

1 UNITED STATES DISTRICT COURT  
 2 FOR THE NORTHERN DISTRICT OF CALIFORNIA

3 -----X  
 4 Case No.: 4:20-CV-05640-YGR  
 5 -----X

6 EPIC GAMES INC.,

7 Plaintiff,

8 v.

9 APPLE INC.,

10 Defendant.  
 11 -----X

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 13 File Name: APL-EG\_07868680  
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DEFENDANT	United States District Court Northern District of California	
	Case No. <b>4:20-cv-05640-YGR</b>	
	Case Title <i>Epic Games, Inc. v. Apple, Inc.</i>	
	Exhibit No. <b>DX-3768</b>	
	Date Entered _____	
		Susan Y. Soong, Clerk
By: _____		Deputy Clerk

1           TIM SWEENEY: Thank you very much. I'm  
2 going to talk about the long-term future of  
3 technology and give -- share some thoughts on  
4 this. This started with a YouTube video that's  
5 been circulating where somebody hands a magazine  
6 to a little girl and she picks it up and she  
7 drags her fingers around it, and it doesn't  
8 respond, and she gets very, very frustrated with  
9 it, and she concludes that it's a broken iPad.

10           As somebody who was born before the  
11 personal computer era even began, it really  
12 impresses on me how far we've come, how much the  
13 technology has changed and how much that's  
14 enabled better experiences with gaming and  
15 computing and the entire consumer experience.

16           And so I wanted to talk about that, but  
17 at the same time we're on the verge of a new  
18 generation of hardware. Everybody is talking  
19 about will there be another console generation or  
20 are consoles good enough today? And perhaps --  
21 perhaps we've already seen our industry's  
22 brightest days.

23           But I don't think so at all. And to  
24 try to move away from just giving a sheer opinion  
25 on this I wanted to draw from some experience in

1 some very diverse fields to share my thoughts on  
2 this important question for us all.

3 Now, one important thing to realize in  
4 all of this is gamers are actually just  
5 biological organisms, right? We tend not to  
6 think of people that way but we are. We are --  
7 our experience of video games is driven by our  
8 ears and our eyes, but most importantly our eyes  
9 and our optical cortex.

10 Now our eyes consist of a huge number  
11 of photoreceptors, they're transmitted through  
12 our optical nerve to our brain. And there are  
13 physical limits to these devices. (to screen)  
14 Thanks, Windows.

15 So there are physical limits to our  
16 capability to perceive detail and scenes. And so  
17 it's reasonable to say that eventually computer  
18 will be good enough. But we really have to ask  
19 how much -- how good is good enough and how close  
20 are we to that right now?

21 And this has actually been really  
22 thoroughly studied in the theoretical research.  
23 We found ultimately that the human eye and  
24 optical cortex is about the equivalent of a 30-  
25 megapixel camera.

1           Now I like to go hiking through the  
2   woods and take 20-megapixel pictures with my  
3   camera of nature photographs. So the human eye  
4   is actually fairly close to that. And we --  
5   scientists have also discovered that you don't  
6   really respond or perceive improvements in frame  
7   rate beyond 70 frames a second.

8           And so from these pieces of data we can  
9   look at resolutions that are actually to the  
10  point of -- hitting the limits of human  
11  perception, and we're very close to that today  
12  with today's iPad and with high definition  
13  televisions. And in another generation or two  
14  we'll actually be there for devices you're  
15  viewing fairly up close. Or from a fairly --  
16  from a distance.

17          But if you want an immersive display  
18  that fills your entire field of view with  
19  imagery, you really need a much higher resolution  
20  display. And it looks like the limit is about  
21  8,000 by 4,000 pixels, or about 16 times higher  
22  resolution than our current high definition  
23  televisions. And so we have a ways to go there,  
24  but the limit is really within sight.

25          Now, knowing these limitations we can

1 really plug them into the graphics pipeline and  
2 look at what impact they have on computing power  
3 and games. Now there's an important theorem.  
4 Gosh, who knows what the theorem is, anybody?  
5 Okay.

6 I'm used to talking to very technical  
7 audiences. But the idea is that if you have a  
8 screen of a given resolution there's no point to  
9 having more than a certain data in your  
10 computer's memory from which you generate the  
11 scene.

12 Beyond that limit known as the Nyquist  
13 limit, any additional detail that you're putting  
14 into rendering your scene is just largely wasted.  
15 And so there is a finite limit of data -- to the  
16 amount of data we need to render to create a  
17 perfect scene that can't be beaten from a human's  
18 point of view.

19 And that limit turns out to be only  
20 about 50 times more triangle rendering power than  
21 we have in today's GPUs. So from that point of  
22 view you can conclude that we have at least two  
23 more generations to go. But that's not the whole  
24 story at all. That's just looking at pixels.

25 But computer graphics is the art of

1 approximating all of the aspects that contribute  
2 to the visual scene, from the objects you see to  
3 the lighting and the way the light traverses  
4 through the environment, to the movement of  
5 objects that are animating within the scene.

6 And as with all sorts of approximation,  
7 we start with a simple approximation and as we  
8 get more computing power we add more to it. The  
9 approximation is also a mathematical concept as  
10 we all learned through calculus. Everybody's a  
11 big fan of calculus, right?

12 At any rate, we start out with a very  
13 simple approximation to some function we're  
14 looking to generate, whether it's a computer  
15 image or a mathematical function or a number, and  
16 we add successive approximations until our  
17 approximation becomes good enough for our  
18 purposes and doesn't need any more clarity.

19 And graphics has gone through the same  
20 process of approximation over the past 20 years.  
21 And it started out -- this is my first game, ZZT,  
22 written back in 1991. It wasn't an approximation  
23 to reality whatsoever. It was just an iconic  
24 representation of some objects that move around a  
25 scene in a puzzle game.

1           It wasn't until the first 3D games that  
2 we began to actually approximate reality through  
3 computer rendering. And Doom is a great example  
4 of that. It's the first-order approximation. In  
5 Doom, the scene is rendered by approximating a  
6 single bounce of light from each point in the  
7 world straight to your eye without any  
8 intermediate affects.

9           And that was very efficient but as we  
10 got more computing power we were able to reach  
11 the second-order approximation. And I mean this  
12 in the strictest -- approximation in the  
13 strictest sense. We're modeling two bounces of  
14 light.

15           Light starts at a light source, it  
16 bounces off a point in the world, and it reaches  
17 the viewer's eye. And in between it might  
18 encounter shadows and color propagates throughout  
19 the environment. And this is a scene from Unreal  
20 I that shows the -- an early second-order  
21 approximation of computer graphics.

22           And this same approximation has been  
23 carried over. In fact, 99 percent of the  
24 graphics you see in even today's games for Xbox  
25 360 and PlayStation 3 are just using the second-

1 order approximation. And we're just starting to  
2 get enough computing power now to reach a third-  
3 order approximation.

4 And this is a scene from the Samaritan  
5 demo that we put together for the Games Developer  
6 Conference last year. It's running on the  
7 fastest in video cards that money can buy. And  
8 here we're approximating three bounces of light.

9 Light goes from a light source to a  
10 point on the world, it lights that point up, and  
11 then we reflect all of the surfaces in the world  
12 off of all of the other surfaces in the world and  
13 the light eventually reaches the eye.

14 So what you see here in this scene are  
15 all of the bright areas and all of the walls,  
16 they received a lot of light bouncing off of the  
17 ground in a glossy reflection and reaching your  
18 eye. And as you move around you see an amount of  
19 detail that's fairly surprising and shocking  
20 relative to today's games.

21 It clearly shows that there's at least  
22 room for another generation here. But I think we  
23 have a lot more than that to go. Now if we boil  
24 this down to raw computing power, Doom's  
25 rendering approximation required about 10 million



1 floating point operations per second of computing  
2 power.

3 Unreal in 1998 required a billion, and  
4 then our latest demo required about two and a  
5 half trillion floating point operations per  
6 second. So we've already scaled performance  
7 across many orders of magnitude. I think we have  
8 farther to go still. Because many aspects of  
9 realistic scenes we see today require many  
10 bounces of light to simulate accurately.

11 For example, the soft shading you see  
12 on skin is the combination of many different  
13 effects. There is the oiliness to their skin  
14 which reflects light and other aspects of the  
15 environment off of our skin and to the viewer.

16 There's also light transmitting through  
17 the surfaces and through the three-dimensional  
18 space within your skin picking up and  
19 transmitting color as it goes to produce the real  
20 subtle highlights that you expect in the human  
21 face.

22 And we're so far short of being able to  
23 achieve this in real time with a complete and  
24 movie-level of accuracy. We seem to be stuck  
25 here. Well, figure out if we can advance the

1 slide. There we go.

2 Anyway, the point I'm working up to  
3 here is that there are some known knowns, and any  
4 scientific problem which we completely understand  
5 we can eventually approximate perfectly given  
6 sufficient computing power.

7 And we absolutely understand lighting  
8 and shadows and color and skin 100 percent, and  
9 we can expect over the next several decades that  
10 we'll achieve, you know, very close to reality in  
11 computer graphics in these areas.

