mother's is a Luria, back to my
388 third cousin which is Salvador Luria whom I never met. The Luria family was a
389 Piedmontese Jewish family, it goes way back, but is unrelated to other very famous
390 Luria families that are Eastern European, and even there was a very famous rabbi in
391 the 15th century, unrelated. So, my mother was a Luria and her sister Laura Luria
392 married Flavio Finzi who was a chemist and miller. He owned mills around Rome and
393 had two sons Alberto and Franco. So, Alberto was my first cousin. It was the first one
394 of our family who came to the United States.

395 **WEST:** When did you come?

396 **VITERBI:** About six-months before we did in early '39.

397 **WEST:** And so did the rest of the Finzi's come?

398 **VITERBI:** No, no his brother came just before the war, and that was it, and his
399 mother, my aunt Laura.

400 **WEST:** So, is this a big factor in why you end up in LA rather than San Francisco?

401 **VITERBI:** Yeah it was a significant factor. I thought LA had more opportunities
402 frankly. I interviewed with Lockheed in San Francisco was not at all impressed, I
403 mean a big aerospace. The only ones that impressed me were Hughes, TRW and JPL
404 and I picked the right one because it was more research even than the others. I was
405 very naïve as one would normally be at 22.

406 **WEST:** So you are coming out in this story...

407 **VITERBI:** This was the year before we came out to just get the lay of the land.

408 **WEST:** So you weren't actually job interviewing at that time?

409 **VITERBI:** I did briefly, I did actually made contact with TRW but I wasn't serious. It
410 wasn't until the following February that I came out and interviewed with all three I
411 think. So, we came out just to see what it was like.

412 **WEST:** We being your whole family.

413 **VITERBI:** My parents and I, and my father was pushing almost 75. My mother was in
414 her early 60's. It was time for them to get out of the cold and ice. So, I met my wife
415 there. The fact that her name was Finci, but had not been Finci really for, it was a
416 mixed up thing. They obviously had gone through Italy, probably Padua in coming
417 out of Spain in 1492, probably been there a few generations enough to pick-up the
418 name obviously, and then they went to Sarajevo. In Sarajevo there is this mix between
419 Latin and Cyrillic alphabets. So, when the Austrians came I would I imagine Finci was
420 spelled with a Z but going back to the Turkish Empire it was with a C and after it was
421 Yugoslavian it was with a C. The only reason—it's just a shaggy dog tale really but,
422 but really quite a coincidence, the only reason that my cousins found them was that
423 my cousin Alberto he is still alive at 96, believe it or not but he was looking for Finzi
424 in the phonebook and they at that time was spelled with Z because when they came
425 to LA there was an uncle who had come here back in the 20's I think and had spelled
426 his name with a Z. So, first they say, well we shouldn't be in the same family you
427 spelled with it a Z. But then they changed it actually it was her brother when he got
428 drafted into the Korean War. He went in and spelled it with a C. So, they became

429 Finci with a C. But during that one-year or two in the phonebook they were listed
430 Finzi with a Z and that is how my cousin found them.

431 **WEST:** How did he find them?

432 **VITERBI:** He was looking in the phone book and he saw this Finzi...

433 **WEST:** He called them up.

434 **VITERBI:** He didn't even do that. He went to their house. And he said, "Are you
435 Italians?" They said, "No we aren't but we spent a lot of time in Italy." They had
436 practically grown up in Italy and then they become friends. They said, "Come visit us
437 anytime," and they did. He was living actually in a trailer in Pacific Palisades.

438 **WEST:** Did he know Erna before you...?

439 **VITERBI:** Yes, so they had become friends actually both brothers and their families,
440 their wives especially had become friends of Erna's mother and Erna, and so they had
441 known each probably a couple of years maybe more when I came out.

442 **WEST:** So, you saw Erna for the first time...

443 **VITERBI:** In synagogue yeah.

444 **WEST:** And then you start dating.

445 **VITERBI:** We dated after I came out permanently. Well actually went out with my
446 cousins and they said, "Wouldn't you like the girl along." I said, "Well, if you can get
447 her yes." So, this was when I was interviewing in February. Then I came out in June
448 and within a few weeks we were dating, and within three-months we were engaged.
449 So, that is the history.

