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Transcript of Dr. Gregory F. Welch

Date: May 3, 2024

Case: Meta Platforms, Inc. -v- Eight kHz, LLC (PTAB)

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WORLDWIDE COURT REPORTING & LITIGATION TECHNOLOGY

Transcript of Dr. Gregory F. Welch
Conducted on May 3, 2024

1 (1 to 4)

1 UNITED STATES PATENT AND TRADEMARK OFFICE 2 BEFORE THE PATENT TRIAL AND APPEAL BOARD 3 ----- 4 META PLATFORMS, INC., 5 Petitioner, 6 V., 7 EIGHT KHZ, LLC, 8 Patent Owner. 9 ----- 10 Case IPR 2023-01021 11 Patent 10,917,737 B2 12 13 Case IPR 2023-01022 14 Patent 11,172,316 B2 15 16 Case IPR 2023-01023 17 Patent 10,798,509 B1 18 ----- 19 Videotaped Deposition of DR. GREGORY F. WELCH 20 Conducted virtually via Zoom 21 Friday, May 3, 2024 22 9:47 a.m. CST 23 Job No.: 536406 24 Pages: 1 - 325 25 Reported by: THERESA A. VORKAPIC, 26 CSR, RMR, CRR, RPR	1 A P P E A R A N C E S 2 ON BEHALF OF THE PETITIONER: 3 CHRISTOPHER W. HENRY, ESQUIRE 4 LATHAM & WATKINS LLP 5 200 Clarendon Street 6 Boston, Massachusetts 02116 7 617-880-4550 8 christopher.henry@lw.com 9 ON BEHALF OF THE PATENT OWNER: 10 HOMAYOON RAFATIJO, ESQUIRE 11 SPENCER FANE LLP 12 1000 Walnut Street, Suite 1400, 13 Kansas City, Missouri 641066 14 816-292-8852 15 hrafatijo@spencerfane.com 16 and 17 ERICK ROBINSON, ESQUIRE 18 SPENCER FANE LLP 19 3040 Post Oak Boulevard, Suite 1400 20 Houston, Texas 77056 21 713-212-2638 22 erickrobinson@spencerfane.com
1 Videotaped deposition of Dr. Gregory F. 2 Welch, conducted virtually via Zoom, pursuant to 3 notice before Theresa A. Vorkapic, a Certified 4 Shorthand Reporter, Registered Merit Reporter, 5 Certified Realtime Reporter, Registered 6 Professional Reporter and a Notary Public in and 7 for the State of Illinois. 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22	1 A P P E A R A N C E S (Continued) 2 ON BEHALF OF THE PATENT OWNER: (Continued) 3 PATRICK M. DUNN, ESQUIRE 4 SPENCER FANE LLP 5 816 Congress Avenue 6 Suite 1200 7 Austin, Texas 78701 8 512-840-4556 9 pdunn@spencerfane.com 10 11 ALSO PRESENT: 12 Jesse Castro, Audiovisual Technician, 13 Planet Depos 14 Micah Hardin, Videographer, Planet Depos 15 16 17 18 19 20 21 22

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2 (5 to 8)

1	C O N T E N T S	5	1	P R O C E E D I N G S	7
2	EXAMINATION OF DR. GREGORY F. WELCH	PAGE	2	THE VIDEOGRAPHER: Here begins Media No. 1	
3	By Mr. Rafatijo	8	3	in the videotaped deposition of Dr. Gregory F.	
4	Examination	302	4	Welch in the matter of Meta Platforms,	
5	By Mr. Henry		5	Incorporated v Eight kHz, LLC, the United States	
6	Further Examination	307	6	Patent and Trademark Office before the Patent	
7	By Mr. Rafatijo		7	Trial and Appeal Board, Case No. IPR 2023-01021 as	
8	Further Examination	320	8	well as 01022 as well as 01023.	
9	By Mr. Henry		9	Today's date is May 3rd, 2024. The time	
10	EXHIBITS		10	on the video monitor is 9:48 a.m. The remote	
11	(Attached to transcript.)		11	videographer today is Micah Hardin representing	
12	WELCH DEPOSITION EXHIBITS	PAGE	12	Planet Depos. All parties of this video	
13	Exhibit 1 University of Central Florida	17	13	deposition are attending remotely.	
14	Grant listing		14	Would counsel please voice-identify	
15	Exhibit 2 Diegetic Representations for	21	15	themselves and state whom they represent.	
16	Seamless Cross-Reality		16	MR. HENRY: Chris Henry of Latham &	
17	Interruptions		17	Watkins for petitioners.	
18	Exhibit 3 Declaration	30	18	MR. RAFATIJO: Homayoon Rafatijo for the	
19	Exhibit 4 US Patent 10,917,737	31	19	patent owner, and with me is Mr. Erick Robinson	
20	Exhibit 5 Declaration US Patent Nos.	32	20	and Mr. Pat Dunn, Patrick Dunn.	
21	10,798,509 and 11,172,316		21	THE VIDEOGRAPHER: The court reporter	
22	Exhibit 6 US Patent 11,172,316	32	22	today is Theresa Vorkapic representing Planet	
1	I N D E X (Continued)	6	1	Depos. The witness will now be sworn.	8
2	Exhibit 7 US Patent 10,798,509	34	2	THE REPORTER: Would you raise your right	
3	Exhibit 8 Greg Welch - Google Scholar	56	3	hand, please.	
4	Exhibit 8B CV	60	4	(The witness was duly sworn.)	
5	Exhibit 8C A Novel Approach for Cooperative	64	5	DR. GREGORY F. WELCH,	
6	Motion Capture (COMOCAP)		6	called as a witness herein, having been first duly	
7	Exhibit 9 Localization with Binaural	91	7	sworn, was examined and testified as follows:	
8	Recordings from Artificial and		8	EXAMINATION	
9	Human Heads		9	BY MR. RAFATIJO:	
10	Exhibit 10 US Patent 9,851,786	235	10	Q Please state your name for the record,	
11	Exhibit 11 3D Sound for Virtual Reality and		11	Dr. Welch.	
12	Multimedia		12	A Gregory Francis Welch.	
13	Exhibit 12 US Patent 9,041,622	256	13	Q Good morning. My name is Homayoon	
14			14	Rafatijo on behalf of the patent owner Eight kHz	
15			15	here. I used to be an academician before	
16			16	practicing, I was a professor, and I hope we can	
17			17	have a conversation as pier to pier. That said,	
18			18	there are certain procedural postures that we have	
19			19	to abide by, but I appreciate you being with us	
20			20	today.	
21			21	Where are you located, right now,	
22			22	Dr. Welch?	

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Eight kHz, LLC
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9 1 A In Boston, Massachusetts. 2 Q Do you reside in Boston, Massachusetts? 3 A No. 4 Q And you are in the office of Latham & 5 Watkins with Mr. Henry, correct? 6 A That's correct. 7 Q And what's your occupation or job title? 8 A I'm' a Pegasus professor, I hold an 9 endowed chair in healthcare simulation at the 10 University of Central Florida. 11 Q Do you have any graduate students or 12 postdocs? 13 A No postdocs at the moment. Several 14 graduate students, yes, and a few undergrads. 15 Q Have you ever had your deposition taken 16 before? 17 A Yes. 18 Q So you understand that I'm going to ask 19 questions. You're going to answer and you're 20 going to let the counsel the opportunity to object 21 when he sees fit. 22 So do you understand that?	11 1 deposition today? 2 A That is correct. 3 Q You understand that you can take a break 4 at any time you want. Just let me know. I 5 probably going to take a break myself but if you 6 need to take a bio break or you feel like you need 7 just a break to step outside, get fresh air, just 8 let me know and we'll take a break. I just want 9 to make that very comfortable the experience today 10 for you, okay? 11 A Okay. Thank you. 12 Q Is there any reason that you may not be 13 able to give me accurate testimony today? 14 A No. 15 Q So you said you've been deposed before. 16 Tell me how many times have you been deposed 17 before. 18 A I couldn't give you an exact count, but I 19 would say more than 20. 20 Q More than 20. And previous depositions 21 were all trial testimony, lawsuits in the District 22 Court or they're all before PTAB, IPR matters?
10 1 A Yes. 2 Q Great. And to be clear, I'm not going to 3 ask any questions regarding attorney-client 4 privilege, so I'm not tricking you to answer any 5 questions with attorney-client privilege content. 6 And I caution you in advance that I'm not trying 7 to get into any sort of conversation that you may 8 have with the counsel, but if you feel 9 uncomfortable for whatever reason and that the 10 answer you might be giving me would reveal some 11 attorney-client information, please let me know 12 and the counsel and I will figure it out. 13 Do you understand that? 14 A Yes. 15 Q Do you understand that you cannot consult 16 with any materials during the deposition. 17 Typically, you know, whatever you need to see is 18 whatever is shown to you on the screen, correct? 19 A Yes. 20 Q I'll just take your word for it, you're 21 not going to see any sort of texts, message, 22 notes, from the counsel while you're in the	12 1 A Variety, District Court, ITC, PTAB, those 2 are the ones that come to mind. 3 Q What would you say percentage-wise of your 4 work is taken up by providing declarations in 5 support of one of the litigants in lawsuits or 6 being deposed or providing deposition testimony, 7 what percentage of your work constitutes -- what 8 percentage of your work is about giving deposition 9 and giving declaration? 10 MR. HENRY: Objection to form. 11 BY THE WITNESS: 12 A I'm sorry. I don't understand when you 13 say "what percentage of your work." What do you 14 mean? 15 BY MR. RAFATIJO: 16 Q Yeah. I mean, what would you say of your 17 work is taken up by being basically an expert 18 witness in a proceeding? 19 A By "your work," what do you mean? 20 Q Generally what you do. You said you are a 21 professor and you are doing this at least 20 times 22 in the past.

13 1 So what percentage-wise of all you do to 2 earn money, this constitutes half, what percentage 3 of your entire work? 4 MR. HENRY: Objection to form. 5 BY THE WITNESS: 6 A So I'm not sure I fully understand the 7 question, but I've been doing this since 2008 so 8 it's over a long period of time and the amount of 9 effort on different matters comes and goes. It 10 depends. I have to get permission from my 11 university for every matter I disclose to them as 12 part of a conflict of interest proceedings, so off 13 hand I really couldn't tell you. It doesn't -- as 14 a part of that conflict of interest oversight none 15 of this interferes with my work so anything I 16 would do is on top of it in the evening or on a 17 weekend. Again, it comes and goes. I don't think 18 I could give you an estimate. 19 BY MR. RAFATIJO: 20 Q At a very broad high level, what was the 21 technology that was involved in that case, in the 22 cases before that you submit declaration or you	15 1 the patent owner or the plaintiff. 2 BY MR. RAFATIJO: 3 Q Have you testified for Meta before? 4 A Not that I recall, no. 5 Q How long ago was your last deposition? 6 A I'm going to guess seven or eight months, 7 something like it that. I think it was within a 8 year. 9 Q In this case, when did you first hear 10 about this case, the lawsuit or the IPR matter? 11 A I don't recall. 12 Q Any guess? 13 A I wouldn't want to guess. I just don't 14 recall. A lot of times for these matters I hear 15 about it and then I hear nothing for a long, long 16 period of time. And then I hear something. 17 So in this case I couldn't tell you. In 18 fact, in any of the cases I did I couldn't tell 19 you without going back and looking at records. 20 Q You submitted your declaration and you 21 executed that declaration sometime in around 22 May and June of 2023, so would it be fair to say
14 1 give a deposition? 2 MR. HENRY: Objection to form. 3 BY THE WITNESS: 4 A There are many different technologies, 5 systems and methods, I am involved in a trade 6 secret case and I think I have been in the past. 7 So it's a wide range of things related to my 8 expertise. 9 BY MR. RAFATIJO: 10 Q Have you ever been retained by a patent 11 owner or have you always been on the side of the 12 petitioner or defendants? 13 A I have been retained by patent owners, 14 yes. 15 Q And what percentage of time you were 16 retained by patent owners out of the 20 cases you 17 had in the past? 18 MR. HENRY: Objection to form. 19 BY THE WITNESS: 20 A So I don't think I said 20 cases, 20 21 depositions, and I couldn't tell you. It's 22 certainly less than -- probably fewer times for	16 1 that you know about this case prior to that 2 point? 3 A I certainly would have known about the 4 case before filing any declarations or any other 5 testimony, absolutely, of course. 6 Q So were you hired by Meta through a third 7 party agency or directly? 8 A I don't know. I believe I'm hired by -- I 9 believe my agreement is with the law firm for the 10 client, but I might have that wrong. I don't -- 11 it might be reversed, yeah. 12 Q What's the compensation terms of your 13 agreement? 14 A The terms? I don't know what do you mean 15 by the terms. 16 Q What is your hourly rate in terms of your 17 agreement with the counsel? 18 A My hourly rate is \$600 per hour. 19 Q Do you have any relationship with Meta 20 outside of your retention as an expert witness in 21 this case? 22 A I know people who work at Meta. One of my

17 1 former Ph.D. students works at Meta, somebody I 2 haven't spoken to for over a year, almost two 3 years, and I had a small grant that was given from 4 Meta to the university in my name to pay a student 5 who had done a summer internship with Meta and 6 then they wanted him to continue a little bit of 7 that work into the following academic year and I 8 told them he couldn't do that without being paid 9 because we were paying him out of other federal 10 funds. So we needed to have some money to charge 11 that to. So there was a grant that went directly 12 to pay that student and the work he was doing for 13 them to finish up his internship. 14 MR. RAFATIJO: Can we pull up Exhibit 1, 15 please. 16 (A certain document was marked Welch 17 Deposition Exhibit 1 for identification, 18 as of 05/03/2024.) 19 BY MR. RAFATIJO: 20 Q This is the grant you're talking about, 21 the \$25,000 that was paid to you or to the 22 university?	19 1 yet and available to us in full. Just a moment, 2 please. 3 I have it. Thank you for waiting. One 4 moment please. I have it. 5 THE WITNESS: Okay. It looks like one 6 page, correct? 7 MR. RAFATIJO: Correct. 8 MR. HENRY: It doesn't look like it's 9 stamped, counsel. Are you going to stamp it? 10 MR. RAFATIJO: We are hoping that the 11 Planet Depos can stamp it, but we call it 12 Exhibit 1. 13 MR. KUHN: Would you like to put stamps on 14 your exhibits for today's deposition and circulate 15 stamped copies? 16 MR. RAFATIJO: Sure. It is stamped now. 17 MR. HENRY: Not the copy that we have so 18 please circulate a stamped copy. 19 AV TECH CASTRO: I will upload in the 20 chat. One moment. 21 MR. HENRY: Thank you. 22 BY THE WITNESS:
18 1 MR. HENRY: Hold on a second. Hold on a 2 second. If you're going to be showing exhibits to 3 the witness and asking questions about documents, 4 circulate them via the chat or otherwise so that 5 the witness has the documents. I haven't received 6 this. The witness didn't receive this. Circulate 7 it, please, so that we have the documents that 8 you're going to ask questions about. 9 MR. RAFATIJO: Can Planet Depos 10 representative please drop the document in the 11 chat for the counsel. 12 BY MR. RAFATIJO: 13 Q So do you see if in the middle of this 14 page -- 15 MR. HENRY: Hold on a second. Wait until 16 we get the documents, please. 17 MR. RAFATIJO: It's in the chat. 18 MR. HENRY: Once we have the documents and 19 our witness and I have an opportunity to see what 20 it is, then proceed. 21 MR. RAFATIJO: It's in the chat, Counsel. 22 MR. HENRY: We don't have it downloaded	20 1 A I see a stamped copy of what appears to be 2 Welch 01, one page, PDF. 3 BY MR. RAFATIJO: 4 Q Right. So in the middle of the page, do 5 you see the name of Meta Technology, Meta 6 Platforms Technology? 7 A Yes. 8 Q So is that the grant you're talking about? 9 A Well, I don't know what the source of this 10 information is, Academic Analytics, and I don't 11 have all of my grants and the details of the 12 grants memorized. So I don't know if the dates 13 are correct. The dollar amount looks probably 14 correct. I don't remember. I was thinking it was 15 20,000, but it's in that range, in that realm. 16 Q This was as you said for a student of 17 yours who had an internship in summer with Meta 18 and then he continued working for Meta while 19 under -- during the academic year, correct? 20 A During the academic year. It could have 21 gone into the summer. So just subsequent to the 22 internship while he was back at the university.

21 1 Q Was this student the same student that 2 later joined Meta? 3 A No. That student is still a Ph.D. 4 student. He has not finished. 5 MR. RAFATIJO: Great. So can we pull 6 up -- Planet Depos representative, would you 7 please stamp Exhibit 2 and circulate it to the 8 counsel. 9 AV TECH CASTRO: Yes. Stand by. 10 (A certain document was marked Welch 11 Deposition Exhibit 2 for identification, 12 as of 05/03/2024.) 13 BY MR. RAFATIJO: 14 Q Do you have the exhibit open? 15 A Yes, I do now. 16 Q Do you recognize this document? 17 A Yes. 18 Q What is it? 19 A This is a published paper from my 20 recollection in looking at the face of the paper 21 from ISMAR 2021, the International Symposium on 22 Mixed and Augmented Reality. It's a paper for	23 1 support of Meta's petitions in three different 2 proceedings against Eight kHz, right? 3 MR. HENRY: Objection to form. 4 BY THE WITNESS: 5 A I'm only aware that I submitted two. I 6 guess it depends on what you call a declaration. 7 BY MR. RAFATIJO: 8 Q The declarations you provided were used by 9 Meta in three different proceedings, correct? 10 A I couldn't say exactly what Meta -- what 11 was done with the declarations. I authored and 12 submitted two declarations. 13 Q On how many patents? 14 A Three patents. 15 Q That would be three proceedings? 16 A I don't know what the, you know, the 17 structural legal administrative terms are, but 18 it's for three patents for sure. 19 Q And the patents being involved in these 20 proceedings were US Patent 10,917,737. Going 21 forward, I'm going to refer to this patent as the 22 '737 patent.
22 1 which I am a coauthor. 2 Q Did you coauthor in paper with Ms. Nahal 3 Norouzi? 4 A Yes. 5 Q Is she the student that's working for Meta 6 upon graduation? 7 A Yes, correct. 8 Q She's from Iran, right? 9 A Originally, yes, she is from Iran. 10 Q Okay. And you used Quest device for 11 accomplishing and carrying out experiments you set 12 out in this paper, correct? 13 MR. HENRY: Objection to form. 14 BY THE WITNESS: 15 A In general in my work as I would say the 16 vast majority of my colleagues around the world 17 and in the field as part of what we do we use 18 Quest devices. We use other devices, too, but we 19 certainly do use Quest devices. We have many 20 different devices. 21 BY MR. RAFATIJO: 22 Q So you submitted three declarations in	24 1 Would that be okay with you? 2 A Yes. 3 Q And the other two patents are US Patent 4 11,172,316, which I will refer to it as '316 5 patent, and the other patent was 10,798,509 which 6 I'm going to refer to it as '509 patent. 7 Are those the three patents on which you 8 submitted the declaration? 9 A That sounds correct to me. 10 Q Have you read through these patents prior 11 to drafting your declaration? 12 A Oh, yes, yes. 13 Q Is there any portion of these patents that 14 you did not read or decided not to read while 15 preparing your declaration? 16 A No. 17 Q What other materials did you rely on to 18 prepare your declaration in this case? 19 A The materials that I reviewed and 20 considered are listed in Section 2 of each of my 21 declarations. It's a long list. 22 Q Sitting here today, you are saying that

25 1 you reviewed all those materials, correct? 2 A Yes. 3 Q And what kind of review? Do you read them 4 front to back? 5 MR. HENRY: Objection to form. 6 BY THE WITNESS: 7 A I couldn't say exactly. It would depend 8 on why I was reviewing it, what I was reviewing it 9 for, so I couldn't say. 10 BY MR. RAFATIJO: 11 Q How did you prepare for the deposition 12 today? 13 A Rereading some of the relevant documents 14 for the -- for this matter, and I met with counsel 15 for a couple of days. 16 Q Have you read any other petitions filed by 17 Meta against patent owner? 18 MR. HENRY: Objection to form. 19 BY THE WITNESS: 20 A You said any other petitions. I don't 21 think I said I reviewed any other petitions to 22 begin with, so could you clarify what you mean?	27 1 would have told you that. So please proceed with 2 your deposition. Ask questions instead of looking 3 for fights and disputes as you did even before we 4 got on the record this morning. 5 Please proceed and I suggest you think 6 about turning to substance, but it's your 7 deposition, so go ahead. 8 MR. RAFATIJO: Are you finished? Are you 9 finished, Counsel? 10 MR. HENRY: I'm not being deposed. You 11 don't ask me any questions. Go ahead and ask the 12 witness questions. This is how a deposition 13 works. 14 MR. RAFATIJO: Sure. Yes. 15 MR. HENRY: You mark exhibits, you 16 circulate them. 17 MR. RAFATIJO: If it's my deposition, then 18 please be quiet. Thank you. 19 MR. HENRY: Counsel, Counsel, don't -- 20 Counsel, we're not going to stand for that type of 21 activity. Listen, this has begun even before the 22 get-go. Please control yourself and ask questions
26 1 BY MR. RAFATIJO: 2 Q Have you read any petition that Meta filed 3 or submitted against patent owner? 4 MR. HENRY: Objection to form. Ambiguous. 5 BY MR. RAFATIJO: 6 Q You can answer. Dr. Welch? 7 A Yes, I'm here. I'm thinking. I'm looking 8 and thinking. 9 Q Looking at what? 10 A My declaration. 11 Q As I need to admonish you, sir, I asked 12 you at the beginning of this deposition, that 13 anything that we would like to show you we'll show 14 you on the screen and we'll get to that point. So 15 please refrain from looking at the stuff that's 16 not in the exhibits. 17 MR. RAFATIJO: This is highly 18 inappropriate, Counsel. 19 MR. HENRY: Objection. Your narrative is 20 highly inappropriate. 21 Dr. Welch has copies of his declarations 22 with him today. If you had asked him that, he	28 1 of the witness. 2 MR. RAFATIJO: This is my deposition. 3 Please be quiet. I'm proceeding with asking 4 questions. If you need to stop from giving 5 monologs here today. Thank you. 6 MR. HENRY: Counsel, I'm not going to 7 accept an instruction from you to me as another 8 officer -- 9 MR. RAFATIJO: I'm not going to accept 10 discussion from you, either. 11 MR. HENRY: -- of the court for you to say 12 be quiet to opposing counsel. You may want to 13 discuss with the rest of your team at a break 14 appropriate decorum for a proceeding like a 15 deposition. Go ahead. 16 BY MR. RAFATIJO: 17 Q Dr. Welch, have you read expert 18 declarations Meta submitted in support of any 19 other petitions it filed against Eight kHz? 20 A I have not read any other expert 21 declarations that I can recall. 22 Q Have you read any deposition transcripts

29 1 of any of Meta's experts? 2 A So in general, I reviewed a lot of things 3 so I don't have a memorized list in my head of 4 everything I reviewed. 5 The things I considered as part of this 6 matter or relied on are listed in my declarations. 7 Again, I don't have those lists memorized. So off 8 the top of my head, I don't think I did. I don't 9 recall ever doing that. 10 Q And the answer would be the same for your 11 preparation for the deposition today, correct? 12 You did not review any deposition transcript of 13 any Meta's experts in an effort to prepare for 14 this deposition today? 15 A That I can definitively say yes to. That 16 is correct. I have not. 17 Q Have you read any other patents owned by 18 Eight kHz that are not the subject of this 19 proceeding? 20 A I don't recall. 21 Q And earlier you said you met with the 22 counsel. So how long did you meet with the	31 1 Please stamp it and drop it in the chat for the 2 counsel. 3 (A certain document was marked Welch 4 Deposition Exhibit 4 for identification, 5 as of 05/03/2024.) 6 BY THE WITNESS: 7 A Okay. I have Exhibit 4. 8 BY MR. RAFATIJO: 9 Q Is this the '737 patent that you read? 10 A It appears to be so. 11 Q Earlier you testified that you have read 12 this document fully so my question is was there 13 any part of it that you did not understand like 14 you say, you know, that's beyond my realm of 15 expertise or something like that? 16 MR. HENRY: Objection to form, compound, 17 ambiguous. 18 BY THE WITNESS: 19 A Nothing I read is beyond my expertise from 20 a technical standpoint. 21 MR. RAFATIJO: Let's stamp Exhibit 5 and 22 drop it into the chat and pull it up. Thank you.
30 1 counsel? 2 A We met -- we had a Zoom meeting or maybe 3 two for a couple of hours in the preceding weeks. 4 Then I flew up here on Tuesday. We met on 5 Wednesday, I'm trying to remember, and we met on 6 Thursday and I'm here today. 7 Q Okay. 8 MR. RAFATIJO: Let's pull up Exhibit 3. 9 Please stamp it and drop it in the chat for the 10 counsel and Dr. Welch. 11 (A certain document was marked Welch 12 Deposition Exhibit 3 for identification, 13 as of 05/03/2024.) 14 BY THE WITNESS: 15 A Okay. I have Exhibit 3. 16 BY MR. RAFATIJO: 17 Q Is this the declaration that you provided 18 in support of the 1021 IPR involving the '737 19 patent? 20 A It appears to be so as far as I can tell. 21 Q Great. 22 MR. RAFATIJO: Let's pull up Exhibit 4.	32 1 (A certain document was marked Welch 2 Deposition Exhibit 5 for identification, 3 as of 05/03/2024.) 4 BY THE WITNESS: 5 A I have Exhibit 5. 6 BY MR. RAFATIJO: 7 Q Is this the declaration you provided in 8 support of IPRs 1022 and 1023 involving the '316 9 and '709 {sic} patents? 10 A Sorry. Could you repeat the numbers? 11 Q '316 and '509. 12 A Yes, it's for those patents. 13 Q Great. 14 MR. RAFATIJO: Let's pull up Exhibit 6. 15 (A certain document was marked Welch 16 Deposition Exhibit 6 for identification, 17 as of 05/03/2024.) 18 BY MR. RAFATIJO: 19 Q Is this the '316 patent that you read? 20 A It appears to be so, yes. 21 Q Was there any part of this patent that you 22 did not understand?

33 1 MR. HENRY: Objection to form. 2 BY THE WITNESS: 3 A I think I was able to comprehend every -- 4 everything that was written in the patent. 5 BY MR. RAFATIJO: 6 Q Was there any part of this patent or any 7 technology disclosed in this patent that was 8 beyond your realm of expertise? 9 A No. 10 MR. RAFATIJO: Let's pull up Exhibit 7, 11 please. 12 (A certain document was marked Welch 13 Deposition Exhibit 7 for identification, 14 as of 05/03/2024.) 15 BY THE WITNESS: 16 A Okay. I have Exhibit 7. 17 BY MR. RAFATIJO: 18 Q Is this the '509 patent that you read? 19 A It appears to be so. 20 Q Was there any part of this patent that you 21 did not understand? 22 A There is nothing in this patent that is	35 1 patents. Again, I wouldn't want to make a 2 from-the-hip generalization. 3 MR. RAFATIJO: Can we pull up Exhibit 3. 4 BY THE WITNESS: 5 A Okay. 6 MR. RAFATIJO: I'm waiting for Planet 7 Depos to -- 8 BY MR. RAFATIJO: 9 Q Yes. Can we go to Paragraph 36, please. 10 Scroll down, please. Paragraph 36. 11 AV TECH CASTRO: Page 36? 12 MR. RAFATIJO: No, Paragraph 36. 13 BY MR. RAFATIJO: 14 Q Would you please read this paragraph, 15 Dr. Welch. 16 A Paragraph 36 of Exhibit 3 reads: "A person 17 of ordinary skill in the art would have had a 18 bachelor's degree in computer science/engineering 19 or related field and at least two years of 20 industry experience or academic research 21 experience in virtual/augmented reality including 22 visual and audio modeling and rendering. In my
34 1 beyond my technical ability. 2 Q Great. So how would you describe very 3 broadly speaking the technology that is 4 encompassed in these patents? 5 MR. HENRY: Objection to form, compound. 6 BY THE WITNESS: 7 A I don't know that I could give a very 8 broad description. I would hesitate to do so 9 because I know this is very important, and my 10 descriptions of the art of the patents were 11 carefully considered and are in my declarations. 12 So I wouldn't want to from the hip develop some 13 other broad characterization of the patents. 14 BY MR. RAFATIJO: 15 Q Would you consider audio rendering and 16 modeling as aspects of these patents? 17 MR. HENRY: Objection to form. 18 BY THE WITNESS: 19 A There is perhaps audio rendering discussed 20 in the specifications of the patents, whether it's 21 claimed, whether it's within the scope -- whether 22 those things are within the scope of these	36 1 view, more education can supplement relevant 2 experience and vice versa." 3 Q So to understand these patents, a person 4 of ordinary skill in the art needs to know audio 5 rendering and modeling, correct? 6 MR. HENRY: Objection to form. 7 BY THE WITNESS: 8 A I don't know what you mean about to 9 understand these patents. 10 BY MR. RAFATIJO: 11 Q What's the person of ordinary skill in the 12 art -- why do we define persons of ordinary skill 13 in the art? 14 MR. HENRY: Objection to form. 15 BY THE WITNESS: 16 A So as I said in Paragraph 34 right above 17 that, I understand that certain issues relating to 18 validity must be judged from the perspective of a 19 person of ordinary skill in the relevant art. 20 BY MR. RAFATIJO: 21 Q Sure. And one of the criteria you set 22 forward in Paragraph 36 is audio rendering and

37 1 modeling, correct? 2 MR. HENRY: Objection to form. The 3 document speaks for itself. 4 BY THE WITNESS: 5 A Not exactly that is not what I said. 6 BY MR. RAFATIJO: 7 Q What did you say again? 8 MR. HENRY: Objection to form. 9 BY THE WITNESS: 10 A I read the paragraph, and the words in the 11 paragraph are different than what you just 12 paraphrased. 13 BY MR. RAFATIJO: 14 Q Is audio rendering and modeling part of 15 this paragraph? 16 A The words visual and audio modeling and 17 rendering with the added last sentence about more 18 education can supplement relevant experience and 19 vice versa, yes. 20 Q So audio modeling and rendering is a 21 component of these patents, correct? 22 MR. HENRY: Objection to form.	39 1 A So I believe I just said there is 2 certainly discussion – again, I'm shooting from 3 the hip here, but within the specifications 4 there's discussion of audio modeling and 5 rendering. 6 BY MR. RAFATIJO: 7 Q Would you consider sound localization and 8 binaural sound as two topics that are relevant to 9 understand these patents? 10 A I think those are topics that would be 11 helpful to understand the specification and I 12 think if a person of ordinary skill had any 13 question in their mind about the specific meanings 14 of those terms, for example, or any term, they 15 would be able to derive it from the specification 16 or go look it up elsewhere, but certainly those 17 are two relevant terms. 18 Q Would a POSITA need to understand those 19 topics in order to understand the specification? 20 MR. HENRY: Objection to form. 21 BY THE WITNESS: 22 A There are certain aspects of some of the
38 1 BY THE WITNESS: 2 A No. That's not what I said. What I said 3 is that is part of the – that's part of the 4 characteristics of a person of ordinary skill in 5 the art that I considered would be interpreting, 6 reading and understanding the patents. 7 BY MR. RAFATIJO: 8 Q Why should a person of ordinary skill in 9 the art know about audio rendering and modeling in 10 order to understand these patents? 11 MR. HENRY: Objection to form. 12 BY THE WITNESS: 13 A There are aspects of the patents that talk 14 about or involve broadly those topics, audio 15 modeling and rendering. 16 BY MR. RAFATIJO: 17 Q So going back to my first questions, are 18 audio rendering and modeling aspects of these 19 patents? 20 MR. HENRY: Objection to form, asked and 21 answered. 22 BY THE WITNESS:	40 1 specifications, and we're talking about three 2 patents here, so I don't know exactly which you're 3 referring to, but generally broadly without, you 4 know, being very specific, there are aspects of 5 those things in the specification and from my 6 perspective, what I had to evaluate was a person 7 of ordinary skill interpreting the claims in light 8 of the specification. So to the extent that those 9 topics were relevant to the claims, a person of 10 ordinary skill would have needed to be able to 11 understand those terms. 12 BY MR. RAFATIJO: 13 Q What aspects? 14 MR. HENRY: Objection to form. 15 BY THE WITNESS: 16 A I'm sorry. I don't understand the 17 question. 18 BY MR. RAFATIJO: 19 Q Well, you just said in your answer that 20 there are certainly aspects of the specifications 21 for which a person of ordinary skill in the art 22 needs to know about binaural and sound

