

[External shot of Galbraith Building, **Professor Jonathan Rose** chats with guests]

Professor **Farid Najm**: Thank you all for coming. My name is Farid Najm. I am a Professor in the Department and Department Chair at this time. It is my pleasure to welcome you back to our annual Fall Alumni Networking Session. We have been doing these for the last 3 years or so and this is really one of my favourite events. It gives us a chance to catch up with our Alumni and to hear about the many exciting things you are doing. We also have a Spring event where we invite Alumni to come in and we invite our graduating class to come in for the reception before they leave, get them thinking about the idea that they are not leaving, they are just becoming Alumni, they are our students of campus. What we will do today is we will hear a brief presentation by Professor Rose and then after that we will continue with the networking and there will be more food coming in so we look forward to that. Just to give you a brief update on the Department, we have been growing and we have been doing exciting stuff. We are now a big Department, we have 78 professors and if you count the Professors Emeritus, these are the folks who are retired but continue to do research, we are about 100 people. There is a great buzz here and energy all the time and it is fun to be here and an honour to be Department Chair. If you attended last year you might remember that I mentioned the renovation of our Energy Systems Lab. Energy Systems is in the basement of Galbraith, just 2 floors done, and we are on a 3 year plan to renovate the lab. This past summer we went through phase 1 which was a renovation of the power supplies and equipment room at the back that you probably didn't see as students. Next summer we will do phase 2 which will upgrade the cabling and the year after that hopefully we will get to the student equipment that is at their stations. We have to do this in multiple stages because we cannot renovate the lab during the year when it is being used, so it is work that happens in the summer. This first year was a million dollars project for which the Dean helped a bit and we had some other support for that. Next year, the renovation will be about 650, 000. We are also getting some help for that from the Dean but we are also working with our supporters to try and get more support for that. I can talk to you about these things, I'll fly in if you're interested.

We have several professors here with us today and I just want to recognize some people – Professor Liscidini is here, Antonio Liscidini. Professor Leon-Garcia was going to show up but I don't think he made it. Professor Wai Tun Ng, Safwat Zaky, Professor Raymond Kwong, Professor Ashish Khisti, Ahsish? He was here. Did I forget anyone? Alright, so thank you all for coming. And of course it is also my pleasure to introduce Professor Jonathon Rose who is our speaker tonight. Let me give you a brief biography. Professor Rose received his Bachelor in Engineering Science from this Department in 1980, a Masters in 1982 and a PhD in 1986, all from this Dept. He was then a post-doctoral scholar at Stanford from 1986 to 1989 and then rejoined the Dept here as a professor in 1989. And Jonathan, in case you didn't know, he is a pioneer in the area of field programmable gate arrays and he has been a technical leader in the field for over 25 years, he has a very high profile in that area, his name is known internationally. In 1998 he started a start-up here Ritackcad Corporation, which developed architecture and software for FPGAs. He was president and CEO of the company until May 2000 when it was acquired by Alterra. He was then part of the Alterra Toronto team and served as the Senior Director of the Alterra lab until 2003. Professor Rose chaired this Dept, he was the chair before I took the job, from 2004-2009. I was going to say before I took the torture chamber, but that's

fine (laughter). He currently serves as the Director of the Engineering Business minor in the Faculty of Engineering and he is Chair of the Advisory Board for the Engineering Entrepreneurship Hatchery, which is a very exciting initiative in the Faculty of Engineering for encouraging our students to get involved in entrepreneurship and preparing them for that. Professor Rose's current research covers all aspects of FPGAs from their architecture to cad to their applications in systems. He is now, however, moving to a new area on interdisciplinary application of mobile software. It is very exciting and I am looking forward to hearing more about it and please join me in welcoming Jonathan Rose.

Jonathan Rose: Thanks Farid, it's great to have a chance to connect to our Alumni and it's fun to talk about this topic and I suspect that lots of you have ideas about this topic so I look forward to talking about it. So, we are talking about mobile phones and smart phones, and it seems to me that the question I have to ask first is what kind of phone are you carrying? How many of you are holding an iPhone in your pockets? There's a fair number of you. How many of you have an android phone? I would say those numbers are not representative of the world – Android is starting to take over from iPhone, but the North American iPhone is doing well. How many of you are packing a Blackberry? [Laughter]. Still kickin', still kickin', it's ok (laughter). It's smaller because that new one is square. Who's carrying a flip phone? There's 1,2,3...I knew there'd be a few here. Ya, Thomas Lin is a graduate student, unbelievably, is carrying a flip phone. I've got to tell you an anecdote by the way just so you know where the next generation is going. My friend and colleague Professor Doug Reid, a professor in Chemical Engineering, was visiting a high school and he was giving a talk there and he forgot to turn off his phone. He was giving the talk and his phone rang and he pulled it out and it was a flip phone, and the entire audience, he said, gasped (laughter). Because you just don't have a flip phone if you're in high school because, I have this on good authority, you are a pariah, a social pariah because you can't communicate with everyone else, unless you have something that sends messages. Anybody not carrying a phone? I thought I would ask this audience that. I actually met someone...you are not carrying a phone. OK, one person. [Audience member asks, what about watches?] Well, I didn't go with Windows phones, I apologize. [Laughter] I was running out of space. The next question I am going to ask, you should definitely jump in and talk about that. It's interesting, most people are carrying something but of course some people reject this notion and don't carry anything but I don't think that's an option much longer.