12 But we're still a very long way from  
13 accomplishing that and I think we're still about  
14 a factor of 2,000 short of being able to simulate  
15 these known aspects of light transmission  
16 throughout environments and represent completely  
17 accurate scenes.

18 But it gets worse than that because  
19 there are unknown problems, there are problems  
20 which we don't even know how to solve given  
21 infinite computing power. These come in the form  
22 of simulating accurate human thought or movement  
23 or speech, or any other aspect of human  
24 intelligence.

25 We don't have the algorithms, and even

1 if you gave us an infinitely fast computer today,  
2 we still wouldn't be able to conduct -- or  
3 animate characters more realistically than you  
4 see today in games like Gears of War and Call of  
5 Duty.

6 So we're relying on not more computing  
7 power in the areas but simple advances in the  
8 state of the art and invention. And in the  
9 meantime we'll resort to tricks and other hacks  
10 to get those aspects of gaming good enough.

11 But -- so knowing that we want a whole  
12 lot more computing power, the next question is  
13 can we actually have it. And this is an  
14 interesting question right now because we've seen  
15 about 40 years' worth of Moore's Law ever since  
16 Gordon Moore at Intel articulated the principle  
17 in 1968.

18 We've seen computing power double  
19 roughly every two years as transistor sizes have  
20 been shrunk smaller and smaller. But we're  
21 starting to run into trouble because our  
22 transistors are approaching the size of atoms.

23 And while you might be able to make a  
24 one atom transistor, you certainly can't split an  
25 atom in half and create smaller transistors. So

1 we're really running into a crossroads here in  
2 approaching the physical limits.

3 But nobody's ever seen more than about  
4 three generations ahead in terms of  
5 microprocessor manufacturing technologies. And  
6 so there are actually a lot of possibilities for  
7 the future to go beyond our current limits.

8 One of the big possibilities is to go  
9 vertical. That's to stack multiple layers of  
10 chips on top of each other vertically until you  
11 achieve the amount -- a much higher amount of  
12 computing power. And if that can be done than  
13 there's another factor of 10,000 to be had  
14 perhaps, in Moore's Law.

15 If you figure out the number of  
16 transistors in a chip, it's about 10,000  
17 transistors by 10,000 transistors. That's a  
18 really impressive number, but the stack is only  
19 one level high now and if you made that as high  
20 vertically as it is horizontal, then there's  
21 another huge increase in computing power.

22 There's also the promise of quantum  
23 computing coming up over the next few years. In  
24 the last few years there have been a lot of  
25 practical advances in this area, people

1 constructing computer chips up to like, five bits  
2 in size. You know, versus the gigabits we have  
3 today in classical computing.

4 But we're really starting to now  
5 develop the fundamental building blocks we need  
6 to build far more powerful computers. And the  
7 big, interesting thing there is that while  
8 traditional computing chip has a series of  
9 transistors, and each transistor performs one  
10 operation at a time, a quantum computer can  
11 operate on many pieces of data in parallel and  
12 thus produce a much, much higher level of  
13 computation.

14 And ultimately if we look at this,  
15 since the 1980s the physicist Stephen Hawking did  
16 some very interesting work that started with  
17 black hole physics that developed into a sort of  
18 quantum theory of information which established  
19 there's actually a physical limit to the amount  
20 of computation -- or computational power that can  
21 be packed into a given space.

22 And that's known as the Bekenstein  
23 bound. And it's a really interesting thing to  
24 look at that bound because it's about a factor of  
25 a trillion trillion higher than our current

1 computers are in processing power. And so if  
2 we're able to get to these limits, then we could  
3 potentially have Moore's Law continuing to double  
4 computing power every couple of years for another  
5 200 years almost.

6 And that starts to sound science  
7 fiction-y at some point, but if we look at  
8 practical advances in physics and how they've  
9 translated to later engineering advances that  
10 affect the real world, there's a fairly long time  
11 lag from the discovery of electricity and its  
12 existence to the employment of practical consumer  
13 electronics devices.

14 And then in 1905 Einstein discovered  
15 the equivalence between matter and energy and  
16 came up with the idea that matter -- a small  
17 amount of matter could be converted into a vast  
18 amount of energy, in 1905. And then 40 years  
19 later that was turned into a physical reality  
20 with the invention of atomic weapons.

21 So these areas of leading-edge physics  
22 can be a bit scary but also promising for the  
23 future of computing. Because you might expect  
24 that over the course of our lifetimes we really  
25 start to push up to such high levels of

1 computational power that we can come very close  
2 to simulating reality.

3 But these technical aspects are very  
4 predictable, just from the laws of physics and  
5 science. The social implications are much, much  
6 cloudier because there's no Moore's Law applied  
7 to invention or to the social adoption of new  
8 technologies.

9 Rather the progress that we see in the  
10 industry comes in fits and starts. You know, the  
11 internet was initially developed in 1968 before I  
12 was born. But it was about 25 years later that  
13 it actually became a consumer force that started  
14 to affect people's lives.

15 The technology and substrate that was  
16 there for Facebook could have been developed 10  
17 years earlier, but for some reason it didn't come  
18 along. And these -- the reasons behind these  
19 fits and starts in the industry are really social  
20 rather than technical.

21 Facebook is something that my  
22 generation really has trouble with. I mean am I  
23 supposed to take up drinking so I can post  
24 embarrassing pictures of myself for my friends to  
25 see? I don't get it.

1           But what Facebook needed was a new  
2 generation of kids who'd grown up seeing  
3 computers as a social device, not as a tool for  
4 work or science or development, but as a social  
5 medium. And who are comfortable doing that sort  
6 of thing online.

7           And -- so many of the limitations we  
8 face are really just limits of the imagination  
9 here. You know, the progress -- the lack of  
10 progress that occurred between the invention of  
11 the Blackberry, this breakthrough device which  
12 put email in everybody's pocket, to the invention  
13 of the iPhone was marked with a real lack of  
14 progress for many years.

15           That was just because somebody who was  
16 really brilliant had to come along and realize  
17 that you could combine touch screen technology  
18 with a very fast, mobile CPU, with a high-  
19 resolution display and internet connectivity, and  
20 create a device like the iPhone.

21           It's limited by invention. And the  
22 technologies that have been put before us, you  
23 know, with this always on 3G-based internet  
24 connectivity that goes with you mobilely, and all  
25 the other technologies we have among us, these



1 ultra-fast CPUs that are in our pockets, are  
2 driven by completely different forces than  
3 Moore's Law.

4 And so we can't predict the future here  
5 but all we can do are identify trends that might  
6 shape the future of computing and gaming. And so  
7 I'm not going to try to make a detailed proposal  
8 here, but I'm just going to point to some of the  
9 things that really inspire me and make me think  
10 that we're headed to an entirely new level of  
11 consumer experience. And that this will continue  
12 to happen over the next couple of decades.

13 First of all is the pervasive  
14 connectivity in GPS and orientation sensors. You  
15 know, my iPhone always knows exactly where it is.  
16 I can now go on a hiking trip and never have any  
17 possible risk of getting lost because it always  
18 knows exactly where I am, can place me on a map.

19 This is fundamentally important. You  
20 know, if you look at what Facebook does with  
21 social networking, enabling people to make social  
22 connections, there's a whole new dimension of  
23 that that could be connected physically based on  
24 physical proximity, connecting people to business  
25 and other nearby aspects.

1           So I think technologies like Google  
2       search haven't even begun to touch on that. And  
3       then there's the thought of integrating, you  
4       know, your 3D positioning in the real world into  
5       games, you know, through augmented reality. And  
6       that's incredibly tantalizing.

7           There have been some early experiments  
8       there but I think that's a whole area that's  
9       prone to a major revolution over the next decade  
10      or so as people just discover the right ideas for  
11      games and the right mix that makes an  
12      entertaining experience.

13          Right, really see the possibility of  
14      Zynga-scale startups coming along, figuring out  
15      the key mechanics of that space and exploiting it  
16      successfully. With Kinect, we've also seen the  
17      idea of pervasive sensors becoming aware of your  
18      body and its motion and being able to replicate  
19      that in a computer environment.

20          And Kinect is really -- this is an idea  
21      that's been around for a long time, but the  
22      Kinect is the first consumer product that's  
23      actually carried that through to its full  
24      completion with a combination of some amazing  
25      Microsoft research work on camera technology and

1 3D image recognition, combined with the fun  
2 consumer experiences developed by game creators.

3 We're starting to see some -- a lot of  
4 new possibilities. But just think what's going  
5 to happen over the next decade or two as these  
6 sensors become mounted to every device. You  
7 know, what if your iPhone could see your entire  
8 body and could recognize gestures? And what  
9 other control mechanisms could we have that way  
10 as we get more and more precise input from these  
11 sorts of devices?

12 I also find Apple's work with Siri  
13 really impressive. You know, it's a voice  
14 recognition app but it's the first one that  
15 really works. You know voice recognition,  
16 everybody's been talking about it since the 1980s  
17 as being just on the verge of practicality.