41 1 localization topics, so what aspect? Can you be 2 more specific? 3 MR. HENRY: Objection to form. Compound, 4 ambiguous. The witness has already said there are 5 three patents involved here. 6 BY THE WITNESS: 7 A You characterized what I said, and I don't 8 think that's what I said. I don't know if you can 9 go back and read what I said or ask a different 10 question. It doesn't sound like what I said. 11 BY MR. RAFATIJO: 12 Q What aspects of the specifications would 13 require understanding of binaural sound and sound 14 localization? 15 MR. HENRY: Objection to form. Compound. 16 BY THE WITNESS: 17 A So I thought I had answered this. 18 What matters to me or what matters in my 19 testimony in these declarations is a person of 20 ordinary skill's understanding of the scope of the 21 claims and the claims in light of the 22 specifications. So to the extent that there are	43 1 the claims at issue. 2 BY MR. RAFATIJO: 3 Q Let's look at Claim 1. 4 A I'm sorry. 5 MR. HENRY: Which patent, Counsel? 6 BY MR. RAFATIJO: 7 Q Sorry, the '737 patent, Exhibit 4, 8 Claim 1. 9 A I'm looking at the '737 patent Claim 1. 10 Q Great. So reading through Claim 1, where 11 exactly a POSITA needs to understand sound 12 localization and binaural sound, those concepts in 13 order to comprehend the meaning of the claim or 14 the scope of the claim? 15 MR. HENRY: Objection to form. Counsel, 16 if you meant to show Claim 1 on the screen, on the 17 Zoom, you're not showing it. 18 AV TECH CASTRO: Which page would be 19 Claim 1? 20 MR. RAFATIJO: You should go to Page 53. 21 MR. HENRY: Would you like to repeat your 22 question?
42 1 components of the specification that are relevant 2 to understand to do that for a person of ordinary 3 skill to understand the claims and to determine 4 the scope of the patent, then those are things 5 that they would need to understand enough to be 6 able to do that. 7 BY MR. RAFATIJO: 8 Q Again, what aspects of the specification 9 require an understanding of binaural sound and 10 sound localization? 11 MR. HENRY: Same objections. Asked and 12 answered. 13 BY THE WITNESS: 14 A So I feel like I've already answered this 15 now twice. So your question is very broad. 16 Understanding is a – the word understanding is a 17 very broad term. I believe a person of ordinary 18 skill as I've defined them will understand enough 19 in terms of the claims to utilize anything in the 20 specification, to interpret anything in the 21 specification, to understand anything in the 22 specification that's related to those terms and	44 1 MR. RAFATIJO: Can the court reporter 2 please read back my question. 3 (The record was read by the reporter.) 4 MR. HENRY: Same objection. Objection to 5 form. 6 BY THE WITNESS: 7 A So the question I think if I understand 8 the question was very broad about those subjects 9 in general, which could encompass lots of things 10 and lots of knowledge and lots of experience and 11 lots of understanding, so a person of ordinary 12 skill looking at this specific claim would need to 13 understand the things that involve the appearance 14 of those words as they are discussed in the 15 patent, in the specification or as they would 16 understand from their general knowledge. 17 BY MR. RAFATIJO: 18 Q So what exactly, what aspect of this claim 19 or what limitation in this claim require 20 understanding about sound localization and 21 binaural sound? 22 MR. HENRY: Objection to form, compound,

45 1 asked and answered. 2 BY THE WITNESS: 3 A I'm still not sure I'm fully 4 understanding – I understand the words of your 5 question, but there's some meaning behind it that 6 I don't fully understand, and this is obviously 7 not something that I've opined about in my 8 declarations, this thing you're asking. So I 9 would really have to take some time I think to go 10 back and think about that and look at the patents. 11 As I said, just looking at it here now, we can all 12 see where those words appear and in the context of 13 the claim, in the places where those appear, a 14 person of ordinary skill would have to understand 15 enough about those concepts and the use of those 16 concepts in the claim to be able to make a 17 judgment about the scope of the claim to 18 understand the claims. 19 BY MR. RAFATIJO: 20 Q So you do not really know what a specific 21 background a POSITA should have to understand this 22 claim?	47 1 that's what you're telling me? 2 MR. HENRY: Objection to form, object to 3 the narrative, mischaracterizes Dr. Welch's 4 testimony, compound. 5 BY THE WITNESS: 6 A As I've said before, I'm unwilling to 7 synthesize new opinions sitting here about things. 8 I'm happy to answer questions or explore things, 9 the opinions that I've offered in my declarations. 10 What you're asking me as a person who is an expert 11 in this field I know that what you're asking me 12 does not have a simple answer, and I cannot give 13 you a simple answer. I'm unwilling to give you a 14 simple answer sitting here under oath as an expert 15 in this field. I need to think about that 16 specific question more carefully. I would need to 17 do that and go off and spend time to answer that 18 question in a way that is relevant to this matter. 19 Generally, as I said before, a person of 20 ordinary skill would need to understand every 21 concept that's in the claim, that appears in the 22 claim including the words you used as they appear
46 1 MR. HENRY: Objection to form, 2 mischaracterizes Dr. Welch's testimony. 3 BY THE WITNESS: 4 A I think you said don't know. I'm 5 certainly capable from a technology standpoint of 6 going off and doing an analysis and writing 7 something that offers an opinion about I think the 8 answer to your question. The fact that I'm 9 unwilling or unable to just shoot from the hip and 10 give you some characterizations here on something 11 that is so important does not mean that I'm 12 incapable of doing it or don't understand it. I 13 do understand I think where you're going. It's 14 not something that I can just sit here and tell 15 you off the cuff. 16 BY MR. RAFATIJO: 17 Q So are you telling me that sitting here 18 today and you are prepared to testify on your 19 declaration and about these patents, so you're 20 telling me that you cannot opine on the relevance 21 of binaural sound and sound localization to 22 understand this patent with enough specificity,	48 1 in the claim enough to understand the scope of the 2 claim. 3 BY MR. RAFATIJO: 4 Q So the word sound localization is used in 5 this claim, correct? 6 A Yes, I do see that, yes. 7 Q So is it your testimony that a person of 8 ordinary skill in the art should understand the 9 meaning of that term? 10 A So your question is difficult because that 11 is – there's a question of should they be able to 12 understand that term as if it was a term of art in 13 general, in the world, from a technical expert, 14 that particular term you're only grabbing a part 15 of it, but at least where I'm looking at the 16 patent, it says sound localization point and then 17 has SLP in parenthesis after that, the acronym. 18 That is something that is very clearly and 19 explicitly defined within the patent. So a person 20 of ordinary skill is certainly capable of reading 21 the specification and reading the patent owner's 22 explanation and definition for what a sound

49 1 localization point is and then taking that and 2 using that to interpret the claim. 3 That does not mean that in the absence of 4 this proceedings in general somebody needs to have 5 some other explanation or understanding, I'm 6 sorry, of what that means. They need to 7 understand it and how it's used in the patent. 8 BY MR. RAFATIJO: 9 Q Does the patent specification of this 10 patent talk about localization of sound or 11 localizing sound? 12 A Yes, it does. 13 Q So a POSITA needs to understand what that 14 concept entails, correct? 15 MR. HENRY: Objection to form. Asked and 16 answered. 17 BY THE WITNESS: 18 A They need to understand everything in the 19 claim. Most of the things or many of the things 20 as I recall, and, again, I'm shooting from the hip 21 here, are explained or taught. The relevant 22 things are likely to be in the specification	51 1 specification, and I am asking whether the term 2 localization of sound doesn't appear in the claim 3 as you just pointed out, sound localization point, 4 whether a low localization of sound is a concept 5 appearing in the specification. You answered yes. 6 My question to you is: If a POSITA needs 7 to have an understanding of what localization of 8 sound means in order to understand the 9 specification? 10 MR. HENRY: Objection to form, long 11 narrative, compound, ambiguous. 12 BY THE WITNESS: 13 A So I didn't follow all of that but I think 14 looking at the patent and, you know, even in the 15 summary binaural sound localizes to a listener, a 16 person of ordinary skill in the art as I've 17 defined them would certainly understand what that 18 means. 19 BY MR. RAFATIJO: 20 Q Independent of the specification and the 21 patent, correct? 22 MR. HENRY: Objection to form.
50 1 somewhere. You yourself just pointed out that 2 that particular concept is in the specification. 3 So I don't know what you mean by they would need 4 to know. Certainly they would need to know or 5 understand to evaluate the claim. Where that 6 knowledge or understanding would come from could 7 or would likely be within the specification if the 8 claims use language that is used in a very 9 specific way in the specifications. That's where 10 they would get that knowledge or that's the 11 definition or the meaning or the understanding of 12 that term that they would apply in the claim. 13 BY MR. RAFATIJO: 14 Q So your view of a POSITA is someone who 15 can learn the background from the specification, 16 correct? 17 MR. HENRY: Objection to form. 18 BY THE WITNESS: 19 A No. That's not what I said. 20 BY MR. RAFATIJO: 21 Q Well, you said that the claims or the 22 terms in the claim are defined in the	52 1 BY THE WITNESS: 2 A I'm not sure I understand what you mean by 3 independent of. The words appear in the patent. 4 So they would have to -- they would look at the 5 words in the patent, in the context in which those 6 words are used and I'm saying they would be able 7 to understand what's there. 8 BY MR. RAFATIJO: 9 Q Would they understand based on experience 10 or education? 11 A Yes, not exclusively, but they would 12 understand based on everything they bring to bear. 13 It could be their experience, if necessary it 14 could be that they would get it from some other 15 document nearby. I can't think of any situation 16 where that would be needed, but, yes, as part of 17 what they would use to understand. 18 Q But you didn't point that in your 19 declaration, did you? 20 A I don't know what "that" you're talking 21 about. 22 Q That a person of ordinary skill in the art

53 1 needs to know some of the concepts like sound 2 localization or localization of a sound 3 independent of the patent and the specification? 4 MR. HENRY: Objection to form. I don't 5 even know if there's a question here. 6 MR. RAFATIJO: I clarified the previous 7 question for the witness. He asked me what I mean 8 by "that", and I just clarified. So my question 9 is still pending. 10 MR. HENRY: I'm not following. Can you 11 say your question, then? 12 BY MR. RAFATIJO: 13 Q Dr. Welch, did you point out in your 14 declaration that a person of ordinary skill in the 15 art needs to understand the concept of sound 16 localization apart from what is said or taught in 17 the specification of these patents? 18 MR. HENRY: Objection to form. 19 BY THE WITNESS: 20 A My person of ordinary skill, the 21 characteristics that I used are listed in 22 Paragraph 36 of Exhibit 3 for that patent, it	55 1 have defined them would have any trouble 2 understanding. There is nothing that is that 3 deeply technical. It would all be understandable. 4 Q Do you consider yourself an expert in the 5 field of sound localization and sound rendering 6 and modeling? 7 A I do not consider myself someone who does 8 research at that level of expertise in those 9 areas. I do not, you know, discover and publish 10 new methods in those sorts of things, but 11 certainly as a user and as a teacher and as a 12 signal processing expert and somebody who has used 13 these and studied these and reviewed papers that 14 involved those concepts over the years, I think I 15 have a very, very, very good grasp of how those 16 things work, better than a person of ordinary 17 skill for sure. 18 Q So you have not published any paper or 19 scientific peer-reviewed article related to the 20 field of audio processing? 21 MR. HENRY: Objection to form. 22 BY MR. RAFATIJO:
54 1 includes audio modeling and rendering. That is a 2 very broad area. Those things you're talking 3 about are well within that area. So I cannot – I 4 don't quite understand what it is you seem to be 5 expecting I would say somewhere. I can't list 6 every single thing in those very broad areas that 7 somebody would need to know. Generally an 8 understanding and experience with audio modeling 9 and rendering would be just fine for them to 10 understand all of those terms that are in the 11 specification and in the claims. 12 BY MR. RAFATIJO: 13 Q Even though a specification may not 14 provide a definition for a term, a technical term, 15 example, binaural sound, is it your testimony 16 today that a POSITA would be able to understand 17 based on experience and knowledge the meaning of 18 that term? 19 A I believe the answer is yes. I would have 20 to, you know, go look at a specific thing, but I'm 21 not aware of any terms anywhere in the 22 specification or the claims that a POSITA as I	56 1 Q Name, please, one of the paper and 2 articles that you have published in this field? 3 MR. HENRY: Objection to form. 4 BY THE WITNESS: 5 A So I don't have all of the hundreds of 6 papers I have published memorized. Can we pull up 7 my CV? 8 MR. RAFATIJO: Can we please pull up 9 Exhibit 8. 10 (A certain document was marked Welch 11 Deposition Exhibit 8 for identification, 12 as of 05/03/2024.) 13 BY THE WITNESS: 14 A This is not my CV. This appears to be a 15 print of a Google Scholar page about me. 16 BY MR. RAFATIJO: 17 Q This Google Scholar page was created and 18 maintained by you, correct? 19 A No, that is not correct. 20 Q Well, on top of the page it says -- it has 21 verified e-mail for University of Florida, 22 correct? So you did not create a Google Scholar

57 1 page for yourself using your e-mail address? 2 A So, first of all, you just said University 3 of Florida. It's University of Central Florida 4 for the record. How this was created originally, 5 I don't think I did anything originally. I think 6 Google creates it. You can ask for I believe any 7 author and it will assemble a collection of papers 8 for that person. How it, you know, came to be in 9 this specific form I don't really remember. Yes, 10 of course I verified my e-mail and, of course, I 11 occasionally look at it. 12 Beyond that it's not as if I add papers to 13 this or delete papers or do something. It is 14 Google that basically does all of the crawling of 15 the internet in the world and all of the digital 16 libraries I presume and collects that information 17 here. 18 Q Please take your time and review the list 19 of publications here and let me know if this 20 represents an accurate list of your publications. 21 A I could take hours and hours and I don't 22 know that I could tell you that. I can tell you	59 1 in fact, represent an accurate list. I don't see 2 inaccuracies looking at like the first page. I 3 recognize all of these publications on the first 4 page but I certainly could not go through 400 5 items and tell you compared to my 200 or more 6 items on my CV how this would -- 7 Q Where would a complete list be found? On 8 your website? 9 A The most complete list of my publications 10 would be my CV. 11 Q If we go over your CV, would you please 12 name a publication for me that involves audio 13 processing and modeling? 14 MR. HENRY: Objection to form. Are you 15 going to distribute the CV? 16 MR. RAFATIJO: Yes. We are going off the 17 record until I find the CV. 18 THE VIDEOGRAPHER: Stand by. We are going 19 off the video record. The time is 10:55 a.m. 20 (A recess was had.) 21 THE VIDEOGRAPHER: We are back on the 22 video record. The time is 11:07 a.m.
58 1 that the -- for one we'd have to define what we 2 mean by publications, your publications. You as 3 having been in academia I think can understand 4 there could be different meanings for that. I can 5 tell you right now looking at the words at the top 6 that says 85 articles available. In my CV I list 7 I believe over 200 articles of various forms. So 8 this would appear just looking through it like it 9 cannot be a complete list. 10 Q There are 400 items in this document, 85 11 of them are publicly available. 12 A I would have no way of knowing there are 13 400 in this document. If you tell me that, that's 14 fine. I could not tell you if it's complete. I 15 seem to recall sometimes there are errors in 16 these, you know, listings. There may be 17 publications for another Welch, another Welch with 18 a G that's not me. There may be other 19 publications of mine that are not here, and I have 20 never gone through and I find it hard to believe I 21 could do it in even a day one by one and try to 22 check off and confirm that these are -- this does,	60 1 MR. RAFATIJO: Would you please stamp and 2 circulate Exhibit 8-B. 3 (A certain document was marked Welch 4 Deposition Exhibit 8B for identification, 5 as of 05/03/2024.) 6 BY MR. RAFATIJO: 7 Q Dr. Welch, is this your CV? 8 A One moment, please. That looks like a 9 version of my CV from August 9, 2022, so somewhat 10 old, but a version at that time. 11 Q Is this a CV that you provided with your 12 declaration in this proceeding? 13 A I don't recall. I presume it's listed in 14 my declarations, but I don't recall. 15 Q Can you scroll down, please. 16 So I represent to you that this is 17 Exhibit 1004 that Meta submitted in this 18 proceeding as your exhibit. So this is a CV that 19 we have of you. 20 Would you please point to a paper 21 publication that you have in the field of binaural 22 sound or audio rendering?

61 1 MR. HENRY: Objection to form. 2 BY THE WITNESS: 3 A First of all, I want to make sure and I 4 think you as an academic that would understand 5 that that work that I do in that area is not all 6 represented in my CV. 7 As I said earlier, I don't generally do 8 research such that I would publish papers in those 9 particular areas. So I believe I said that 10 earlier, but I'll give you a few examples if I 11 can. Let's see. So there's -- there's some 12 papers, some teaching. 13 By the way, I would add on a personal note 14 as a subject, those things are things I have been 15 interested in since I was an undergraduate at 16 Purdue. I was reading -- I always wanted to be a 17 sound engineer or recording engineering or sound 18 engineer so I did a lot of reading about signal 19 processing of sound and things like that just for 20 fun. And it's always been an interest of mine and 21 I've followed that. 22 So going back to papers, for example, if	63 1 exhibit Page 014 which is happily Page 14 2 everywhere, there's a section that is classroom 3 teaching. So there are two courses where this 4 came up, those topics came up, one is the fourth 5 bullet, Exploring Virtual Worlds. And I taught 6 that I believe three times and that's a graduate 7 level course where we teach all of the 8 fundamentals of -- not all, the many fundamentals 9 of virtual reality and augmented reality and sound 10 modeling and rendering and all aspects of that 11 were part of what I taught in that class and they 12 were, you know, among the lectures, among the 13 material taught and then students on multiple 14 occasions made use of that with my help in their 15 semester projects because every student did a 16 semester project and we also talked about it. I 17 don't know that we really used it, but I taught it 18 as part of the first bullet, 3D Computer Modeling 19 and Animation to those students in that particular 20 course which I thought several times and got a 21 teaching award for, the students I both lectured 22 on and taught them about the concepts. I know we
62 1 we look at I guess it's Item 96 here, paper 96, 2 Page 22 of the PDF, which is also print Page 22, 3 the very top item, a cooperative motion capture 4 paper, and this is a 2018 paper that is really a 5 continuation of some work -- I'm trying to 6 remember -- that's not reflected in my CV but work 7 that I did with some other students at the 8 University of North Carolina at Chapel Hill years 9 prior to that, but I don't remember exactly when. 10 I would have to go and dig for it, but this paper 11 is all about I, mean, a central aspect of this 12 particular paper is the use of audio signal 13 processing to estimate locations of devices by 14 using audio signal processing, could have been 15 using multiple methods, but we happened to use 16 audio for this. As I said, there are other 17 examples or things in my CV that reflect work in 18 that area and there are things that are not in my 19 CV that reflect work in those areas. 20 So other examples I can give you, that was 21 just one off the top of my head, if you go to 22 page -- oh, okay, if we go to page I guess it's	64 1 had exams and quizzes. I could not tell you what 2 was on them and then the students each had a 3 semester project where they produced a short film 4 essentially, an animation that we showed at a 5 animation festival together so they were using 6 some of those concepts in those animations. 7 MR. RAFATIJO: Can you please pull up 8 Exhibit 8-C, stamp it and circulate. Thank you. 9 (A certain document was marked Welch 10 Deposition Exhibit 8C for identification, 11 as of 05/03/2024.) 12 BY MR. RAFATIJO: 13 Q Do you have this? 14 A Yes. 15 Q I asked you to give me one example and 16 this was the example you provided. Please point 17 me to the portion of this paper that you talked 18 about audio rendering or audio modeling? 19 MR. HENRY: Objection to form, 20 mischaracterizes Dr. Welch's testimony and 21 compound. 22 BY THE WITNESS:

65 1 A So, as I said earlier, I don't have any 2 published papers directly in that area because I 3 don't do work, publishable work directly in that 4 area. So the work that I've done that is directly 5 in that area is in the teaching that I described 6 to you and then informally in other VR, virtual 7 reality, setups we did for human subjects research 8 and other things over the years which was never 9 documented. We never write about because it 10 wasn't an important part of the work. 11 So this is audio signal processing. 12 That's what this specific example is about because 13 as I said, I don't have research papers, per se, 14 in that area. It's not an area I do fundamental 15 research in, but this is very related in terms of 16 the audio signal processing used -- 17 (Simultaneous speaking) 18 Q Please point to the portion of -- 19 MR. HENRY: Hold on a second. Hold on a 20 second, Counsel. Dr. Welch was not done with his 21 answer and you just interrupted him. You have to 22 let the witness finish the witness's answer to	67 1 receipt of signals in 3D space throughout that 2 space. 3 As I've said, this is a follow-on paper to 4 work that began years ago and in the earlier, and 5 the earlier work which I'd have to go digging for 6 we'd actually built prototypes, little modules, 7 maybe 50 of them, that could be moved around in 8 space and we would track them using audio signal 9 processing to estimate the spacial location of 10 those devices. 11 BY MR. RAFATIJO: 12 Q Going back to Section 3.2 that you 13 mentioned this is about sound processing, does 14 that section concern Kalman filters? 15 A One moment. I think I closed the exhibit 16 or I lost it. Here we go. 17 I would say Kalman filters, Kalman filter 18 is used throughout the paper. That is the 19 framework for which we do the cooperative 20 estimation of the spacial locations of all of the 21 acoustic devices throughout the space. 22 Q Does Kalman filter usually -- is Kalman
66 1 your questions. Then you follow up and ask a 2 question. That's how this works. 3 BY THE WITNESS: 4 A I don't remember what I was saying or 5 where I was going, but this is a paper that is 6 entirely throughout it the audio signal processing 7 is inherent kind of through the whole thing. I 8 mean, 3.2 is probably -- Section 3.2 on Page 76 is 9 I think one example, but all of -- I believe that 10 whole section, Section 3, Section 3.3, measurement 11 valuation selection, that all involves modeling, 12 estimating modeling, various sonic sound, distance 13 parameters and characteristics and then making 14 decisions based on those. 15 And then as I look through somewhere, I 16 thought I had a picture here, I don't have a 17 picture, close-up picture of the prototypes but if 18 I look at Figure 2 on page -- Figure 2 on Page 78, 19 you can see where there are some zoom-ins where it 20 says simulated acoustic transceiver that's got 21 a microphone and a speaker. So part of those 22 systems used acoustic signals, transmissions and	68 1 filter usually used for -- scratch that. 2 Is Kalman filter a recursive algorithm for 3 optimization? 4 MR. HENRY: Objection to form. 5 BY THE WITNESS: 6 A I would say no. 7 BY MR. RAFATIJO: 8 Q So you are sitting here today, you say 9 Kalman filter is not used by optimization? 10 MR. HENRY: Objection to form, 11 mischaracterizes Dr. Welch's testimony. 12 BY THE WITNESS: 13 A So I am one of the I think foremost 14 experts in Kalman filters in the world. I go 15 around the world and people refer to my papers. 16 The Google Scholar page you had earlier has this 17 paper I wrote in 1995 that's been cited almost 18 12,000 times by people around the world so I know 19 very well what a Kalman filter does. 20 The words you used don't match what I 21 think a -- anybody would, expert or a person of 22 ordinary skill, would say a Kalman filter is for.

69 1 I cannot sit here and tell you definitively what 2 everybody in the world for all time has used them 3 for. The words you used do not describe a primary 4 use of the Kalman filter, not in my experience, I 5 wouldn't use those words. 6 Q Is Kalman filter used for trajectory 7 optimization for let's say a drone? 8 MR. HENRY: Objection to form. Calls for 9 speculation. 10 BY THE WITNESS: 11 A You're saying is it used. It certainly 12 could be used. It wouldn't surprise me. It is -- 13 I wouldn't say it is used for optimization and I 14 wouldn't say a person who works in the field who 15 uses a Kalman filter or does signal processing 16 like that would use that word. 17 It is a mathematical framework that is 18 used I would say more for estimation, not for 19 optimization. It is an optimal estimation by some 20 measures, but it is not optimization, per se, that 21 the filter is being used for, at least I can't 22 think of anybody I know who would characterize it	71 1 A I does not appears to be there at all, and 2 I would be surprised if it did to show up. I 3 don't think there's the word binaural in here. 4 Q How many times does the word render appear 5 in this paper? 6 A The word render does not appear here, but 7 the concept of doing rendering or computing where 8 or computing signals that would be received at a 9 particular place is central to this paper. It is 10 in some contexts people would refer to something 11 as rendering and other contexts they wouldn't. 12 They would refer to it as something else. A 13 person of ordinary skill would understand that. 14 Q How many times does the word local appear 15 in this paper? 16 A I'm sorry, what was the word? 17 Q Local. 18 MR. HENRY: Local, L-o-c-a-l? 19 MR. RAFATIJO: Yes. 20 MR. HENRY: Local, okay. 21 BY THE WITNESS: 22 A It does not appear that it ever occurs in
70 1 in that way. 2 BY MR. RAFATIJO: 3 Q Does the word audio appear in this 4 publication? 5 A I don't know. I will search. But I do 6 know it looks like maybe not if the OCR is, you 7 know -- if the searching is working well, but of 8 course there are other words that mean audio. So 9 acoustic appears, for example, throughout because 10 acoustics are the core aspect of the measurement 11 system we used for this. 12 Q How many times does the word sound appear 13 throughout the paper? 14 A Well I'm sitting here counting at least 15 three but, of course, I'm a little puzzled by the 16 implication in your question because sound, audio, 17 acoustic, those are all synonyms. They would be 18 used in different contexts, but they mean in my 19 mind the same thing. The specific words used 20 could range widely depending on the circumstances. 21 Q How many times does the word binaural 22 appear in this paper?	72 1 this particular document. I don't even know -- I 2 can't even imagine what that word -- how can I put 3 this. I don't even know what concepts in here 4 would relate to local. If I understood what you 5 meant by that, it might be -- the concepts might 6 be here. The word does not appear. 7 BY MR. RAFATIJO: 8 Q How many times does the word localization 9 appear in this paper? 10 A Well, I just searched for local and didn't 11 find anything, so I think localization does not 12 appear, but, again, these words, there are many 13 many many many many words as I'm sure you as a 14 once academic could understand that mean the same 15 thing. 16 So the localization that's being done here 17 is estimating where something is in space based on 18 the audio, predicting it, so predicting what would 19 be received at that place and then measuring 20 what's received at that place in order to localize 21 that microphone, for example. 22 Q So the sound localization is a known

73 1 concept in the field, correct? 2 A I couldn't tell you what field you mean. 3 You said "the field." I think the words sound 4 localization to probably anyone with a much less 5 expertise than even a person of ordinary skill in 6 the art that I refer to would be able to 7 understand what that means, to localize sound. 8 Q In your declaration you talk about sound 9 localization as the state of prior art, correct? 10 MR. HENRY: Objection to form. 11 BY THE WITNESS: 12 A You said I talk about sound localization 13 as the state of prior art. That doesn't make 14 sense to me. I don't know what you're asking. 15 BY MR. RAFATIJO: 16 Q Can we pull up Exhibit 3. Can we go to 17 page i, i, would be the second page of the 18 document. 19 MR. KUHN: Table of contents, Counsel? 20 MR. RAFATIJO: Yes. 21 BY THE WITNESS: 22 A I see that.	75 1 of the '737 patent's earliest possible date. So 2 it's material or topics or technologies or 3 knowledge that is pertinent. I did not say it was 4 necessarily something that someone had to 5 understand by whatever definition that means in 6 order to understand the patent. Everything that's 7 in this section would be well known to a person of 8 ordinary skill, and by definition they would know 9 it. It was in the art before they would have ever 10 read this patent so they would know everything in 11 there. 12 Q But that knowledge is pertinent to 13 understand the patent, correct? 14 A No. As I said a moment ago, I did not say 15 it was pertinent to understand it. I just said it 16 was pertinent to the patent. There's a 17 difference. 18 Q What's the difference? 19 A Something can be related to something. My 20 coffee can be black. That doesn't mean it needs 21 to be something you need to understand – 22 analogies are difficult, but I'm struggling to
74 1 BY MR. RAFATIJO: 2 Q You see the state of the art, that's the 3 section -- the heading of the Section 7? 4 A Yes. 5 Q The subsection of that section is 6 number -- is letter E, sound localization and 7 binaural sound, correct? 8 A Correct. 9 Q So when you are studying this page about 10 the state of the art, necessary to understand the 11 patent, you felt the need to talk about sound 12 localization and binaural sound, correct? 13 MR. HENRY: Objection to form. 14 BY THE WITNESS: 15 A Not correct. 16 BY MR. RAFATIJO: 17 Q Why did you talk about sound localization 18 and binaural sound? 19 A As it says in Paragraph 42, at the 20 beginning of Section 7, in this Section I provide 21 overviews of technologies and prior art pertinent 22 to the '737 patent and to the state of the art as	76 1 answer your question because it seems like an 2 obvious question. Something is relevant to an 3 understanding means that it has to do with 4 comprehension or knowledge. This is simply 5 providing and really for the board a sense of -- a 6 documented sense of things that existed in the art 7 prior to the date that we're concerned about here. 8 Q If a POSITA never understand the concepts 9 of sound localization, would that POSITA 10 understand the patent? 11 MR. HENRY: Objection to form, incomplete 12 hypothetical. 13 BY THE WITNESS: 14 A It is very difficult to answer your 15 question without knowing the scope of what you 16 mean by understand sound localization. That is 17 a -- that is two words, sound localization, that 18 could mean an infinite scope of things. What I've 19 said before, and I'll say it again, is there is 20 nothing in the patent, in the specifications or 21 the claims that a person of ordinary skill as I 22 have defined them would be incapable of

77 1 understanding in order to make a judgment about 2 the scope of the claims. 3 BY MR. RAFATIJO: 4 Q Does a person of ordinary skill in the art 5 need to understand sound localization in order to 6 understand the patent? 7 MR. HENRY: Objection to form, asked and 8 answered. 9 BY THE WITNESS: 10 A As I said a moment ago, I can't tell you 11 sound localization because, again, those two words 12 are very broad in the absence of anything else. 13 What I can tell you is that the use of 14 those terms in the claims, I don't have them 15 memorized, but if they appear there and/or in the 16 patent that a person of ordinary skill would 17 understand them enough so that narrows the scope 18 of what they would need to know about that field 19 to make a judgment about the scope of the claims 20 of the patent. 21 BY MR. RAFATIJO: 22 Q Can a person who has no knowledge of sound	79 1 processing? 2 A I would say overall probably more than two 3 years. It's the subject of something I have been 4 thinking about dealing with off and on. As I 5 said, it's not a central focus of my research, but 6 from very early on from the first time I started 7 doing virtual reality things it is one of the 8 concepts that I understood as a basic component 9 of -- toolkit of things that people doing VR would 10 use. So off and on I've encountered it, used it, 11 taught it, over the what, 25, 30 years of my 12 career off and on. 13 Q Did you take two years of coursework 14 related to audio rendering and modeling? 15 A Certainly not, no. 16 Q Do you have two years of industry 17 experience in the field of audio rendering and 18 modeling? 19 A My industry experience is I think limited 20 to my work for NASA on the Voyager spacecraft, my 21 work at Northrop on radar jammers. There is some 22 aspect of -- which I can't talk about in detail,
78 1 localization understand the meaning of the term 2 appearing in the specification? 3 MR. HENRY: Objection to form, ambiguous, 4 incomplete hypothetical. 5 BY THE WITNESS: 6 A Again you're talking -- you keep using the 7 phrase or the term sound localization as if it's a 8 well-defined body of knowledge. It's not. It 9 could have a wide range of things that would be 10 encompassed by that or a narrow range depending on 11 the context. What I can tell you is that I 12 actually think probably and I haven't done this 13 analysis but it wouldn't surprise me if I were to 14 do the analysis hypothetically that a person would 15 be able to understand enough about that term as it 16 appears in the patent and wherever it or the 17 relevant concepts would appear in the claims to 18 make a judgment about the scope of the claims. 19 Q Dr. Welch, do you have two years of 20 academic experience or, sorry, scratch that. 21 Do you have two years of academic studying 22 in the field of audio rendering and audio	80 1 there's some aspect of the radar jamming which is 2 very relevant. It has to do with, again, being 3 able to -- I'm trying to think about how I can say 4 this. It's in a different area of the spectrum so 5 not in physical sound waves but in radiofrequency, 6 electromagnetic spectrum. It's a different place, 7 but there are aspects of my work at Northrop that 8 were very relevant to that. 9 Q The aspects of your work, did it involve 10 binaural sound? 11 MR. HENRY: Objection to form. 12 BY THE WITNESS: 13 A As I said a moment ago, I don't think it 14 involve what a person would typically call sound 15 because it wasn't in the audio portion of the 16 spectrum, and it wasn't mechanical waves like 17 sound waves, it was radio waves, but the 18 mathematics are very much the same. There's no 19 binaural but there are certainly aspects of the 20 signals coming from different places, different 21 ground-based radar systems, for example, different 22 aircraft that have to be modeled and processed in

81 1 order to make judgments about locations of 2 objects. I think I can't say any more than that. 3 BY MR. NEWTON: 4 Q Are those the only aspects of your 5 experience, industry experience? 6 MR. HENRY: Objection to form. 7 BY THE WITNESS: 8 A I couldn't tell you off the top of my 9 head. Sitting here right now those are the only 10 things that come to mind. I would have to go back 11 and think more carefully, but of course as my 12 person of ordinary skill says, industry or 13 academic research experience with more or less 14 education supplementing. 15 BY MR. RAFATIJO: 16 Q What is binaural sound, Dr. Welch? 17 Dr. Welch? 18 A Yes, I'm here. I'm looking and thinking. 19 Q As a POSITA you need to look at something 20 in order to answer my question? 21 MR. HENRY: Objection to form. Are you 22 withdrawing the previous question because now	83 1 many definitions. So in order to give a precise 2 answer as best I could given the importance of the 3 proceedings I was looking for something that was 4 actually a considered answer to your question as 5 opposed to off the cuff. 6 But off the cuff, generally without being 7 held to it as the be all end all definition or 8 description, it is the sound that would appear 9 in -- so it's aural sound in both the left and the 10 right ear typically of a human or a mannequin, so 11 it's the sound that's produced or either the sound 12 that arrives at those places or the sound that's 13 produced to arrive at those places from a 14 particular location in space. That would be the 15 most common use of it, I believe. Again, I'm just 16 giving this off the top of my head. 17 BY MR. RAFATIJO: 18 Q Can a stereo sound arrive at both ears of 19 a listener? 20 A For a person with normal hearing, all 21 sounds probably arrive at their ears if they're 22 not blocked, any sound anywhere.
82 1 you've posed two while one was pending so I'd like 2 to know if you're going to give the witness time 3 to consider and answer your question or if you're 4 going to interject a second question on top of the 5 first before the witness has answered. 6 MR. RAFATIJO: Well, apparently the 7 witness is trying to find an answer by looking at 8 documents. I'm simply stating -- 9 MR. HENRY: We're not here to listen to 10 you make arguments today. We're here -- 11 MR. NEWTON: I'm stating for the record -- 12 MR. KUHN: My question to you is which 13 question is now pending, the first one you asked 14 or the second one you followed up when you decided 15 to inject argument and narrative into today's 16 proceedings. 17 BY MR. RAFATIJO: 18 Q What is binaural sound, Dr. Welch? 19 A So I'm having trouble finding, I believe I 20 defined it somewhere or it is defined in the art 21 somewhere because there is no universally accepted 22 definition of any of these terms. There appear	84 1 Q So what's the difference between binaural 2 and stereo? 3 A Stereo does not have the latter part of 4 what I said which is about the location or the 5 localization or the source location of a sound. 6 Q How can you create binaural sound? 7 MR. HENRY: Objection to form, ambiguous. 8 BY THE WITNESS: 9 A There are many possible variations of the 10 way it could be done, but fundamentally I think in 11 the context of this matter, and, again, I'm just 12 shooting from the hip here a bit is the knowing 13 where a sound is located, the origin of a sound, 14 so where the emissive location of the sound, 15 knowing that location and knowing the locations 16 of, say, a person's ear and the transfer function 17 that describes how sound propagates from that 18 location through the air, possibly through the 19 room, through the space, reflecting off of things, 20 filtering or not depending on what's around them 21 and then reaching the ears and being processed or 22 transformed by the structure of the ear, the inner