450 **WEST:** That is roughly what I gathered.

451 **VITERBI:** And that is what is all in there.

452 **WEST:** Yes, so when did you get married.

453 **VITERBI:** In June of '58. A year after I got here.

454 **WEST:** And when you came out, you came out with your parents in a car.

455 **VITERBI:** Yes, we drove across in seven-days. And the cousins were very worried that
456 my parents, my father especially that it was too rough on him.

457 **WEST:** When did your parents die?

458 **VITERBI:** My father in '66, so he was here nine years before he passed away,
459 Hodgkin's disease. My mother lasted another 20 years, well she was younger. But she
460 passed away in '86.

461 **WEST:** So, she actually relocated down here with you?

462 **VITERBI:** Yeah she came down to San Diego, under protest. She thought it was crazy.
463 Erna took it well. We had reasons. She understood it quite well. But my mother didn't
464 like it at all.

465 **WEST:** What giving up the professor or moving to San Diego?

466 **VITERBI:** I don't know, the fact that we moved down here. Well, she was by this
467 time, this was '73, she was born in '94. She was almost 80. She enjoyed it much more
468 here. It was much nicer than LA. Although we were on the west side it wasn't all that
469 bad. We found her a lot of Italian friends so her last years were much brightened by
470 the friendships she made. My wife is still very friendly with all of the—they were
471 much younger women than her [my mother], especially one who was from her town
472 in Piedmont. It was a very small town.

473 **WEST:** Her town being your mom or your wife's town?

474 **VITERBI:** My mom's town, actually the town next, but within three kilometers.

475 **WEST:** Now there is a suggestion in your biography that there is some financial
476 pressure on you both at MIT and USC, that some of your education choices were
477 because of finances.

478 **VITERBI:** Oh sure absolutely. My father was an ophthalmologist. He was very
479 comfortable, never rich but very comfortable.

480 **WEST:** In Italy.

481 **VITERBI:** Yes. Being white collar in the 1920's and 30's it meant an awful lot. We had
482 maids, and I had a nanny and all that sort of thing. We came to the United States

483 with just barely enough money to get—well a Visa was a story itself. I won't bore you
484 with the details, but we had just enough money. You had to have \$5,000 per person,
485 which at that time was a lot more than it is today. So we just barely scraped it
486 together and got in. It took him a couple of years to get his, he was 60-years-old he
487 had to get his license by taking all of his medical boards again. He passed them in
488 Massachusetts very much to my good fortune and we moved there in '41. His practice
489 was mediocre, I mean financially very mediocre but it provided sustenance during the
490 war years largely because a lot of the young doctors had left to go into the Army. He
491 had mostly an Italian clientele on Commonwealth Avenue in the best part of the
492 professional area. In fact we lived about a block away because we never had a car.
493 That was not because of finances as much as that we never a car because in those
494 days you didn't in Italy. Then after '51 the practice had really diminished. It was not
495 unusual to have your office in your home so we got a slightly bigger apartment a little
496 further west, still Boston but almost on the Brookline border if you know that area,
497 and he had his office in the home but the practice was very limited. So yes it was—
498 and when we came out—so that is why I didn't go for a PhD. There was not the
499 means. I was a co-op student which helped a little bit.

500 **WEST:** Didn't help much.

501 **VITERBI:** Well, it helped. I put the money into the family. But after we came out I
502 still was helping my parents, and then I got married, and then we had two kids so
503 obviously while I was going to USC I couldn't go full-time. Otherwise I would have
504 gone to Cal Tech, but Cal Tech would not take a part-time student at that time, or
505 even today I think. So, USC was very convenient for me and it gave me the union card
506 to go be an academic. You know about that.

507 **WEST:** Right.

508 **VITERBI:** That is what I wanted to do. That was my dream is to become a professor. I
509 had a very high respect for my teachers not only Bob Fano but Ernst Guillemin and
510 Frank my Physics teacher and on-on-on, Sam Mason. I don't want to get nostalgic
511 here. That was my goal to be like them. That is what I did for ten years. Then the
512 entrepreneurial bug and some colleagues and it wasn't just Irwin, it was a guy named
513 Len Kleinrock, you probably know him.