18 And then you try to use your Windows PC  
19 and tell it open file and it shuts down because  
20 apparently they sound alike. But -- (to screen)  
21 don't do that. But Siri does it well enough that  
22 I'll actually be out driving, I'll say Siri, tell  
23 me how to get to McDonald's or something like  
24 that, and it recognizes it perfectly every time  
25 and it pops up with the correct result.

1           It really -- there's some magic to it  
2   that they've perfected that technology to a level  
3   where it's now easy to see that voice technology,  
4   voice command and control being applied to every  
5   consumer product across a wide range of devices  
6   and becoming a real permanent part of our  
7   computing experience that lets us do a lot in a  
8   hands-free manner that frees up our hands to do  
9   more important things.

10           Whether it's controlling a game or  
11   driving through while you're asking for street  
12   directions, there are some real interesting  
13   possibilities there. Also there's been a lot of  
14   work with cloud computing.

15           The really amazing thing with something  
16   like Google search or Siri is that you enter a  
17   command, it's sent to a server, and then for a  
18   short period of time, a few milliseconds, an  
19   absolutely colossal amount of computing power is  
20   applied to your problem, and it results in a  
21   simple result sent back to you.

22           Now I can just imagine the power grid  
23   in China dimming when you ask Siri for directions  
24   to McDonald's with the computing power it's  
25   applying to recognizing your voice out there.

1 And we're also seeing the move to cloud gaming  
2 with OnLive and Gaikai, and so a lot of people  
3 are thinking about what does this really mean to  
4 us.

5 But as game developers, this is a super  
6 interesting technology because it means that we  
7 could now build games that exploit huge amounts  
8 of computing power in the server farm and don't  
9 require a whole lot of client power.

10 But ultimately the value of these  
11 services isn't going to be that they bring new  
12 features to us, but it's that they're  
13 transparent, that if OnLive and Gaikai are to be  
14 successful, it will be because their gaming  
15 experience is as good as playing on your Xbox or  
16 your computer and as seamless and as perfect.

17 So from a game developer's point of  
18 view, I don't see these having a big effect.  
19 We'll build the same game, we'll create the same  
20 meshes and you know, have the same design  
21 considerations and the consumer will play it in  
22 the same way, and the only question is whether it  
23 runs on a machine that's sitting in your living  
24 room or up on a server somewhere.

25 And so I think we can largely look at

1     that as a factor that's not going to change our  
2     industry fundamentally, but will make it more  
3     convenient to consumers.

4             Now the other interesting thing that's  
5     been happening for the last few years, and Epic's  
6     now in this game despite being a latecomer --  
7     virtual goods and microtransactions. The ability  
8     to sell people things that don't actually exist.

9             It's a kind of a neat idea. But if you  
10    think about it, we have a world full of countries  
11    like China and India, they're becoming  
12    increasingly wealthy. But we can only mine so  
13    much iron ore out of the ground and only pump so  
14    much oil out for mankind.

15            And so in the future, physical goods  
16    are going to be increasingly expensive and  
17    scarce. And rather than being a catastrophe, I  
18    just think this means a larger and larger portion  
19    of our economy will transform from making stuff  
20    to creating virtual experiences and selling them  
21    online.

22            I would say that in another 10 or 20  
23    years you might find that the virtual economy is  
24    a sizeable fraction of the real economy. Like  
25    the worldwide real estate market is something

1     like 25 trillion. Well, the virtual economy in  
2     20 years might be 25 trillion as well, which is  
3     probably a few hundred dollars of today's  
4     dollars.

5             But I really think this is going to  
6     fundamentally change. And if you look at young  
7     people and especially in markets like Korea and  
8     China, there are people who don't -- who are not  
9     enormously wealthy but they're extremely eager  
10    consumers of virtual goods and games.

11            And I think more and more of the world  
12    is going to look like that. You know, we're  
13    going to get by with smaller and more efficient  
14    cars and smaller houses, but we're going to be  
15    living more and more of our lives online and have  
16    incredibly realistic experiences there in that  
17    virtual economy.

18            I also look at augmented reality  
19    experiences like Word Lens. This is a little app  
20    for the iPhone. You pull out your iPhone, you  
21    point it at things and it's kind of a window into  
22    a world where all the text is translated into a  
23    new language.

24            So you point this at a stop sign and it  
25    translates the stop -- the word stop to Spanish

1 in 3D, in a scene that looks just like the real  
2 world behind it. That's one of those few apps  
3 that stood out to me as really magical, and  
4 really is a hint of the things that are to come  
5 to our industry.

6 There are many other things heading in  
7 this direction. You know, Samsung recently  
8 showed the Samsung Window, this really funny  
9 device which is a -- it's a window, a transparent  
10 window, and when the device is turned off it  
11 looks just like any ordinary window.

12 When you turn it on, it pops up a 3D  
13 display that's overlaid on top of the window that  
14 has an alpha channel. So you have the ability to  
15 display color images but also to backlight it  
16 with an LCD so that you have portions of the  
17 background masked out from behind you.

18 And so if you had one of these in your  
19 houses you might, you know, go up to it and you  
20 might, you know, arrange your recipes or control  
21 your microwave oven or do anything like that on a  
22 surface that's a mix of a view into the world and  
23 virtual objects overlaid on top of it.

24 But this could also become a lot more  
25 pervasive. Sony recently has announced a virtual



1 reality headset product. Now this is an idea  
2 that we all kind of look down on because it was a  
3 cool idea in the 1980s but it sucked then and we  
4 assume that it's going to suck forever into the  
5 future.

6 But that's only the case until somebody  
7 does it really well. Now here's a product -- a  
8 company that's announced a product and shown it  
9 in public demos. It's basically like your Oakley  
10 sunglasses except they have a -- basically a very  
11 high resolution LCD display on the inside that  
12 projects onto your eyes.

13 And so as you're walking around with  
14 these they overlay arbitrary images on the  
15 environment in a real augmented reality display  
16 device that's, you know, basically a convenient  
17 consumer form factor.

18 This is going to be really exciting to  
19 see what game developers do like that -- do with  
20 that, because augmented reality, if it's you  
21 walking around doing this sort of thing it's not  
22 very fun, right? But if it's just there and it's  
23 always pervasively in front of you, that's an  
24 entirely new level of experience and it becomes  
25 very interesting.

1           And at the same time we have a lot of  
2 platforms coming together. There are the tablet  
3 platforms, there are the smartphone platforms,  
4 and computers, you know, PC and Macintosh, and  
5 then there are consoles, Xbox 360, PlayStation 3,  
6 Wii, and some new handheld dedicated gaming  
7 devices, and God knows what else.

8           This is too many platforms. And we're  
9 seeing now, iPad sales have surpassed the sales  
10 of desktop PCs. That's a real revelation to me.  
11 This is a product that wasn't invented until a  
12 few years ago, and it's basically supplanting the  
13 personal computer industry as we know it.

14           Over time these platforms will be  
15 winnowed down into a much smaller set of  
16 computing platforms. You know, there might be  
17 one or two or maybe three winners worldwide  
18 across everything -- computers, game platforms,  
19 smartphones.

20           So we should expect a lot of  
21 consolidation here, and winners and losers  
22 according to who picks the right directions and  
23 executes successfully on them.

24           To wrap up, there are a lot of huge  
25 technical changes, and I think just of the

1 technologies and bits of computer hardware that  
2 we know how to manufacture now, I think we've  
3 just barely scratched the surface of their  
4 consumer implications.

5 What we can do with an iPhone or an  
6 iPad today is limited by our experience with  
7 computers and our histories, but when a whole new  
8 generation of kids is raised with these devices  
9 pervasively around us, it's going to lead to an  
10 entirely new world.

11 And I think -- think about that girl  
12 who was handed the magazine and thought it was a  
13 broken iPad. What's life going to be like in 20  
14 years when she goes off to college? You know,  
15 will she just have a Facebook account like  
16 today's college kids or will she be pervasively  
17 connected to all of her friends in a way that we  
18 can't even imagine today?

19 You know, having augmented reality  
20 connections to them wherever she goes in life, to  
21 being able to see and stay connected and see what  
22 friends are doing. I find the possibilities here  
23 fascinating, both scary and interesting.

24 But the big point is I see a bright  
25 future for the future of computing and its

1     implications on games. I really see the ability  
2     for us as game developers to exploit another  
3     thousandfold increase in computing power in  
4     future generations of platforms.

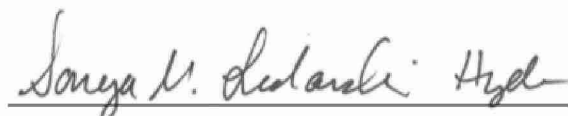
5             Some of them will be consoles, some of  
6     them will be PCs, some of them will be tablets.  
7     The form factors we can't predict, but the  
8     opportunity is there and I think our industry's  
9     brightest days are yet to come. And it excites  
10    me very much. Thank you very much for listening.

11            (Applause)

## C E R T I F I C A T I O N

I, Sonya Ledanski Hyde, certify that the  
foregoing transcript is a true and accurate  
record of the proceedings.