85 1 structure of the ear to finally reach the nerves, 2 that's the goal, that we use to hear. 3 So it would be knowing how to take the 4 sound, the emissive component of the sound from 5 the location it's at and knowing the transfer 6 function is one way you would typically do it to 7 compute what that sound should -- what should be 8 perceived from that source in the ear given all of 9 those physical components that are involved and 10 then you could produce that for somebody, say, in 11 a headphone. 12 Q So if I do have -- I'll give you a hypo. 13 Suppose I have loudspeakers in the corner of the 14 room that plays back a soundtrack, so it is five 15 meters away from me, would that sound be perceived 16 by me as binaural? 17 MR. HENRY: Objection to form, incomplete 18 hypothetical. 19 BY THE WITNESS: 20 A It would depend on the soundtrack. It 21 would depend on how it was produced, how it was 22 encoded, what it was encoded for.	87 1 or two papers, I think it might have been a 2 researcher at Berkeley, UC Berkeley, who was 3 looking at that sort of sound rendering from 4 speakers that is spacialized to produce binaural 5 audio at the ears of a person sitting in the room, 6 a person who they knew the location of the 7 person's head and the orientation of the head and 8 all of those other things you would need to know. 9 Q Are you aware of binaural recording? 10 MR. HENRY: Objection to form, ambiguous. 11 BY THE WITNESS: 12 A Yes, I have heard -- I've heard the term 13 and, I mean, it sounds like something I have 14 certainly heard, come across. Offhand I'm not 15 aware of anything specific that I could tell you 16 about. 17 BY MR. RAFATIJO: 18 Q Hypo, if a stereophonic sound is played 19 back over loudspeakers that is ten meters away 20 from the listener, would that sound be perceived 21 as binaural? 22 MR. HENRY: Objection to form, incomplete
86 1 It is certainly possible to create 2 binaural sound in someone's ears from 3 loudspeakers. I think it's very difficult. I 4 seem to remember reading research papers about 5 people trying to do that. It's quite difficult 6 for a variety of reasons related to physics 7 mostly. So it really it would depend on a lot of 8 things in your hypothetical. 9 BY MR. RAFATIJO: 10 Q So can sounds being played back by 11 loudspeakers capable of being binaural? 12 MR. HENRY: Objection to form. 13 BY THE WITNESS: 14 A I'm not sure I understood your question, 15 but I think you just asked what I just answered 16 which is that I recall reading research papers 17 where people under very controlled conditions were 18 studying ways to produce spacial audio, binaural 19 audio from speakers located around a person. Of 20 course, like anything, there is no perfect. There 21 is no precision. There isn't in any model or 22 anything anybody does, but I remember reading one	88 1 hypothetical. 2 BY THE WITNESS: 3 A So one would have to -- I would have to 4 understand all of the parameters of what you're 5 saying, but divorced from the specifics of this 6 case that really matter, the patents and what 7 really matters just in the most general sense, 8 something someone would call stereo, so use sort 9 of the common use of that term that you just used 10 would not produce what someone would consider 11 binaural audio. It would be stereo audio and it 12 would be the same anywhere somebody -- no one 13 would be able to perceive the, say, true or a 14 specific or accurate location, spacial location of 15 anything from those speakers. They would hear 16 left and right and they would hear some spacial 17 component of that that's limited by what can be 18 perceptually achieved from those speakers. 19 Q So how does binaural recording work? 20 MR. HENRY: Objection to form. 21 BY THE WITNESS: 22 A Can you explain to me precisely what you

89 1 mean by binaural recording? 2 BY MR. RAFATIJO: 3 Q You are a POSITA in this field. 4 Do you understand the term binaural 5 recording? 6 A So I'm more than a POSITA in this field 7 and I understand that the term binaural recording 8 could mean more than one thing. So can you tell 9 me exactly which thing you mean? What do you mean 10 by that? 11 Q Please, what are those things? 12 MR. HENRY: Objection to form. 13 BY MR. RAFATIJO: 14 Q You said it means more than one thing. 15 What are those things? 16 A One example would be to record sound that 17 would be played back for somebody that would be 18 considered binaural. A completely different use 19 would be to capture what is arriving at someone's 20 ear binaurally from a variety of sound sources 21 that are located spacially in the space around. 22 Those are two very different things, and I think a	91 1 mannequin's ears and they would measure the 2 spectral components of those signals as they are 3 received at the ears in order to model the 4 mathematical transformation that happens to sound 5 that is emitted from those locations and perceived 6 at the inner ear as much as can be done with a 7 dummy ear. 8 MR. RAFATIJO: Can we pull up, please, 9 Exhibit 9. 10 (A certain document was marked Welch 11 Deposition Exhibit 9 for identification, 12 as of 05/03/2024.) 13 BY MR. RAFATIJO: 14 Q Can you please scroll down. More further, 15 please scroll down further, further. Okay. Here, 16 stop. 17 Would that be the setting used for 18 binaural regarding? 19 MR. HENRY: Objection to form. Are you 20 referring to something particular as the setting 21 Counsel. There is no foundation there. 22 MR. RAFATIJO: You cannot object like
90 1 person could refer to either of those just as two 2 examples with the words you used. 3 Q So how would you capture sound binaurally? 4 A Again, that seems like a very broad 5 question. I'm not quite sure I understand what 6 you're asking. But I think a typical thing that 7 might be what you're looking for is people use -- 8 I have friends in Europe who do this a lot and 9 I've worked with them on a couple of sound-related 10 projects that didn't get funded, their research 11 proposals. They would set up -- they have 12 anechoic chambers, so special rooms, special 13 places that are designed to minimize sound 14 reflection and so they want to factor that out and 15 then typically in this realm that I'm thinking 16 about to answer your question they would put, for 17 example, a mannequin head, an artificial head of a 18 human somewhere in the room and then produce mono 19 sounds at different places in space around that 20 person and they would know the precise positions 21 of those sounds. They would know the precise 22 positions of microphones that were situated in the	92 1 that, Counsel. It's against PTAB rules. 2 MR. HENRY: I don't know what you're 3 talking about. Your question is: Is that a 4 setting? What are you referring to? 5 MR. RAFATIJO: Counsel, you cannot have 6 running -- talking objections like that. It's 7 inappropriate. 8 MR. HENRY: I'm trying to clarify. 9 BY MR. RAFATIJO: 10 Q Is this image represents binaural 11 recording? 12 MR. HENRY: Objection to form. 13 BY THE WITNESS: 14 A I don't remember this document. If I've 15 reviewed it before I don't remember it so it's 16 going to take me a minute to take a look at it and 17 I'll give you the best answer I can sitting here 18 without a more detailed analysis. 19 BY MR. RAFATIJO: 20 Q Sure. 21 A So, I can't tell enough. It would -- I 22 would really have to study this for a while and

93 1 look at the entire paper and I might even have to 2 go look at some of their other work to try and 3 understand. The caption for the figure is 4 relatively brief, experimental setup of 5 loudspeakers in listening room, ears of recording 6 heads and listeners were in same position. That 7 doesn't tell you very much. 8 I'm trying to look at where that figure is 9 referenced in understanding what it is they're 10 doing. And I cannot tell sitting here right now 11 exactly what it is they're doing. It looks like 12 it's possible there's some recording going on. 13 There might also be some model validation because 14 it talks about different lights and things. So 15 sometimes people do validation of the 16 effectiveness of different binaural, synthesized 17 binaural sound by attempting to make the sound 18 come from a particular spacial location and then 19 asking the human to somehow make a judgment about 20 where the sound is coming from or whether or not 21 it appears -- they perceive it as coming from that 22 location. So it's like trying to judge the	95 1 They'll take it as it is and interpret it as that. 2 So there's no one universal answer to your 3 question. It's not a term that one can say 4 definitively this is or that is or this is not or 5 that is not. You would really have to look very 6 carefully at those things and then it's going to 7 be a judgment of a human about whether or not 8 something would be considered to be binaural 9 recording by that person at least. Other people 10 might disagree. 11 Q If a listener, a person wears two binaural 12 microphones in the listener's ears, would that 13 record the sounds binaurally? 14 MR. HENRY: Objection to form. Incomplete 15 hypothetical. 16 BY THE WITNESS: 17 A It is certainly the case that I would say 18 that if you put two microphones buried in the ear 19 of a human, however far in the ear you could put 20 them you would get some -- you would get some 21 sound -- you would get some recording, some 22 sounds, and if you were recording some recording
94 1 fidelity or the accuracy if you will of that 2 binaural sound. 3 So I can't quite tell here what's going on 4 in that respect. It certainly seems related, but 5 the person in the middle is clearly a human, not a 6 dummy so I'm not quite sure what's going on here. 7 Q Can we not have binaural recording without 8 a dummy head? 9 A Sure. In the most general sense. Again, 10 I wasn't sure what you were asking for before and 11 you seem to be using these terms in mind, you seem 12 to have some very specific narrow thing, but terms 13 can be used widely to mean a variety of different 14 things. Anybody reading a paper like this or 15 patent would have some answer for what they think 16 binaural recordings are before they read the paper 17 and then when they read the paper like this. They 18 would be able to most likely otherwise I think the 19 paper would have been rejected to make sense out 20 of what the authors meant even if they were using 21 the term in some way that was unexpected to them 22 or a variation of what they might have expected.	96 1 that I think people would call binaural sounds. 2 Q Can you capture binaural sounds by a 3 microphone worn by a user as opposed to a dummy 4 head? 5 MR. HENRY: Objection to form. 6 BY THE WITNESS: 7 A First of all, I don't know what worn by a 8 user means. My first thought is a lavalier mic, 9 an ear mic that like a performer would wear. So 10 it's a odd way to ask the question, but also in my 11 previous answer I said microphones in the ear of a 12 person, is that what you -- are you asking me that 13 same question? 14 BY MR. RAFATIJO: 15 Q Yes. I am just basically asking if it is 16 possible not to use a dummy head and still record 17 binaurally with human ears, two microphones in 18 human ears? 19 A Right. And I'm just puzzled because I 20 thought that was the end of the answer that I gave 21 previously said exactly that. 22 Q So the answer is yes?

97 1 MR. HENRY: Objection to form. Asked and 2 answered. 3 BY THE WITNESS: 4 A Under, in some circumstances by some 5 people's definition of what would constitute doing 6 that I would say yes, just in the most general 7 sense outside of this paper or outside of anything 8 else, sure, it's certainly possible, not uncommon. 9 BY MR. RAFATIJO: 10 Q Would you agree that in binaural recording 11 localization is preserved? 12 MR. HENRY: Objection to form. 13 BY THE WITNESS: 14 A No, I would not agree that -- with that. 15 BY MR. RAFATIJO: 16 Q Why not? 17 A Because your words to me as someone who's 18 an expert in the field are very restrictive. 19 Preserve is a very strong word. I will recount a 20 quote that I love by a person named George P. Box 21 and he said all models are wrong but some models 22 are useful.	99 1 the recording of what the microphones capture, 2 would that listener be able to perceive the 3 spacial relationship of the dog and guitar? 4 MR. HENRY: Objection to form. Calls for 5 speculation. 6 BY THE WITNESS: 7 A Again, there are -- as an expert there are 8 things in your words that are very difficult to -- 9 to respond to because they mean something to me 10 that I don't know if it's what you mean. 11 What I will say is there will be some 12 aspect of the spacialization of those sounds will 13 most likely be of evident to a person with 14 appropriate hearing, someone who's not deaf or has 15 low hearing. So most people would likely be able 16 to determine some spacial locations of those 17 things. The exact, or precise or, you know, is 18 better and better estimation of where those things 19 are or perception of where those things were when 20 they were originally -- when the dog originally 21 barked and the guitar player originally played, 22 someone's ability to perceive and estimate those,
98 1 So anything you record, anything you model 2 like those sorts of things are never going to be 3 right. So there is no preservation of anything. 4 I don't know what that would even mean. You would 5 use it to model as best you could sound emanating 6 from that particular location, and probably that 7 very specific sound or sounds that you use, not 8 all sounds but those specific ones that you used 9 in your modeling, and how they would be received 10 at a microphone inside your ear. So there's no 11 preservation. I don't know what you mean by 12 that. 13 Q So I clarify. Suppose you have a barking 14 dog in front of you to your right and a musician 15 playing guitar behind you on your left. Okay? 16 A Okay. 17 Q Now suppose you're wearing two 18 microphones, binaural microphones, in your ears to 19 record the sounds emitted from both of these sound 20 sources, the dog and the guitar; is that clear? 21 A Clear enough to keep going anyway. 22 Q Now, a listener that later on listens to	100 1 the accuracy of that would go up or down depending 2 on how well you were able to model the sound as it 3 arrives at each person's -- individual person's 4 ear because in the inner ear which probably is not 5 where the microphone goes, it can't go too deep in 6 your ear, the sound for me will be a little bit 7 different than the sound for you or for anybody 8 else in this Zoom call because all of our ears are 9 shaped differently. So the locations that we 10 perceive these things to be at could very well be 11 different, not to mention that spacial location is 12 an imprecise -- is a relatively imprecise thing. 13 Our perception, our ability to localize -- 14 perceive sound, binaurally or otherwise, is not as 15 accurate obviously as site. 16 So to some degree yes, to what degree 17 depends on many, many, many things. 18 Q But a listener listening to this binaural 19 recording would at least be able to qualitatively 20 perceive the guitar coming from behind on the left 21 and the dog sounds coming from front to the right, 22 correct?

101 1 MR. HENRY: Objection to form, asked and 2 answered. 3 BY THE WITNESS: 4 A If I understand your hypothetical and 5 without the benefit of talking to you in more 6 detail and spending much more time and thinking 7 about this, just sitting here right now, I think 8 if I understand what you said, you would hear -- 9 most people would likely perceive the guitar 10 playing somewhere near where it was and the dog 11 barking somewhere near where it had barked before. 12 BY MR. RAFATIJO: 13 Q And those localization points for the 14 sound sources are fixed in relationship to one 15 another, correct? 16 MR. HENRY: Objection to form. 17 BY THE WITNESS: 18 A I don't know what you mean by those 19 localization points are fixed. In your 20 hypothetical, there was a dog, there was a guitar 21 player, the guitar player played, the dog barked. 22 You did not say to me they moved around. So I	103 1 playing the recording for and move them physically 2 somewhere else and they would still perceive the 3 dog to their front and right and they would still 4 perceive the guitar to their left and the rear. I 5 don't know if that's what you're asking. 6 Q Yes. 7 A That is the case, yes. 8 Q Okay. And so earlier you said that 9 binaural sounds essentially are two channels of 10 sound, one going to the left ear and one going to 11 the right ear? 12 A Correct. 13 Q Am I correct in understanding what you 14 just described like some five, ten minutes ago? 15 MR. HENRY: Objection to form. 16 BY THE WITNESS: 17 A I think as I said then, I cannot give you 18 a precise definition and I'm not sure where you're 19 going because what you just said could also be 20 true of what someone would typically call stereo 21 sound. So I'm not sure what it is you're asking. 22 BY MR. RAFATIJO:
102 1 presume they're just stationary. So the recording 2 you may made is for those exact circumstances, as 3 exact as anything could be, for those 4 circumstances. 5 BY MR. RAFATIJO: 6 Q Correct. But the localization point for 7 the dog was front of the person to the right and 8 for the guitar was behind the person to the left, 9 and all I'm asking is if the relationship between 10 those two localization points are fixed in the 11 resultant recording? 12 MR. HENRY: Objection to form. 13 BY THE WITNESS: 14 A Again, I don't fully understand your 15 question but the recording was done in my ear then 16 the computation of anything that is -- I'm sorry, 17 the reproduction of anything that was received at 18 those locations should if things were, you know, 19 all right in the world and the room, if you take 20 the room out of the picture, factor the room out, 21 should to most people appear to be the same 22 location. You could take that human that you're	104 1 Q What does the term binaural means? 2 MR. HENRY: Objection to form. Asked and 3 answered. 4 BY THE WITNESS: 5 A The term binaural, when you asked me what 6 does it mean, I think one could look it up in 7 dictionary. I don't know what the dictionary 8 entry would say, I assume it's bi, two, aural, 9 ear, or sound, so to sound, but the definition of 10 that word does not necessarily tell you what the 11 definition of the use of the term in other 12 contexts is, not precisely, it surely would be 13 related you would hope. 14 BY MR. RAFATIJO: 15 Q So for binaural sounds you have two 16 channels of sounds, one goes to your left ear, and 17 one goes to the right ear, correct? 18 A I think I would say that's not incorrect, 19 but I don't -- that is certainly not -- I'm not 20 sure where you're going. That is not definitive 21 because, again, what you just said it would be 22 true for stereo sound or virtually any sound.

105 1 Q But is it not true that the binaural sound 2 should be played back over earphones or 3 headphones? 4 MR. HENRY: Objection to form, compound. 5 BY THE WITNESS: 6 A If the binaural sounds were recorded in 7 the inner ear and they represent the arrival of 8 sound waves at that point that are filtered by the 9 physical surroundings and by all of the other 10 characteristics, physical surroundings including 11 the person's ear, then in order to reproduce that 12 you would ideally want something that was played 13 back at the same place, but, of course, it's very 14 hard to get a sound probably in the same place as 15 the microphone so you would do it as closely as 16 you could. So headphones would be a common -- a 17 common way to get an a crude -- to give the person 18 a crude perception, relatively crude perception of 19 where something is spacially. 20 BY MR. RAFATIJO: 21 Q Great. So now -- so you have two 22 headphones, each of them different one channel of	107 1 of them stand alone, are they binaural or 2 monaural? 3 MR. HENRY: Objection to form. Ambiguous. 4 BY THE WITNESS: 5 A I don't know what you mean exactly, but it 6 would be -- I mean, a single speaker is only a 7 single speaker. So a headphone can only play back 8 a single signal. That signal could be composed 9 from other signals, but there's only one speaker. 10 That's all it can do is play one -- produce one 11 audio waveform going into the ear. That's it. 12 BY MR. RAFATIJO: 13 Q Would that be binaural by definition or 14 not? 15 A Would what be binaural? 16 Q The single speaker, the sound that is 17 coming from a single speaker, a single headphone, 18 would that be binaural or monaural? 19 MR. HENRY: Objection to form, incomplete 20 hypothetical. 21 BY THE WITNESS: 22 A You're asking a question for which I don't
106 1 sound to the ears of the listener, total of two 2 channels, correct? 3 MR. HENRY: Objection to form. 4 BY THE WITNESS: 5 A I don't know what's correct or incorrect. 6 This is your hypothetical. 7 Again, stereo would be done with two 8 headphones, left and a right like you just said. 9 BY MR. RAFATIJO: 10 Q The headphone in the binaural reproduction 11 or reproduction of binaural recording delivers a 12 channel of sound to each ear, correct? 13 A If under some circumstances I think that 14 that is the way I or others would characterize 15 what's going on if I understand your hypothetical, 16 which I'm still struggling to a little bit, but if 17 I had headphones that were playing back sounds 18 that were previously recorded in my inner ear, as 19 I said a moment ago, that should give me a crude 20 approximation of a sense of where those sound 21 sources were when they were recorded. 22 Q Each of those channels stand alone, each	108 1 I think there is a universal answer so I can't say 2 yes it is or it isn't. One would have to talk 3 about why is this being asked? What's the 4 context? You might call it binaural audio if, for 5 example, again, this is off the top of my head, 6 you might call it binaural if it was part of a 7 collection of binaurally recorded sounds that were 8 then being reproduced, but if you focus just at 9 that particular sound, one might say it was mono 10 because it is only one sound source, mono, one. 11 Now, it is a mono source that is part of I 12 think in your hypothetical a binaural collection 13 of data. So whether one person would call it one 14 thing or not it's hard to say. It depends -- 15 Q Sure, sure. But the binaural sound 16 essentially is the combination of two mono sounds, 17 each of them goes to one ear to of the listener, 18 one for the left, one for the right, correct? 19 MR. HENRY: Objection to form. 20 BY THE WITNESS: 21 A There is no correct or incorrect. What 22 you just said I think it would be a reasonable --

109 1 sitting here right now not an unreasonable 2 characterization of the circumstances in which 3 spacial audio is produced, that is, the binaural 4 sound, two components are presented to each ear, 5 each component in and of itself as I said a moment 6 ago, and I'll say again, is produced with a single 7 speaker and can therefore only produce a single 8 sound wave or complex sound wave going into each 9 ear. 10 BY MR. RAFATIJO: 11 Q And each sound wave coming from any one of 12 those earphones or headphones is monaural, 13 correct? 14 MR. HENRY: Objection to form. 15 BY THE WITNESS: 16 A It would depend on headphones. There are 17 many many many many types of headphones. I'm not 18 aware off the top of my head of headphones that 19 produce sound from more than one location but I 20 have this general sense that a lot of headphones 21 today, especially noise canceling headphones, are 22 very complicated in terms of the number of	111 1 whether universally this is or is not that is not 2 something anybody can do. Anybody who would do 3 that would not be credible. 4 BY MR. RAFATIJO: 5 Q What's the difference between binaural 6 sound and monaural sound? 7 A There are probably in general, again, what 8 somebody would refer to as binaural sound, again, 9 there is no universal definition, that doesn't 10 mean you won't find definitions, but I'm saying 11 there isn't one that everybody adheres to. 12 Generally binaural is exactly -- and mono are 13 exactly what words say, bi two, mono one. 14 Q So bi has two monos, correct? 15 MR. HENRY: Objection to form. 16 BY THE WITNESS: 17 A It's a very odd question. I don't know 18 how to answer that. I mean, I don't know anybody 19 who would necessarily say yes or no to binaural 20 audio having two monos. It depends on what we 21 mean by binaural audio. It depends -- there's so 22 many things that that depends on. I don't think
110 1 microphones they have to capture ambient audio and 2 the number of -- and components of speakers they 3 have to reproduce audio. So nobody could say 4 definitively yes or no to your question. Again, I 5 think generally it's a single sound wave. 6 BY MR. RAFATIJO: 7 Q Okay. So suppose you take the left 8 channel of a sound that is recorded binaurally 9 with two microphones in the ear of a dummy head or 10 a listener, okay, is the left channel, is the left 11 channel singled out by and of itself binaural? 12 MR. HENRY: Objection to form, ambiguous, 13 asked and answered. 14 BY THE WITNESS: 15 A As I've said repeatedly, there is no right 16 or wrong answer to what you're saying, what you're 17 asking because there is nobody in the world who 18 owns and decides what exactly those terms mean. 19 The words are useful. They're not perfect. They 20 are useful in certain contexts for people to 21 understand what they're talking about or 22 communicating in a paper. So to be able to say	112 1 anybody can say yes or no to that question. 2 BY MR. RAFATIJO: 3 Q So moments ago I give a hypo of the 4 barking dog and the guitar. 5 Do you remember that? 6 A Yes. 7 Q We recorded that binaurally with two 8 microphones in the ear of a listener or dummy 9 head. 10 Do you remember that? 11 A Yes. 12 Q And we said if we played back for a 13 listener over headphones the listener would 14 perceive qualitatively at least the location and 15 sound localization points for the dog and guitar 16 near where they actually were when the recording 17 was in process, correct? 18 MR. HENRY: Objection to form. 19 BY THE WITNESS: 20 A I don't remember all the details of 21 everything we discussed, but I'm trying to ingest 22 and retain in my head all of these things you just

113 1 said but okay, I have a memory generally of that, 2 yes. 3 BY MR. RAFATIJO: 4 Q Now, if we provide only one channel of the 5 binaural recording, only the left one to a 6 listener, would that person still be able to 7 perceive the location of the dog being front to 8 the right and the location of the guitar being 9 rear or behind on the left? One channel? 10 MR. HENRY: Objection to to form, 11 incomplete hypothetical. 12 BY THE WITNESS: 13 A If I'm following what you're asking and, 14 again, we have to be very careful about the words 15 because what humans perceive does not necessarily 16 mean what arrives at the ear. People can perceive 17 things for a variety of different reasons 18 including if you show me a picture of a dog and I 19 hear barking, I can perceive that sound as coming 20 from that location whether or not the sound 21 accurately represents that. There's a pretty 22 broad range of spacial circumstances under which	115 1 lunchtime, past the lunch here on the east coast. 2 Do you think we could go off the record? 3 MR. RAFATIJO: Sure. How long do you want 4 to be off the record? 5 MR. HENRY: Let's go off the record and 6 then we'll discuss including with the other folks 7 on the Zoom. 8 MR. RAFATIJO: Sure. 9 THE VIDEOGRAPHER: Stand by. We are going 10 off the video record. The time is 12:20 p.m. 11 (A lunch recess was had from 12:20 p.m. to 12 1:05 p.m. CST.) 13 14 15 16 17 18 19 20 21 22
114 1 the visual components of something really dominate 2 someone's perception of where something is or 3 where something is coming from, but for a person 4 who simply closed their eyes and listen to one 5 sound or the other, they would not be able to very 6 accurately determine anything. Perception is a 7 very qualitative thing. It's personal. So if you 8 only -- let's the as say for example you only 9 played the right ear and nothing in the left ear, 10 for example, and the dog happened to be to the 11 right and you didn't tell them anything, the user, 12 they might perceive the dog being to the right 13 simply because the sound is coming from the right 14 that they're hearing. So it would depend which 15 thing you present and where it's coming from, but 16 it would be very crude. At best they would 17 perceive that it's coming from sort of the right 18 hemisphere of the head but they wouldn't be able 19 to perceive, accurately perceive much more than 20 that. 21 MR. HENRY: Counsel, we've been going for 22 over an hour now and we're creeping up on	116 1 A F T E R N O O N S E S S I O N 2 THE VIDEOGRAPHER: We are back on the 3 video record. The time is 1:04 p.m. 4 I apologize, Counsel. The witness is 5 appearing a little jittery. Can we go back off 6 the record? 7 MR. RAFATIJO: Sure. 8 THE VIDEOGRAPHER: We are going off the 9 record. The time is 1:05 p.m. 10 (A recess was had.) 11 THE VIDEOGRAPHER: We are back on the 12 video record. The time is 1:11 p.m. 13 DR. GREGORY F. WELCH, 14 called as a witness herein, having been previously 15 duly sworn and having testified, was examined and 16 testified further as follows: 17 EXAMINATION (Resumed) 18 BY MR. RAFATIJO: 19 Q Welcome back, Dr. Welch. 20 A Thank you. 21 Q I would like to shift gears and talk about 22 what I will call binauralization of the sound.

117 1 Would you be able to create binaural sound 2 from non-binaural sound? 3 A Do you mean me personally? 4 Q No, a POSITA. Would a POSITA know how to 5 make binaural sound from non-binaural content? 6 A Yes. 7 Q And if I refer to this process 8 binauralization, would you understand me for the 9 sake of this testimony? 10 MR. HENRY: Objection to form. 11 BY THE WITNESS: 12 A Well, I understand something. I don't 13 know if I'm understanding exactly what you mean, 14 but I certainly have an understanding of 15 something. 16 BY MR. RAFATIJO: 17 Q How would a POSITA binauralize a 18 non-binaural sound? 19 A A POSITA would use a variety of tools 20 available to them at the heart of which would be 21 some mathematical computation, some function that 22 would take, for example, the position of the	119 1 Q Okay. Within that -- what's the 2 definition of these binaural sound HRTFs? 3 A Again, like many things, I don't know that 4 there is a definition for anything like that. 5 There may be many, and I don't know exactly what 6 you mean when you say that. So I might have many 7 different responses depending on what it is you 8 meant. 9 What did you mean? Can you explain that 10 or ask it differently? 11 Q Well, as a POSITA sitting here today, do 12 you have a definition for the term HRTF? 13 A So an answer to your question would appear 14 I believe in Paragraph 106 of my declaration for 15 the '737 patent. Paragraph 106 has a general 16 explanation. I called it a definition, and then 17 another further explanation, and then I have 18 dictionary definition also at the bottom of that 19 page from the Wiley Electrical and Electronics 20 Dictionary -- Engineering Dictionary. 21 Q Do you agree with this definition here in 22 the footnote of Page 61?
118 1 source of the sound, the positions of the ears of 2 the recipient, and then transform those sounds by 3 the transfer function that relates to the sound 4 emanating from that location if you have it to 5 traveling through space and being received at the 6 inner ear of the left and right ear of that 7 person. 8 So you'd transform those signals 9 mathematically using those parameters to generate 10 sounds that would then be played for the user as 11 close to or in the ear as possible so that they 12 would then hear that sound coming from that other 13 location. 14 BY MR. RAFATIJO: 15 Q And those transfer functions that you were 16 referring to are HRTF or head-related transfer 17 functions? 18 A Head-related transfer function would be 19 part one part of it. It could have other parts 20 such as transformations associated with the 21 acoustics of the room, but HRTFs or HRTF would 22 typically be one part of that, yes.	120 1 MR. HENRY: Objection to form. 2 BY THE WITNESS: 3 A I certainly wouldn't disagree with it in 4 the context of this case. I couldn't sit here and 5 tell you it's universally correct for every 6 circumstances, but generally yes, I agree with it. 7 BY MR. RAFATIJO: 8 Q As a POSITA, do you understand what the 9 term interaural time difference mean? 10 A Yes. 11 Q If I use acronym ITD, would you understand 12 that I am referring to interaural time difference? 13 A I will try to do that. I have lots of 14 acronyms in my head, but I will try to do that, 15 yes. 16 Q So what does it mean? 17 A Intraaural -- what does what mean, the 18 acronym? 19 Q No, intraaural time difference? 20 A It means the difference of arrival of a 21 signal between one ear and the other ear. 22 Typically in this context, that's what it would

121 1 be, time difference. 2 Q Would the concept of ITD -- is it 3 incorporated in the definition of HRTF? 4 MR. HENRY: Objection to form. 5 BY THE WITNESS: 6 A I don't know what you mean by incorporated 7 in the definition. What do you mean by that? 8 BY MR. RAFATIJO: 9 Q Would HRTF include interaural time 10 difference? 11 MR. HENRY: Objection to form. 12 BY THE WITNESS: 13 A So a HRTF would have a spectral component 14 that transfer function taking a time domain signal 15 and processing that would result in an appropriate 16 delay from the source to that ear if this is where 17 you are going. So HRTF essentially functions for 18 each ear would result in the same source, the same 19 single source somewhere in space, the simulated 20 sound waves or modeled sound waves arriving at the 21 two ears potentially at different times depending 22 on lots of things.	123 1 way of saying that, but I think what you might be 2 saying is the magnitude of that part of the 3 spectrum however it's defined is reduced, that is, 4 if you think about it in a spectral sense, then 5 the energy at that frequently component would be 6 reduced from what it would otherwise be. 7 Q Suppose I show you a function, a 8 mathematical expression that takes the frequency 9 of the sound and based on the frequency attenuates 10 the sound, would you say that function is HRTF? 11 MR. HENRY: Objection to form, ambiguous. 12 BY THE WITNESS: 13 A I'm sorry. Could you restate the 14 question? 15 BY MR. RAFATIJO: 16 Q Sure. I show you a function that takes 17 the frequency of a sound wave and based on 18 whatever the frequency is attenuates the sound 19 meaning diminished quality of the sound as you 20 just explanted. 21 Does that mean that my function -- 22 essentially my function is a binaural HRTF just
122 1 BY MR. RAFATIJO: 2 Q Would binaural HRTF modify the time of 3 arrival of sound at both ears? 4 A It would depend -- generally the HRFT has 5 certainly a time delay component of it, the result 6 of applying that function will affect the timing 7 of the time domain of the waveform, the simulated 8 or recorded propagation of sound waves toward a 9 person's ear. If we're talking about binaural 10 HRTF, meaning both left and right ear components, 11 then that collectively, yes, would include -- 12 would incorporate that relative arrival time or 13 delays to the two different ears. 14 Q Are you familiar with the concept of 15 attenuation? 16 A Yes, that is a very general word. So 17 attenuation is a very very very very general word 18 from an engineering and computer science 19 standpoint, so yes. 20 Q If I ask you what does it mean for a sound 21 frequency to be attenuated, what would you say? 22 A I would say first of all it's a little odd	124 1 because it attenuates the sound? 2 MR. HENRY: Objection to form. 3 BY THE WITNESS: 4 A To me listening to your -- I'm trying to 5 listen precisely to the words that you use, a 6 function that takes the frequency and does some 7 attenuation doesn't quite make sense to me. So if 8 I -- I'm not following your hypothetical. If the 9 function takes, for example, 440hz as an input, if 10 that's the frequency, 440, then cycles per second, 11 440 cycles per second, what do you mean the 12 function then attenuates that and how are you 13 relating -- how does it attenuate a number, 440hz? 14 BY MR. RAFATIJO: 15 Q Sure. Sure. You have an incoming sound 16 wave as an input. You determine the frequency of 17 the sound wave, and based on whatever that number 18 is you just attenuates the sound, diminishes the 19 quality or the volume of the sound. 20 Does that mean that the function is HRTF? 21 MR. HENRY: Objection to form, incomplete, 22 hypothetical, ambiguous.