514 **WEST:** Yes.

515 **VITERBI:** Some consider him, he himself also, considers himself a father of the
516 Internet, a very bright kid. Kid he's older than I am actually, but very productive, very
517 capable. But we started and he got involved in the DARPA NET which later became
518 the Internet, morphed ultimately into the Internet.

519 **WEST:** So, you knew Len better than Irwin did?

520 **VITERBI:** Oh yes much better. Well, except they had been at MIT together. But Len
521 and I started at UCLA the same year in '63. He had just come out from MIT. So, we
522 socialized. I think I had known him a little better, maybe but he had known him back
523 at MIT.

524 **WEST:** You cite him in your Viterbi Algorithm papers as having read it and giving
525 feedback.

526 **VITERBI:** Yeah, that is correct. He had listened to me anyway.

527 **WEST:** Was there a cultural thing here? Here we've got three Jewish boys from the
528 northeast who went through MIT, all of whom start a company.

529 **VITERBI:** Is that unusual today? It would be three Chinese kids from Tsinghua
530 University.

531 **WEST:** Or Berkeley.

532 **VITERBI:** Or Berkeley.

533 **WEST:** There was one other question were you born Andrea or Andrea Giacomo?

534 **VITERBI:** Andrea Giacomo that's right. Giacomo was my grandfather who had
535 passed away my maternal grandfather who had passed away recently. We had a
536 funny, never mind its trivia, is how I chose James. Initially I thought for Giacomo a
537 better translation was Jack, but then in the Latin school catalog that year it wasn't
538 even official yet because I didn't have citizen papers until 1948, although my parents,
539 I was derivative but I didn't need citizenship papers until I got a passport. I needed a
540 passport to go to Italy in '48. So, we put down Andrew Jack and it came out Andrew
541 Jackson. I said, "Well, I respect the President but I don't want to be Andrew Jackson,"
542 so we decided to make it James.

543 **WEST:** So you actually are not Andrew until '48.

544 **VITERBI:** Officially, well yes and no. My parents had the good sense when they put
545 me in kindergarten in New York to put it in as Andrew. I don't think they even listed
546 a middle name, Andrea could you imagine especially in those times. So, on school
547 records I was Andrew well before there were any official government records. The
548 first official government records were my citizenship papers, and the citizenship was
549 granted to me, I actually went before a commissioner, not a judge but a
550 commissioner who had me swear even though I was 13-years-old had me swear
551 allegiance, and it even says on the paper no longer any allegiance to a foreign
552 government etcetera. So, at that point it was listed as Andrew James. I always took
553 that as my official paper which it is.

554 **WEST:** And your kids were '59, '61, '71?

555 **VITERBI:** Correct.

556 **WEST:** So, Audrey must have been quite a prodigy then if she graduated...

557 **VITERBI:** She graduated with two degrees at age 19. Well, she had finished high
558 school at age 16. Her Bachelor's in EE and Math was in '79.

559 **WEST:** Did she take classes at UCSD when she was at...?

560 **VITERBI:** Yeah she was taking them in high school already. Her last year at La Jolla
561 High I think three of her courses were on campus at UCSD. So, she came in with a big
562 head start. She got admitted to Cal Tech and MIT. But she didn't like Cal Tech. I
563 don't blame her. It's smoggy.

564 **WEST:** Why do you say that?

565 **VITERBI:** It's smoggy and also it had a bad reputation of the kids working all of the
566 time. We would have gone along with Cal Tech. MIT was too far away and she was 16-
567 years-old. So, she ultimately went to Berkeley at 19 which was okay.

568 **END INTERVIEW**

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The San Diego Technology Archive (SDTA), an initiative of the UC San Diego Library, documents the history, formation, and evolution of the companies that formed the San Diego region's high-tech cluster, beginning in 1965. The SDTA captures the vision, strategic thinking, and recollections of key technology and business founders, entrepreneurs, academics, venture capitalists, early employees, and service providers, many of whom figured prominently in the development of San Diego's dynamic technology cluster. As these individuals articulate and comment on their contributions, innovations, and entrepreneurial trajectories, a rich living history emerges about the extraordinarily synergistic academic and commercial collaborations that distinguish the San Diego technology community.