Date: March 26, 2021

A handwritten signature in cursive script, reading "Sonya M. Ledanski Hyde", is written over a horizontal line.

Sonya Ledanski Hyde

**[05640 - bounces]**

<b>0</b>	<b>7</b>	<b>amounts</b> 21:7	<b>assume</b> 25:4
<b>05640</b> 1:4	<b>70</b> 4:7	<b>animate</b> 11:3	<b>atom</b> 11:24,25
<b>07868680</b> 1:13	<b>8</b>	<b>animating</b> 6:5	<b>atomic</b> 14:20
<b>1</b>	<b>8,000</b> 4:21	<b>announced</b> 24:25	<b>atoms</b> 11:22
<b>10</b> 8:25 15:16	<b>9</b>	25:8	<b>audiences</b> 5:7
22:22	<b>99</b> 7:23	<b>anybody</b> 5:4	<b>augmented</b> 18:5
<b>10,000</b> 12:13,16,17	<b>a</b>	<b>anyway</b> 10:2	23:18 25:15,20
<b>100</b> 10:8	<b>ability</b> 22:7 24:14	<b>apl</b> 1:13	27:19
<b>12151</b> 29:10	28:1	<b>app</b> 19:14 23:19	<b>aware</b> 18:17
<b>16</b> 4:21	<b>able</b> 7:10 9:22	<b>apparently</b> 19:20	<b>b</b>
<b>1905</b> 14:14,18	10:14 11:2,23	<b>applause</b> 28:11	<b>back</b> 6:22 20:21
<b>1968</b> 11:17 15:11	14:2 18:18 27:21	<b>apple</b> 1:9	<b>background</b> 24:17
<b>1980s</b> 13:15 19:16	<b>absolutely</b> 10:7	<b>apple's</b> 19:12	<b>backlight</b> 24:15
25:3	20:19	<b>applied</b> 15:6 20:4	<b>barely</b> 27:3
<b>1991</b> 6:22	<b>accomplishing</b>	20:20	<b>based</b> 16:23 17:23
<b>1998</b> 9:3	10:13	<b>applying</b> 20:25	<b>basically</b> 25:9,10
<b>2</b>	<b>account</b> 27:15	<b>approaching</b>	25:16 26:12
<b>2,000</b> 10:14	<b>accuracy</b> 9:24	11:22 12:2	<b>beaten</b> 5:17
<b>20</b> 4:2 6:20 22:22	<b>accurate</b> 10:17,22	<b>approximate</b> 7:2	<b>becoming</b> 18:17
23:2 27:13	29:4	10:5	20:6 22:11
<b>200</b> 14:5	<b>accurately</b> 9:10	<b>approximating</b>	<b>began</b> 2:11 7:2
<b>2021</b> 29:6	<b>achieve</b> 9:23 10:10	6:1 7:5 8:8	<b>begun</b> 18:2
<b>25</b> 15:12 23:1,2	12:11	<b>approximation</b>	<b>bekenstein</b> 13:22
<b>26</b> 29:6	<b>add</b> 6:8,16	6:6,7,9,13,17,20	<b>better</b> 2:14
<b>3</b>	<b>additional</b> 5:13	6:22 7:4,11,12,21	<b>beyond</b> 4:7 5:12
<b>3</b> 7:25 26:5	<b>adoption</b> 15:7	7:22 8:1,3,25	12:7
<b>30</b> 3:24	<b>advance</b> 9:25	<b>approximations</b>	<b>big</b> 6:11 12:8 13:7
<b>360</b> 7:25 26:5	<b>advances</b> 11:7	6:16	21:18 27:24
<b>3d</b> 7:1 18:4 19:1	12:25 14:8,9	<b>apps</b> 24:2	<b>billion</b> 9:3
24:1,12	<b>affect</b> 14:10 15:14	<b>arbitrary</b> 25:14	<b>biological</b> 3:5
<b>3g</b> 16:23	<b>ago</b> 26:12	<b>area</b> 12:25 18:8	<b>bit</b> 14:22
<b>4</b>	<b>ahead</b> 12:4	<b>areas</b> 8:15 10:11	<b>bits</b> 13:1 27:1
<b>4,000</b> 4:21	<b>algorithms</b> 10:25	11:7 14:21	<b>black</b> 13:17
<b>40</b> 11:15 14:18	<b>alike</b> 19:20	<b>arrange</b> 24:20	<b>blackberry</b> 16:11
<b>4:20</b> 1:4	<b>alpha</b> 24:14	<b>art</b> 5:25 11:8	<b>blocks</b> 13:5
<b>5</b>	<b>amazing</b> 18:24	<b>articulated</b> 11:16	<b>body</b> 18:18 19:8
<b>50</b> 5:20	20:15	<b>asking</b> 20:11	<b>boil</b> 8:23
	<b>amount</b> 5:16 8:18	<b>aspect</b> 10:23	<b>born</b> 2:10 15:12
	12:11,11 13:19	<b>aspects</b> 6:1 9:8,14	<b>bounce</b> 7:6
	14:17,18 20:19	10:15 11:10 15:3	<b>bounces</b> 7:13,16
		17:25	8:8 9:10

**[bouncing - design]**

<b>bouncing</b> 8:16 <b>bound</b> 13:23,24 <b>brain</b> 3:12 <b>breakthrough</b> 16:11 <b>bright</b> 8:15 27:24 <b>brightest</b> 2:22 28:9 <b>brilliant</b> 16:16 <b>bring</b> 21:11 <b>broken</b> 2:9 27:13 <b>build</b> 13:6 21:7,19 <b>building</b> 13:5 <b>business</b> 17:24 <b>buy</b> 8:7	<b>chip</b> 12:16 13:8 <b>chips</b> 12:10 13:1 <b>circulating</b> 2:5 <b>clarity</b> 6:18 <b>classical</b> 13:3 <b>clearly</b> 8:21 <b>client</b> 21:9 <b>close</b> 3:19 4:4,11 4:15 10:10 15:1 <b>cloud</b> 20:14 21:1 <b>cloudier</b> 15:6 <b>coal</b> 13:17 <b>college</b> 27:14,16 <b>color</b> 7:18 9:19 10:8 24:15 <b>colossal</b> 20:19 <b>combination</b> 9:12 18:24 <b>combine</b> 16:17 <b>combined</b> 19:1 <b>come</b> 2:12 10:21 15:1,17 16:16 24:4 28:9 <b>comes</b> 15:10 <b>comfortable</b> 16:5 <b>coming</b> 12:23 18:14 26:2 <b>command</b> 20:4,17 <b>company</b> 25:8 <b>complete</b> 9:23 <b>completely</b> 10:4 10:16 17:2 <b>completion</b> 18:24 <b>computation</b> 13:13,20 <b>computational</b> 13:20 15:1 <b>computer</b> 2:11 3:17 5:25 6:14 7:3 7:21 10:11 11:1 13:1,10 18:19	21:16 26:13 27:1 <b>computers</b> 13:6 14:1 16:3 26:4,18 27:7 <b>computer's</b> 5:10 <b>computing</b> 2:15 5:2 6:8 7:10 8:2 8:24 9:1 10:6,21 11:6,12,18 12:12 12:21,23 13:3,8 14:4,23 17:6 20:7 20:14,19,24 21:8 26:16 27:25 28:3 <b>concept</b> 6:9 <b>conclude</b> 5:22 <b>concludes</b> 2:9 <b>conduct</b> 11:2 <b>conference</b> 8:6 <b>connected</b> 17:23 27:17,21 <b>connecting</b> 17:24 <b>connections</b> 17:22 27:20 <b>connectivity</b> 16:19 16:24 17:14 <b>considerations</b> 21:21 <b>consist</b> 3:10 <b>console</b> 2:19 <b>consoles</b> 2:20 26:5 28:5 <b>consolidation</b> 26:21 <b>constructing</b> 13:1 <b>consumer</b> 2:15 14:12 15:13 17:11 18:22 19:2 20:5 21:21 25:17 27:4 <b>consumers</b> 22:3 23:10	<b>continue</b> 17:11 <b>continuing</b> 14:3 <b>contribute</b> 6:1 <b>control</b> 19:9 20:4 24:20 <b>controlling</b> 20:10 <b>convenient</b> 22:3 25:16 <b>converted</b> 14:17 <b>cool</b> 25:3 <b>correct</b> 19:25 <b>cortex</b> 3:9,24 <b>countries</b> 22:10 <b>couple</b> 14:4 17:12 <b>course</b> 14:24 <b>court</b> 1:1 <b>cpu</b> 16:18 <b>cpus</b> 17:1 <b>create</b> 5:16 11:25 16:20 21:19 <b>creating</b> 22:20 <b>creators</b> 19:2 <b>crossroads</b> 12:1 <b>current</b> 4:22 12:7 13:25 <b>cv</b> 1:4
<b>c</b>			<b>d</b>
<b>c</b> 29:1,1 <b>calculus</b> 6:10,11 <b>california</b> 1:2 <b>call</b> 11:4 <b>camera</b> 3:25 4:3 18:25 <b>can't</b> 5:17 11:24 17:4 27:18 28:7 <b>capability</b> 3:16 <b>cards</b> 8:7 <b>carried</b> 7:23 18:23 <b>cars</b> 23:14 <b>case</b> 1:4 25:6 <b>catastrophe</b> 22:17 <b>certain</b> 5:9 <b>certainly</b> 11:24 <b>certify</b> 29:3 <b>change</b> 22:1 23:6 <b>changed</b> 2:13 <b>changes</b> 26:25 <b>channel</b> 24:14 <b>characters</b> 11:3 <b>china</b> 20:23 22:11 23:8			<b>data</b> 4:8 5:9,15,16 13:11 <b>date</b> 29:6 <b>days</b> 2:22 28:9 <b>decade</b> 18:9 19:5 <b>decades</b> 10:9 17:12 <b>dedicated</b> 26:6 <b>defendant</b> 1:10 <b>definition</b> 4:12,22 <b>demo</b> 8:5 9:4 <b>demos</b> 25:9 <b>design</b> 21:20