125 1 BY THE WITNESS: 2 A It's a very difficult hypothetical to 3 follow because some of the things you said in 4 setting it up leave only questions, for example, 5 you said the input frequency, that was something 6 you added. You didn't say that the first time. 7 So the actual signal versus the frequency which to 8 me would be an ordinal number, a number like 440. 9 So if that original signal came in in your 10 hypothetical, is that signal a 440hz signal or is 11 it a signal that comprises a much wider spectral 12 components of spectral energy? 13 BY MR. RAFATIJO: 14 Q It's a signal that comprises wide spectral 15 energy. 16 A Now that I understand that. Can you start 17 again with your hypothetical? 18 So there is a signal coming into this box 19 and it's multi-spectral, but where does the 440 20 come in, the frequency? 21 Q Yeah, the only thing you change in that 22 box is attenuation of the sound. So essentially	127 1 MR. HENRY: Same objections. 2 BY THE WITNESS: 3 A Make sure I understand, you said a sound 4 with a particular frequency and you attenuate that 5 sound if I understood what you said. So I don't 6 know, again, what it means to attenuate that 7 sound. 8 If you mean reduce amplitude of the time 9 domain signal, then everything gets reduced. If 10 you mean somehow reducing the energy at that part 11 of the spectrum, then that would be some sort of a 12 notch filter. I think you used a word notch, so 13 it would be a -- if I understand where you're 14 going, that would be considered a form of 15 filtering would be to attenuate, perhaps even 16 accentuate different parts of the signal that's 17 being fit in. 18 BY MR. RAFATIJO: 19 Q So it's in the HRTF, correct? 20 MR. HENRY: Objection to form, asked and 21 answered. 22 BY THE WITNESS:
126 1 you're damping the sound or you are diminishing 2 the volume or quality or whatever energy of the 3 sound, would that by itself mean that this box 4 represents HRTF? 5 MR. HENRY: Objection to form, compound, 6 ambiguous. 7 BY THE WITNESS: 8 A When you say diminish the energy of the 9 sound, again, I don't know whether you mean across 10 the entire spectrum, do you mean in a particular 11 place? I would say neither one of those if I'm 12 following your hypothetical, which I'm struggling 13 a little bit, would not be considered the same 14 function. They would be either filtering or 15 attenuation but not a transfer function that is 16 head-related, so not a HRTF in that sense. It 17 would not do the right thing if that's where 18 you're going. 19 Q What about attenuation at the specific 20 notch of frequencies, like you receive a sound 21 with a specific frequency and you attenuate that 22 sound. In that case, would you have HRTF?	128 1 A If I'm following your hypothetical, again, 2 all I have is a black box and the two things you 3 told me. So I don't know what else is involved 4 here in your hypothetical, but given those two 5 things, you said it to me is a filter which is not 6 an HRTF. It's just a -- could be a digital 7 filter, could be an analogue filter, whatever is 8 in that box, I don't know, but it would just be 9 considered a filter. 10 BY MR. RAFATIJO: 11 Q Okay. Great. Can you attenuate a stereo 12 sound? 13 A Yes, of course. 14 Q Are stereo sound -- are stereo sound 15 results from binaural processing? 16 MR. HENRY: Objection to form. 17 BY THE WITNESS: 18 A I'm sorry. I don't understand the 19 question. I think you said are stereo sound 20 resulting from binaural processing, is that what 21 you asked? 22 BY MR. RAFATIJO:

129 1 Q Yes. 2 A Could you reask that, please, a 3 different -- 4 Q Sure. Sure. Suppose -- you said you can 5 attenuate a stereo sound. All I'm asking is 6 whether you can have a stereo sound when you are 7 processing a sound with binaural HRTF, if the 8 resultant sound would be stereo? 9 MR. HENRY: Objection to form, ambiguous, 10 incomplete hypothetical. 11 BY THE WITNESS: 12 A I'm really having trouble following what 13 you're asking. Can you break it down into smaller 14 pieces? 15 BY MR. RAFATIJO: 16 Q Sure. If you have non-binaural content 17 and process it by binaural HRTF, would you be 18 able to to say that the resultant sound can be 19 stereo? 20 A Would you be able to say -- people I think 21 people -- if I understand your question you have 22 monaural sound let's say it's supposed to be	131 1 read it out loud? 2 MR. RAFATIJO: Yes, he can read it out 3 loud if he's comfortable with it. 4 MR. HENRY: You want him to read the 5 document? Okay. 6 BY THE WITNESS: 7 A Column 3 of the '316 patent, lines 32 8 through 38 I guess -- 9 BY MR. RAFATIJO: 10 Q Correct. 11 A -- read: "Binaural sound typically 12 delivers two types of localization cues, temporal 13 cues and spectral cues. Temporal cues arise from 14 an interaural time difference (ITD) due to the 15 distance between the ears. Spectral cues arise 16 from an intraaural level difference (ILD) or 17 intraaural intensity difference (IID) due to 18 shadowing of sound around the head. Spacial cues 19 are ITDs and ILDs and their combination." 20 Q Do you agree with this paragraph? 21 A Sitting here right now, I think I would 22 not disagree with that. I don't -- I wouldn't say
130 1 emanating from a particular 3D location and you 2 apply the appropriate HRTF for a person sitting in 3 a particular location with a particular inner ear 4 distance and, you know, all of those geometric 5 parameters and then you apply that transfer 6 function to that the same signal, one to the left 7 ear and one to the right ear, would a person of 8 ordinary skill or a normal person in the art 9 consider that stereo? Generally they would not 10 refer to that as stair so if that's what you're 11 asking. 12 Q Yes, exactly. Thank you. 13 Can we please pull up Exhibit 6. 14 A Okay. Exhibit 6, I have it open in front 15 of me. 16 Q Go to Page 19. 17 A Columns 3 and 4 of the patent? 18 Q Yes. Column 3, Line 32 to 38. 19 A Okay. I see that, yes. 20 Q Would you please read it to yourself or 21 for the record, whatever your preference is. 22 MR. HENRY: Which one? You want him to	132 1 that it's necessarily comprehensive in terms of 2 the conclusions. It does start by saying 3 typically provides these or delivers these two 4 types of cues. 5 So sitting here right now without having 6 given it much more thought, I don't see anything 7 offhand that I would disagree with in that 8 paragraph. 9 Q Would processing sound with binaural HRTF 10 imposes these cues, the two cues that you just 11 read, ITE and ILD, on a sound in order to create 12 binaural sound? 13 MR. HENRY: Objection to form, ambiguous. 14 BY THE WITNESS: 15 A The wording is a little odd for me. I 16 don't know what imposes means, but the result of 17 applying that transfer function to a signal will 18 have results that are related to or result in a 19 particular ITD or an ILD. There is no explicit 20 functional act that controls those things. It's 21 the application of the transfer function that 22 results in a new signal that has different

133 1 components of time and level. 2 MR. RAFATIJO: Can we please pull up 3 Exhibit 5. 4 THE WITNESS: Okay. 5 BY MR. RAFATIJO: 6 Q Page 106? 7 MR. HENRY: PDF or document page? 8 MR. RAFATIJO: PDF page. 9 BY MR. RAFATIJO: 10 Q 106, Paragraph 178. 11 A That's a different page. 12 MR. HENRY: That's document page I think. 13 BY THE WITNESS: 14 A Paragraph 178. Okay. I am looking at 15 Paragraph 178. 16 BY MR. RAFATIJO: 17 Q There is a quote there that you put there 18 toward like six lines toward the end of the page, 19 and the quote read: "The basis of 3D sound 20 processing lies in imitation of the spacial cues 21 present in natural spacial hearing where the 22 binaural HRTF imposes a spacially dependent	135 1 Can you please -- yes here. 2 The word imposes spacially dependent 3 spectral modifications and time delays on incoming 4 wavefront to the hearing system? 5 A As I think I said before, it's odd, I -- 6 different people say things in different ways. I 7 think to say that a function imposes something on 8 anything is an odd thing to say. The function 9 processes the data passed to the function and 10 produces different data to say anything imposes 11 anything is a little odd, but I understand it. I 12 understand what is being said. It's just an odd 13 way of saying it. 14 Q So what's your understanding of this 15 sentence? 16 MR. HENRY: Objection to form, asked and 17 answered. 18 BY THE WITNESS: 19 A Basically what it's saying as I sit here 20 and look at it applying that transfer function 21 results in a signal, or a simulated signal that 22 has spectral modifications and time delay. So
134 1 spectral modifications and time delays on an 2 incoming wavefront to the hearing system." 3 So you see the word imposes there. What 4 do you make sense of this word because moments ago 5 you said you don't understand the word impose in 6 my hypothetical question? 7 MR. HENRY: Objection to form. Objection 8 to form, mischaracterizes Dr. Welch's testimony. 9 Also, Counsel if you're trying to show the 10 paragraph to the witness on the Zoom, you are in 11 the wrong spot on the Zoom but the witness is at 12 Paragraph 178. 13 BY MR. RAFATIJO: 14 Q I am Paragraph 178, Page 106 of the 15 declaration, Page 125 of the doc? 16 MR. HENRY: The Zoom display was not. 17 BY THE WITNESS: 18 A Now it is. 19 MR. HENRY: Now we were all aligned on the 20 Zoom and where we are. Please proceed. 21 BY MR. RAFATIJO: 22 Q Can we scroll down -- sorry, Dr. Welch.	136 1 those things are modified. The spectral component 2 and the temporal component, so the phase and the 3 spectral phase and spectral magnitude are as a 4 result of applying that function are different. 5 BY MR. RAFATIJO: 6 Q Can we also go to Paragraph 103. That 7 would be Page 61. 8 A Okay, I'm there. 9 Q And you are quoting from a 1992 article by 10 Cohen where he says: "Binaural localization cues 11 may be captured by head-related transfer 12 functions," going to the next page, "impulse 13 responses measured for head or pinna (outer ear) 14 of human or dummy heads." 15 So these cues that he's talking about 16 here, would that include ITD? 17 MR. HENRY: Objection to form. 18 BY THE WITNESS: 19 A Michael Cohen, I know something about his 20 work in general I think that what he's saying is 21 effectively what you said, the cues are features 22 of something that we see or hear or some behavior

137 1 that we observe. So they cue us in or give us a 2 sense of something that's happening and so 3 localization cues effectively means all of the 4 things -- to me would mean all of the things that 5 we would perceive in the real circumstances, all 6 of the changes that would convey to us or give us 7 a perception that something was at a particular 8 place. So it's basically saying I think if you 9 apply the HRTF, it would do the right thing in 10 that sense, it would -- if you apply it correctly 11 with the correct parameters, the correct HRTF, all 12 of those correct things, it would as best as 13 anyone could provide the appropriate cues. 14 Q My question is only if these cues also 15 include ITEs? 16 A It's a little odd to say it that way, but 17 one of the cues that a person would -- one of the 18 aspects that a person is perceiving would convey 19 the spacial origins of a sound would be the time 20 difference between their ears. It is not 21 something someone could tell you about. They're 22 not conscious of it. It's something we all learn	139 1 out, and the signal that comes out is different 2 and we humans might characterize one of the 3 differences, one component or one -- if we're 4 trying to use words to describe how that signal 5 has changed, one of the ways we might describe it 6 would be to say what you said there, that time 7 difference, if I follow what you're asking. 8 BY MR. NEWTON: 9 Q Sure. Yes. And about the word introduce, 10 I would like for you to continue reading the 11 Paragraph 103, which continues on Page 62, the 12 first full sentence beginning with: "Sound can 13 then be spacialized..." 14 Would you please read it for the record. 15 A "Sound can then be spacialized by driving 16 digitized input signals through these HRTFs in a 17 convolution engine, creating psychoacoustic 18 localization effects by introducing binaural 19 spacial cues into an originally monaural channel," 20 and then there is a word quoted in middle of the 21 quote, "'placing' the channel within the 22 perception actual space of the user.." and then
138 1 growing up, and it happens subconsciously. We 2 understand that -- we don't realize it, but when a 3 sound is coming from a particular location, one 4 component of the cues, if you will, in the 5 characteristic of the sound that's coming to our 6 ears is that there's a difference in timing. It 7 depends on the sound and depends on a lot of 8 things, but generally that is one component of the 9 result of the waveforms that are being presented 10 to our ears. 11 Q And processing or converting the sound 12 with HRTF would introduce those spacial cues 13 including ITD into the sound, correct? 14 MR. HENRY: Objection to form, lacks 15 foundation. 16 BY THE WITNESS: 17 A In the most general sense -- I'm not sure 18 what we're talking about. In the most general 19 sense, again, wording you're using is a little odd 20 to me as someone who has done signal processing 21 for a long time. I wouldn't say it introduces 22 something. A signal goes in and a signal comes	140 1 there are some ellipses and close quotes on that. 2 Q So word introduced here do you understand 3 what it says? 4 A Yes, again, I wouldn't say it that way. I 5 think it's an odd way but people use different 6 words to describe things and most of the time a 7 person of ordinary skill like myself or anybody 8 would get what they mean. This might be a little 9 bit of a weird word because nothing new is added 10 so I wouldn't say introduction because there's 11 nothing new there, but introduce in the sense that 12 the newness might be that you've reduced 13 something. You've introduced a reduction of 14 something, but it's just a little odd but it's 15 fine. 16 Q In both cases the word impose and the word 17 introduce, they appear in your declaration, 18 correct? 19 A Yes. 20 Q Okay, great. We've talked about ITD and 21 the D stands for difference, correct. 22 A Yes, I believe so. I can't remember all

141 1 the acronyms. I remember the concepts, but yes, I 2 believe so. 3 Q Have you heard the word delay in the 4 context of audio processing? 5 A Of course. 6 Q What does it mean to you? 7 A It would depend on the context. It could 8 mean a lot of different things, but it would have 9 in audio generally I think, again, it depends on 10 the context, the plain and ordinary meaning of 11 something being delayed. It is arrives maybe 12 later than it was transmitted, for example, or 13 arrives it in one place and arrive someplace after 14 that so one might say that the second -- the 15 arrival at the second place is delayed or a 16 delayed receipt of the thing that was received at 17 the first place. 18 Is that what you're looking for? It's 19 just delay in the plain and ordinary English. 20 Q Let me clarify. 21 Is delay a audio effect? 22 MR. HENRY: Objection to form.	143 1 return took longer. So it is a crude way to 2 simulate echo or reverberation. It can -- that 3 can be one thing that's related to what you asked 4 I believe. 5 BY MR. RAFATIJO: 6 Q Are you aware of the sound effects that 7 are used to guide human ears to detect the 8 placement of sound sources? 9 MR. HENRY: Objection to form. 10 BY THE WITNESS: 11 A I'm not sure what you mean by sound 12 effects. When I use those words, those words said 13 it generally to a person in my field would mean a 14 intentional manipulation of the sound to produce 15 some effect. So I'm not sure exactly what you're 16 asking. Could you reask it? 17 BY MR. NEWTON: 18 Q Sure. Can I give you an example. 19 Suppose you are manipulating the volume of 20 a sound to create a perception that the sound 21 source is farther away from the listener. 22 Would that be a sound effect?
142 1 BY THE WITNESS: 2 A The word delay is very broad. So to ask 3 is is delay an audio effect? I mean, delay is not 4 inherently an audio effect people talk about and 5 you can certainly create delays in audio in a 6 variety of different ways. 7 BY MR. RAFATIJO: 8 Q Is delay referring to a technique that 9 takes an audio track and plays a duplicate of it 10 to create echo? 11 MR. HENRY: Objection to form, lacks 12 foundation. 13 BY THE WITNESS: 14 A One could simulate an echo or reverb 15 crudely as I can remember even from high school 16 musical instrument reverb units or delay units by 17 replicating a signal with a time delay and 18 probably an amplitude attenuation. 19 So it's a crude way to approximate sound 20 bouncing off a first surface and then a second 21 surface and maybe a third surface, and presumably 22 those surfaces are farther away because the sound	144 1 A I suppose one could call it a sound effect 2 in some context where it was clear that that is 3 what was meant by that word. You could call it 4 sound attenuation, you could call it sound 5 manipulation, you could call it all sorts of 6 things in the context of whatever it is you're 7 doing, and a person of ordinary skill would 8 probably understand what it is you're saying. 9 There's no universal meaning as I've said before 10 for all the other terms for sound effect and what 11 exactly that means and what is and isn't a sound 12 effect. It's just the two English words put 13 together to describe an effect on the sound 14 essentially. 15 Q Sure. Let me continue with more 16 specificity. Relative volume, like if I play -- 17 (undiscernible) would the volume of a sound, I 18 might be able to create a perception that this 19 sound originates from a source that may be farther 20 away from the user than the actual sound source? 21 A I'm sorry. Was that a question? 22 Q Yes.

145 1 A Could you repeat it. I didn't get a 2 question out of that. I'm sorry if I missed it. 3 MR. RAFATIJO: Sure. Can the court 4 reporter please read back the question. 5 (The record was read by the reporter.) 6 BY MR. RAFATIJO: 7 Q Might I be able to create that effect? 8 MR. HENRY: Objection to form. 9 BY THE WITNESS: 10 A I'm just puzzled. I'm sorry. I'm 11 confused. Are you asking could you create the 12 effect, could you attenuate the sound? Of course 13 you could. Anybody could do that. Is that what 14 you're asking? 15 BY MR. RAFATIJO: 16 Q Would that attenuation cause the user to 17 perceive the sound at a different location than 18 the actual sound source? 19 MR. HENRY: Objection to form. 20 BY THE WITNESS: 21 A Presumed in that question is that the 22 sound -- I'm trying to understand your question,	147 1 changes. Just some very particular ones. 2 Q Are you familiar with cone of confusion? 3 A Yes. I'm familiar with that concept. 4 Q So what is it? 5 A The way I've seen that generally used and 6 referred to has to do with whether a sound is 7 perceived as being in front of or behind you. 8 Their inability to determine based on what you're 9 hearing whether the sound or the object emitting 10 the sound is in front of you or behind you. 11 Q If the sound is right in front of you, 12 what would be the value of ITD for that sound? 13 MR. HENRY: Objection to form. 14 BY THE WITNESS: 15 A Saying the value of ITD is odd. ITD is 16 not something you add and you make a decision 17 about whether it's valuable or not. There are 18 delays even for something that was right in front 19 of you. Your right ear, for example, might be 20 shaped a little differently than your left ear. I 21 think most of us don't have symmetric ears much to 22 our chagrin. And so it could well be that there
146 1 the sound is -- in your hypothetical, the sound -- 2 there is a universe in which the sound sounded 3 correct or was perceived at its correct location, 4 and are you asking if you simply reduced the 5 amplitude of that signal overall if someone would 6 perceive it at a different location? 7 BY MR. RAFATIJO: 8 Q Yes. 9 A I would say likely yes, it would depend on 10 a lot of things, how much attenuation and where 11 the sound was, the spectral component of the 12 sound. It would depend on a bunch of things. 13 Again, as I've said before, if there were visuals 14 accompanying this, that can be a very powerful cue 15 to something. So sometimes when there are visuals 16 involved, one can get away with, in air quotes, 17 one can achieve a perception of something crudely 18 through a mechanism, for example, maybe like 19 attenuating the volume of something under some 20 circumstances. 21 Volume attenuation itself wouldn't work 22 for -- wouldn't be matched to all sorts of spatial	148 1 is some spectral component of a sound that was in 2 front of me that has a different phase shift or a 3 different latency as sound is transformed around 4 my head and into my ears. There could be things 5 in the room that are affecting that. So there are 6 things -- 7 Q Sorry to interrupt. Go ahead. 8 A There are things that would give rise to 9 that delay. I don't know what value -- what you 10 were talking about when you said something about 11 value of that. 12 Q If I ask you I have a sound of an ITD 13 equals zero, where would you place that sound 14 around yourself? 15 A It probably depends on the sound and it 16 depends on what you're presenting to me visually, 17 but generally I think people would hear that, 18 would perceive it as somewhere like in the middle 19 of their head. It would have no -- no real 20 location. 21 Q So a sound that is right in front of the 22 listener or the sound that is right behind the

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149 1 listener, would that sound have ITD equals zero? 2 MR. HENRY: Objection to form, incomplete 3 hypothetical. 4 BY THE WITNESS: 5 A So I thought I just answered that. I 6 don't know what -- zero is a very precise number. 7 Very few things ever have zero, and so it would be 8 very unlikely that you would have zero delay no 9 matter what you did. There's also -- delay isn't 10 a single -- isn't a single parameter when you're 11 talking about a nonsinusoidal more complex sound. 12 There are components to the sound, different 13 frequency components, if it's someone talking or 14 it's your guitar player or it's the dog barking, 15 all of those spectral -- the frequency spectrum, 16 the signal which has all of these frequently 17 components, this energy, is going -- bouncing off 18 my ear through my inner ear, and, again, my left 19 and my right ear are different. So some 20 components of that spectral energy will be phase 21 shifted, maybe a little more than other 22 components. So the temporal, time domain phase	151 1 record. The time is 2:06 p.m. 2 BY MR. RAFATIJO: 3 Q Dr. Welch, I was about -- I don't know if 4 you heard my question when I froze up, but my 5 question was whether an ITD could help a listener 6 to determine whether the sound is emitting from 7 front or behind the listener? 8 A So, again, it's a weird hypothetical 9 question because ITD is not something you add to 10 help something. The delay is a measure of 11 something, and, again, it's frequency dependent. 12 It's not just a single number. It's something -- 13 it's a characteristic of the signal that is 14 arriving at your ears from a particular place, 15 each of your two ears. 16 So you're asking about what sounds to me 17 like injecting or adding or somehow introducing, 18 there's that word, a delay and would that help 19 somebody determine if something was in front of 20 him or behind them. Do I have that right? 21 BY MR. RAFATIJO: 22 Q What I asked you what is the cone of
150 1 shift of things is going to be frequency 2 dependent. It's not just a single number. People 3 often talk about the delay as a single number, but 4 in real, complex signals, it's not a single 5 number. It would be a function. It would be like 6 the phase -- the phase component, the imaginary 7 component of a power spectrum. So zero? No, I 8 doubt it. Small? Yes. And, again, it's not a 9 single number. It's a complex function. 10 Q So can you -- hello? 11 MR. KUHN: Are you on the phone? What 12 just happened? 13 MR. HENRY: Should we go off the record, 14 Counsel? 15 MR. RAFATIJO: Can anyone hear me? Hello? 16 THE WITNESS: Yes. 17 MR. HENRY: Why don't we go off the 18 record. He can't hear us obviously. 19 THE VIDEOGRAPHER: Stand by. Going off 20 the video record. The time is 1:56 p.m. 21 (A recess was had.) 22 THE VIDEOGRAPHER: We're back on the video	152 1 confusion, you said the inability to distinguish 2 sound sources in the front and sound sources in 3 the back. 4 I'm asking whether ITD can be used to help 5 the listener distinguish between the two 6 scenarios? 7 A Again, it's your phrasing of ITD can be 8 used. ITD isn't used by anyone. It's not added. 9 It's not something you introduce to do something. 10 It is a feature or characteristic of the sound. 11 So it's very likely that -- of course -- first of 12 all, ITD is a very rough -- I'll say very rough 13 term because, again, it implies or says a single 14 number when the sounds -- the wavefronts in my ear 15 is complex signal with both magnitude and phase in 16 the spectral domain. So it's got delays that are 17 frequency dependent, not just one delay, but they 18 are dependent on the frequency. So there is a 19 component of a person's perception about where 20 something is that is impacted by that phase shift 21 of the signal as it arrives at each ear. So it's 22 not a single number. Could -- I think maybe where

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153 1 you're going maybe is if I had the same sound in 2 front and the same sound at exactly the same 3 position but just like flipping the sign, if you 4 will, negative distance, would there be a 5 difference, would I be able – would there be a 6 difference in the time delay function, let's say, 7 the phase in the spectral domain? And the answer 8 is there might be. It would depend again on the 9 shape of the ear and depend on how that delay was 10 manifested as a function of the frequency of the 11 sound across the whole spectrum because, again, 12 it's not just a single delay. 13 So I don't know what you're saying 14 because, again, it's not like I introduce a delay. 15 You don't say I'm going to delay this 10 16 milliseconds in the hope that it will help 17 somebody perceive something in a different place. 18 It's that you produce something and the effect of 19 that is the 10 millisecond difference at let's say 20 a particular frequency, something like that. 21 So the question is a little odd for me. I 22 don't know if I'm answering it.	155 1 front. So the sound in practice would be 2 encountering different physical or mechanical 3 circumstances. 4 Your ear looks different, if you will, in 5 air quotes, or has different transfer function for 6 sounds coming from the rear than it does for 7 sounds coming from the front. So those transfer 8 functions would not be identical. The phase 9 component of those transfer functions will not be 10 identical. Would they be at some very crude level 11 like if you said, for example, the maximum across 12 the spectrum or something like that, they would 13 probably be very comparable. Would someone be 14 able to tell the difference? It depends on a lot 15 of things. 16 Q The difference in the ITD in the two 17 scenarios when the sound is in front of you and 18 the same sound, same frequency behind you, the 19 difference in the ITD in the two scenarios, would 20 that help the user or the listener to distinguish 21 front and behind? 22 A So if this was binaural audio and there
154 1 Q Sure. So I understand that the ears, the 2 shape of the ears are not symmetric but for a 3 sound that is in a positive distance let's say 4 five meter right in front of the listener and a 5 sound that is negative distance, five meter behind 6 the listener, would the ITD be the same? I'm not 7 saying zero but would the ITD be the same in the 8 two scenarios? 9 A So once again, ITD is a phrase that people 10 use that's kind of a crude phrase. I would have a 11 hard time talking about that in this example you 12 just gave because, once again, the actual delays 13 are a function of frequency. There isn't just one 14 ITD. It's actually a function of frequency, and 15 the shape of the ear will affect the perceived 16 delay because the sound wave from the front is 17 going to hit the back of my ear first, for 18 example, perhaps and then bounce to the front of 19 my ear and then the back again and front again and 20 back and forth in there. The sound that was 21 coming from the rear would hit the front of my ear 22 first then perhaps the back and then perhaps the	156 1 was a sound that was synthesized from the front 2 and a sound that was synthesized from the rear, 3 certainly the phase component of the resulting 4 signal that is being played in my ears is a 5 factor. It certainly has a role as does 6 everything that is transformed in the application 7 of the HRTF to the incoming signal. It's changing 8 the phase across the spectrum. It's changing the 9 magnitude across the spectrum. So it's changing 10 all of those things, and they are certainly 11 different in the front and in the rear. There is 12 no single delay at the signal level. 13 If you want to talk about a single like a 14 beep, like an impulse, we could imagine the 15 infinitely brief impulse function although now as 16 soon as I'm saying that I realize that that 17 doesn't work, either. 18 So I keep coming back to you keep asking 19 about ITD and I keep saying that if I'm 20 understanding your hypothetical, there is no 21 single number. There is a phase component to the 22 sound that is coming from the rear or the front,

157 1 that phase component would I think, certainly 2 could and might even likely be a little different 3 in the front than it is in the rear and could a 4 person make a correct perceptual judgment, correct 5 meaning more likely than not to perceive it in the 6 right hemisphere, front or rear. It certainly 7 would have some component. But, again, it's not 8 that one thing. You can't ask about that one 9 thing. It's a combination of several factors. 10 Q But did you not establish that if it's in 11 the front that would fall under the cone of 12 confusion, the user cannot be able to distinguish 13 the two? 14 MR. HENRY: Objection to form. 15 BY THE WITNESS: 16 A We're talking about two different things. 17 The cone of confusion, in quotes, is a very 18 casual, a very nontechnical phrase that people use 19 to describe roughly these region within which it's 20 difficult to perceive whether something might be 21 in front or in back. Of course, even that depends 22 on the type of sound, it depends on all sorts of	159 1 past. 2 Q You used Dr. Begault's reference book for 3 this proceeding. Would that be your reason for 4 doing so? Was there a reason for using 5 Dr. Begault's book? 6 A It just happens to be a very good 7 reference with a lot of information in it. No 8 reference is perfect. But it on balance compared 9 to other things that I looked at it seemed to have 10 the things that were important to me and it just 11 so happens seems to have a lot. 12 MR. RAFATIJO: Can we pull up Exhibit 11 13 stamped and circulated. Thank you. 14 (A certain document was marked Welch 15 Deposition Exhibit 11 for identification, 16 as of 05/03/2024.) 17 MR. HENRY: Counsel by my count I'm up to 18 Exhibit 9 and this went to Exhibit 11. Are you 19 going to circle back to 10 or is there a 10? 20 MR. RAFATIJO: Yes, it's going to be 21 Exhibit 10, but I'll introduce it later. 22 MR. HENRY: So 10 is coming later, this is
158 1 other things, the environment, the shape of the 2 environment. It's just a very general, very crude 3 way to capture possibility, maybe even likelihood 4 that things that are in front and back without 5 appropriate binauralization are difficult to 6 perceive in the correct hemisphere. 7 The question you're asking is much more 8 precise in my -- the way I read it as an expert 9 right here -- about some numerical differences. 10 That's a very -- that's something I can't compare 11 with this very crude motion of a cone of silence 12 or cone of silence -- cone of confusion. 13 Q Dr. Welch, do you know Dr. Begault? 14 A Personally I do not know him. I don't 15 think we've ever met. 16 Q Are you familiar with his works besides 17 and apart from these proceedings? 18 A I feel like I might have actually come 19 across, yes, some of his work I'm quite certain I 20 have seen it in the past in reading various things 21 for various reasons. I don't have a concrete 22 memory of that, but I have seen his work in the	160 1 11. Got it. 2 MR. RAFATIJO: Yes. For the Planet Depos, 3 we go to Page 41 of the book, Page 51 of the 4 document. 5 BY MR. RAFATIJO: 6 Q Dr. Welch, let me know, please, whenever 7 you have it downloaded and opened. 8 A Will do. I am having a problem with the 9 download. I'm having a problem with the download. 10 Just give me a moment. 11 MR. RAFATIJO: What's the time on the 12 record? 13 THE VIDEOGRAPHER: The time is three hours 14 and 20 minutes. 15 THE WITNESS: I'm still waiting for it to 16 download. For some reason it's slow. I think I 17 have it. One moment. Okay. I have it in front 18 of me. Thank you. 19 BY MR. RAFATIJO: 20 Q Sure. I'd like for you to read the 21 sentence on starting on Line 2. 22 A Line 2 of what page?