The second question that you get from any group is, what do you use it for? There are the obvious things you use the phone for – it navigates you, you play with it, you can Facebook it, you can email with it, send texts and of course make phone calls, maybe. But I'm curious to know outside of that what's your favourite app, do you have one? "Facebook messenger". "Reading books" – Yes, I should have that on the list. "Universal Remote". Yes, I can do my Rogers TV with my phone, that is kind of cute. "Browsing the net". Ya – I didn't put it there, I guess I didn't think of that, asking questions and getting answers. "Dual languages" – Ya it does translations, yeah, that's amazing. "Banking". I don't trust my phone to bank yet [Laughter]. "Stream music". Streaming music is wonderful, right. "Some restaurants can use an app to check in". "Starbucks app". Dan, do you have a favourite app? "Music". Yeah...Dan's working for a company that is making a wrist watch, a great company, I don't think I'm talking about it so I'll mention it, it's a company that measures how well you are shooting a basketball and helps

you improve. Then they tuned it up by using a varsity coach, actually, it's cool. "Google maps" Yes it's on the list here, it's the first one. Which keeps getting better and scary smart. I was coming back from San Francisco the other day and I googled SFO on google maps and it said 'oh your flight is on time' and I never told it that. It looked in my mail because I got an email from Air Canada that said that, it's pretty scary. "Great golf apps" Oh yeah, to help measure distance or to make your swing better? "No, where you are on the course". Oh yes yes, not allowed in the PGA though right? [Laughter]

When these devices came on the scene they were revolutionary. We had computers before but never before did we have them so portable in our pocket, connected to the world, the internet, that told us everything what we needed to know, but it also senses the world around us in a way that computers don't do. They see, they hear and they feel what is happening and it's all in one place, and it's programmable. We can take our ideas and make new things out of them, and so because it's programmable, we can change them. I think of it as a new canvas for all kinds of new creativity. And that's because not everybody quite gets what's in your phone, there are lots and lots of things and I've been talking about this for a while now, only some people know all the different things that are in their phone. The thing that brought them into everybody's attention is this wonderful touch screen, which is how to talk to them, so we know about that. My favourite part of the phone is the accelerometer, it's a 3 dimensional accelerometer that measures motions in 3 different ways quite rapidly. There is a 3 dimensional gyroscope that measures rotations on all 3 axes, about all 3 axes, and there is 3 dimensional magnetometer which helps the compass work, it also measures magnetic fields in Tesla in 3 dimensions. That's an amazing set of things and here's a buzzword for you that's worth knowing, because it took a long time to say that, 3 dimensional this, 3 dimensional that, so people are tired of saying that, so they just say 9 axis. Three for each of the accelerometer, magnetometer and gyroscope. So that's a buzzword, I'll use it a couple more times, and it takes so long, so it's good to know that one, 9 axis. So, that's in the phone. This iPhone 6 newly has a barometer in it, up until then only the Android phones had a barometer in it. They measure air pressure if that wasn't so obvious. There's a GPS of course that tells us where we are, there's a really good quality microphone despite what you hear when you make a phone call, the microphone is actually quite good. There is a back facing camera, a really nice display, a light, that lights up the thing, the flash, there can be a flashlight of course. There is a proximity detector, not so obvious, it turns off the phone when your ear is too close, so your ear doesn't start hitting the buttons. That could be used for other things. There is a light meter, that is measuring the ambient light in lux, it is quite sensitive, it is notionally used to dim the screen. But it could be used for other things. There is a really important Bluetooth radio that gets you those Bluetooth headsets, or anything else that is talking Bluetooth. And that I think is really important, we're going to talk more about that. There is a near field communications radio that lets you pay for things quickly and there is a thing that buzzes when you want it to buzz. All of that is in one tiny place and it is programmable.