**[desktop - finite]**

<b>desktop</b> 26:10 <b>despite</b> 22:6 <b>detail</b> 3:16 5:13 8:19 <b>detailed</b> 17:7 <b>develop</b> 13:5 <b>developed</b> 13:17 15:11,16 19:2 <b>developer</b> 8:5 <b>developers</b> 21:5 25:19 28:2 <b>developer's</b> 21:17 <b>development</b> 16:4 <b>device</b> 16:3,11,20 19:6 24:9,10 25:16 <b>devices</b> 3:13 4:14 14:13 19:11 20:5 26:7 27:8 <b>didn't</b> 15:17 <b>different</b> 9:12 17:2 <b>dimension</b> 17:22 <b>dimensional</b> 9:17 <b>dimming</b> 20:23 <b>direction</b> 24:7 <b>directions</b> 20:12 20:23 26:22 <b>discover</b> 18:10 <b>discovered</b> 4:5 14:14 <b>discovery</b> 14:11 <b>display</b> 4:17,20 16:19 24:13,15 25:11,15 <b>distance</b> 4:16 <b>district</b> 1:1,2 <b>diverse</b> 3:1 <b>doesn't</b> 2:7 6:18 <b>doing</b> 16:5 25:21 27:22	<b>dollars</b> 23:3,4 <b>don't</b> 2:23 4:5 10:20,25 15:25 19:21 21:8,18 22:8 23:8 <b>doom</b> 7:3,5 <b>doom's</b> 8:24 <b>double</b> 11:18 14:3 <b>drags</b> 2:7 <b>draw</b> 2:25 <b>drinking</b> 15:23 <b>driven</b> 3:7 17:2 <b>driving</b> 19:22 20:11 <b>duty</b> 11:5	<b>enormously</b> 23:9 <b>enter</b> 20:16 <b>entertaining</b> 18:12 <b>entire</b> 2:15 4:18 19:7 <b>entirely</b> 17:10 25:24 27:10 <b>environment</b> 6:4 7:19 9:15 18:19 25:15 <b>environments</b> 10:16 <b>epic</b> 1:6 <b>epic's</b> 22:5 <b>equivalence</b> 14:15 <b>equivalent</b> 3:24 <b>era</b> 2:11 <b>especially</b> 23:7 <b>established</b> 13:18 <b>estate</b> 22:25 <b>eventually</b> 3:17 8:13 10:5 <b>everybody</b> 2:18 <b>everybody's</b> 6:10 16:12 19:16 <b>exactly</b> 17:15,18 <b>example</b> 7:3 9:11 <b>excites</b> 28:9 <b>exciting</b> 25:18 <b>executes</b> 26:23 <b>exist</b> 22:8 <b>existence</b> 14:12 <b>expect</b> 9:20 10:9 14:23 26:20 <b>expensive</b> 22:16 <b>experience</b> 2:15 2:25 3:7 17:11 18:12 20:7 21:15 25:24 27:6 <b>experiences</b> 2:14 19:2 22:20 23:16	23:19 <b>experiments</b> 18:7 <b>exploit</b> 21:7 28:2 <b>exploiting</b> 18:15 <b>extremely</b> 23:9 <b>eye</b> 3:23 4:3 7:7,17 8:13,18 <b>eyes</b> 3:8,8,10 25:12
	<b>e</b>		<b>f</b>
	<b>e</b> 29:1 <b>eager</b> 23:9 <b>earlier</b> 15:17 <b>early</b> 7:20 18:7 <b>ears</b> 3:8 <b>easy</b> 20:3 <b>economy</b> 22:19,23 22:24 23:1,17 <b>edge</b> 14:21 <b>effect</b> 21:18 <b>effects</b> 9:13 <b>efficient</b> 7:9 23:13 <b>einstein</b> 14:14 <b>electricity</b> 14:11 <b>electronics</b> 14:13 <b>email</b> 16:12 <b>embarrassing</b> 15:24 <b>employment</b> 14:12 <b>enabled</b> 2:14 <b>enabling</b> 17:21 <b>encounter</b> 7:18 <b>energy</b> 14:15,18 <b>engineering</b> 14:9		<b>f</b> 29:1 <b>face</b> 9:21 16:8 <b>facebook</b> 15:16,21 16:1 17:20 27:15 <b>fact</b> 7:23 <b>factor</b> 10:14 12:13 13:24 22:1 25:17 <b>factors</b> 28:7 <b>fairly</b> 4:4,15,15 8:19 14:10 <b>fan</b> 6:11 <b>far</b> 2:12 9:22 13:6 <b>farm</b> 21:8 <b>farther</b> 9:8 <b>fascinating</b> 27:23 <b>fast</b> 11:1 16:18 17:1 <b>fastest</b> 8:7 <b>features</b> 21:12 <b>fiction</b> 14:7 <b>field</b> 4:18 <b>fields</b> 3:1 <b>figure</b> 9:25 12:15 <b>figuring</b> 18:14 <b>file</b> 1:13 19:19 <b>fills</b> 4:18 <b>find</b> 19:12 22:23 27:22 <b>fingers</b> 2:7 <b>finite</b> 5:15



**[first - infinite]**

<b>first</b> 6:21 7:1,4 17:13 18:22 19:14 <b>fits</b> 15:10,19 <b>five</b> 13:1 <b>floating</b> 9:1,5 <b>force</b> 15:13 <b>forces</b> 17:2 <b>foregoing</b> 29:4 <b>forever</b> 25:4 <b>form</b> 10:21 25:17 28:7 <b>found</b> 3:23 <b>fraction</b> 22:24 <b>frame</b> 4:6 <b>frames</b> 4:7 <b>free</b> 20:8 <b>frees</b> 20:8 <b>friends</b> 15:24 27:17,22 <b>front</b> 25:23 <b>frustrated</b> 2:8 <b>full</b> 18:23 22:10 <b>fun</b> 19:1 25:22 <b>function</b> 6:13,15 <b>fundamental</b> 13:5 <b>fundamentally</b> 17:19 22:2 23:6 <b>funny</b> 24:8 <b>future</b> 2:2 12:7 14:23 17:4,6 22:15 25:5 27:25 27:25 28:4	18:5,11 21:7 23:10 28:1 <b>gaming</b> 2:14 11:10 17:6 21:1,14 26:6 <b>gears</b> 11:4 <b>generate</b> 5:10 6:14 <b>generation</b> 2:18 2:19 4:13 8:22 15:22 16:2 27:8 <b>generations</b> 5:23 12:4 28:4 <b>gestures</b> 19:8 <b>getting</b> 17:17 <b>gigabits</b> 13:2 <b>girl</b> 2:6 27:11 <b>give</b> 2:3 <b>given</b> 5:8 10:5,20 13:21 <b>giving</b> 2:24 <b>glossy</b> 8:17 <b>go</b> 4:1,23 5:23 8:23 9:8 10:1 12:7 12:8 17:16 24:19 <b>god</b> 26:7 <b>goes</b> 8:9 9:19 16:24 27:14,20 <b>going</b> 2:2 17:7,8 19:4 21:11 22:1 22:16 23:5,12,13 23:14 25:4,18 27:9,13 <b>good</b> 2:20 3:18,19 3:19 6:17 11:10 21:15 <b>goods</b> 22:7,15 23:10 <b>google</b> 18:1 20:16 <b>gordon</b> 11:16 <b>gosh</b> 5:4 <b>gps</b> 17:14	<b>gpus</b> 5:21 <b>graphics</b> 5:1,25 6:19 7:21,24 10:11 <b>great</b> 7:3 <b>grid</b> 20:22 <b>ground</b> 8:17 22:13 <b>grown</b> 16:2	<b>human's</b> 5:17 <b>hundred</b> 23:3 <b>hyde</b> 29:3,11
		<b>h</b>	<b>i</b>
		<b>hacks</b> 11:9 <b>half</b> 9:5 11:25 <b>handed</b> 27:12 <b>handheld</b> 26:6 <b>hands</b> 2:5 20:8,8 <b>happen</b> 17:12 19:5 <b>happening</b> 22:5 <b>hardware</b> 2:18 27:1 <b>haven't</b> 18:2 <b>hawking</b> 13:15 <b>headed</b> 17:10 <b>heading</b> 24:6 <b>headset</b> 25:1 <b>here's</b> 25:7 <b>high</b> 4:12,22 12:19 12:19 14:25 16:18 25:11 <b>higher</b> 4:19,21 12:11 13:12,25 <b>highlights</b> 9:20 <b>hiking</b> 4:1 17:16 <b>hint</b> 24:4 <b>histories</b> 27:7 <b>hitting</b> 4:10 <b>horizontal</b> 12:20 <b>houses</b> 23:14 24:19 <b>huge</b> 3:10 12:21 21:7 26:24 <b>human</b> 3:23 4:3,10 9:20 10:22,23	<b>iconic</b> 6:23 <b>idea</b> 5:7 14:16 18:17,20 22:9 25:1,3 <b>ideas</b> 18:10 <b>identify</b> 17:5 <b>image</b> 6:15 19:1 <b>imagery</b> 4:19 <b>images</b> 24:15 25:14 <b>imagination</b> 16:8 <b>imagine</b> 20:22 27:18 <b>immersive</b> 4:17 <b>impact</b> 5:2 <b>implications</b> 15:5 27:4 28:1 <b>important</b> 3:2,3 5:3 17:19 20:9 <b>importantly</b> 3:8 <b>impresses</b> 2:12 <b>impressive</b> 12:18 19:13 <b>improvements</b> 4:6 <b>increase</b> 12:21 28:3 <b>increasingly</b> 22:12 22:16 <b>incredibly</b> 18:6 23:16 <b>india</b> 22:11 <b>industry</b> 15:10,19 22:2 24:5 26:13 <b>industry's</b> 2:21 28:8 <b>infinite</b> 10:21
<b>g</b>			
<b>gaikai</b> 21:2,13 <b>game</b> 6:21,25 19:2 20:10 21:5,17,19 22:6 25:19 26:18 28:2 <b>gamers</b> 3:4 <b>games</b> 1:6 3:7 5:3 7:1,24 8:5,20 11:4			