161 1 Q Oh, yes, Page 41 of the book. Actually 2 let's start with the first full paragraph, Page 41 3 of the book, Page 51 of the document. 4 A I see a section titled: The Head-Related 5 Transfer Function. 6 Is that what you're referring to? 7 Q Well, no. I'm talking about -- well, yes. 8 Above that the very first paragraph, "in fact," 9 starting with "in fact," above the Figure 2.8., 10 would you please read that first full sentence. 11 A Begin with "in fact"? 12 Q Yes. 13 A So the first full sentence of the book's 14 Page 41 of Exhibit 11 reads: "In fact, identical 15 values of ITD and IID can be calculated for a 16 sound source in a space anywhere on a conical 17 surface extending out from the ear (see 18 Figure 2.8) which is the figure below." It goes 19 on to say -- oh, I guess that's the end. Sorry, 20 you just wanted the first sentence. Okay. 21 Q Do you agree with this sentence? 22 A Well, I agree that something of value you	163 1 other distinguishing characteristic and no other 2 information that you have, then, of course, you 3 won't be able to understand where it is. So it's 4 a helpful simplified diagram and concept. 5 Q The next sentence says: "This is called 6 the cone of confusion in the literature". 7 Do you see that that? 8 A Yes. 9 Q So apparently there is this concept in the 10 literature, it's not being used in a colloquial 11 sense, at least according to Dr. Begault, correct? 12 MR. HENRY: Objection to form 13 argumentative. 14 BY THE WITNESS: 15 A No. I disagree. I don't know what makes 16 you say that. Nothing here makes me change what 17 I'm saying. It's an English phrase to refer to 18 this general concept as I said a moment ago 19 unobservability of a signal source in this 20 location in this very simplified world so nothing 21 in the real world is exactly what's shown here and 22 the cone is not a single cone. The cone is a
162 1 would call ITD and the value would call IID can be 2 calculated for let's just say a purely sinusoidal 3 waveform. 4 I would not agree and I don't think 5 Dr. Begault would agree that if you ask about the 6 spectral component of the phase of a complex 7 signal in any of those places that there is one 8 that ITD or one IID associated with that signal. 9 So this is a very kind of an abstract or 10 simplified representation of what in signal 11 processing one might call the or could call the 12 unobservability of the location of the sound 13 because in this simple, noncomplex frequency 14 example, the measures that you get perceptually in 15 your ear in the simplified diagram or simplified 16 example here are the same at any location around 17 the circle at the base of any cone in any distance 18 from your ear. 19 So in that very simplified world if the 20 time for each of the sound anyplace around that 21 base of that cone or around the circle, if the 22 time to reach your ear is the same and there's no	164 1 concept of a cone emanating from someone's ear and 2 sounds being on the same plane at some orthogonal 3 distance from your ear and around a circle, 4 certain described round that plane, around the 5 center of the cone. So it's still a very notional 6 thing. I can't imagine Dr. Begault would disagree 7 with that. It doesn't mean it's not valuable. It 8 doesn't mean that it's flawed. It just means it's 9 not a -- it doesn't have a precise utility when it 10 comes to asking questions about specific signals 11 emanating from particular places in a room. 12 Q But the cone of confusion is a concept 13 found in the literature, that's all I'm asking, at 14 least according to Dr. Begault? 15 A Well, sure. 16 Q Okay. 17 A Oh, for sure. 18 Q So this is not some colloquial term used 19 by laymen who are not expert in the field? 20 MR. HENRY: Objection. Form, calls for 21 speculation. 22 BY THE WITNESS:

165 1 A So we could argue all day about what's 2 colloquial or not and it doesn't really matter. 3 I'm simply saying it's not a -- it's a 4 notional or conceptual thing. It's not a really 5 precisely mathematical thing that you can use to 6 do something. Is it a term, a phrase that people 7 use, absolutely. It's a very useful term in 8 teaching, for example, somebody who doesn't 9 already understand that things with similar 10 distance in different places under similar 11 circumstances might sound just the same so you 12 might not be able to distinguish the location of a 13 sound because it sounds just like your perception 14 of it is the same as it is in some other place. 15 It's not a real thing, but it's a notional thing 16 that is useful for teaching and understanding 17 things. 18 BY MR. RAFATIJO: 19 Q Line 4 towards the end, this ability to, 20 would you please read the full sentence into the 21 record? 22 A I believe what you're looking for begins:	167 1 Q Reading this sentence, does it not say ITD 2 and ILD would not supply this information, do you 3 see that this sentence says that, ITD and ILD -- 4 A Yes. 5 Q Okay. And by this information, what does 6 it mean? Where does this information refer to? 7 The term information? 8 A I believe -- I believe when Begault says 9 the ability to disambiguate sources from front to 10 back or from above and below in cases where ITD 11 and IID would not supply this information, the 12 "this information" I believe is referring to the 13 location and in the figure it would be like is the 14 source at X, B, V or A. 15 Q Do you agree that ITD and ILD would not 16 supplies this information? 17 MR. HENRY: Objection to form. The 18 document speaks for itself. 19 BY THE WITNESS: 20 A I would not -- I would quibble with the 21 way you said it, and I would quibble to some 22 extent but not like -- I would quibble with
166 1 "The ability to disambiguate sources" -- 2 Q Yes. 3 A I'll start again. 4 "The ability to disambiguate sources from 5 front to back or from above and below in cases 6 where ITD and IID would not ply this information 7 has brought about hypotheses regarding the role of 8 spectral cues and localization." 9 BY MR. RAFATIJO: 10 Q Do you agree with this sentence? 11 A I don't know how I can agree with 12 something has brought about hypotheses regarding 13 the role of something. I mean, I would have to go 14 look in the literature and see if there were 15 expressed hypotheses about that. 16 Generally if you ask me if I would 17 hypothesize that or if I would agree or disagree, 18 agree is too strong, if I would consider that 19 there might be some validity to any hypothetical 20 hypothesis that it's referring to I would say yes 21 and I would say that is exactly what I was saying 22 to you a few moments ago, a few minutes ago.	168 1 Dr. Begault and I don't think he would disagree if 2 I explained my quibbling with him about that 3 wording. I don't think he would disagree. So 4 it's not a show stopper. It's not like you agree 5 with it or disagree with it. It's just words are 6 imperfect. There is no perfect book. There is 7 no, you know, accepted biblical reference for all 8 of audio and so looking at any of these words and 9 any of these books anything I wrote, God knows 10 probably everything I write has imperfections in 11 it in some ways, so and you don't get to go back 12 and change wording. 13 This is really mixing as I've tried to say 14 repeatedly two things, a very crude -- I'm 15 searching for the right words -- a single number 16 that I'm calling the ITD and then talking about 17 spectral cues which don't have -- there is no 18 single number that corresponds to the spectra for 19 that signal. 20 It might be that he's talking about the 21 frequency component, but when I talk about 22 spectral cues or a person who does signal

169 1 processing, you would be talking about the 2 complete spectrum. So the magnitudes and phases 3 at all frequencies and those phases are what give 4 rise to frequency dependent delays in the time 5 domain. 6 So you're talking about something that has 7 many delays I guess if you want to think about it, 8 many components of signals or components of 9 signals being shifted a little bit in time, and 10 you're talking about comparing that or discussing 11 that in the context of a single number and it just 12 doesn't quite make sense, but I get it. I'm just 13 saying the words one cannot -- I cannot answer 14 your question in some definitive way because the 15 words don't match, but I certainly get 16 what Begault is saying here. I understand it and 17 I think anybody in the art who read this would 18 understand it. 19 BY MR. RAFATIJO: 20 Q For a single frequency impulse, I want to 21 just take out from the equation, the frequency 22 dependent concept of ITD, for a single frequency	171 1 the inside of the ear, exactly what the delay was 2 for that waveform as it arrives at the ear, then 3 it is more plausible to say because then there 4 really is a single delay because we're talking 5 about one frequency, one signal, not a complex 6 sound, and that one signal under fixed conditions 7 is going to have a particular delay. It still 8 might be a little different from A and B or X and 9 V it in the diagram depending on the shape of the 10 ear, there might still be a difference, but 11 generally very roughly the delays of that single 12 beautiful sign wave, the phase delay would be the 13 same, very -- to a perceptible difference 14 probably. 15 So, again, this is a useful illustrative 16 diagram that's trying to convey the notion that 17 under certain geometric circumstances such as on 18 this base of this cone for different size cones in 19 different diameter, different radius cones, the 20 location is unobservable. 21 A better practical example that is more 22 sort of pure is that of like GPS navigation. You
170 1 impulse, would you say that ITD does not supply 2 information to disambiguate sources from front to 3 back? 4 MR. HENRY: Objection to form, incomplete 5 hypothetical. 6 BY THE WITNESS: 7 A So a single impulse I think you would say 8 that I started to say that before but I stopped 9 myself because I realized in the moment it wasn't 10 the right example. It's hard to come up with 11 examples on the fly, but a single impulse in a 12 signal processing sense would correspond to a 13 constant frequency -- I'm sorry, constant 14 magnitude in the frequency domain would be all 15 frequencies effectively if we're talking about 16 purely an impulse. So it would have lots of -- a 17 nontrivial spectrum. So I don't think you can 18 talk about that. If you wanted to, for example, 19 say I had a sign wave, a pure sign wave at a 20 particular location, and I knew the frequency, 21 therefore, I knew the period and I knew the phase 22 shift, I knew when every waveform was arriving at	172 1 can get to places where the satellite signals 2 coming to you that you have all have the same 3 timing and so you don't know where you are 4 exactly. You could be on a circle, for example, 5 that just like this that represents all possible 6 solutions to the delay you are seeing from those 7 two source. Any point on that circle, that grade 8 circle it's called would in the GPS sense which is 9 more -- which doesn't have a problem with ear 10 shape and all those things, they would all give 11 you the same value. So you cannot observe where 12 you are because you could be anywhere on that 13 circle around the earth. This is the same 14 concept. You can't determine where X, A, B and V 15 are generally. If the only -- somehow magically 16 the only component of what you were perceiving was 17 a phase delay component and there was no spectral 18 component, it's very possible you would not be 19 able to perceive and generally you would not be 20 able to perceive which was which location, that's 21 all Begault is saying here. Begault is saying 22 that the shape of the magnitudes of the frequency,

173 1 that spectral cue I think that's what he means, so 2 the filtering, so higher frequencies appearing 3 more prominent in, say, X and less prominent in V, 4 those could play a role in a person's ability to 5 distinguish something that isn't at X or V, 6 different opposite ends of the circle, and as I 7 was saying a moment ago, the reason those could be 8 different is because the shape of my ear might 9 filter the signal differently depending on whether 10 it's coming from X or coming from V down below. 11 That's all Begault is saying. 12 Q Can we pull up Exhibit 3. Page 60, 13 Paragraph 105. 14 A Okay. I have that open. 15 Q So the first sentence you are talking 16 about sound localization? 17 A Correct. 18 Q That it is an important aspect of creating 19 an immersive AR or VR experience. Do you see 20 that? 21 A I do. You mostly read I think the latter 22 part of the sentence.	175 1 don't remember what it is. I've heard of it. 2 Q So what is it? 3 A I just said I don't remember what it 4 means. I've heard of it. I don't remember what 5 it means. 6 Q Have you heard the term lateralization? 7 A I've heard that term in different 8 contexts. So I don't recall whether I've heard it 9 in the context of sound localization or not. I 10 don't remember. I mean, I probably have, but I'm 11 sure I could understand what it means, but I don't 12 recall off the top of my head that I have 13 encountered that recently. 14 Q So what is sound externalization? 15 A Again, you're asking a question as if 16 there is a single definitive definition of what 17 something like that means. So to a person of 18 ordinary skill, it would mean to place the sound 19 somewhere external to the user. Generally that's 20 what it would mean. 21 Q Would that be localizing the sound at a 22 position outside the head of the user?
174 1 Q Sure. Would you please describe what is 2 sound localization? 3 A The point at which the sound is perceived 4 as having originated from very generally, that's 5 what that would mean in this case, so in an AR/VR 6 experience as it's describing here if I saw the 7 dog in front of me but the dog barking appeared to 8 come from a difference place and worse I saw the 9 dog's mouth opening and closing in a way that 10 matched what I'm hearing, but what I'm hearing 11 sounded to me or I perceived it as coming from one 12 place, say to the left, and visually I saw the dog 13 to the right, that would generally be something 14 that would not be helpful to this concept, this 15 very qualitative concept of immersion. 16 Q Are you familiar with in-head 17 localization? 18 A I've heard that term. I don't remember -- 19 I have encountered it and I remember that term. I 20 don't remember offhand what it means. I don't 21 know if I wrote about it in here somewhere, I'd 22 have to go back, but off the top of my head I	176 1 A If I understood your question, I believe 2 the answer is -- would be yes, I talk about this a 3 little bit. There's a quote I see at the end of 4 Paragraph 107 from Exhibit 1107 which is Z-h-o-u, 5 Zhou. 6 Q One question before I get to that 7 paragraph, how can you externalize the sound? 8 A It depends on what you mean precisely by 9 externalize the sound. If you mean somewhere 10 external to me, around me it's everything we've 11 been talking about for quite some time now, the 12 HRTF that would be the most common way you'd know 13 where you want to externalize that sound and you'd 14 know where the person who is supposed to perceive 15 it is positioned and oriented. You would know 16 where their ears are and then you would compute 17 the modified signal that you're trying to 18 externalize and present that through some sound 19 transducer, speaker, headphones, near their ears, 20 as close to the inner ear as possible, and that's 21 what would do that. 22 Q Great. So let's pull up Exhibit 6.

177 1 Column 29, Page 32, column 29. 2 A Okay. 3 Q Line 27 to 40. 4 A Okay. I see it. It looks like a full 5 paragraph. 6 Q Yes. Would you please read it to 7 yourself. 8 A Okay. 9 Q In Line 36, do you see it says: Localize 10 to the SLP that is away from but proximate to 11 hair? 12 A The question is do I see that, yes, I see 13 that. 14 Q Yes. So and then it says the next 15 sentence: This external localization notifies her 16 that this location will be used as the SIP for 17 Bob's voice. 18 "This location" refers to what? 19 A First of all, I remember this because I 20 read the patents a lot. I remember this passage, 21 the words it uses in terms of, what does it say, 22 it says the external localization notifies her --	179 1 saying is that she hears -- I believe what this is 2 saying Alice hears Bob's voice and from then on 3 she I guess functions or proceeds with the 4 assumption that that's where Bob's voice is going 5 to be for the rest of the conversation. 6 That doesn't seem very magical to me. It 7 just seems very -- I mean, it's hard to imagine 8 Alice would think that Bob's voice was going to 9 move around. So I didn't quite understand that, 10 but, at any rate, that's all it's saying I 11 believe. 12 Q Does this mean that Alice would hear Bob's 13 voice as if it originates from a location away 14 from or proximate to Alice? 15 A So to give you a definitive answer, I 16 would want to spend more time looking at this, but 17 I believe what you said is correct, that she -- 18 her phone application selects this point in space 19 that it found, that it has HRTF, has HRTFs for, 20 has information about, that's relevant to the 21 location, the geometric relationship and maybe 22 some other circumstances, but it's obviously it's
178 1 I don't know what notifies her means. I've 2 wondered that when I read this before. To me 3 notifies would mean like a message pops up or 4 something alerts me to this is where Bob is going 5 to be. So I'm not sure what that means. I think 6 maybe it means that you perceive it from a 7 location and that is I guess what the inventors 8 are saying is in this hypothetical Bob-and-Alice 9 conversation, that Alice because she hears Bob's 10 voice coming from a particular place that she will 11 proceed under the assumption that Bob's voice will 12 always come from that location although it really 13 isn't true given the first part of the -- it isn't 14 true in terms of like where she is. 15 So the first part it's talking about her 16 being in her kitchen, at her kitchen table wearing 17 headphones and her phone checks GPS location and 18 finds an SLP record that corresponds to Bob and 19 her location in the kitchen table so she could be 20 somewhere else and the may be no SLP record or 21 maybe a different SLP record or maybe a different 22 thing, but under those circumstances all this is	180 1 not going to be the exact one but it finds 2 something close and so it's going to use that and 3 so whatever that does, that externalization to 4 whatever place she perceives it which will be 5 proximal to her. So it's not going to be distal. 6 It's going to be somewhere close, I guess; of 7 course that would depend on the SLP that came 8 back, so in this case it's proximal across the 9 table so that seems to be sort of arms length, 10 which generally someone would refer to as being 11 proximal. 12 Q So would that mean that Alice is able to 13 hear Bob's voice binaurally? 14 A I believe that is what that is saying. 15 That's exactly what that is saying. Her 16 application and it even says in the middle of the 17 paragraph Line 33 maybe, a binaural phone 18 application executing in her phone, meaning 19 Alice's phone, selects this SLP to convolve the 20 call with Bob. So that's exactly what it's doing. 21 It's creating binaural audio for her that gives 22 her the perception that Bob is at the location

181 1 that corresponds to the SLP record that the system 2 found. 3 Q Awesome. Let's look at Figure 13 in this 4 patent. Yes. Are you there, Dr. Welch? 5 A One moment. 6 Q Sure. 7 A Okay. I'm at Figure 13. 8 Q Do you see those cubes around the 9 listener? 10 A I do see cubes located sort of within a 11 solid angle of a sphere about the listener, I see 12 small boxes, small cubes. 13 Q Are those SLPs? 14 A My memory says yes and my looking at the 15 patent also says the same. I see in Column 28, 16 Line 19 through 22 says "Figure 13 shows a person, 17 1300, sitting in a share, 1310, at a table, 1320, 18 and being surrounded by a plurality of SLPs, 1330, 19 illustrated as square blocks located away from but 20 proximate to his face. 21 Q So are these SLPs external to the user? 22 A Again, these words don't have a universal	183 1 speaking with me, right, how would you perceive 2 your own voice? 3 MR. HENRY: Objection to form. 4 BY MR. RAFATIJO: 5 Q Well, does your voice originate from 6 inside your head when you're talking to me? 7 A That is a question better answered by 8 someone who is an expert in human perception. I 9 know a lot about human perception. I couldn't 10 definitively say that, but I believe the answer is 11 yes, but I also will say as I said in other 12 instances, I think a lot of that depends on the 13 circumstances. What I hear is conditioned by 14 what's around me. As I speak right now my voice 15 is bouncing off the monitor in front of me and 16 coming back to my ears so I'm hearing through the 17 bones in my head. I'm hearing through all of the 18 nerves. I'm the one speaking. I know what's 19 going on. I know cognitively that I, Greg, am the 20 one speaking that I know my mouth is in my head so 21 there's a lot going on there, but generally I 22 think people perceive their voice as coming from
182 1 meaning but, yes. I would say they are certainly 2 not in the user. They are points that appear in 3 front of and around the user so I would consider 4 that external to the user, yes. 5 Q To localize sound to any of these SLPs 6 does the user need to convolve the sound HRTF or 7 binaural HRTF? 8 MR. HENRY: Objection to form. 9 BY THE WITNESS: 10 A Generally, I don't -- I think I understand 11 the basics of your question. 12 The user doesn't necessarily need to do 13 anything, but something needs to do that. 14 Something needs to take the sound source and 15 convolve the function. The application of the 16 HRTF would involve the convolution, so do the 17 convolution to produce the signal that when played 18 in the earphones 1370 of that user 1300 would 19 sound as if it is emanating from the corresponding 20 little square block. 21 Q Sure. One last question before I take a 22 break because I really need to, suppose now you're	184 1 them. So is it in your head, in front of your 2 mouth, inside, somewhere around there. I don't 3 know that anybody could make a precise judgment 4 about where exactly that is perceived. Again, 5 it's a human perception thing so it's very 6 qualitative. 7 Q But it's not external to you meaning it's 8 not like you don't hear it from five meters away 9 from you or two meters away from you? 10 A I would say generally no unless someone 11 took my voice and convolved it with or applied a 12 HRTF from one of those boxes from somewhere and 13 played it back to me, in which case maybe that 14 would dominate my perception of where my voice was 15 coming from, which would be a very weird 16 experience to talk and have my voice seeming to 17 come from another location, but short of that just 18 me speaking, no, I would not consider it to be 19 externalized. 20 Again, I think I have to think about this 21 more if it really mattered, but you said speaking 22 between us. So just in the most general sense

185 1 away from any particular patent or claims or 2 anything else, I think that would not be 3 considered external. 4 MR. RAFATIJO: Awesome. Can we take a 5 break. 6 MR. HENRY: Sure. Let's go off the 7 record. 8 MR. RAFATIJO: Yes. 9 THE VIDEOGRAPHER: Stand by. Going off 10 the video record. The time is 2:54 p.m. 11 (A recess was had.) 12 THE VIDEOGRAPHER: We are back on the 13 video record. The time is 3:06 p.m. 14 BY MR. RAFATIJO: 15 Q Welcome back, Dr. Welch. 16 A Thank you. 17 Q So can we pull up Exhibit 6, Figure 13 18 again. 19 A Okay. Sorry, I see it. 20 Q Sure. So these SLPs represent locations 21 in the empty space in a room proximate to the 22 user, correct?	187 1 location in the real world at which sound can be 2 localized? 3 A I'm not sure what you mean in the real 4 world. They are in -- they have 3D coordinates. 5 Is that what you're asking? 6 Q Yes. 7 A Did I answer the question? I thought I 8 answered the question. 9 Q I said yes. I didn't hear your answer. 10 A I asked if what you meant they had 3D 11 coordinates and you said yes. They have 3D 12 coordinates if that answers your question. 13 Q These are the 3D coordinates, these points 14 represents points in the space, correct? 15 A It depends what you mean by the space. 16 They certainly represent coordinates in some 17 Euclidian space or they could be represented I 18 should say. They could be, yeah, represented as 19 positioned at some coordinates in some Euclidian 20 space. 21 Q Would that be a physical space around the 22 listener?
186 1 A It sounds like you were just reading 2 something from the patent. 3 In the most general sense, I think I might 4 not disagree if it matters in terms of the words 5 you used and how those would be used in this 6 matter, I would want to look more carefully. 7 Q Sure. 8 A But generally if I've followed the whole 9 thing, they are proximal to the user and they are 10 external. Is that what you were asking? 11 Q Yes. 12 A Okay. 13 Q It's just a question that I asked before 14 we went for the break. I wanted to refresh your 15 memory. And you said you reviewed Column 28, 16 Lines 19 to 22 if you remember. But you can feel 17 free if you want to reread it, please. 18 A I don't remember reading that. I remember 19 reading -- what was on the left, did we read what 20 was on the right? Yeah, okay, maybe let me take a 21 look at it again. Oh, of course, yes. 22 Q Great. So do these SLPs represent	188 1 A That would make the most sense. The 2 functions associated with each of the square 3 blocks as the inventors call them, the functions 4 of each of those are specific to the location of 5 those relative to the person, 1300, his or her 6 head. 7 So it it's as I said before, if you picked 8 that person up and moved them to a different 9 place, in effect all of those little blocks would 10 go with them, if you could think about it that 11 way. That the positions of those SLPs are 12 relative to that person's head and, in fact, 13 they're really relative to a particular 14 orientation of the head probably. It depends 15 what's recorded. 16 Q Can we please go to Page 32 of the -- 17 sorry, not 32. Page 37 of the document. 18 A Do you mean Columns 39 and 40? 19 Q Correct, specifically Column 40, Line 57, 20 which is Claim 1. 21 A Okay. I see that. 22 Q Would you please read Claim 1 which

189 1 continues on the next page Column 41. 2 A Claim 1 of the '316 patent reads -- 3 Q Read it to yourself, not for the record. 4 Thank you. 5 A Oh, okay, okay. I've just read it through 6 once. 7 Q So the first limitation it says or it 8 reads: "Dividing with a portable electronic 9 device held in the hand of at user an area around 10 the user into a zone that extends around the user 11 and that includes a sound localization point." 12 Do you see that? 13 A Yes. 14 Q Would that be the area around the user, 15 does it refer to the physical environment around 16 the user? 17 A Well, it says area around the user so the 18 area is relative to the user as they are doing 19 that, in this case, as I read that now. 20 Q Sure. 21 A So at the time when the person is doing 22 this, this step of the first element of that claim	191 1 BY THE WITNESS: 2 A I don't think I can tell you sitting here 3 right now an understanding of that specific 4 limitation alone. I can tell you how I would have 5 interpreted or a person of ordinary skill would 6 interpret the scope of that given the rest of the 7 claim, the first claim, Claim 5, Claim 1 and all 8 of the specification, but to single out a 9 particular element, I'm not sure sitting here 10 right now I can tell you. In other words, it's 11 not that as an expert is incapable of that. It's 12 that in doing so would require some careful 13 analysis that I haven't done. 14 Q Did you not do that analysis to write your 15 declaration? 16 MR. HENRY: Objection to form, 17 mischaracterizes testimony. 18 BY THE WITNESS: 19 A I did what I would say is a different 20 analysis in order to do that. The goal was not 21 for me to explain what elements of the claims 22 meant to anybody, but to describe how a person of
190 1 and they use their portable electronic device to 2 divide to indicate a zone, that zone is generally 3 in the physical spaces where they are standing or 4 where they are, wherever they're doing this, I 5 presume they're standing but wherever there is -- 6 however they're positioned in that space. 7 Q Great. So can we now read Claim 5, if I'm 8 not mistaken would be Column 41, Line 27 or 28. 9 A Okay, I've read the claim. 10 Q Great. Do you understand that Claim 5 is 11 a dependent claim depending from Claim 1? 12 A Yes, I do. 13 Q I would like to direct your attention to 14 where it says in Claim 5: "Displaying the WED, VR 15 images at the location of the multiple SLPs in 16 empty space in the zone." 17 Do you see that? 18 A Yes, I do. 19 Q What's your understanding of this 20 limitation? 21 MR. HENRY: Objection to form, calls for a 22 legal conclusion.	192 1 ordinary skill would have seen prior art with 2 respect to the words of the claim. Those are not 3 the same thing. 4 BY MR. RAFATIJO: 5 Q So as part of your analysis, you did not 6 determine what is the meaning and scope of the 7 claims in these patents, did you? 8 MR. HENRY: Objection to form, 9 mischaracterizes Dr. Welch's testimony. 10 BY THE WITNESS: 11 A No, I did not say that. 12 BY MR. RAFATIJO: 13 Q So did you analyze the claims to 14 understand the meaning and scope of each claim? 15 A Certainly the scope. I don't know what 16 you mean exactly by meaning. I analyzed the 17 claims looking at how a person of ordinary skill 18 as I defined in my declarations would read those 19 claims, what they would read the claims to claim 20 so the scope of those claims based on the words of 21 the claim. That is not the same thing as picking 22 out elements and explaining -- doing some analysis

193 1 on what the meaning of those elements are. I 2 don't think I ever did that, and I don't think I 3 would need to do that or want to do that as part 4 of this -- the analysis I did. 5 Q In order to determine the scope of the 6 claim, a POSITA -- does a POSITA need to 7 understand the meaning of each term in the claim? 8 A I would say yes. A POSITA would need to 9 have some understanding of the term as it is used, 10 each term as it is used in the claim in order to 11 read it and assess the scope of that claim. 12 Q Sure, and my question was what is your 13 understanding of this language, displaying the 14 WED, VR images at the location of the multiple 15 SLPs in empty space in the zone? 16 MR. RAFATIJO: Counsel, can we go off the 17 record while Dr. Welch is reviewing his 18 declaration in the interest of time? 19 MR. HENRY: A question is pending. I 20 mean, I don't think we have to, but if you want to 21 we can go off the record. You'll have to restate 22 your question when we come back. It's your call.	195 1 or explain what those words mean. So I'm 2 reluctant to say anything along those lines. 3 Again, not because I'm incapable as an expert but 4 because that is not something I have considered as 5 part of my effort here. 6 BY MR. RAFATIJO: 7 Q Looking at the language of this 8 limitation, does it say that VR images are 9 displayed to the user at locations of SLP? 10 A Earlier in Claim 1, it says that the 11 wearable electronic device, the WED, is worn on 12 the head of the user and that in Claim 5 in the 13 element you're pointing to it says with the WED, 14 the WED meaning the same one described earlier in 15 the claim, VR images at the locations of the 16 multiple SLPs, so it does -- I think it speaks for 17 itself. I'm not sure what you're asking me. 18 You're asking me if I agree with what it says? I 19 don't understand. 20 Q I just want to establish that this 21 limitation's explain and ordinary meaning says VR 22 images are displayed to the user at the location
194 1 It's your depo. 2 MR. RAFATIJO: Can we go off the record. 3 THE VIDEOGRAPHER: Stand by. We are going 4 off the video record. The time is 3:23 p.m. 5 (A recess was had.) 6 THE VIDEOGRAPHER: We are back on the 7 video record. The time is 3:26 p.m. 8 MR. RAFATIJO: Would the court reporter 9 ask the pending question. 10 (The record was read by the reporter.) 11 BY THE WITNESS: 12 A So my analysis never involved doing 13 exactly what you're saying. I think if it as two 14 different directions. You are asking what the 15 words mean. My analysis is about whether a person 16 of ordinary skill would find something, some 17 example to be obvious or comport with what that 18 says. So comparing an example of something and 19 asking a person of ordinary skill does it fall 20 within the scope of those words is a very 21 different thing from going in the other direction 22 saying what do those words mean trying to define	196 1 of the SLPs? 2 A I think I'm fine with that in general, 3 although, again, that may -- that's not the same 4 question I would have asked or would have thought 5 about in terms of an obviousness analysis as I had 6 done. 7 So for one example, some of those words 8 might have a variety of different meanings. So 9 depending on how they're used and -- but generally 10 I'll say without -- with the qualification that I 11 might need to go back and revisit this I certainly 12 cannot -- cannot disagree with the words that are 13 here in the claim. The words are what they are. 14 Say what they say. 15 Q And the SLPs we established in Claim 1 16 that they correspond to locations in the physical 17 environment around the user, correct? 18 MR. HENRY: Objection to form, 19 mischaracterizes Dr. Welch's testimony. 20 BY THE WITNESS: 21 A I think earlier we were talking about the 22 words of the claim. I don't think I was making a

197 1 general statement about what SLPs are or where 2 they reside or their shapes or anything like that. 3 That is something that is defined I believe in the 4 patent and so a person of ordinary skill who was 5 interpreting the scope of those claims, who was 6 reading the claims and trying to understand the 7 scope of the claims would take into account what 8 the inventors said were SLPs and I don't think 9 it's quite as simple as maybe you're implying. 10 I'm not sure. 11 BY MR. RAFATIJO: 12 Q How does a person of ordinary skill in the 13 art understand what the patent means by SLPs? 14 A So a person of ordinary skill would take 15 into account any explicit definitions for SLP in 16 the patent and how the term was used in different 17 contexts and what meaning might be imparted from 18 the use of that term in that particular context. 19 So there is no that I recall definitive 20 definition, but there are references to SLPs at 21 least throughout this patent that convey some 22 sense of what the inventors are saying would	199 1 precise in their words, for example, 2 mathematically would refer to a point, but it's 3 not clear from the specification that -- in fact, 4 it's clear we're not only talking about points 5 because, for example, in column 37 at Line 28, the 6 specification says: A size and/or shape of an SLP 7 refers to that, and I think there are other 8 references to non-point SLP examples in the 9 patent. So I'm just not able to find things in an 10 efficient manner here right now. 11 So I think it generally describes it as a 12 location, but that's a very kind of a nebulous 13 term which could mean point in space. If you look 14 at like, for example, Figure 13, it's not drawing 15 points for the SLP. They are little boxes so they 16 have volume. They have little regions and it's 17 referring to those volumes as SLPs. And in Column 18 37, Line 28 it refers to the size and/or shape of 19 a SLP. 20 So I believe a person of ordinary skill 21 reading this just sitting here right now trying to 22 assess what I'm seeing would be a region or a
198 1 constitute an SLP or examples of a SLP. 2 Q And what's the sense that you get from 3 reviewing the specification? 4 A Sorry, I thought there was a clear 5 definition in the patent but I can't find it 6 sitting here right now, my memory of -- well, two 7 things. One I thought there was a clear -- 8 somewhat of a clear articulated explanation for 9 what SLPs are in the context of this patent and 10 then there are many uses of it throughout the 11 patent. It's used all over and over and over 12 again, all over as I'm sure you are aware. So a 13 person of ordinary skill understanding what might 14 or might not constitute a SLP would take in all of 15 those uses in trying to understand what might 16 constitute a SLP generally, but from my 17 recollection, it's somewhere it discussed as the 18 location from which a sound emanates, that's my 19 word, emanate, something to that effect, and then 20 among -- I do remember there's some -- I don't 21 know whether to call it confusion of the naming 22 because sound localization point to someone who is	200 1 volume or a shape from which the sound emanates. 2 Q Is SLP a location in the physical 3 environment around the user? 4 A I think it might be the case that the 5 inventors use the word location following on what 6 I just said, I would not use the word location to 7 define a SLP based on my understanding of what the 8 inventors mean when they use that term. I would 9 say the SLP whatever size and/or shape it is, 10 again at column 37, Line 28 is located somewhere 11 in this physical space. I would not say it is a 12 location. I would say that that SLP whatever its 13 shape or form is located somewhere in physical 14 space. 15 Q And this limitation says the VR images -- 16 I believe you were talking about Claim 5, it says 17 VR images are displayed at the locations of the 18 SLPs, correct? 19 A That is what it says I believe. You read 20 it correctly I believe. 21 Q And VR images, VR stands for what? 22 A In this context it would be virtual

201 1 reality. 2 Q Sure. So the virtual reality images are 3 at the location of the SLPs, correct? 4 A That is correct. It's a little maybe 5 unclear, again, coming at it forward. There are 6 lots of examples where someone would say a person 7 of ordinary skill would say yes, those are VR 8 images at the location of the of the SLP and to 9 try and go in the other direction and try and 10 define exactly what that means I couldn't do, they 11 don't need to do, they wouldn't do. 12 Q Is it possible to carve out a portion of 13 the physical environment and build a virtual 14 reality environment within that portion? 15 A It's a little bit of an odd question 16 because one builds generally a virtual reality 17 environment in a virtual representation of the 18 space. In some instances, that virtual reality 19 might be in a real place which is sometimes called 20 augmented reality in which case if someone was 21 designing a virtual experience, a VR experience in 22 that real space, they have full control presumably	203 1 proceedings, in the very first paragraph, 2 second-to-last sentence, it says: "We used an 3 Oculus Quest 2 HMD and its default controllers for 4 this experiment." 5 BY MR. RAFATIJO: 6 Q Do you use Quest devices and Quest 7 headsets often for your studies? 8 MR. HENRY: Objection to form. 9 BY THE WITNESS: 10 A I don't know what often means. That's a 11 relative term. We certainly do use them. We have 12 lots of different brands of headsets we use, 13 HTC5s, HP headset, occasionally HoloLens, 14 Microsoft HoloLens, all custom headsets made by 15 private companies like Vision products and like of 16 different HMDs. I will say Oculus Quest HMDs in 17 general are very common in the field, AR and VR, 18 relatively common. 19 BY MR. RAFATIJO: 20 Q Are you familiar with Guardian feature in 21 Oculus Quest headsets? 22 A Yes.
202 1 over where they position the virtual objects or 2 sounds or whatever it is that they're positioning, 3 placing, programming, wherever they like. 4 So when you say carve out, I don't know 5 what that means exactly, but they certainly could 6 limit their positioning of virtual things to a 7 particular volume, for example, that someone had 8 defined. 9 Q Awesome. So earlier today we talked about 10 one of your publications with Ms. Norouzi where 11 you use Oculus Quest headsets. 12 Do you remember that conversation? 13 A Well, I don't remember entire 14 conversation. I certainly remember we pulled up 15 the paper and discussed the authors I think, and 16 beyond that I don't remember what we discussed. 17 Q Can we please pull up Exhibit 2? 18 A I have Exhibit 2 ready. 19 Q Did you use Quest 2 to conduct this study? 20 A It appears so. Of course, I don't 21 remember, this is a long time, for me this is a 22 long time ago, in Section 3.2.1 on Page 312 of the	204 1 Q What is it used for? 2 MR. HENRY: Objection to form. 3 BY THE WITNESS: 4 A I'm not sure how to answer that question 5 but in general the feature is I would say as Greg 6 characterizing the feature I don't know how Meta 7 would describe it, but in my sense it is a feature 8 that is designed to help prevent individuals from 9 accidentally or inadvertently straying into 10 something physical in their space that they were 11 unaware of for whatever reason because they didn't 12 see it or they were distracted or whatever or also 13 maybe something that encroached your space like 14 your dog. 15 Q Does it have anything to do with making 16 sure that reading from the title of your paper 17 cross reality interactions and transactions occur 18 in a safe manner? 19 A I'm sorry. Could you reask that question? 20 I'm struggling to make the connection. Please try 21 again. 22 Q Sure. Does the Guardian feature in Oculus