## [infinitely - microwave]

<b>infinitely</b> 11:1 <b>information</b> 13:18 <b>initially</b> 15:11 <b>input</b> 19:10 <b>inside</b> 25:11 <b>inspire</b> 17:9 <b>integrating</b> 18:3 <b>intel</b> 11:16 <b>intelligence</b> 10:24 <b>interesting</b> 11:14 13:7,16,23 20:12 21:6 22:4 25:25 27:23 <b>intermediate</b> 7:8 <b>internet</b> 15:11 16:19,23 <b>invented</b> 26:11 <b>invention</b> 11:8 14:20 15:7 16:10 16:12,21 <b>ipad</b> 2:9 4:12 26:9 27:6,13 <b>iphone</b> 16:13,20 17:15 19:7 23:20 23:20 27:5 <b>iron</b> 22:13 <b>isn't</b> 21:11 <b>it's</b> 2:9 3:17 6:14 7:4 8:6 12:16 13:23,24 16:21 19:13,14 20:3,10 20:17,24 21:12 22:9 23:21 24:9 25:4,9,20,21,22,22 26:12 27:9 <b>i'll</b> 19:22,22 <b>i'm</b> 2:1 5:6 10:2 17:7,8	<b>k</b> <b>key</b> 18:15 <b>kids</b> 16:2 27:8,16 <b>kind</b> 22:9 23:21 25:2 <b>kinect</b> 18:16,20,22 <b>know</b> 10:10,20 13:2 15:10 16:9 16:23 17:15,20 18:4,5 19:7,13,15 21:20 23:12 24:7 24:19,20 25:16 26:4,13,16 27:2,14 27:19 <b>knowing</b> 4:25 11:11 <b>known</b> 5:12 10:3 10:15 13:22 <b>knowns</b> 10:3 <b>knows</b> 5:4 17:15 17:18 26:7 <b>korea</b> 23:7	<b>lens</b> 23:19 <b>level</b> 9:24 12:19 13:12 17:10 20:2 25:24 <b>levels</b> 14:25 <b>life</b> 27:13,20 <b>lifetimes</b> 14:24 <b>light</b> 6:3 7:6,14,15 7:15 8:8,9,9,13,16 9:10,14,16 10:15 <b>lighting</b> 6:3 10:7 <b>lights</b> 8:10 <b>limit</b> 4:20,24 5:12 5:13,15,19 13:19 <b>limitations</b> 4:25 16:7 <b>limited</b> 16:21 27:6 <b>limits</b> 3:13,15 4:10 12:2,7 14:2 16:8 <b>listening</b> 28:10 <b>little</b> 2:6 23:19 <b>lives</b> 15:14 23:15 <b>living</b> 21:23 23:15 <b>long</b> 2:2 10:12 14:10 18:21 <b>look</b> 4:9 5:2 13:14 13:24 14:7 17:20 21:25 23:6,12,18 25:2 <b>looking</b> 5:24 6:14 <b>looks</b> 4:20 24:1,11 <b>losers</b> 26:21 <b>lost</b> 17:17 <b>lot</b> 8:16,23 11:12 12:6,24 19:3 20:7 20:13 21:2,9 24:24 26:1,20,24	<b>magazine</b> 2:5 27:12 <b>magic</b> 20:1 <b>magical</b> 24:3 <b>magnitude</b> 9:7 <b>major</b> 18:9 <b>making</b> 22:19 <b>mankind</b> 22:14 <b>manner</b> 20:8 <b>manufacture</b> 27:2 <b>manufacturing</b> 12:5 <b>map</b> 17:18 <b>march</b> 29:6 <b>marked</b> 16:13 <b>market</b> 22:25 <b>markets</b> 23:7 <b>masked</b> 24:17 <b>mathematical</b> 6:9 6:15 <b>matter</b> 14:15,16 14:17 <b>mcdonald's</b> 19:23 20:24 <b>mean</b> 7:11 15:22 21:3 <b>means</b> 21:6 22:18 <b>mechanics</b> 18:15 <b>mechanisms</b> 19:9 <b>medium</b> 16:5 <b>megapixel</b> 3:25 4:2 <b>memory</b> 5:10 <b>meshes</b> 21:20 <b>microprocessor</b> 12:5 <b>microsoft</b> 18:25 <b>microtransactions</b> 22:7 <b>microwave</b> 24:21
	<b>l</b> <b>lack</b> 16:9,13 <b>lag</b> 14:11 <b>language</b> 23:23 <b>largely</b> 5:14 21:25 <b>larger</b> 22:18,18 <b>latecomer</b> 22:6 <b>latest</b> 9:4 <b>law</b> 11:15 12:14 14:3 15:6 17:3 <b>laws</b> 15:4 <b>layers</b> 12:9 <b>lcd</b> 24:16 25:11 <b>lead</b> 27:9 <b>leading</b> 14:21 <b>learned</b> 6:10 <b>ledanski</b> 29:3,11	<b>m</b> <b>machine</b> 21:23 <b>macintosh</b> 26:4	

**[million - proceedings]**

<b>million</b> 8:25 <b>milliseconds</b> 20:18 <b>mine</b> 22:12 <b>mix</b> 18:11 24:22 <b>mobile</b> 16:18 <b>mobilely</b> 16:24 <b>modeling</b> 7:13 <b>money</b> 8:7 <b>moore</b> 11:16 <b>moore's</b> 11:15 12:14 14:3 15:6 17:3 <b>motion</b> 18:18 <b>mounted</b> 19:6 <b>move</b> 2:24 6:24 8:18 21:1 <b>movement</b> 6:4 10:22 <b>movie</b> 9:24 <b>multiple</b> 12:9	<b>nyquist</b> 5:12	<b>people's</b> 15:14 <b>perceive</b> 3:16 4:6 <b>percent</b> 7:23 10:8 <b>perception</b> 4:11 <b>perfect</b> 5:17 21:16 <b>perfected</b> 20:2 <b>perfectly</b> 10:5 19:24 <b>performance</b> 9:6 <b>performs</b> 13:9 <b>period</b> 20:18 <b>permanent</b> 20:6 <b>personal</b> 2:11 26:13 <b>pervasive</b> 17:13 18:17 24:25 <b>pervasively</b> 25:23 27:9,16 <b>photographs</b> 4:3 <b>photoreceptors</b> 3:11 <b>physical</b> 3:13,15 12:2 13:19 14:19 17:24 22:15 <b>physically</b> 17:23 <b>physicist</b> 13:15 <b>physics</b> 13:17 14:8 14:21 15:4 <b>picking</b> 9:18 <b>picks</b> 2:6 26:22 <b>pictures</b> 4:2 15:24 <b>pieces</b> 4:8 13:11 <b>pipeline</b> 5:1 <b>pixels</b> 4:21 5:24 <b>place</b> 17:18 <b>plaintiff</b> 1:7 <b>platforms</b> 26:2,3,3 26:8,14,16,18 28:4 <b>play</b> 21:21 <b>playing</b> 21:15	<b>playstation</b> 7:25 26:5 <b>plug</b> 5:1 <b>pocket</b> 16:12 <b>pockets</b> 17:1 <b>point</b> 4:10 5:8,18 5:21 7:6,16 8:10 8:10 9:1,5 10:2 14:7 17:8 21:17 23:21,24 27:24 <b>pops</b> 19:25 24:12 <b>portion</b> 22:18 <b>portions</b> 24:16 <b>positioning</b> 18:4 <b>possibilities</b> 12:6,8 19:4 20:13 27:22 <b>possibility</b> 18:13 <b>possible</b> 17:17 <b>post</b> 15:23 <b>potentially</b> 14:3 <b>power</b> 5:2,20 6:8 7:10 8:2,24 9:2 10:6,21 11:7,12,18 12:12,21 13:20 14:1,4 15:1 20:19 20:22,24 21:8,9 28:3 <b>powerful</b> 13:6 <b>practical</b> 12:25 14:8,12 <b>practicality</b> 19:17 <b>precise</b> 19:10 <b>predict</b> 17:4 28:7 <b>predictable</b> 15:4 <b>principle</b> 11:16 <b>probably</b> 23:3 <b>problem</b> 10:4 20:20 <b>problems</b> 10:19,19 <b>proceedings</b> 29:5
<b>n</b>	<b>o</b>		
<b>n</b> 29:1 <b>name</b> 1:13 <b>nature</b> 4:3 <b>nearby</b> 17:25 <b>neat</b> 22:9 <b>need</b> 4:19 5:16 6:18 13:5 <b>needed</b> 16:1 <b>nerve</b> 3:12 <b>networking</b> 17:21 <b>never</b> 17:16 <b>new</b> 2:17 15:7 16:1 17:10,22 19:4 21:11 23:23 25:24 26:6 27:7 27:10 <b>nobody's</b> 12:3 <b>northern</b> 1:2 <b>number</b> 3:10 6:15 12:15,18	<b>o</b> 29:1 <b>oakley</b> 25:9 <b>objects</b> 6:2,5,24 24:23 <b>occurred</b> 16:10 <b>oil</b> 22:14 <b>oiliness</b> 9:13 <b>okay</b> 5:5 <b>online</b> 16:6 22:21 23:15 <b>onlive</b> 21:2,13 <b>open</b> 19:19 <b>operate</b> 13:11 <b>operation</b> 13:10 <b>operations</b> 9:1,5 <b>opinion</b> 2:24 <b>opportunity</b> 28:8 <b>optical</b> 3:9,12,24 <b>order</b> 7:4,11,20 8:1,3 <b>orders</b> 9:7 <b>ordinary</b> 24:11 <b>ore</b> 22:13 <b>organisms</b> 3:5 <b>orientation</b> 17:14 <b>oven</b> 24:21 <b>overlaid</b> 24:13,23 <b>overlay</b> 25:14	<b>p</b>	
	<b>packed</b> 13:21 <b>parallel</b> 13:11 <b>part</b> 20:6 <b>pc</b> 19:18 26:4 <b>pcs</b> 26:10 28:6 <b>people</b> 3:6 12:25 17:21,24 18:10 21:2 22:8 23:7,8		

**[process - shown]**

<b>process</b> 6:20 <b>processing</b> 14:1 <b>produce</b> 9:19 13:12 <b>product</b> 18:22 20:5 25:1,7,8 26:11 <b>progress</b> 15:9 16:9 16:10,14 <b>projects</b> 25:12 <b>promise</b> 12:22 <b>promising</b> 14:22 <b>prone</b> 18:9 <b>propagates</b> 7:18 <b>proposal</b> 17:7 <b>proximity</b> 17:24 <b>public</b> 25:9 <b>pull</b> 23:20 <b>pump</b> 22:13 <b>purposes</b> 6:18 <b>push</b> 14:25 <b>put</b> 8:5 16:12,22 <b>putting</b> 5:13 <b>puzzle</b> 6:25	20:12 22:24,25 24:1 25:15 26:10 <b>realistic</b> 9:9 23:16 <b>realistically</b> 11:3 <b>reality</b> 6:23 7:2 10:10 14:19 15:2 18:5 23:18 25:1 25:15,20 27:19 <b>realize</b> 3:3 16:16 <b>really</b> 2:11 3:18,21 4:6,19,24 5:1 12:1 12:18 13:4,23 14:24 15:19,22 16:8,16 17:9 18:13,20 19:13,15 20:1,15 21:3 23:5 24:3,4,8 25:7,18 28:1 <b>reason</b> 15:17 <b>reasonable</b> 3:17 <b>reasons</b> 15:18 <b>received</b> 8:16 <b>recipes</b> 24:20 <b>recognition</b> 19:1 19:14,15 <b>recognize</b> 19:8 <b>recognizes</b> 19:24 <b>recognizing</b> 20:25 <b>record</b> 29:5 <b>reflect</b> 8:11 <b>reflection</b> 8:17 <b>reflects</b> 9:14 <b>relative</b> 8:20 <b>relying</b> 11:6 <b>render</b> 5:16 <b>rendered</b> 7:5 <b>rendering</b> 5:14,20 7:3 8:25 <b>replicate</b> 18:18 <b>represent</b> 10:16	<b>representation</b> 6:24 <b>require</b> 9:9 21:9 <b>required</b> 8:25 9:3 9:4 <b>research</b> 3:22 18:25 <b>resolution</b> 4:19,22 5:8 16:19 25:11 <b>resolutions</b> 4:9 <b>resort</b> 11:9 <b>respond</b> 2:8 4:6 <b>result</b> 19:25 20:21 <b>results</b> 20:20 <b>revelation</b> 26:10 <b>revolution</b> 18:9 <b>right</b> 3:5,20 6:11 11:14 18:10,11,13 25:22 26:22 <b>risk</b> 17:17 <b>room</b> 8:22 21:24 <b>roughly</b> 11:19 <b>run</b> 11:21 <b>running</b> 8:6 12:1 <b>runs</b> 21:23	<b>scientific</b> 10:4 <b>scientists</b> 4:5 <b>scratched</b> 27:3 <b>screen</b> 3:13 5:8 16:17 19:20 <b>seamless</b> 21:16 <b>search</b> 18:2 20:16 <b>second</b> 4:7 7:11,20 7:25 9:1,6 <b>see</b> 6:2 7:24 8:14 8:18 9:9,11 11:4 15:9,25 18:13 19:3,7 20:3 21:18 25:19 27:21,21,24 28:1 <b>seeing</b> 16:2 21:1 26:9 <b>seen</b> 2:21 11:14,18 12:3 18:16 <b>sell</b> 22:8 <b>selling</b> 22:20 <b>sense</b> 7:13 <b>sensors</b> 17:14 18:17 19:6 <b>sent</b> 20:17,21 <b>series</b> 13:8 <b>server</b> 20:17 21:8 21:24 <b>services</b> 21:11 <b>set</b> 26:15 <b>shading</b> 9:11 <b>shadows</b> 7:18 10:8 <b>shape</b> 17:6 <b>share</b> 2:3 3:1 <b>sheer</b> 2:24 <b>shocking</b> 8:19 <b>short</b> 9:22 10:14 20:18 <b>showed</b> 24:8 <b>shown</b> 25:8
<b>q</b>		<b>s</b>	
<b>quantum</b> 12:22 13:10,18 <b>question</b> 3:2 11:12 11:14 21:22	<b>recognize</b> 19:8 <b>recognizes</b> 19:24 <b>recognizing</b> 20:25 <b>record</b> 29:5 <b>reflect</b> 8:11 <b>reflection</b> 8:17 <b>reflects</b> 9:14 <b>relative</b> 8:20 <b>relying</b> 11:6 <b>render</b> 5:16 <b>rendered</b> 7:5 <b>rendering</b> 5:14,20 7:3 8:25 <b>replicate</b> 18:18 <b>represent</b> 10:16	<b>sales</b> 26:9,9 <b>samaritan</b> 8:4 <b>samsung</b> 24:7,8 <b>scale</b> 18:14 <b>scaled</b> 9:6 <b>scarce</b> 22:17 <b>scary</b> 14:22 27:23 <b>scene</b> 5:11,14,17 6:2,5,25 7:5,19 8:4,14 24:1 <b>scenes</b> 3:16 9:9 10:17 <b>science</b> 14:6 15:5 16:4	
<b>r</b>			
<b>r</b> 29:1 <b>raised</b> 27:8 <b>range</b> 20:5 <b>rate</b> 4:7 6:12 <b>raw</b> 8:24 <b>reach</b> 7:10 8:2 <b>reaches</b> 7:16 8:13 <b>reaching</b> 8:17 <b>real</b> 9:19,23 14:10 16:13 18:4 20:6			