205 1 headset have anything to do with making sure that 2 cross reality interactions occur in a safe manner? 3 MR. HENRY: Objection. Form. 4 BY THE WITNESS: 5 A I have no idea how to answer that. The 6 cross reality interactions is a very broad 7 statement. This is a very narrow research paper 8 about one experiment looking at interruptions from 9 across reality so a real world interruption is 10 shown in the upper right figure in Figure 1 a real 11 human tapping you on the holder while when you are 12 in the middle of doing some VR experience, VR or 13 AR, versus an interruption that comes from another 14 VR or AR experience. 15 I think if I remember right we really only 16 looked at the real physical -- I'm sorry, the 17 physical virtual interruptions. So there's 18 nothing in this paper that says anything 19 definitively about anything you asked if I 20 understand your question. I don't even remember 21 whether Guardian comes into play in this 22 experiment. I don't think it does. I don't see	207 1 you have me a long answer, but part of that was 2 when something encroached in your space like your 3 dog, remember you said that? 4 A Yes. 5 Q So would that not be cross reality 6 interruption that user being in virtual reality 7 using Oculus Quest would be interrupted by their 8 dog? 9 A Certainly we don't have that in the paper 10 but I would think that certainly under some 11 circumstances I wouldn't disagree with you. The 12 cross reality, again, interruptions here were not 13 the dog, nothing like that. Guardian was never 14 involved. It was just somebody tapping you on the 15 shoulder, somebody who -- participants were 16 standing in one place, they never moved, and 17 someone came up behind them and tapped them on the 18 shoulder. 19 Q But the Guardian feature in Quest makes 20 sure or is implemented to ensure that this cross 21 reality interruption takes place in a safe manner, 22 correct?
206 1 the word showing up. I can't imagine it would 2 because for this particular experiment the human 3 participants, in the study, the human subjects 4 research, as I recall, it's probably documented 5 here, stood in one place while they did some task 6 and then and somebody, a real human, one of my 7 research -- one of my students would tap them on 8 the shoulder and interrupt them. So there was no 9 reason for them to be moving around. They 10 wouldn't be unsafe. There is no danger from them 11 being distracted. We as you might remember as 12 being in academia have to go through some very 13 rigorous institutional review board human subjects 14 reviews of experiments we are going to do to 15 assure our IRB, the institutional review board, 16 that the participants will be safe, that they 17 won't be harmed and that means broadly physically 18 harmed, mentally harmed or financially or in any 19 way harmed. So this is a very low risk or I might 20 say no risk experiment. 21 Q Sure. So when I asked you about Guardian 22 feature, one of the answer you gave me, I mean,	208 1 MR. HENRY: Objection to form, lacks 2 foundation calls for speculation. 3 BY THE WITNESS: 4 A I have not done an analysis of what the 5 Guardian system in the Quest product does or 6 doesn't do. My only basis for any comments I 7 might have about it are times I've encountered it 8 or seen it used by other people, but in this 9 proceeding, I have not offered any sort of 10 analysis of how anything in the Quest works or 11 doesn't work or any of I goes the accused 12 products. 13 Q Do you remember in this article you talked 14 about passthrough feature in Guardian in Oculus 15 Quest device? 16 A I do not remember, but I can do a quick 17 search. I do remember likely it was there and 18 indeed it is there. I certainly see it, yes. 19 Q So what's the passthrough feature? 20 A The passthrough feature, passthrough it's 21 one word, it's kind of a modern name for something 22 that someone might traditionally and by

209 1 traditionally I mean back into the, gosh, 2 1960s might call -- would call augmented reality. 3 So passthrough simply means that there is a region 4 within a typically predominantly scene, I'm sorry, 5 predominantly virtual scene, you might be looking 6 at, let's pretend as an example, I'm not trying to 7 give a definitive definition, let's say you were 8 in a virtual outer space, virtual experience where 9 you are supposed to be an astronaut who is flying 10 around, flying by planets or something and then 11 some comes near you or you can also as I recall as 12 a programmer, so as the developers can initiate 13 this, you can using the cameras that are on the 14 device that are included with the device on the 15 outside they're looking outward in front of you, 16 you can in effect "passthrough" some of the video 17 from those cameras into the space, the immersive 18 space experience you are in. So you would 19 suddenly see what might look like a portal or kind 20 of a circular or odd-shaped opening, if you will. 21 Conceptually it's an opening into the real world 22 from the virtual place where you are, but it's	211 1 research purposes. I have on occasion in the past 2 of course used, like fired up a different game 3 bike Beat Saber or something like that or some 4 other game momentarily, but I wouldn't say that I 5 "play it" or played it. 6 Q For your research when you used Oculus, 7 has there ever been a circumstance that you need 8 to talk to someone using Oculus? 9 A By talk to someone, I would say yes, the 10 participants talk to the researchers and the 11 researchers talk to the participants, that 12 certainly happens. 13 Q So when you're saying the participants 14 talk to the researcher, talking via Oculus, 15 correct, not just face-to-face talking, what I 16 mean is talking while participants and the 17 researchers are both in the virtual reality 18 setting? 19 A I don't recall that we've ever done 20 anything with a researcher and a participant both 21 in a virtual reality setting together at all. I 22 mean, maybe we did. I don't remember and I
210 1 really just augmented reality done in a very 2 specific circumstance. 3 Q Would that be a feature of Guardian system 4 in Oculus Quest? 5 MR. HENRY: Objection to form. 6 BY THE WITNESS: 7 A I can't answer that. I haven't done any 8 analysis and I couldn't answer that for you. 9 BY MR. RAFATIJO: 10 Q Have you used Oculus device yourself? 11 A Yes, of course. 12 Q Have you used it to converse with your 13 friends or play a game? 14 MR. HENRY: Objection to form, compound. 15 BY THE WITNESS: 16 A Off the top of my head, I can't remember 17 everything, the dominant use that I can remember 18 are research uses. So not playing around. I 19 wish -- it's not one of my typical things to spend 20 a lot of time playing maybe unfortunately, but 21 most of my -- the dominant recollections I have 22 are of using all of those sorts of devices for	212 1 certainly don't remember them communicating in any 2 way in world. Most I would say almost exclusively 3 though, again, it's hard for me to give a 4 definitive recollection, I'm just going from 5 memory, what you would have is something like 6 what's illustrated in Figure 1, the upper right, 7 where my student Matthew is putting his hand on 8 the shoulder of my student Zupan and they might 9 talk to each other it's real world talking. 10 MR. RAFATIJO: We'll take a break now. 11 What's the time on the record? 12 THE VIDEOGRAPHER: We're been on the 13 record for 4 hours and 45 minutes. 14 MR. RAFATIJO: Thank you. 15 THE VIDEOGRAPHER: Stand by. We are going 16 off the video record. The time is 3:59 p.m. 17 (A recess was had.) 18 THE VIDEOGRAPHER: We are back on the 19 video record. The time is 4:11 p.m. 20 BY MR. RAFATIJO: 21 Q Great. Let's pull up Exhibit 5 22 Paragraph 87, Page 50 of the declaration.

213 1 A I'm at Page 50. I'm sorry. Did you give 2 a paragraph number? 3 Q 87. That would be Page 69 of the 4 document. 5 A Sorry. Which exhibit? 6 Q Exhibit 5. 7 A Exhibit 5. I'm at Page 50 -- what am I 8 missing, I'm at Page 50. I'm sorry, could you say 9 one more time, Exhibit 5, which paragraph number? 10 Just tell me that. 11 Q 87. 12 A All right. I'm there. Paragraph 87 of 13 Exhibit 5. 14 Q Would you please read this paragraph to 15 yourself. 16 A Okay. 17 Q Is there any difference between the two 18 methods of tracking that you describe in this 19 paragraph as depicted in Figure 5? 20 A I'm sorry. You're asking if there is a 21 difference between what's in the left outside 22 looking in versus what's on the right inside	215 1 imagine other than -- in any source-based tracking 2 system, not a source list, so like an inertial 3 measurement unit for example which to a some 4 degree or a large degree depending on the 5 circumstances does not need external references at 6 least for some period of time but for systems that 7 use a source and a sensor, of some sort, something 8 has to be stable to be non moving whether it's 9 something that the developer or as part of the 10 system or if it's something in the room, it has to 11 be something is remaining fixed otherwise it's 12 just a mishmash of things that are moving 13 independently and nobody would be able to make 14 sense out of that. 15 BY MR. RAFATIJO: 16 Q So in outside in tracking, the sensor is 17 fixed or mounted on the wall, correct? 18 A Not necessarily, those are not outside in 19 versus look out or I don't know what the phrase 20 was we were kind of going on back and forth 21 before. These are just general sort of 22 illustrative terms in general to teach to a person
214 1 looking out in this figure which is -- 2 Q Yes. 3 A Okay. Yes, there are clearly differences. 4 Q What are those differences? 5 A Well, in one it illustrates an example of 6 a camera or a lab mounted optical sensor of some 7 sort on the left on the outside looking in that is 8 aimed toward this caricature of a person with some 9 sort of fixed landmarks on their head. They could 10 be infrared LEDs, they could be QR codes, AR 11 markers, all sorts of anything identifiable with 12 the optical sensor, and on the right in the inside 13 looking out the illustration is the sensor is 14 instead mounted on the person's head and as the 15 person moves around it's sensing the lab-mounted 16 landmark. So the two relationships are swapped. 17 Q Is it true that the two require a fixed 18 element? 19 MR. HENRY: Objection to form. 20 BY THE WITNESS: 21 A I'm not sure what you mean by an a fixed 22 element but I will say it's difficult for me to	216 1 that would be thinking about doing tracking that 2 it makes a difference in some cases whether the 3 sensors you are using are mounted on you and you 4 are moving around so the sensor itself is moving 5 and what it's observing or sensing might be fixed 6 or the other way around. It doesn't necessarily 7 mean on the wall or on the lab. This is just an 8 illustration. This is discussed a bit more in the 9 I think 2001 SIGGRAPH ACM, S-I-G-G-R-A-P-H, course 10 on tracking that I taught with a few colleagues 11 and in that case we say also these are not great 12 words, great terms. They are not definitive 13 because there are -- the reason, one reason to be 14 aware of the relationship between the sensors and 15 the landmarks in this particular example here is 16 that the properties of the measurements change 17 depending on which things are moving. 18 There are systems that a normal person 19 would look at and say here is a sensor that is 20 looking outward from the user and here is a source 21 that's on the wall that's pointing inward and yet 22 it would be more most rationale for reasons having

217 1 a discussion about that would involve these terms 2 you would you would perhaps draw the wrong 3 conclusion if you called it an inside looking out 4 configuration even though the sensor is on the 5 person and source is in the lab a have good 6 example of that is the HTC Vive Lighthouse 7 tracking units made by -- the ones that come with 8 the HTC Vive headset. So those actually have a 9 sweeping light source that emanates from the unit 10 on the wall, for example, or on a tripod and the 11 person who is moving around has sensors on them 12 and those light sweeping plates passthrough the 13 sensors and there is a pulse of -- a current or a 14 voltage that appears and the system they look at 15 the timing and try to decide where you are. 16 So in that case the sensor is on the 17 person's head, if you will, it's a headset we're 18 talking about and the source is in the lab. So 19 you might want to call it inside looking out, but 20 mathematically the properties from an error 21 analysis standpoint and sensitivity standpoint the 22 are more aligned with outside looking in because	219 1 examples on the right, it says lab mounted? In 2 parenthesis it says fixed landmarks. So those are 3 attached to the ceiling with screws or double 4 stick tape or something like that. I'm making 5 that up. I'm just trying to give a concrete sense 6 of what it would be like, and in the left, the 7 lab-mounted camera is fixed to the wall, screwed 8 in with a bracket or something like that. But, of 9 course, on the left also the landmarks on the 10 person's head are fixed on something on the 11 person's head and, of course, on the right the 12 inside looking out the camera is fixed to the 13 person's head. The camera can't be wobbling 14 around on the head and on left probably the 15 landmarks can't be wobbling around on the head so 16 in order to make stable estimates of the 17 relationships between those components, things 18 have to be generally be stable unless you know 19 they're not going to be table and then you design 20 the system for them not being stable. 21 Q But the person is moving around, right? 22 The person is moving around, correct?
218 1 of the way the source is swept through the 2 environment for example. 3 So these are imperfect, not universal, not 4 definitive classifications, they're simply meant 5 to help somebody understand that one needs to 6 consider where you put sources and sensors and do 7 the right thing which people generally do. I 8 think this is from it's from my 2001 paper on our 9 highball system and this concept of outside and 10 inside out has been around since at least the 11 seventies. 12 Q So going back to my questions, is there a 13 fixed component in any of the two embodiments that 14 you have in this figure? 15 MR. HENRY: Objection to form, asked and 16 answered. 17 BY THE WITNESS: 18 A In this hypothetical, the two 19 hypothetical, really illustrative diagrams, they 20 are not intended to be schematics for some working 21 system or anything like that. In these particular 22 examples, it's not universal, in the particular	220 1 A That's correct. 2 Q So does any of the configurations in this 3 figure involve a scenario where both sensor and 4 landmarks are moving? 5 A In this particular -- again, this is just 6 an illustration, a concept so you're asking a 7 question that is sort of implying that there's a 8 system or something here. I don't know. But the 9 figure is what it is, says what it says so you can 10 see that in this example, there are some rigid 11 things, some things that are fixed, they're either 12 rigid on the head or rigid on the wall or rigid on 13 the ceiling and then the system is -- the 14 illustrative system is using those. That's the 15 most straightforward simple thing and that's not 16 the point of this diagram. So this diagram is 17 trying to make the point -- we were trying to make 18 the point that on the left in the outside looking 19 in case, as you might imagine, because the 20 head-mounted landmarks are a fixed distance apart 21 from each other, let's just say 30 centimeters, as 22 you get farther away from the lab-mounted camera

221 1 the image of those two landmarks gets closer and 2 closer and closer in the camera's prospective view 3 of you so it gets harder and harder and harder to 4 determine how your head is oriented so you're 5 relatively insensitive to orientation in the left 6 configuration and on the right configuration it 7 doesn't matter where you are, you have the same 8 sensitivity to orientation. 9 So from an orientation standpoint inside 10 looking out is better. Outside looking in this 11 illustrative configuration is worst. So there's 12 no intent to talk about really anything else here 13 other than illustrating that. 14 Q Do these systems, the two embodiments that 15 you show in Figure 5 here determine the location 16 of the user or head of the user based on 17 monitoring the relative distance between the 18 sensor and the landmarks? 19 A So these are again hypotheticals, they are 20 just figures that are very simple intended to 21 convey one concept. So if we are imparting much 22 more meaning into these with some hypothetical set	223 1 location of the person without regard to the 2 rotation or the direction of the head. 3 Would the systems work based on measuring 4 the distance between the landmark and the sensor 5 as the user moves? 6 MR. HENRY: Objection to form. 7 BY THE WITNESS: 8 A So when you say this system what's 9 illustrated here just says head-mounted sensor a 10 on the left lab mounted optical sensor and lab 11 mounted landmarks so this could fit a variety of 12 different modalities, different physical signals, 13 for example, on the right there is a relatively 14 popular system sold by a company that used to be 15 called inter sense, you had a camera on the head 16 and used acoustics along with images as I recall 17 but it used acoustics for sure to measure your 3D 18 position and, yes, orientation too even if you 19 don't care about that it's all estimated together 20 using acoustic -- what they would call acoustic 21 beacons. So each of those beacons would create a 22 short sound as I recall and the system would
222 1 up, then any system that resembles these in terms 2 of an optical sensor or some sort of optical 3 sensor or actually could be acoustic, could be -- 4 could even be magnetic, of course something has to 5 be stable or fixed and then everything else is 6 estimated relative to that. And so everything 7 that's moving, everything you would know about, 8 things that are not moving, you would estimate the 9 relationship between them which means you would do 10 what you were asked which was you as part of that 11 would be estimating the distance. You would be 12 estimating in these hypotheticals the full 13 six-degree of freedom post a POSITA would call it, 14 a POSA would call it POSE, P-O-S-E meaning 15 position and orientation, so three degree, X, Y, Z 16 position and three rotation around each of these 17 axis, so you know the distance, orientation, all 18 of these things. Again, I'm going way out on a 19 limb with a hypothetical imagined set up based on 20 something that's like in this figure. 21 Q Right now I'm only asking about the 22 translational motion, not rotational. Just the	224 1 estimate -- would try to measure the time between 2 the transmission of that sound and the receipt of 3 that sound at the head. That time since you 4 generally know the speed of sound which varies a 5 lot unfortunately for the temperature and all 6 sorts of other things but generally you can 7 estimate the distance and that is how that 8 component of that system it would work is to use 9 acoustic sounds to estimate the distance. 10 Q So essentially all of these systems either 11 acoustics or emission of light or 12 electromagnetics, or magnetic waves they are 13 working based on determining the distance between 14 the sensor and the landmarks, correct? 15 MR. HENRY: Objection, mischaracterizes 16 testimony. 17 BY THE WITNESS: 18 A No, that's not correct if I understand 19 your question. 20 BY MR. RAFATIJO: 21 Q So how does the system work outside 22 looking in, what the sensor senses?

225 1 A So the sensor in one example here is an 2 optical sensor. If you think about it as a 3 camera, a camera alone just a simple image-forming 4 camera like say on your smartphone has no way to 5 generally no way to estimate distance unless a 6 human programs something that is, let's say, 7 looking at an object of known size so a human 8 might be looking at a soda can and if somebody has 9 programmed into the system the dimensions of a 10 soda can and you could identify the soda can in 11 image you might be able to figure out how it far 12 away you are from that soda can. 13 In this example on the left the outside 14 looking in, likely this system here all this is 15 intended to reflect, and this is kind of what I 16 was getting at before, are angular measures. So 17 this optical sensor would be measuring the, let's 18 say, horizontal and vertical angle to the landmark 19 on the person's left side of their head and also 20 measuring the two-dimensional angle to the 21 landmark on the right side of the person's head 22 and using that information probably with other	227 1 filter and the appropriate models, measurement 2 model, motion model and the appropriate parameters 3 one can estimate the position and orientation of 4 the head only from angles of those devices. 5 Q Can you still -- can you still determine 6 the location of the user's head if both of the 7 landmarks and the sensors are moving? 8 A It would depend in this case, if you mean 9 all of the landmarks are using, every single 10 landmark you were trying to use, and every single 11 landmark was moving independently of other 12 landmarks and you had no idea why they were moving 13 on how they were moving, it's hard for me to 14 imagine how just using the optical sensors you 15 would be able to do that. If you wanted to do 16 that, a person of ordinary skill would -- it's 17 probably pretty hopeless. You could use some 18 inertial components on the head in the figure on 19 the right which are sourceless, that's how people 20 would refer to them. They don't require seeing an 21 external source because they're just using 22 accelerometers, maybe a compass, gyros,
226 1 information, too, to try and estimate the position 2 and orientation of that person's head in the room. 3 So it's not measuring distance. It's measuring 4 angles. 5 Q How does the position being calculated at 6 the end? 7 A There are multiple ways. A classic way 8 would be to set up a system of linear equations 9 that describe how the angles of a set of 10 measurements, a sufficient set of measurements 11 relate to the position and then solving that for 12 the angles that you know, solving for the position 13 from that linear system or another way, I wouldn't 14 say the only other way, is to do what the system 15 that this paper is about, the highball, the light 16 area, optical tracker, the highball tracking 17 system which used an algorithm which was my Ph.D. 18 work which is to use a Kalman filter to 19 sequentially sample those angles, and it's a long 20 discussion, but basically invert backwards from 21 those measurements into the state of the head. 22 So using those angles and the Kalman	228 1 microelectronic machine, MEMs devices. So those 2 could be very helpful and then if periodically you 3 can see some inertials that you believe are not 4 moving, some landmarks that are not moving that 5 the system believes are stable then it can fuse 6 those together and help it continue to estimate 7 the position, the 3D position and 3D orientation 8 of the head. 9 So it really depends. If it's just 10 chaotic and the landmarks are all moving -- every 11 one of them is moving independently and nobody has 12 any idea how they're moving, they're not going to 13 be very helpful to anybody. 14 Q Suppose a landmark is attached to a user's 15 chair and the sensor is mounted on the user's head 16 and there's no other stationary sensor or landmark 17 can you still determine the location of the user's 18 head, in the coordinate system, the six degrees of 19 freedom, X, Y, Z and the three angles while the 20 user is walking? 21 MR. HENRY: Objection to form. Compound. 22 BY THE WITNESS:

229 1 A So there is no system that I'm aware of 2 that could imagine that uses a sensor. A person 3 of ordinary skill in this realm, anybody who does 4 work in this area would understand that these 5 systems, most systems, especially today or in the 6 past I'd say 15, 20 years are what people would 7 call hybrid systems that combine information from 8 multiple sensors and multiple components. So 9 clearly if all you were doing is looking at a 10 person's chest from their head, then probably if 11 that's the only information you had, it could very 12 well be that the only thing you can estimate is 13 the pose or position or some information about the 14 head relative to the chest, there is a whole body 15 of area of work called body relative tracking, 16 which is like tracking my arms and my chest and 17 things with respect to my body to my head. 18 But it doesn't exist that I'm aware of. 19 So it's not a very useful system that only did 20 that so in practice the system would have multiple 21 sensors some of which would be used to estimate 22 position orientation of let's say a head-mounted	231 1 understanding the information that's available to 2 estimate the person's position, for example, in 3 the room. You have to think about which sensors 4 you would use. It's all within the realm of a 5 person of ordinary skill, but it's not as simple 6 as saying, oh, I'm going to have some sensors. 7 And sensors are very broad. They, again, could be 8 magnet, could be acoustic, some use different 9 references, some don't. You might have two or 10 three of time, you might have five of them, you 11 might have one of them, one dimensional, two 12 dimensional, three dimensional, all of these 13 different characteristics, where they're mounted 14 with respect each other. All of this matters and 15 it's pretty standard to a person of ordinary skill 16 who works in tracking to sort of figure this out, 17 but to just say sensors on your head, nobody can 18 draw any conclusion from that. So I'm not what 19 you're looking for. That would be like saying if 20 I put sensors on my car, can I determine where my 21 car is? It would depend on the sensors and where 22 they are and what they're sensing and lots of
230 1 display in the space the person is in and 2 additionally estimating the location of maybe 3 their hands or controllers relative to the 4 head-mounted display. That would be a very common 5 circumstance. 6 BY MR. RAFATIJO: 7 Q Is it your testimony today, that if you 8 have sensors, not just one, multiple sensors but 9 all of them mounted on the user's head and they 10 are just sensing the landmarks that are -- that is 11 attached to the user's chest, then such system 12 cannot determine the location of the user as the 13 user moves around the reasonable, correct? 14 MR. HENRY: Objection to form, 15 mischaracterizes testimony. 16 BY THE WITNESS: 17 A No, not correct. 18 BY MR. RAFATIJO: 19 Q I say not correct because I think you 20 started your question with something like the word 21 sensors or something. 22 This is incredibly complicated in terms of	232 1 other information. 2 MR. HENRY: Counsel, sorry to interrupt, 3 real quick. I got some light streaming in on 4 Dr. Welch's face. Can we just pop off the record 5 I'm going to pull some shades down and then we'll 6 pop back on. 7 MR. RAFATIJO: Sure. 8 THE VIDEOGRAPHER: Stand by. We are going 9 off the video record. The time is 4:38 p.m. 10 (A recess was had.) 11 THE VIDEOGRAPHER: We are back on the 12 video record. The time is 4:40 p.m. 13 BY MR. RAFATIJO: 14 Q Dr. Welch, in Figure 5 in your 15 declaration, you will showed a sensor on the 16 user's head that's sensing something from 17 landmarks fixed on the ceiling. 18 Do you see that? 19 A Yes, I would agree with that. 20 Q Without any specificity you draw a lot of 21 conclusion based on this very figure, correct? 22 MR. HENRY: Objection to form.

233 1 BY THE WITNESS: 2 A First of all, I'm the one who created the 3 figure so I know what the purpose of the figure 4 was. I know where the figure came from. I know 5 what the context of the figure was I know what 6 it's intent was. For example, this is not a 7 schematic that's meant to describe some mechanical 8 design or some design of a system. It is solely 9 intended as imperfect as it may be but I think 10 it's pretty good, people use it, meant to 11 illustrate this particular notion of what 12 sometimes people would call outside looking in and 13 sometimes would call inside looking out as 14 imperfect as those terms may be as I've said 15 earlier. That's all this figure is doing. 16 BY MR. RAFATIJO: 17 Q And -- remove the landmarks from the 18 ceiling and put it on the chest of the user and 19 then I asked you did that system where the 20 landmark was placed on the chest of the user would 21 that system be capable of tracking the user as the 22 user moves in the room?	235 1 discuss that because it doesn't make any sense. 2 If you want to ask me if you put a camera 3 on your head and it's looking down at your chest 4 and it only sees your chest, can you track where 5 you are in the world or in the room, probably not. 6 I mean, if that's all you have, but nobody 7 would -- no sane person of ordinary skill or sane 8 person in general who knows something about 9 sensors and system like this would ever attempt to 10 do that. It just doesn't make sense. 11 Q So let's pull up Exhibit 17 and we're 12 going to name this Exhibit 10. 13 (A certain document was marked Welch 14 Deposition Exhibit 10 for identification, 15 as of 05/03/2024.) 16 MR. HENRY: Would you clarify if you don't 17 mind, you said we're pulling out Exhibit 17 and 18 naming it Exhibit 10. If you don't mind 19 clarifying on the record. 20 MR. RAFATIJO: Sure. Because the exhibits 21 we provided, we provided to the Planet Depo and 22 they are numbered from 1 to 20, I don't know, we
234 1 A It's very difficult for me. I cannot -- I 2 don't understand what that system is because 3 there's no system in Figure 5. Figure 5 is simply 4 meant to represent the geometric relationships 5 between fixed landmarks in the room and the moving 6 head-mounted sensor or the other way around. So 7 it's simply trying to illustrate the geometry. 8 This is not a figure that says you can track you 9 know with this head-mounted camera and do 10 something like that. You could not probably do 11 everything you needed to do from a tracking 12 standpoint, for example, on the left system. It 13 doesn't have enough landmarks on the head, and 14 you're going to have more than four landmarks on 15 the ceiling if that's the ceiling on the right. 16 So I think you're trying to get me to say 17 some hypothetical sweeping statement about 18 inability to track position with sensors on the 19 head or something like that which -- in a head 20 mount are on the head which is in my world that's 21 a completely unrealistic world. Nobody -- it's 22 hard for me to understand why anybody would even	236 1 skipped Exhibit 10 if you remember so now we are 2 renaming it so it's Exhibit 10 for the record. 3 MR. HENRY: So this will be Exhibit 10 of 4 Dr. Welch's deposition that was previously 5 identified as an Exhibit 17, but it's now 6 renumbered as 10. 7 MR. RAFATIJO: Correct. 8 BY THE WITNESS: 9 A What I am downloading has a file name 10 Exhibit 17 so should I rename it to Exhibit 10 to 11 reduce confusion? 12 BY MR. RAFATIJO: 13 Q We'll check the stamp. 14 MR. HENRY: But Dr. Welch is right, 15 Counsel, still has the PDF file name as Exhibit 17 16 but I can see in the Zoom feed that it is bearing 17 the correct stamp, and let's make sure the local 18 copies that you circulated have the correct stamp. 19 Just a second. 20 MR. RAFATIJO: I have the correct stamp on 21 my copy it says Welch 10. 22 BY MR. RAFATIJO:

237 1 Q Is this prior art I referred to as 2 Pedrotti, is that one of the prior art you studied 3 and you reviewed to draft your peck in this case, 4 correct? 5 A I would say, yes, from my quick look 6 through it does indeed appear to be the one that I 7 used I'm happy to help if you tell me that it is 8 I'm happy to accept that it looks likes. 9 Q This is what the counsel submitted to the 10 PTAB? 11 A Okay. 12 Q Does this patent disclose a system of 13 tracking? 14 A This system discloses many forms of 15 tracking. This system – sorry, this patent, the 16 Pedrotti, P-e-d-r-o-t-t-i, patent discloses or 17 teaches discloses to a person of ordinary skill 18 many forms of tracking, it gives some specific 19 examples as embodiments but more generally it 20 discloses many. 21 Q Are they inside out or outside in? 22 MR. HENRY: Objection to form.	239 1 configuration and the other components of the 2 exact same system that work together that one 3 might look at and say are really an outside in. 4 Again, the inside out outside in is an 5 imperfect labelling and it really is in reference 6 to the relationships between source and sensors 7 and because you can have hybrid systems and have 8 multiple types source and sense certificates you 9 could have a mix ever geometric relationship 10 between those things. 11 Q Does Pedrotti determine the location of 12 HMD and head-mounted device relative to a fixed 13 base station? 14 MR. HENRY: Objection to form. 15 BY THE WITNESS: 16 A Pedrotti discloses many examples to a 17 personal of ordinary skill. One of them would 18 indeed be tracking head/hand controllers with 19 respect to a, for example, magnetic coil that 20 might be situated somehow on a fixed station but 21 that's just one of the examples that Pedrotti 22 offers.
238 1 BY THE WITNESS: 2 A One could not I think say that probably 3 about -- I'm not sure you could say that about the 4 embodiments. I'd have to think about that and 5 frankly -- well, let me hold on to that for a 6 second. The embodiments it's hard to answer, the 7 specific examples. The general teachings about 8 tracking systems and the different ways tracking 9 happened don't specify whereby where the sensors 10 and the components have to be necessarily so a 11 person of ordinary skill would know sort of -- 12 would know how to place these, what the 13 relationship would be and they would know from the 14 concepts that were taught in my -- in that 15 particular paper or more likely in five, six, 16 seven, eight, ten books on tracking and papers 17 on -- survey papers on tracking and hundreds of 18 other, maybe thousands of papers on tracking, they 19 would know how to arrange those and it could be a 20 single system has components of it or aspects of 21 it that a person of ordinary skill in discussion 22 might refer to as being in an inside out	240 1 BY MR. NEWTON: 2 Q Does Pedrotti disclose an example that 3 doesn't have a base station? 4 A So beginning at the bottom of column 4 is 5 one example of a long -- relatively long passage 6 so I would say starting somewhere around like I'll 7 say Line 45 of column 4, for example, and going 8 all the way through maybe the line 10 of column 6, 9 for example. So there's a long section where 10 Pedrotti is talking about the tracker being 11 attached to the HMD, for example, on Line 49 of 12 Column 4 and it goes on, I mean, we could read 13 through all of that but it gives lots of examples 14 of different types of tracking systems and 15 tracking methods, for example, if you look at the 16 top of page -- of Column 5, the paragraph that 17 begins around Line 8 and ends at Line 24, Pedrotti 18 is disclosing examples of light-emitting trackers 19 and trackers with inertial sensors, magnetic, 20 optical, electrical, sonar, radar, ultrasonic, any 21 combination. 22 So Pedrotti is just giving some examples

241 1 of again what a person of ordinary skill would 2 know that there are all these different methods 3 for tracking some of which he's referenced and 4 some of which don't and specific with respect to 5 the base station one particular genre of 6 embodiment or clause of embodiments, concrete 7 embodiments that Pedrotti teaches about, uses to 8 teach the invention, it looks like, for example, 9 at the bottom of column five, around 64 with 10 respect to the base station, so everything I just 11 mentioned above doesn't necessarily need to have a 12 base station, but it can done with a variety of 13 things, but starting at Line 64, Column 5, it 14 reads: "In other embodiments, the base station 15 may be only a cradle or dock upon which the 16 controller may rest perhaps with a groove or 17 contour that conforms to the shape of the 18 controller with the processor or other components 19 located elsewhere." 20 So, in other words, what Pedrotti is 21 teaching to a person of ordinary skill there is 22 the base station is not part of the system. The	243 1 set them down when in this example as I recall 2 they would be charging as you could well imagine 3 like many other systems. So you would set them in 4 their charger, the charger could be in one place, 5 could be in another place. Again, Pedrotti isn't 6 relying on -- Pedrotti isn't tell a person of 7 ordinary skill that somehow the dock is essential 8 to the tracking. That be just like saying the 9 base station is essential to the tracking. 10 Neither one is essential to the tracking. That's 11 just one particular example of how one could do 12 tracking. A person of ordinary skill probably 13 what would come for them which is what comes to 14 mind for me is that the person's head in this sort 15 of embodiment realm that Pedrotti is talking about 16 is being tracked by some other means and the 17 handheld controllers are being tracked with 18 respect to the head. So as you move around which 19 is very -- quite common, that was done like in I 20 believe the Samsung gear VR system which was a 21 collaboration between Sixth Sense who is the I 22 guess owner, yes, the assignee, the applicant, the
242 1 base station could be on the kitchen table, it 2 could be your couch, just set anyplace where the 3 dock for the controllers may rest as said in 4 Line 65 of five. So Pedrotti discloses in my 5 opinion a lot of examples, maybe near infinite 6 combinations of things to a person of ordinary 7 skill that would not use the base station. 8 Q But in all those examples the -- is a 9 stationary place, as you just said, a place where 10 the controller can rest, correct? 11 A I'm sorry, I didn't understand the first 12 few words you said. Could you repeat that? 13 Q Those other places that they are not base 14 stations, Pedrotti says located elsewhere, they 15 are all places that are stationary, correct, 16 because you said as the controller can rest? 17 MR. HENRY: Objection to form. 18 BY THE WITNESS: 19 A If I understand your question, those 20 places may or may not be stationary. When 21 Pedrotti says the controller may rest, it simply 22 means that's a place you can put the controllers,	244 1 company that filed this patent and Samsung who 2 made this system for head mount displays that used 3 a smartphone in your HMD frame so it used I think 4 magnetic tracking to track controllers with 5 respect to the head but the head was independently 6 tracked with respect to the room and everything 7 else. So there's no -- so you could set the 8 controllers down in a charger and then pick the 9 charger up and move it somewhere else and it 10 wouldn't matter. The system would still probably 11 track those and know that the controllers went to 12 this other place but the system is not using the 13 controller to estimate where it is. It's using 14 its estimate of where it is to locate the 15 controllers. That's all. 16 Q Well, the processor and other components 17 in Pedrotti may be located elsewhere, but would 18 the system still act in the same way as Pedrotti's 19 base station, in other words, there is a tracker 20 fixed someplace and the sensor sensed the location 21 of the HMD with respect to the tracker or the 22 position of HMD with respect to the tracker?