**[shows - today's]**

<b>shows</b> 7:20 8:21 <b>shrunk</b> 11:20 <b>shuts</b> 19:19 <b>sight</b> 4:24 <b>sign</b> 23:24 <b>signature</b> 29:10 <b>simple</b> 6:7,13 11:7 20:21 <b>simulate</b> 9:10 10:14 <b>simulating</b> 10:22 15:2 <b>single</b> 7:6 <b>siri</b> 19:12,21,22 20:16,23 <b>sitting</b> 21:23 <b>size</b> 11:22 13:2 <b>sizeable</b> 22:24 <b>sizes</b> 11:19 <b>skin</b> 9:12,13,15,18 10:8 <b>slide</b> 10:1 <b>small</b> 14:16 <b>smaller</b> 11:20,20 11:25 23:13,14 26:15 <b>smartphone</b> 26:3 <b>smartphones</b> 26:19 <b>social</b> 15:5,7,19 16:3,4 17:21,21 <b>soft</b> 9:11 <b>solve</b> 10:20 <b>somebody</b> 2:5,10 16:15 25:6 <b>sony</b> 24:25 <b>sonya</b> 29:3,11 <b>sort</b> 13:17 16:5 25:21 <b>sorts</b> 6:6 19:11	<b>sound</b> 14:6 19:20 <b>source</b> 7:15 8:9 <b>space</b> 9:18 13:21 18:15 <b>spanish</b> 23:25 <b>speech</b> 10:23 <b>split</b> 11:24 <b>stack</b> 12:9,18 <b>start</b> 6:7,12 14:25 <b>started</b> 2:4 6:21 13:16 15:13 <b>starting</b> 8:1 11:21 13:4 19:3 <b>starts</b> 7:15 14:6 15:10,19 <b>startups</b> 18:14 <b>state</b> 11:8 <b>states</b> 1:1 <b>stay</b> 27:21 <b>stephen</b> 13:15 <b>stood</b> 24:3 <b>stop</b> 23:24,25,25 <b>story</b> 5:24 <b>straight</b> 7:7 <b>street</b> 20:11 <b>strictest</b> 7:12,13 <b>stuck</b> 9:24 <b>studied</b> 3:22 <b>stuff</b> 22:19 <b>substrate</b> 15:15 <b>subtle</b> 9:20 <b>successful</b> 21:14 <b>successfully</b> 18:16 26:23 <b>successive</b> 6:16 <b>suck</b> 25:4 <b>sucked</b> 25:3 <b>sufficient</b> 10:6 <b>sunglasses</b> 25:10 <b>super</b> 21:5	<b>supplanting</b> 26:12 <b>supposed</b> 15:23 <b>surface</b> 24:22 27:3 <b>surfaces</b> 8:11,12 9:17 <b>surpassed</b> 26:9 <b>surprising</b> 8:19 <b>sweeney</b> 2:1 <b>t</b> <b>t</b> 29:1,1 <b>tablet</b> 26:2 <b>tablets</b> 28:6 <b>take</b> 4:2 15:23 <b>talk</b> 2:2,16 <b>talking</b> 2:18 5:6 19:16 <b>tantalizing</b> 18:6 <b>technical</b> 5:6 15:3 15:20 26:25 <b>technologies</b> 12:5 15:8 16:22,25 18:1 27:1 <b>technology</b> 2:3,13 15:15 16:17 18:25 20:2,3 21:6 <b>televisions</b> 4:13,23 <b>tell</b> 19:19,22 <b>tend</b> 3:5 <b>term</b> 2:2 <b>terms</b> 12:4 <b>text</b> 23:22 <b>thank</b> 2:1 28:10 <b>thanks</b> 3:14 <b>that's</b> 2:4,13 5:23 5:24 8:19 12:9,17 13:22 18:6,8,8,21 18:22 21:23 22:1 22:4 24:2,13,22 25:6,8,16,23 26:10 <b>theorem</b> 5:3,4	<b>theoretical</b> 3:22 <b>theory</b> 13:18 <b>there's</b> 5:3,8 8:21 9:16 12:13,20,22 13:19 14:10 15:6 17:22 18:3 20:1 20:13 <b>they're</b> 3:11 21:12 22:11 23:9 <b>they've</b> 14:8 20:2 <b>thing</b> 3:3 13:7,23 16:6 20:15 22:4 25:21 <b>things</b> 17:9 20:9 22:8 23:21 24:4,6 <b>think</b> 2:23 3:6 8:22 9:7 10:13 17:9 18:1,8 19:4 21:25 22:10,18 23:5,11 26:25 27:2,11,11 28:8 <b>thinking</b> 21:3 <b>third</b> 8:2 <b>thoroughly</b> 3:22 <b>thought</b> 10:22 18:3 27:12 <b>thoughts</b> 2:3 3:1 <b>thousandfold</b> 28:3 <b>three</b> 8:8 9:17 12:4 26:17 <b>tim</b> 2:1 <b>time</b> 2:17 9:23 13:10 14:10 18:21 19:24 20:18 26:1 26:14 <b>times</b> 4:21 5:20 <b>today</b> 2:20 4:11 9:9 11:1,4 13:3 27:6,18 <b>today's</b> 4:12 5:21 7:24 8:20 23:3
--	---	--	---

## [today's - zzt]

27:16 <b>tool</b> 16:3 <b>top</b> 12:10 24:13,23 <b>touch</b> 16:17 18:2 <b>traditional</b> 13:8 <b>transcript</b> 29:4 <b>transform</b> 22:19 <b>transistor</b> 11:19 11:24 13:9 <b>transistors</b> 11:22 11:25 12:16,17,17 13:9 <b>translated</b> 14:9 23:22 <b>translates</b> 23:25 <b>transmission</b> 10:15 <b>transmitted</b> 3:11 <b>transmitting</b> 9:16 9:19 <b>transparent</b> 21:13 24:9 <b>traverses</b> 6:3 <b>trends</b> 17:5 <b>triangle</b> 5:20 <b>tricks</b> 11:9 <b>trillion</b> 9:5 13:25 13:25 23:1,2 <b>trip</b> 17:16 <b>trouble</b> 11:21 15:22 <b>true</b> 29:4 <b>try</b> 2:24 17:7 19:18 <b>turn</b> 24:12 <b>turned</b> 14:19 24:10 <b>turns</b> 5:19 <b>two</b> 4:13 5:22 7:13 9:4 11:19 19:5 26:17	<b>u</b> <b>ultimately</b> 3:23 13:14 21:10 <b>ultra</b> 17:1 <b>understand</b> 10:4,7 <b>united</b> 1:1 <b>unknown</b> 10:19 <b>unreal</b> 7:19 9:3 <b>use</b> 19:18	<b>ways</b> 4:23 <b>wealthy</b> 22:12 23:9 <b>weapons</b> 14:20 <b>we'll</b> 4:14 10:10 11:9 21:19,19 <b>we're</b> 2:17 4:11 6:13 7:13 8:1,8 9:22 10:12,13 11:6,20 12:1 13:4 14:2 17:10 19:3 21:1 23:12,14 26:8 <b>we've</b> 2:12,21 9:6 11:14,18 18:16 27:2 <b>whatsoever</b> 6:23 <b>what's</b> 19:4 27:13 <b>who'd</b> 16:2 <b>wide</b> 20:5 <b>wii</b> 26:6 <b>window</b> 23:21 24:8,9,10,11,13 <b>windows</b> 3:14 19:18 <b>winners</b> 26:17,21 <b>winnowed</b> 26:15 <b>woods</b> 4:2 <b>word</b> 23:19,25 <b>work</b> 13:16 16:4 18:25 19:12 20:14 <b>working</b> 10:2 <b>works</b> 19:15 <b>world</b> 7:7,16 8:10 8:11,12 14:10 18:4 22:10 23:11 23:22 24:2,22 27:10 <b>worldwide</b> 22:25 26:17	<b>worse</b> 10:18 <b>worth</b> 11:15 <b>wouldn't</b> 11:2 <b>wrap</b> 26:24 <b>written</b> 6:22
			<b>x</b>
			<b>x</b> 1:3,5,11 <b>xbox</b> 7:24 21:15 26:5
			<b>y</b>
	<b>v</b> <b>v</b> 1:8 <b>value</b> 21:10 <b>vast</b> 14:17 <b>verge</b> 2:17 19:17 <b>versus</b> 13:2 <b>vertical</b> 12:9 <b>vertically</b> 12:10,20 <b>video</b> 2:4 3:7 8:7 <b>view</b> 4:18 5:18,22 21:18 24:22 <b>viewer</b> 9:15 <b>viewer's</b> 7:17 <b>viewing</b> 4:15 <b>virtual</b> 22:7,20,23 23:1,10,17 24:23 24:25 <b>visual</b> 6:2 <b>voice</b> 19:13,15 20:3,4,25		<b>y</b> 14:7 <b>year</b> 8:6 <b>years</b> 6:20 11:19 12:23,24 14:4,5,18 15:12,17 16:14 22:5,23 23:2 26:12 27:14 <b>years'</b> 11:15 <b>ygr</b> 1:4 <b>young</b> 23:6 <b>youtube</b> 2:4 <b>you're</b> 4:14 5:13 20:11 25:13
			<b>z</b>
			<b>zynga</b> 18:14 <b>zzt</b> 6:21