245 1 MR. HENRY: Objection to form, compound. 2 BY THE WITNESS: 3 A So embedded in your question was something 4 about a tracker fixed to a place. There's nothing 5 in Pedrotti that says that that has to happen and 6 a person of ordinary skill would understand that's 7 not essential. That's one way you could do it. I 8 would say there are well within the realm of a 9 person of ordinary skill's tools or skill set the 10 ability to prototype or develop different 11 combinations of these technologies that track in 12 different ways that to the end user would seem the 13 same. I mean, there might be some performance 14 difference or some battery life difference or 15 something like that engineers differences and 16 trade off and ease of use by consumers but 17 otherwise one could make one system that could use 18 a bunch of components in one way without use ago 19 fixed sensor anywhere and make everything work to 20 could do what Pedrotti says and yet turn around 21 and make a different system, replace the first 22 system and the person who is using wouldn't even	247 1 Q So in this -- he is talking about 2 radiating antennas, correct? 3 A That's correct, that's what it says, those 4 are the words that Pedrotti uses. 5 Q And under a number of receiving antennas 6 that are attached to the user, correct? 7 A I don't think what you said is correct. I 8 mean, we could read the sentence beginning at 9 Line 64 of Column 4, it says, it shows, referring 10 to the patent that it cites, it shows a plurality 11 of radiating antennas located at a source, it 12 doesn't say where that source is, to provide a 13 plurality of electromagnetic fields spanning three 14 dimensional space and defining a source reference 15 coordinate frame and a plurality of receiving 16 antennas located on an object to be tracked, 17 doesn't say what the object is for receiving that 18 field. That description and what's in that patent 19 is a very well known technique. It goes back to 20 again I think the 1960s and there are a couple of 21 companies that make exactly that system and they 22 are still in operation today and they make lots of
246 1 know because it would still behave the a same way. 2 BY MR. NEWTON: 3 Q Would you please start reading Pedrotti 4 Column 4, Line 59 to Column 5 Line 7. 5 A Would you like it for me to read it out 6 loud or to myself? 7 Q No, to yourself. 8 A Okay. 9 Q So this is one of the tracking mechanism 10 that Pedrotti discloses, correct? 11 MR. HENRY: Objection to form. 12 BY THE WITNESS: 13 A I don't know that I would characterize it 14 quite in that way, but this is -- Pedrotti is -- 15 certainly -- we could read words. Pedrotti is -- 16 says the ways to do this and how to use processors 17 and what to do are well known and Pedrotti gives 18 one example and talks through a little bit in a 19 few sentences that one example which I think to a 20 person of ordinary skill would immediately 21 recognize. They would know what that is. 22 BY MR. RAFATIJO:	248 1 versions of them and they are popular for a 2 variety of reasons. 3 Q So the radiating antennas according to 4 Pedrotti, are located at a source, right? Located 5 at? What does that mean to a POSITA? 6 A The wording is a little odd but a POSITA 7 would understand probably the way it would 8 normally be talked about is that there is a source 9 for the system and that source comprises three 10 orthogonal coils, electromagnetic coils so granted 11 about each of three axis, X, Y and Z together in a 12 small -- the commercial products you can buy 13 together in a small relatively small case or 14 component so that would be sometimes people 15 discussing this particular technology which again 16 super popular would refer to a source and a sensor 17 and the source would be the component -- so both 18 the source and the sensor would have three 19 electromagnetic coils orthogonal coils. The only 20 reason the one would be called the source is 21 because those coils are excited electrically so 22 for example it would sequentially excite the X

249 1 coil for a moment and then turn it off and then 2 excite the Y coil for a moment and then turn it 3 off and then excite the Z coil for a moment and 4 turn it off and do that over and over and over and 5 over again. And then the unit that has also three 6 coils in it that instead is being used for 7 sensing, they would simply measure all three coils 8 every time one of the coils is energized in the 9 opposite unit. So the opposite unit when you 10 excite it sets off a magnetic field. That 11 magnetic field is measured in three dimensions 12 with what would be called the sensor, and you do 13 that over and over and over again and you can 14 estimate the relationship between those two 15 things, the distance, three, location, 16 orientation, all six degrees of freedom between 17 those two things. 18 So when Pedrotti says plurality of 19 radiating antennas located at a source, what that 20 means is there is this source component which has 21 radiating antennas inside of it that's exactly 22 what this systems do and a person of ordinary	251 1 that is referenced in this paragraph of Pedrotti 2 and that is patent, US Patent 4,737,794? 3 A I know that I looked at it at one point in 4 time. It's been a long time so I don't remember 5 but at one point in time absolutely I did look at 6 that. 7 Q Did you list this patent as materials that 8 you reviewed to prepare your declaration? 9 A I don't know, we could go and look but I 10 would say that even if Pedrotti had not -- had 11 omitted that first part and hadn't said anything 12 about a patent and just said was a system for 13 electromagnetic coupling with a plurality of 14 radiating antenna and everything else they said a 15 person of ordinary skill would know it 16 immediately. I would say furthermore even if that 17 whole paragraph is gone, when Pedrotti talks about 18 I believe says below in Column 5 magnetic at 19 Line 16, e.g., the very first thing listed is 20 magnetic, there are very few examples of working 21 examples of systems that use magnetic fields like 22 that and a person of ordinary skill would know
250 1 skill would know that. 2 Q But they are located at, right? 3 MR. HENRY: Objection to form. 4 BY THE WITNESS: 5 A No. I don't know what that means. As I 6 said before, the wording here is a little bit 7 wonky to me but overall reading a person of 8 ordinary skill is going to immediately know what 9 that means and they are going to know what 10 Pedrotti means by radiating antennas locating at a 11 objection. That's exactly what I just said is a 12 thing that would generally be referred to as the 13 sort and it would contain radiating antennas. One 14 could perhaps say those radiating antennas are 15 located at that source but it's a little bit of an 16 odd way to say it so Pedrotti is like the rest of 17 us doesn't always use probably the best wording 18 but overall a person of ordinary skill would 19 understand that in a hard beat would understand 20 that. 21 BY MR. RAFATIJO: 22 Q Dr. Welch, did you read the patent number	252 1 these immediately. It's in every -- that system 2 that's described at the bottom of four and the top 3 of five is I will say -- I will eat my hat so to 4 speak if it's not described, I'm quite certain 5 it's described in every survey of tracking systems 6 that I'm aware of which this may be six or seven 7 including the one that I it -- I think they cite 8 in -- actually wrote a couple but one that's 9 titled something like no silver bullet, we talked 10 about exactly that. 11 Q Did you list the patent 4,737,794 as a 12 document that you reviewed in preparing your 13 declaration? It's a yes-or-no question. 14 A It appears that I did not but I didn't 15 rely on it. I reviewed a lot of things that I 16 didn't list in my declarations. I read things all 17 the time but I didn't rely on them. I didn't rely 18 on this. The as I said, you don't need that. I 19 did pull it. I remember that. The I don't 20 remember when or what I did with it. 21 Q So Pedrotti in that paragraph says it 22 shows a plurality of radiating antennas located at

253 1 the source it certainly means whatever that patent 2 shows, correct. 3 A No. 4 Q The pronoun it refers to what? 5 A The patent. 6 Q So Pedrotti says this patent shows a 7 plurality of radiating antennas located at the 8 source and clearly Pedrotti means what the patent 9 says were radiating antennas are located, correct? 10 A If I'm following what you're saying, I 11 would say I think that's correct. A person of 12 ordinary skill would read this as that patent is 13 describing this thing that I know very well. It 14 is one patent and I actually happen to remember 15 there are multiple patents that are the basis of 16 companies like Polhemus, P-o-l-h-e-m-u-s, and 17 Ascension, two big companies that make 18 electromagnetic tracking systems, and they have 19 some very famous, very old patents. 20 So this to a person of ordinary skill is 21 just saying to them here is a patent that 22 describes this method that a person of ordinary	255 1 A No, not correct. 2 BY MR. RAFATIJO: 3 Q Why not? 4 A Because as you read it says a camera 5 mounted on the base station or elsewhere and the 6 person of ordinary skill, again, would know all of 7 these alternatives. I mean, if you think about 8 back to the Figure 5 line that of mine that we 9 were looking at earlier, it had what you could 10 think of as a camera or an optical sensor mounted 11 into different places. So those are just two 12 examples, but there are an infinite number of 13 places you could put the camera. A person of 14 ordinary skill would know that. 15 So Pedrotti does not say it has to be on a 16 base station. Pedrotti is just using that as an 17 example. It says or elsewhere. It's very broad. 18 BY MR. RAFATIJO: 19 Q So when Pedrotti talks about elsewhere, 20 doesn't it mean a stationary apparatus other than 21 a base station? 22 A I don't know what Pedrotti intended when
254 1 skill is going to immediately say yes, I know that 2 method very well. 3 So the fact that there is an example I 4 guess is there for somebody maybe who – I don't 5 know – needs an example or Pedrotti is just 6 trying to be concrete. I don't know what the 7 rationale was, but it's certainly not necessary. 8 Q Let's move to Column 5, Line 8. 9 A Okay. 10 Q It says: "Another such example of 11 light-emitting trackers which can be seen by and 12 therefore provide position orientation information 13 to a camera mounted on the base station or 14 elsewhere." 15 Do you see that sentence? 16 A Yes, I do. 17 Q So, again, here in Pedrotti there is the 18 base station that the camera is mounted on, 19 correct? 20 MR. HENRY: Objection to form, the 21 document speaks for itself. 22 BY THE WITNESS:	256 1 that inventor wrote this. I don't think – I 2 don't know in a person of ordinary skill would 3 that come to mind, maybe, but as you read further 4 down the paragraph and, again, what a person of 5 ordinary skill knows especially at this time those 6 cameras could be – it was very common to have 7 cameras mounted on the head on the device. The 8 highball system that I helped developed that my 9 Ph.D. work was all about the algorithms for it 10 it's crudely illustrated in that Figure 5 used 11 what sometimes people call cameras, they're 12 actually optic sensors (audio distortion) with 13 photo diodes. Those are mounted on the person's 14 head, not on the head-mounted display and they 15 were used to track a variety of things, primarily 16 the head with respect to the ceiling, but they 17 were camera mounted on the head-mounted display. 18 It's a very common approach. 19 Q So we'd like to establish what this means 20 in Pedrotti. So now I direct your attention to 21 Column 4, Line 49 to 58. Would you please read it 22 to yourself?

257 1 A Okay, I've read it. 2 Q I direct your attention to where it says: 3 For example, sensing an electromagnetic field 4 generate he had from a local base station -- or 5 other apparatus not shown, do you see that? 6 A Yes, I do. 7 Q If it's not a base station Pedrotti 8 discloses a video game console or apparatus, 9 correct? 10 MR. HENRY: Object to form. 11 BY THE WITNESS: 12 A First of all, it's for example. So it is 13 not a closed list of places where something can or 14 cannot be and even if it was, that would be 15 absurd. A person of ordinary skill would not be 16 sometime stymied by that, but it isn't, it's a for 17 example, it's open ended and it's just giving some 18 examples. 19 BY MR. RAFATIJO: 20 Q And yet I ask you to give me one example 21 that the sensor or a landmark, one of them, is not 22 mounted on a stationary apparatus or a stationary	259 1 handheld controllers. That system functions are 2 exactly what is described and is at the end of 3 column 4 beginning around where you just had me 4 read, Line 49 and all the way through the top of 5 column, that magnetic tracking apparatus, it has 6 one I don't know which the probably the source in 7 the plastic charging cradle, and the sensors I 8 believe are in the handheld controllers so that 9 it's tracking the controllers to that cradle and 10 the cradle you can put anywhere you want. So you 11 can sit it in front of your work station and you 12 start doing your thing, whatever it is, moving 13 those controllers, you pick it up and go to 14 another work stations, do it again, pick it up 15 take it home and put it in the kitchen, do it 16 again. So you take that wherever you want and set 17 is it on wherever you want. The system tracks -- 18 that's a real product whose name escapes me made 19 by this company who owns this patent. 20 Q Where did this talk about that product? 21 A It doesn't explicitly, but I'm telling you 22 that a person of ordinary skill reading Line 49
258 1 spot, I just asked you to give one example in 2 Pedrotti that shows that a moving object is a base 3 for both landmark or both landmark and sensor and 4 you still have not given me that. 5 MR. HENRY: Objection to form. Compound, 6 argumentative, mischaracterizes Dr. Welch's 7 testimony. 8 BY THE WITNESS: 9 A I don't recall you ever asking me that. 10 You might think you were trying to ask me that but 11 I don't remember you ever asking me that. You 12 want a great example, I'm happy to give it to you. 13 BY MR. RAFATIJO: 14 Q Sure. Please. Go ahead. 15 A Just off the top of my head, I would say 16 so the owner of this patent, the assignee and the 17 applicants were from a company called Sixth Sense 18 and Sixth Sense makes as I recall a device whose 19 name I cannot remember the specific product name 20 but it is a cradle if you will or small circular 21 maybe 20 centimeters or something like that in 22 diameter plastic unit within which you can put two	260 1 and onward who is halfway awake and sees that the 2 patent is from Sixth Sense would know. It was a 3 very popular gaming product people used 3D gaming 4 even in front of 2D displays. So 3D gaming or 3D 5 interactions in front of a flat panel monitor with 6 3D content, didn't have to be something just head 7 based. So this is very well-known product that 8 existed long before this. Again, that's just one 9 example. I'm just giving you one example because 10 it's very relative because it's an example that 11 matches the discussion at the bottom of four or 12 top of Column 5 and is a product manufactured by 13 the owner of the patent. 14 Q Let's pull up Exhibit 18 and we're going 15 to rename it Exhibit 12 I guess. 16 (A certain document was marked Welch 17 Deposition Exhibit 12 for identification, 18 as of 05/03/2024.) 19 MR. RAFATIJO: If I'm wrong, correct me. 20 How many exhibits do we have on the record? 21 AV TECH CASTRO: I believe 11. 22 MR. RAFATIJO: 11, so let's pull up

261 1 Exhibit 18, thank you, and stamp it as Exhibit 12. 2 THE WITNESS: Actually just to be clear, 3 let me take that back, I think at least I have 4 files that are Exhibit 8, Exhibit 8B, Exhibit 8C 5 so there are three files that are counted as 8 I 6 guess. So it may not -- it might be more than 11, 7 how many? 8 MR. HENRY: Your stamp number should be 12 9 for the next one Counsel but you have 8s as 10 Dr. Welch indicated. 11 BY THE WITNESS: 12 A So there are 13 exhibits I have in front 13 of me. Even though the next one you're saying 14 would be Exhibit 12. 15 BY MR. RAFATIJO: 16 Q Correct because we have three Exhibits 8A, 17 B, 8C, let's pull up Exhibit 18 and stamp it as 18 Exhibit 12. 19 MR. HENRY: If you care, Counsel, your 8 20 was never stamped 8A, it was just 8 and you have 21 an 8B and an 8C but you actually don't have an 8A. 22 MR. RAFATIJO: We can leave it as 8, B and	263 1 document? 2 A Yes. It looks like one of the prior art 3 patents that I used in my analysis. 4 Q Does this patent disclose a system of 5 tracking? 6 A This system discloses like the Pedrotti 7 reference we were looking at a moment ago I 8 believe a lot of methods of tracking. It's sort 9 of -- how can I put this -- examples that that a 10 person of ordinary skill would read and say yes 11 yes yes yes yes to all of those so it describes a 12 lot of alternatives as I recall or covers a lot of 13 alternatives. 14 Q Are they inside out or outside in? 15 MR. HENRY: Objection to form. 16 BY THE WITNESS: 17 A So as with Pedrotti and as I've said 18 before, you cannot universally or globally refer 19 to a tracker as being necessarily one or the 20 other. It's the concept that is only useful when 21 you talk about the configuration of sources and 22 sensors and even then it depends. So it's not
262 1 C. There is enough differentiation. 2 MR. HENRY: We're also creeping up on an 3 hour. You can see that you've circulated Welch 12 4 now but if now is a good time for a break it would 5 probably make sense if you're switching gears. 6 THE WITNESS: I would appreciate that. 7 MR. RAFATIJO: Sure. 8 MR. HENRY: Let's go off the record. 9 THE VIDEOGRAPHER: We are going off the 10 video record, the time is 5:22 p.m. 11 (A recess was had.) 12 THE VIDEOGRAPHER: We are back on the 13 video record. The time is 5:35 p.m. 14 BY MR. RAFATIJO: 15 Q Welcome back, Dr. Welch. 16 A Thank you. 17 Q So did you get that exhibit that the 18 representative from Planet Depos dropped in the 19 chat? 20 A Yes, I believe so. I have Welch 12 in 21 front of me. 22 Q Okay, great. Do you recognize this	264 1 like you can sit here and say every system or 2 everything is inside out or outside in. Some 3 might have components that are one would consider 4 have the properties of inside out configuration 5 which is really what it's about and some might 6 have properties of an outside in configuration and 7 some might have both and a lot of variety of 8 things. There is no hard classification of 9 systems or technologies as one or the other. 10 Q Can we go to Column 8, Line 17 of this 11 patent, that would be Page 26 of the document. 12 A Okay, I'm there. 13 Q Would you please read to yourself 14 Column 8, Line 17 to 30? 15 A Okay. Okay. 16 Q Where are the sensors located? 17 MR. HENRY: Objection to form. 18 BY THE WITNESS: 19 A So just to be clear, first of all, this is 20 just in one embodiment if you read above or prior 21 to this, this is talking about -- this is 22 essentially one example so in this one example I

265 1 believe it's in some places you could probably 2 infer what McCulloch the inventor, lead inventors 3 was thinking about where things would be but maybe 4 they are typically done a certain way. Another 5 component that McCulloch mentions it wouldn't 6 necessarily be clear, it could be one, could be 7 the other and other components McCulloch mentions 8 those concepts are completely irrelevant. So, for 9 example, it doesn't make sense to talk about 10 inside out or outside in with respect to a three 11 axis magnetometer or a three axis gyro or a three 12 axis accelerometer as they don't have in those 13 examples sources and sensors. They don't have 14 multiple components. It's all self contained 15 source less. 16 Q Does McCulloch disclose a controller 17 device? 18 A McCulloch discloses certainly embodiments 19 that uses at least one, if not multiple, I don't 20 remember, physical controllers, physical device 21 that would be held in your hand. 22 Q And does McCulloch disclose that the	267 1 detect infrared light from which depth data may be 2 determined. So sensing infrared light from LE Ds, 3 infrared LE Ds and handheld controllers is a very 4 common mechanism for tracking near body things. 5 Tracking handheld controller near body from a 6 head-mounted display is common. It makes a lot of 7 sense because the controller is always going to be 8 near your body so the visibility of it, the 9 signals, the observations of it, everything about 10 it is generally associated with the front of a 11 person's body in front of their head. They might 12 sometimes do something behind their back or 13 something like that but if I had to try to track 14 it with respect to some global thing in the room 15 then a person of ordinary skill would know this, 16 then as I get farther away from that thing the 17 signals get course, as I turn there might be 18 occlusion by optics in the environment so there 19 are all sorts of reasons that people do body 20 relative tracking or head relative tracking of 21 handheld controllers. But I'd also say that the 22 system that's doing that is tracking everything
266 1 controller device is being tracked by the headset 2 to determine where the controller device is 3 located? 4 A So there's a lot here. McCulloch is 5 relatively long and it's packed full of really 6 great information. There's not repetition in 7 here, it's every paragraph, everything disclosed 8 is useful and new so it's difficult to get through 9 on the fly and try to find something like that. 10 So sitting here right now I don't know that there 11 is an explicit mention like that, the tracking of 12 the real controllers from the head-mounted display 13 but it certainly would be obvious for a lot of 14 reasons so McCulloch for example discloses lots of 15 tracking technologies and mechanisms for sensing 16 various things, just one example in column 7 that 17 jumped out at me down around Line 34 starting at 18 Line 34 where it says: In some examples the 19 capture device 114 which is on the front of the 20 example head-mounted display the embodiment that 21 McCulloch is talking about at that point there may 22 be deputy sensitive cameras which transmit and	268 1 relative -- everything that's relevant relative to 2 everything else. It's having to maintain 3 awareness of where all of the components are 4 generally with respect to everything -- with 5 respect to the room and with respect to each 6 other. So anything it's tracking in any way it's 7 going to know the relationship between those. 8 (Reporter clarification). 9 BY MR. RAFATIJO: 10 Q Dr. Welch, you mentioned Column 7, Line 34 11 and you read a few lines down, Line 34, would you 12 please show me exactly where in those lines it 13 says that HMD tracks the controller? 14 A So I did not say that. That's not what I 15 head, what it said was it would have at least been 16 obvious to do it for all sorts of reasons, and 17 McCulloch provides just examples of all sorts of 18 sensors that would be helpful, useful to do that. 19 Some of them are also listed in Column 8, lines 17 20 through 39 where it talks about at the very end 21 like 39 IR detector camera these are all common 22 things people used for doing that and there are

269 1 really good reasons to do the head tracking, 2 handheld controllers with respect to the head. It 3 makes the most sense, it's most commonly done. A 4 person of ordinary skill would know that and would 5 do it because there's really good reason to do it. 6 It might be disclosed here somewhere in McCulloch. 7 Sitting here right now I am unable to identify 8 that for you. It's a long, long, long patent. I 9 would have to sit here and read the entire patent 10 to try and make a more definitive statement about 11 that. 12 BY MR. RAFATIJO: 13 Q Sitting here today, you cannot tell us 14 where exactly in McCulloch a controller is being 15 tracked by HMD? You need to read the patent, 16 correct, to answer that question? 17 MR. HENRY: Objection to form. 18 Mischaracterizes testimony. 19 BY THE WITNESS: 20 A I'm unable to sitting here right now 21 although I could really I could look at my 22 declaration, but just sitting here right now I	271 1 or to myself. 2 Q Yes, loud please. 3 A The first paragraph of -- the first 4 sentence of Paragraph 476 of Exhibit 5 reads: 5 "Further, McCulloch discloses that its HMD 6 contains capture devices, including cameras, and 7 infrared tran receivers (sensors) that detect and 8 track infrared light that may be emitted by a 9 controller (i.e., one or more sensors in the 10 WED)." 11 Q To support this sentence, you have cited 12 to different places in McCulloch. 13 Do you see those positions? 14 A I do. 15 Q Let's go first to Column 7 Line 34 to 67. 16 If you need time to read those lines, please feel 17 free to take your time. 18 AV TECH CASTRO: Counsel, which page? 19 MR. RAFATIJO: Column 7, so that would be 20 Page 26 of the document. 21 BY THE WITNESS: 22 A It's a relatively long passage but I think
270 1 can't tell you. As I said it certainly would have 2 been obvious to do that for a variety of reasons 3 and McCulloch tells a person of ordinary skill 4 everything they would need to know to sort of 5 remind them of that or set the stage for 6 circumstances where that would make by far the 7 most sense to do. I might talk about this in my 8 declaration. I could go look for that if you want 9 to give me the time I'll go look in there also but 10 sitting here right now pouring through all of this 11 nothing jumps out at me and I don't recall that 12 there is a particular place. It doesn't mean it's 13 not there. It just means I don't have these 14 patents memorized and I don't have my declaration 15 memorized. 16 Q Let's pull up Exhibit 5. 17 A Okay. 18 Q Page 264. Paragraph 476? 19 A Okay. I see that. 20 Q So the paragraph reads -- would you please 21 read the first sentence in the paragraph. 22 A Would you like for me to read it out loud	272 1 I got through it. 2 BY MR. RAFATIJO: 3 Q Would you please show me where exactly in 4 those lines McCulloch says that the HMD tracks 5 controllers? 6 MR. HENRY: Objection to form. 7 BY THE WITNESS: 8 A So I never said that. I think I have 9 repeatedly said that I've never said that but I'll 10 say it again and in my declaration in the sentence 11 that you had sentence that you had me read in 12 Paragraph 476, the cite to that passage you just 13 had me read I've written in parenthesis that it 14 describes capture devices. That's what that 15 section does. And that's what it does so I never 16 said that it does whatever it was that you just 17 asked. 18 BY MR. RAFATIJO: 19 Q So this citation that you provide does not 20 support the sentence, the thesis sentence of this 21 paragraph, right? 22 MR. HENRY: Objection, form.

273 1 BY THE WITNESS: 2 A No. I would disagree. All of this 3 evidence that I'm providing, I mean, there's 4 plenty more but all of these cites are examples of 5 passages in McCulloch that support that very first 6 sentence. 7 BY MR. RAFATIJO: 8 Q Show me where exactly in these citations 9 we can find HMD tracking the controller? 10 A So I'll repeat again. I don't think I've 11 ever said that. I'm not saying that. If we read 12 the first sentence in my declaration it says: 13 McCulloch discloses that it's HMD contains capture 14 devices including cameras an infrared transceivers 15 which are sensors, include sensors that detect and 16 track infrared light that may be emitted by a 17 controller, i.e., one or more sensors in the WED. 18 And then I go on to provide support for that. 19 So that statement I don't know if you 20 called it a thesis, but that first sentence in 476 21 is simply saying that that McCulloch discloses 22 embodiments with a HMD that contains capture	275 1 paragraph in support of your first sentence do not 2 go on to expressly say that HMD in McCulloch track 3 controllers? 4 MR. HENRY: Objection to form, asked and 5 answered. 6 BY MR. RAFATIJO: 7 Q Correct? 8 MR. HENRY: Same objections. 9 BY THE WITNESS: 10 A I think I've answered that multiple times. 11 The statement in the first sentence of my 12 declaration in Paragraph 476 says exactly what it 13 says and it does not say what you just said so I 14 don't know why you're asking me to confirm that 15 the passages I'm citing don't do something that I 16 don't state they do. There are a lot of things 17 those passages don't that I don't state. They do 18 do what I did state. 19 BY MR. RAFATIJO: 20 Q And what it is that they don't do is a 21 disclosure that HMD tracks controllers, correct? 22 MR. HENRY: Objection. Mischaracterizes
274 1 devices that could be used to detect and track 2 infrared light that might be emitted by a 3 controller. 4 Q But that could be used, you don't get that 5 from any of the McCulloch disclosures, you are 6 essentially saying that a POSITA would understand 7 that, right? 8 MR. HENRY: Objection is to form. 9 BY THE WITNESS: 10 A I'm not X sure exactly which thing you're 11 referring to. All of that, everything I describe 12 here and all of that would be is very, very basic 13 tracking concepts and tracking mechanism, there 14 exist plenty of books and papers and examples of 15 hardware systems that do exactly that. It's very 16 well known. So I'm not -- of course anything I'm 17 talking about here I'm relying on the person of 18 ordinary skill both in terms of what they're 19 reading in the claims, what they're reading in the 20 specification of the patents, what they're seeing 21 in this prior art and everything else they know. 22 Q So the citations you provided in this	276 1 testimony. 2 BY THE WITNESS: 3 A As I've said repeatedly, it discloses just 4 that passage we just looked at capture devices and 5 those are capture devices that along with the 6 other examples I give following that in my 7 declaration and all of the citations that are 8 examples of McCulloch's support for that would 9 support the statement at the beginning of 476 10 which says that McCulloch discloses that it's HMD 11 contains capture devices including, not 12 exclusively, but including cameras and infrared 13 transceivers that detect and track infrared light 14 that may be emitted by a controller. That's all 15 it says. May be emitted by a controller so I'm 16 not sure why you're repeatedly asking me something 17 that I don't -- whether to confirm or refute or 18 whatever something that I don't say. 19 BY MR. RAFATIJO: 20 Q So you don't say that McCulloch ever says 21 the HMD tracks controller? 22 MR. HENRY: Objection to form. The

277 1 document speaks for itself. 2 BY THE WITNESS: 3 A I certainly don't say that in that 4 sentence. This is a long document. It's 5 478 pages. I don't know what else I say in other 6 places. I don't have it memorized. 7 BY MR. RAFATIJO: 8 Q So let's pull up again Exhibit 12. 9 A Okay. 10 Q Would you please go to figures 8A through 11 8D? 12 A Okay. I'm looking at 8A at the moment. 13 Q Do you see a stationary cameras in those 14 figures, that would be 20A and 20B. 15 A So I see what McCulloch describes as 16 capture devices 20A and 20B. McCulloch does not 17 say cameras just for the record. McCulloch says 18 capture devices. I'm looking at for example 19 column 14, Line 32. 20 Q Okay. So you are saying 20A and 20B are 21 not cameras? 22 MR. HENRY: Objection to form.	279 1 or a capture device sitting on a monitor. I'm not 2 aware that McCulloch specifically says what those 3 should be for. If you are I'd be happy to look at 4 that if you could point me to something. 5 Q Sure. Could we go to column 6, lines 33 6 to 39 and 39 and that would be Page 25 of the 7 document? 8 A Yes, I see it, I'm there. 9 Q Would you please read those lines to 10 yourself if? 11 A Sure. Okay. 12 Q Does McCulloch there in those lines 13 explain why he uses capture devices? 14 A This paragraph -- the sentence says. The 15 image and depth data of the one or more 3D capture 16 devices 20, that would include 20A and 20B that 17 you're referring to, may supplement data captured 18 by one or more capture devices 113 on the near eye 19 1A display device and other such display devices 20 in the environment and then it goes on longer. At 21 least in that passage McCulloch is saying that 22 optionally those could exist and could be use
278 1 BY THE WITNESS: 2 A No. That's not what I said. I said -- 3 characterized they are described by McCulloch as 4 capture devices, I didn't say they were not 5 cameras, they were described as capture devices. 6 BY MR. RAFATIJO: 7 Q Would they be cameras? 8 A Yes, certainly they could be cameras. 9 Q Great. And why McCulloch uses these 10 stationary capture devices? 11 A I don't recall offhand that there's any 12 particular purpose. What I remember about 13 McCulloch just off the top of my head is McCulloch 14 discloses a lot, a wide range of possible sensor 15 systems, configurations, it's not exhaustive but a 16 pretty wide set of possible scenarios for where 17 someone might have or put a variety of sensor 18 sources, other technologies including those to 19 capture devices. For me it makes me think of 20 maybe even like a Sony I device, Sony motion 21 controller device or something like that but 22 that's just Greg the random thought about a camera	280 1 today gather more measurements that might be 2 helpful. It's, again, something that a person of 3 ordinary skill would understand without -- they 4 wouldn't even need to be told that, that you could 5 be sensors cameras in different places kind of, 6 again, as my Figure 5 correctly illustrated. 7 Q But toward the end in that sentence, it 8 says: "For 3D mapping, gesture recognition, 9 object recognition and other functions as 10 discussed further below," correct? 11 A That's the purpose of McCulloch's capture 12 devices. 13 MR. HENRY: Objection. Form, compound. 14 BY THE WITNESS: 15 A I don't know that it's "the purpose". 16 McCulloch doesn't state a single purpose. 17 McCulloch just says you can have capture devices 18 and McCulloch says one use would be to supplement 19 data captured by the head-worn capture devices and 20 the examples McCulloch appears to give are to help 21 supplement -- using McCulloch's words supplement 22 data about 3D mapping, gesture recognition, object

281 1 recognition and so forth as it says there. 2 So it's certainly not saying that's what 3 those are for. It's just saying they're there. 4 They're capture devices and one example use is to 5 provide additional data, that means supplement the 6 data, that is already being gathered from another 7 place. 8 It's not uncommon to add more points of 9 observability of something if you know something 10 about the circumstances and the settings where 11 people will be using things. You absolutely take 12 that to your advantage, advantage of that. If you 13 knew they were going to be in front of that 14 television most of the time, which is the case, 15 for example, for like a Nintendo Wii or something 16 like that, then you should feel free. It would be 17 a smart thing to do to have some of the components 18 attached to that device. It's certainly an 19 option. You certainly could do that and a person 20 of ordinary skill would know that and would 21 consider that. So McCulloch is not saying that's 22 why those cameras are there or those capture	283 1 another sensor or a slightly different 2 configuration or a slightly different parameter 3 for a camera or sensor, different field of view, 4 different focal length, different resolution 5 sensors, change all of these things and it won't 6 transform the system from working to not working 7 typically. It will just change performance or the 8 characteristics of the system. 9 So that's the way a person of ordinary 10 skill would understand McCulloch's disclosure of 11 those two capture devices, 20A and 20B, is, sure, 12 you can add them, you could have something like 13 that if you want and that could be helpful. 14 That's all McCulloch is saying. 15 Q So McCulloch discloses computing 16 environment, correct? Have you ever seen that 17 word in McCulloch, that term? 18 MR. HENRY: Objection to form. 19 BY THE WITNESS: 20 A I don't recall that specific term. 21 Certainly McCulloch talks about computers and 22 processing and processors and those sorts of
282 1 devices, it just says they are there and one 2 example of use is to help provide some additional 3 data for a variety of things. 4 Q Would McCulloch's system be any effective 5 without those capture devices? 6 A So McCulloch doesn't describe just one 7 system. There are multiple embodiments and there 8 are a variety of components that McCulloch says 9 you can use, not use, but I will certainly those 10 capture devices and that place are certainly not 11 needed. In fact, McCulloch, again, says you can 12 have those capture devices and they could be used 13 to supplement the data. 14 In systems like this, usually it's not the 15 case typically that one would say it works or 16 doesn't work. It's not that binary unless 17 something is really broken or unless you really 18 don't have enough information from the sensors to 19 do what you need to do. It's more likely the case 20 that you can make something work with a particular 21 configuration. You might be able to make it work 22 a little better with a limb additional data from	284 1 things in general. There are lots of words a 2 person of ordinary skill would or could use to 3 describe elements, electronic elements that do 4 some form of something that a person of ordinary 5 skill would consider to be computation or 6 calculation or program execution. So I don't know 7 off the top of my head if those words exist 8 somewhere. It wouldn't surprise me if they did, 9 wouldn't surprise me if they didn't. 10 BY MR. RAFATIJO: 11 Q Does the tracking in McCulloch require 12 computing environment? 13 A Can you please tell me what you mean by a 14 computing environment? 15 Q You read the patents, don't you? 16 A Yes, many times. 17 Q Okay. And you never come across computing 18 environment? 19 A I don't have the patent memorized. So if 20 you know that those words appear somewhere, please 21 just tell me and I will look to see what McCulloch 22 is -- what McCulloch seems to mean by that term.

285 1 Q We can start with Figure 4B. 4A. Sorry. 2 A Okay. 3 Q Do you see on top McCulloch has computing 4 environment 54? 5 A I do, yes. 6 Q What's that? 7 A That appears to be it's discussed on the 8 bottom of Column 13 beginning around Line 52 where 9 it says Figure 4A is a block diagram of and 10 embodiment of a system from a software perspective 11 for control a virtual object displayed by an 12 augmented reality display system, an example of 13 which is a near eye see through display device 14 system. And it goes on to talk about a bunch of 15 other things. 16 So I think -- I would have to study this 17 more carefully, but there are a couple of things. 18 One, it just says Figure 4A is a diagram 19 associated with an embodiment, one embodiment. So 20 it's just an example that McCulloch is giving. It 21 doesn't say that has to be -- that anything has to 22 be in any particular form that would in any way	287 1 Q In Figure 4A -- 2 A Sorry, I wasn't finished yet. 3 Q Sure. Sorry. 4 A A concrete example would be the Samsung 5 Gear VR which I talk about in Paragraphs 56 of 6 Exhibit 5, just this one example, and maybe in my 7 other declaration, too, but this is a system that 8 used as described in 57 Sixth Sense positional 9 tracking for its controllers, I was referring to 10 that earlier. The Gear VR used a smartphone that 11 you insert, presumably a Samsung, smartphone that 12 you insert into the frame and it does everything. 13 It does all the tracking, it does all the 14 computing, it does all the rendering, it puts the 15 images up, it creates the sounds. So that gives 16 you some sense that a smartphone could do all of 17 that. That's not unusual. 18 Q So going back to Figure 4A McCulloch, do 19 you see computer systems 12? 20 A Yes, I do at the top. 21 Q Great. So why does McCulloch always 22 include a computing system in addition to the
286 1 resemble Figure 4A. It's just an example, a 2 useful example. 3 I'd also say that I believe that 54 the 4 computing environment here is really a functional 5 organization of things that do computing. It does 6 not mean that those things necessarily, it 7 wouldn't to a person of ordinary skill mean that 8 those things necessarily have to happen even in 9 the same place on the same hardware. They may 10 functionally associated with each other, but I 11 don't believe that there's anything in that figure 12 or anywhere that would purport to say that all of 13 that stuff is in a single physical embodiment if 14 that's what you mean. 15 Q So for tracking of hand controllers in 16 McCulloch or any virtual objects, how powerful of 17 a computing environment is needed? 18 A I think it would depend on a lot of 19 things, it would depend what the controllers are, 20 it would depend on what one is tracking, as a 21 concrete example, not a hypothetical embodiment, 22 but --	288 1 processing available in the headset? 2 MR. HENRY: Objection to form. Lacks 3 foundation. 4 BY THE WITNESS: 5 A First of all, I would disagree with the 6 premise of your question. McCulloch doesn't 7 always do it that way I don't see it that way as 8 an earth -- where I believe McCulloch first begins 9 to substantively talk about Figure 4A and 10 McCulloch says a block diagram of an embodiment of 11 a system from a software -- it goes on and if you 12 look at Figure 4A in the box marked computer 13 systems 122 says image and processing engine 191N 14 which a person of ordinary skill would understand 15 is not an engine like a gasoline engine. It's not 16 a mechanical, physical thing. It is a software 17 component that may use computational machinery or 18 hardware or firmware that is in different places, 19 but to the programmer it would seem like a single 20 function interface, the audio engine, which might 21 provide lots of services in software. 22 So there is nothing in that box computer

Conducted on May 3, 2024

289 1 systems 12 that to me says anything about 2 specifically about what hardware must exist or 3 must or even exists in that example. This is a 4 diagram that's about software, perspectives. 5 That's what McCulloch says and, again, it's a 6 block diagram for an embodiment of a system. So 7 one example, and it's only about software. 8 Q In Figure 4A why does it need computing 9 system 12? 10 MR. HENRY: Objection to form. 11 BY THE WITNESS: 12 A I don't understand what you mean by why 13 does a diagram need computer system 12. That 14 doesn't make any sense to me. 15 This is a diagram authored presumably by 16 the inventors to to help illustrate the example, 17 the embodiment that they're discussing in the 18 specification. So they put whatever they thought 19 made sense. 20 BY MR. RAFATIJO: 21 Q So diagram 4A requires computing system 22 12, right, otherwise the inventors wouldn't put it	291 1 Q Sure, do you also see companion processing 2 module four? 3 A Yes, I do in Figure 1A. 4 Q Why does it have a companion processing 5 module? What is used? 6 A I don't know if I'd call it what's its use 7 per se, that column, I'm sorry, Column 4, Line 43 8 which is where I believe McCulloch first starts to 9 talk substantively about Figure 1A, McCulloch says 10 these are example components of an embodiment so 11 the embodiment is itself an example, so these are 12 example components of an example, and if you look 13 at Figure 1B, that doesn't exist, companion 14 processing module and in Figure 1A it does exist 15 and so McCulloch is simply saying you could have 16 if you needed it which a person of ordinary skill 17 would know but McCulloch is just saying it anyway, 18 you could have a separate component that did other 19 things, for example, processing and that some uses 20 for that in McCulloch are described in Column 5 in 21 a variety of places. A person of ordinary skill 22 wouldn't have needed McCulloch to tell them that.
290 1 there, correct? 2 A No, I would disagree with that. I don't 3 know what it means for a figure to require 4 something. I'm sure there are many things that 5 were omitted from here that would be essential to 6 actually building or doing something. I think the 7 inventors as anybody would who is drafting a 8 patent I've done my own, made figures would put 9 things there that they think are useful or 10 relevant to talk about the given particular 11 invention disclosed or claimed in the patents. 12 There is no requirement for anything. This is 13 just something McCulloch chooses to include in the 14 example embodiment and they are just listing it 15 there along with a lot of other things. 16 Q Perfect. Let's go Figure 1A and 1B. 17 A Okay, I'm looking at Figure 1A and 1B. 18 Q Do you see that McCulloch has computing 19 systems 12? 20 A Sure, I see that both in Figure 1A and 21 Figure 1B a box with the words computing systems 22 12 in sides.	292 1 They would know they could have done that and they 2 would do it or not do it depending on a lot of 3 different tradeoffs if they were going to make a 4 product, think of the weight, size, cost, how 5 often do people break the wire that goes from the 6 head mount to the companion processing module, how 7 much does it cost us as a company to maintain 8 that, to answer phone calls from people who break 9 their companion processing module, just all sorts 10 of considerations and there is advantages perhaps 11 because you might get more computing done, but the 12 disadvantages are the complexity of the design, 13 maintenance and all sorts of things. I'm just 14 giving you a few examples. 15 I'm just saying that McCulloch gives lots 16 of example things that that could be done which, 17 again, wouldn't be any surprise to person of 18 ordinary skill and it's simply an example 19 component of an example system that McCulloch is 20 using. 21 Q Would the performance of McCulloch glasses 22 in Figure 1A and 1B are the same even though

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293 1 Figure 1B doesn't have that companion processing 2 module? 3 A That would be impossible to say. These 4 are just examples. There's not enough detail here 5 to say anything about anything's performance. It 6 would depend on hundreds if not thousands of 7 factors, none the least of which are processing 8 power embedded in -- the one device 115 in and of 9 itself. I don't know which component is it that, 10 maybe 136, but if, for example, one knew that you 11 were willing to pay the cost, and by cost I mean 12 development cost, component cost, maintenance 13 cost, all of those other things, to include 14 companion processing module 4, you might get away 15 with lower cost computing components somewhere 16 else because you know you're going to off load 17 some of that computation to companion processing 18 module 4. So it could be that there are 19 comparable but they are there are just other 20 reasons to do, other tradeoffs, could be weight, 21 by moving some of the processing off into a 22 companion processing module you would maybe put	295 1 used in them. I have never taken one apart. I 2 don't know what processing power they have 3 exactly. There's so much I don't know. I don't 4 have any idea of what's inside. I probably know 5 more about McCulloch's hypothetical examples here 6 than I do anything there, but even McCulloch's I 7 don't have any really any idea. This is -- 8 McCulloch's is not a specific -- a specific 9 things. It's just giving some examples. It's the 10 concept of doing all of these things and McCulloch 11 is giving some examples of these glasses, smart 12 glasses or AR glasses or VR glasses or whatever 13 you want. 14 A similar is a very qualitative word. 15 What is similar? How do you judge what is 16 similar? They are certainly similar in the 17 sense -- they are more similar than, say, a pickup 18 truck is to a Quest, certainly these are more 19 similar in that sense, but are they more similar 20 than certain other head-mounted displays? I don't 21 know how you would -- I don't know how anyone 22 could answer that. I'm not going to answer that
294 1 that on your belt or put it in your pocket and you 2 then you don't have the weight of the associated 3 circuitry additionally on your head, on your ears. 4 So it's just a bunch of tradeoffs. It's not 5 necessarily the case that one is better or worse 6 than the other. There's no way to definitively -- 7 there is no objective better or worse. It's a 8 matter of judgment of the person of ordinary skill 9 who would be implementing a system having been 10 enlightened by McCulloch. 11 Q If you want to compare McCulloch to Quest 12 2, let's say, would you say that the two are 13 similar, McCulloch Figure 1A and 1B, are they 14 similar in function and performance to Quest 2? 15 MR. HENRY: Objection to form, calls for 16 speculation, ambiguous. 17 BY THE WITNESS: 18 A Okay. There's a lot there. First of all, 19 for the Quest 2, Quest 3 or any Quest device, I 20 don't know a lot about how they actually function. 21 I know as a consumer, and as an expert who 22 understands the wealth of technology that could be	296 1 because I can't. I don't know how to answer that. 2 BY MR. RAFATIJO: 3 Q In terms of processing power, are they 4 similar? 5 MR. HENRY: Same objections. 6 BY THE WITNESS: 7 A So, again, I don't know anything specific 8 about the in terms of Quest or for that probably 9 most headphones I can think of. I don't need to 10 and I don't know a lot about the specifics of the 11 internals. 12 Second of all, McCulloch's doesn't have 13 any specifics and McCulloch is a patent from 2015, 14 issued in 2015 filed in 2012 which obviously like 15 any patent isn't going to have some inherent 16 fundamental set of processing that must be used 17 because it's a moving target. I mean, McCulloch 18 the patent like any patent you'd want it to be 19 valuable and to describe your invention in as 20 timeless a manner as you could so that the patent, 21 of course, retains value over some period of time. 22 So McCulloch's description is I would say

297 1 presumably by necessity or intention not going to 2 be specific about anything like that. It may give 3 examples, but there is no definitive sort of 4 processing power or memory or anything like that 5 that one could attribute to McCulloch. McCulloch 6 would not want you doing that. McCulloch does not 7 do that. I have no idea. I don't know about 8 anything such a candidate hypothetical McCulloch 9 example would be and I don't know anything about 10 the internals of the Quest device and I also don't 11 know how -- which things you would compare even if 12 I knew those two things, which I don't. 13 Q Does the processing module four provide 14 any additional processing power? 15 MR. HENRY: Objection to form. 16 BY THE WITNESS: 17 A So as I said a moment ago or a few moments 18 ago, it's not explicitly stated, what it would do, 19 there is no what it will do or wouldn't do. It is 20 an example component that McCulloch says just as a 21 by the way, you could have this and when you ask 22 about additional, it would depend on what you mean	299 1 better worlds, more clearer rendering, better 2 pictures. I don't know. It could be anything. 3 BY MR. NEWTON: 4 Q So one last question. 5 If a sensor senses a user leaving a zone, 6 would that be the same as the sensor sensing a 7 controller in hand of the user leaving the zone? 8 A It would depend on what the system is, but 9 in general if a person of ordinary skill reading 10 this art or not was developing a system to do 11 something like McCulloch does, everything would be 12 tracked by some mechanism, by some device, and its 13 position and orientation would be known relative 14 to each other. They would all be known relative 15 to each other, and they would be known relative -- 16 so if one of those devices, for example, that was 17 being tracked was used to create a boundary or to 18 define some zone or to define some place, then the 19 system is going to know for as long as it's 20 running it's going to know if any of the things 21 it's tracking or keeping track of intersect with 22 that space or go in that zone or whatever the
298 1 by additional. 2 So, for example, it's an additional -- 3 perhaps it could potentially be an additional 4 processor, but as I said a moment ago, it could be 5 that somebody who is designing and building this a 6 person of ordinary skill can have a system based 7 on the teachings from McCulloch could therefore 8 decide to do less processing or have lower 9 processing power in the headset in order to save 10 weight or power or other things because they know 11 they're going to offload some of that to the 12 companion processing model. 13 So in total overall, it could very well be 14 that the sort of floating point operations percent 15 or computational power by some measure would 16 remain basically unchanged. You're just shifting 17 where some of the work is done so it's not all 18 done in components that are resting on the user's 19 ears and on their nose or it could be something 20 else. Users could pay an extra amount of money to 21 get this companion processing module that they 22 hook up to the headset and maybe they get more --	300 1 criteria is that they're interested in using. So 2 it would just be a matter of the developer's 3 desire to do that and choosing to look for that. 4 It would be easily done well within the realm of a 5 person of ordinary skill, and it would make the 6 most sense that they are all relative to each 7 other in that space. 8 Q A follow-up question on that. 9 So if the sensor senses -- is it possible 10 that a sensor senses that the user is leaving a 11 zone or a predefined zone, but the controller in 12 the hand of the user does not leave the zone? 13 A Well, to answer your question, we would 14 have to first -- I would have to first know what 15 you mean by the user leaving the zone. Because it 16 could mean a variety of things. It could mean I 17 get up and start walking toward the zone, it could 18 be that I'm part way in, part way out. The zone 19 might be thick, it might be narrow. I don't know 20 what you're saying exactly, but it's certainly 21 possible that one of the things that's being 22 tracked is in one place. In fact, it's not more

301 1 than possible. It's a certainty. They cannot be 2 at the same place. So things are tracked are 3 going to be at different places. One of the 4 things that are being tracked might be in one 5 place of interest and another might not and the 6 system might want to do something relevant to one 7 of the tracked objects being in a particular place 8 or not, and so that would be an incredibly 9 standard set of functionality or approach that a 10 person of ordinary skill could do. So by whatever 11 means you wanted to define whatever the scenario 12 is you're imagining, it could be implemented. 13 It's just a question of what you want to call 14 leaving or coming or going or whatever. 15 MR. RAFATIJO: So let's take five minutes 16 break if possible. 17 THE WITNESS: Sounds good. Thank you. 18 MR. RAFATIJO: Thank you. 19 THE VIDEOGRAPHER: Stand by. We are going 20 off the video record. The time is 6:36 p.m. 21 (A recess was had.) 22 THE VIDEOGRAPHER: We are back on the	303 1 citations to McCulloch that appear in the second 2 or at the end of the first sentence of this 3 paragraph? 4 A Yes, I do. 5 Q I'd like you to look now at Exhibit 3 and 6 in particular Paragraph 464 of Welch Exhibit 3 7 which you can find on PDF Page 266. 8 A Okay, I'm at Page 266. Which paragraph 9 did you say? 10 Q 464, PDF page -- 11 (Simultaneous speaking) 12 A Okay. Paragraph 464 of Exhibit 3. I'm 13 there. 14 Q Why don't you read that to yourself. Let 15 me know when you're done. 16 A Okay, I've read that. 17 Q And Mr. Rafatijo did not ask you about 18 this paragraph in Exhibit 3, did he? 19 A Not that I recall. 20 Q What did you explain in this paragraph of 21 your declaration? 22 A So I was explaining with a lot of support
302 1 video record. The time is 6:42 p.m. 2 MR. RAFATIJO: Okay. So I really don't 3 have any further questions for you. Thank you for 4 entertaining me, engaging in my questions and 5 thank you, Mr. Henry, for your cooperation. Thank 6 you. 7 MR. HENRY: I have a few questions 8 briefly. 9 EXAMINATION 10 BY MR. HENRY: 11 Q Dr. Welch, if you could you go to 12 Exhibit 5, Welch Exhibit 5. And in particular 13 Paragraph 476 on PDF Page 283. Let me know when 14 you're there. 15 A I'm sorry. What was the paragraph number 16 again? 17 Q 476. 18 A Okay, I'm there. 19 Q Do you remember that Mr. Rafatijo asked 20 you questions about this paragraph? 21 A I do, yes. 22 Q And asked you questions about a particular	304 1 that at least in the one embodiment McCulloch 2 discloses or at minimum renders obvious tracking 3 movement of the real controller, what McCulloch 4 calls the real controller with it's HMD because of 5 the way the McCulloch describes the HMD receiving 6 inertial and position data for that particular 7 controller device in that particular example, and 8 I go on to give support for translation or 9 position, rotation and other information that 10 comes from those inertial devices and it's used to 11 do that tracking of the real controller with HMD. 12 Q And the support that you referred to there 13 includes citations to other portions of the 14 McCulloch reference you did not discuss with 15 Mr. Rafatijo, right? 16 A That's correct, yeah. These are very 17 different sections of McCulloch. 18 Q I'd like you to flip back still in 19 Exhibit 3 to Paragraph 469, please. And read that 20 to yourself and let me know when you're done. 21 A Okay, I've read it. 22 Q What did you explain in Paragraph 469 of

305 1 your declaration -- 2 A I forgot about this, this is where I'm 3 talking about how the tracking -- I mean I say the 4 tracking of the controller takes place entirely 5 within McCulloch's HMD and I go on to explain how 6 that computing environment 54 is contained within 7 the HMD or device displaces 8 which include the 8 head-mounted display device and the companion 9 processing module and so then I provide cites to 10 places in McCulloch that support that. 11 Q Dr. Welch, I'd like to look now back at 12 Exhibit 5, please, and if you could if we could go 13 to Paragraph 38, which is on PDF Page 45. 14 A Okay, I'm there. 15 Q Read that to yourself and let me know when 16 you're done. 17 A Okay, I've read it. 18 Q Paragraph 38 in your declaration that's 19 been marked as Exhibit 5 appears under a heading 20 titled Claim Construction, right? 21 A Correct. 22 Q Does Paragraph 38 accurately explain the	307 1 to those topics, but certainly I've taken courses 2 like on signal processing, mathematics courses, 3 calculus, other things, that are certainly 4 relevant, but I've had lots of formal coursework. 5 So I don't know if that changes what I said of it 6 in that way, but my memory is I was trying to find 7 exactly a course that would be named something 8 like that but, no, that is not the only way that 9 I've gotten that knowledge. 10 MR. HENRY: I have no further questions. 11 Unless Mr. Rafatijo has any followup I think we're 12 done. Mr. Rafatijo. 13 MR. RAFATIJO: Yes, I need five minutes 14 and I have followup. 15 THE VIDEOGRAPHER: We're going off the 16 video record. The time is 6:51 p.m. 17 (A recess was had.) 18 THE VIDEOGRAPHER: We are back on the 19 video record. The time is 6:55 p.m. 20 FURTHER EXAMINATION 21 BY MR. RAFATIJO: 22 Q Dr. Welch, Mr. Henry asked you about two
306 1 approach you took to claim construction and to the 2 meanings attributed to claim terms in your 3 analysis? 4 A Yes, I would say so, yes. 5 Q And now, Dr. Welch, not referring to any 6 documents, do you recall -- you may not because it 7 was at the beginning of the day, but do you recall 8 having some discussion with Mr. Rafatijo about 9 your academic experience with audio modeling and 10 rendering? 11 A Yes, I do. 12 Q And at one point do you happen to recall 13 where you were asked whether you took two years of 14 coursework related to audio rendering and 15 modeling? 16 A Yes, I do. 17 Q Is coursework the only academic experience 18 you have with audio modeling and rendering? 19 A No, certainly not and I also realize now 20 that you reask that that I was perhaps -- I don't 21 remember what the exact question was, but I think 22 in my head I was thinking about courses dedicated	308 1 paragraphs in Exhibit 3, that was Paragraph 464 2 and 469. 3 Do you recall that? 4 A I recall we looked at two paragraphs. I 5 don't recall which ones they were. 6 Q They were Exhibit 3. Would you please 7 pull that up. 8 A Yes, I'm sorry, that much I remember. I 9 just don't remember the specific paragraph 10 numbers, but I have 469 open in front of me so I 11 think that was the last one we looked at. 12 Q Did you submit this declaration in support 13 of your declaration -- in support of IPR 1022 and 14 IPR 1023? 15 A I don't know off the top of my head and I 16 don't see it here in my declaration which like the 17 IPR numbers unless I'm missing something. What I 18 see are the patent numbers. 19 Q What patent number does this declaration 20 address? 21 A There is for the '737 patent. 22 Q So this is not -- these two paragraphs are

309 1 not related to the other two patents for which you 2 submitted the declaration, correct? 3 MR. HENRY: Objection to form. 4 BY THE WITNESS: 5 A I wouldn't say they're not related. 6 They're certainly related. It is clearly those 7 paragraphs are in my '737 declaration. 8 BY MR. RAFATIJO: 9 Q Are they in your other declaration? 10 A Pardon me? 11 Q Are they in your other declaration? 12 A Are you asking if those two paragraphs are 13 in the declaration for the '509 and '316 patents, 14 is that what you're asking? 15 Q Yes, yes. 16 A I couldn't answer that without doing a 17 complete search. I believe it's very likely that 18 the same things are said somewhere else. I do 19 give good examples in each of these things but I 20 couldn't tell you right now whether each of those 21 paragraphs were reproduced somewhere else in my 22 second declaration. I mean, if they are, they	311 1 Exhibit 3 is referring to that all of that would 2 be taking place in the -- in or on the headset 3 shown in Figure 1A or 1B for that matter. So 4 everything as I recall from memory is being done 5 by that device in that headset so anything that 6 would be the computational video controller and 7 things like that is being done there, essentially 8 all of the things listed in Figure 4A. 9 Q Let's go to Paragraph 469, that's the 10 paragraph you were talking about now. 11 A Okay. 12 Q So remember when I asked you about 13 computing environment you first didn't know what 14 it is. Now here you are referencing Column 28, 15 Line 63 to 66 in support of your conclusion that 16 tracking the controller takes place within HMD. 17 Let's read McCulloch Exhibit 12, Column 28, 18 Line 63 to 66. 19 A Okay. I'm there, but to be clear 20 obviously there's an entire paragraph there with 21 lots of cites to different places so we're just 22 looking at the first one.
310 1 are. 2 Q So Paragraph 464 you are citing to 29 -- 3 sorry, column 29, lines 4 to 36 of my column, do 4 you see that? 5 A I'm sorry. I'm looking at the top of page 6 PDF page 266 so in Paragraph 464 where at the very 7 top there is a citation to Exhibit 1008, rows 4 8 through 36, is that what you were referring to? 9 Q Yes. 10 A Okay. And those words in the quotation 11 would they say that HMD tracks controller. I'm 12 not aware that particular passage says that. I 13 think I know that my opinions are based on more 14 than just that one passage, for one, that entire 15 Paragraph 464 has a lot of information, a lot of 16 other cites, and, again, as I've said before those 17 are just examples. I try to find good examples, 18 but then also as I think we've discussed before in 19 computing environment 54, McCulloch, in Figure 4A 20 we were looking at before which includes all the 21 computing device data, the real controller data 22 and interface which is what Paragraph 464 in my	312 1 Q We can go look at every one of them, 63 to 2 66, where does it say that the HMD tracks 3 controller? 4 MR. HENRY: Objection to form. 5 BY THE WITNESS: 6 A So in that passage, one of the things it 7 says in that passage at Line 63 in column 28, it 8 says Joe, and there is a lot proceeding this of 9 course that sets this up, it says Joe holding a 10 handheld IMU real controller device 19 in this 11 example which has established communication with 12 his display device system eight, e.g., two and 13 four. 14 So a person of ordinary skill would 15 understand that if the handheld controller that 16 contains the IMU has established communication to 17 the system that McCulloch has described as having 18 all of that computational infrastructure in at 19 least Figure 1A if not Figure 1B, then there is a 20 reason why it's established the connection because 21 that data from the handheld IMU real controller is 22 going to the display device system eight and there

313 1 would be only one reason for that and it would be 2 to compute the POSE of the handheld real 3 controller device 19 by that display device system 4 eight. So it's just one example just in that 5 first passage. 6 BY MR. RAFATIJO: 7 Q If my computer established a communication 8 or connection with my mouse, does that mean my 9 computer tracks the location of my mouse? 10 MR. HENRY: Objection to form. 11 BY MR. RAFATIJO: 12 Q It's a yes-or-no question. 13 MR. HENRY: Objection. 14 BY THE WITNESS: 15 A Sorry. I just had not answered yet. 16 I would say that in any practical 17 commonsense way the answer to that would be yes, 18 it does mean that's what it's there. I don't know 19 why you would have a connection between those two 20 devices if the computer was not itself tracking 21 the mouse. The mouse -- typically mice most of 22 them don't have processing power, don't do any	315 1 BY THE WITNESS: 2 A No, that is not at all what I said. That 3 is very, very far from what I said. 4 BY MR. RAFATIJO: 5 Q Well, I just asked you if my mouse is in 6 connection my computer, my computer knows where my 7 mouse is located exactly and you said yes, right? 8 A That is correct. A mouse is a very 9 specific peripheral that typically has a very 10 specific purpose. The computer likewise -- mice 11 connected to computers there's a lot of context in 12 your first example and then your question to me I 13 think was about general devices being connected to 14 each other and, oh, my gosh, there are probably an 15 infinite number of devices that are connected to 16 each other that don't mean necessarily that. It's 17 the context and the surrounding explanations and 18 figures for example in McCulloch that tell you 19 that, tell a person of ordinary skill that. There 20 would be no other reason that I can think of to 21 connect those two devices which would mean you're 22 transmitting data, what data would you transmit,
314 1 tracking of themselves, for example, if it's an 2 electromechanical mouse it would have rolling 3 wheels with shaft encoders or something like, if 4 it's an optical mouse, it would have some infrared 5 light source that looks down at the surface and 6 reflects something back up and would have a sensor 7 and would be sending information back to the 8 computer about the pulses it's seeing and it's the 9 computer with some driver in the computer that 10 would be tracking the mouse. It would be 11 computing where the mouse is on the surface where 12 it's being moved. 13 Q Does it track the location of the mouse, 14 the physical location of the mouse? 15 A Yes, yes, absolutely. 16 Q So if two devices are in communication 17 with one another, they are necessarily one is able 18 to say where the other device is exactly located, 19 that's what you're saying? 20 MR. HENRY: Objection to form, 21 argumentative, mischaracterizes Dr. Welch's 22 testimony, incomplete hypothetical.	316 1 why? The only data you would transmit and why 2 would be the data from the sensors in that 3 handheld roll controller device where computing 4 can be done on them perhaps supplemented by some 5 other sensors or other things, that is exactly -- 6 I don't think there's any question, there is no 7 question in my mind that that's what that means 8 and I don't think there would be any question in a 9 person of ordinary skill's mind, and it has 10 nothing do with a broad characterization of 11 sensors being connected to each other. It is this 12 specific sensor in this specific controller which 13 is being used for this specific purpose along with 14 this specific head-mounted display that is doing a 15 very specific things and these are two things that 16 routinely go together and communicate and do what 17 I just said. 18 So I don't think there's any question in a 19 person of ordinary skill's mind that that's what 20 that is doing. 21 Q One last question. You said you never had 22 any coursework dedicated to the field of audio

317 1 rendering and modeling, correct? 2 MR. HENRY: Objection to form. 3 BY THE WITNESS: 4 A What I don't recall and, frankly, I would 5 have to go back and look at transcripts and other 6 learning modules and things that I've taken on the 7 side I don't recall a particular course that had a 8 title, for example, or a syllabus that was solely 9 focused on that. I do remember courses that 10 covered topics like signal processing and the 11 mathematics involved in those things, convolutions 12 and fourier transformers and all of those things 13 that were very very very relevant to signal 14 processing associated with audio or sound modeling 15 and externalization. In fact, those are the 16 hardest -- those are the most complex, most 17 difficult to understand aspects of that sort of 18 thing. So all of that I've certainly had in other 19 courses and been doing routinely off and on 20 throughout my professional career even, as I said, 21 from as an undergrad when I developed an interest 22 in audio sampling, digitization, reproduction and	319 1 now. I would be surprised frankly if there was. 2 I would have to go back and look at my 3 transcripts, but I don't think there's anything I 4 could have taken in any one of those -- a course 5 that I could imagine throughout my educational 6 background that would have taught me something I 7 don't already know. So much those concepts, 8 again, that are not specific to audio but appear 9 in computer graphics, they appear in computer 10 vision and signal processing that is done in 11 those, the convolutions, the different transforms, 12 transfer functions, all of those things all exist 13 in these other domains, computer vision, so 14 sensing, computer graphics, renderings, when you 15 think about all sorts -- all different aspects of 16 those, and I've had fundamental courses on all of 17 those things which were, again, not specific to 18 audio but specific to computer vision and/or 19 computer graphics and use the same concepts just 20 not exactly the same concepts, very close in the 21 same mathematics and to someone in the art who 22 understands the hardest part, basic things of
318 1 those sorts of things. I had a keen interest in 2 that and followed it very closely and read papers 3 and read books and went to conventions. I 4 remember going to conventions where some of the 5 original first systems that did that sort of audio 6 sampling and reconstruction were demonstrated and 7 it was pretty memorable experience, went with my 8 father. 9 So lots of -- lots of things over my life 10 reading, learning in different ways related to 11 that and certainly course material that is 12 teaching some of the core concepts that you need 13 for doing those sorts of things even if the course 14 itself was not explicitly named that. 15 Q But you didn't have any coursework 16 dedicated to the field of audio rendering and 17 modeling? 18 MR. HENRY: Objection to form. Objection 19 to form, mischaracterizes testimony, asked and 20 answered. 21 BY THE WITNESS: 22 A Not that I can recall sitting here right	320 1 convolutions and transfer functions and spectral 2 properties and fourier transforms and spectral and 3 all of those things, that's basically it, 4 understanding I think that's the most -- if there 5 is an a challenging part that would probably be 6 the most challenging part for most people and I've 7 had lots of that over the years. 8 MR. RAFATIJO: I have no further 9 questions. 10 MR. HENRY: I have just a couple of follow 11 ups. 12 FURTHER EXAMINATION 13 BY MR. HENRY: 14 Q Dr. Welch, could you put Exhibit 3 which 15 is your declaration for the '737 patent? 16 MR. RAFATIJO: Counsel, objection, 17 objection. You cannot do any follow up. The PTAB 18 says after recross the deposition ended. If you 19 are going to pursue this we need to stop this and 20 go and seek the board's intervention. 21 MR. HENRY: Show me the rule. Off the 22 record, show me the rule. Let's go off the

Transcript of Dr. Gregory F. Welch
Conducted on May 3, 2024

81 (321 to 324)

321 1 record. 2 MR. RAFATIJO: You need to do your own 3 home work. 4 MR. HENRY: Let's go off the record and 5 we'll come back. 6 THE VIDEOGRAPHER: We are going off the 7 record. The time is 7:16 p.m. 8 (A recess was had.) 9 THE VIDEOGRAPHER: We are back on the 10 video record. The time is 7:29 p.m. 11 MR. HENRY: Before we took the break, 12 Counsel indicated to me that there was a rule 13 against a redirect within the scope of his recross 14 but was unable to identify for me any express 15 language to that effect in any type of rule in the 16 Trial Practice Guide or otherwise and but was 17 instead stating that that's the rule by 18 implication only. 19 Nevertheless, because we've taken so much 20 time from Dr. Welch today, I don't have further 21 questions. So at this time this deposition is 22 over. 322 1 MR. RAFATIJO: I object and I object that 2 you are mischaracterizing my position. The 37 CFR 3 Section 42.53, Section C. Section 2 clearly says 4 that the order for conducting a deposition is 5 cross, followed by redirect, followed by recross. 6 There's nothing after that. 7 MR. HENRY: That's the point. There's 8 nothing after that and if you don't have any 9 questions for the witness sir we're done. Are we 10 done? We're done. Let's go off the record. 11 MR. RAFATIJO: That's my deposition. I 12 didn't end it. 13 MR. HENRY: Okay. End it. 14 MR. RAFATIJO: I didn't. So you don't get 15 to do it for me, okay. 16 MR. HENRY: End it, sir. Let's go. Are 17 we over? 18 MR. RAFATIJO: You don't get to do it for 19 me. It's my deposition. 20 MR. HENRY: All right. 21 MR. RAFATIJO: We are done. Thank you, 22 Dr. Welch.	323 1 THE VIDEOGRAPHER: Stand by to go off the 2 video record. 3 This marks the end of the video deposition 4 of Dr. Greg Welch. The time on the video monitor 5 is 7:31 p.m. 6 (Deposition concluded at 7:31 p.m. CST.) 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 324 1 CERTIFICATE OF SHORTHAND REPORTER - NOTARY PUBLIC 2 I, Theresa A. Vorkapic, Certified 3 Reporter and Notary Public within and for the 4 State of Illinois do hereby certify: 5 That GREGORY F. WELCH, the witness whose 6 deposition is hereinbefore set forth, 7 Was duly sworn by me before the 8 commencement of such deposition and that such 9 deposition was taken before me and is a true 10 record of the testimony given by such witness. 11 I further certify that the adverse 12 party, Petitioner, was represented by counsel at 13 the deposition. 14 I further certify that the deposition of 15 GREGORY F. WELCH, occurred virtually on Friday, 16 May 3rd, 2024, commencing at 9:47 a.m. to 7:31 17 p.m. CST. 18 I further certify the inspection, 19 reading and signing of said deposition was 20 waived on the record by agreement of all parties. 21 I further certify that I am not related 22 to any of the parties to this action by blood
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Exhibit 2012
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325	
1 or marriage, I am not employed by or an attorney	
2 to any of the parties to this action, and that I	
3 am in no way interested, financially or otherwise,	
4 in the outcome of this matter.	
5 IN WITNESS WHEREOF, I have hereunto set	
6 my hand this 6th day of May, 2024.	
7 	
8 Theresa A. Vorkapic	
9 My commission expires November 6, 2027.	
10 NOTARY PUBLIC IN AND FOR THE	
11 ILLINOIS	
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