So this has given rise to what I think is one of the greatest surges of creativity in human history. And, the numbers are: there is about 1.3 million apps in both the Apple store and the Android market. The apps are in many different areas. The biggest bar here is games, the second is education, then business, then lifestyle, entertainment. Lots of great things out there. So you

might think, like the Greeks said way back in the day, it's all been invented but I think the opposite is true. Lots of great ideas already and if you have a great idea, by the way, you should google it to make sure somebody hasn't already thought of it. But, I think that there's more ideas to come and that's in part because we're still not used to these things, it's only been 6 years, and we change, and what we might want out of these things keeps changing and lots of ideas just come because of that. Now I can connect this to that and these people to that people, amazing things happen. Like what happened in Hong Kong the other day, when they were protesting. The big app that made that change in a big way was ad hoc mesh network via Bluetooth that the government could not stop. Same thing happened in Iran, I think, too maybe. So, stuff like that, becomes important and really important to keeping things going. And many more things. The other thing is it's a highly competitive spot. I am seeing a bunch of people here from Qualcomm and IBM and elsewhere that are thinking of where to take this technology. The big players, Apple, Samsung, Google, Huawei, MediaTek, all kinds of new companies, are pushing the economics of scale constantly. The economics of scale are amazing. They take things, they take instruments, these gyroscopes I'm talking about, would have cost thousands if not tens of thousands of dollars and we all get them inside this 200-500 dollar device. On top of many other things. So the economics of scale, as soon as somebody, one of those peak players, decides to take something and stick it in this phone, they're going to engineer it so it's cheap. And so, things that were expensive become cheap and combined with all these things, it's an amazing canvas. So this is why I think we've only gotten partway there and one of the things I've been focusing on. You know, some people have been coming up with ideas and whipping them off quickly. The experts haven't really been brought in to play much yet. The people who really know how to do stuff in other disciplines haven't really been put together with other people who program and make useful things. I'm trying to do that and I'm going to talk about that today. But that is barely half of it, so lots of great things to come.

What I'm going to talk about – wow that's a big, long introduction – is my time up? [Laughter] – is what I've been doing. I've been doing a couple of things for the past 4 years. The most interesting thing is I started a graduate course called, the same title as this talk, Creative Applications for Mobile Devices. The graduate course is open to every graduate student on campus so it's kind of unusual. EVERY graduate student on campus, and the idea is to bring people from other disciplines – music, physics, medicine, psychology, psychiatry – and give them a couple of programmers from our department and computer science (there are other programmers around too) and they do a project and the project has to be in the field of the non-programmer. So, that's the rule of the course. So I'm going to talk about the interesting apps that have been prototyped in that course here, so I'm going to talk about that, and a few other projects that undergraduates have done, some of the interesting apps I have come across (if I can get to it quickly) and this has caused me to launch my research in this direction, so I'm going to talk a bit about that and hopefully not put you to sleep. So, that's why the talk is called Creative Applications for Mobile Devices. This was an opening slide from my course last year and it was snapshots of all the apps from the previous year and I'll just talk through them super briefly. This one here was like a virtual reality app done by a PhD in Drama to actually put a virtual actor amongst real actors that you had to look at through your phone. This was a music app that analyzed music coming in after annotating it. The one with Obama there was an actual diagnostic, you know how a doctor makes you look like that, so they were actually using a phone

to analyze and look for what the doctor looks for when they look at your eyes – apparently lots of things are given away by your eyes. There is a ton of them, I won't do all of them. This was from somebody in OISE, an app to help children to learn to tell time. So that was driven by someone who knows about how to teach young children things. And this was also another theatre app, it was part of a play that was put on here at U of T, and you could watch the play and learn something about it through that app. A bunch of them. I am going to pick a few to talk about in a little more detail. Here's one that was very exciting. It's called myAnkle. So the terminology in the course is we have the 'programmers', that's a positive statement. We don't want to call the other folks 'non-programmers', that seems negative. So we call them 'appers', that's what I came up with. So we have the 'appers' and in all these slides the 'appers' will be in bold and the programmers are not in bold.

So Nirtal is actually a physiotherapist, he works at the Macintosh Clinic here at U of T. He was helping me fix an elbow problem I had one day and I told him about my course. And he said "Oh, I've got all these ideas for apps". Lots of people have ideas for apps actually, talk to almost anyone and they've got ideas. And I said well if you're a graduate student you can take this course. And it turned out he was doing his Masters in Public Health, so he took the course and came out with a really great idea. And these two guys are Masters of Engineering students who worked at Alterra, they were part time students, and then we've carried this on in my research group still collaborating with him, these are a couple undergraduate students and my PhD student Braiden Brosseau, kind of oversees this particular kind of 'side project'. And here's what it is: it's a physiotherapist in the phone if you've had an ankle problem and it makes use of the accelerometer. And just to review, it is my favourite sensor, the accelerator is the thing that, well mainly you see it when the phone changes it's aspect ratio sideways, because it's noticed that gravity has turned on its side, so that's what you mainly see it for. But the accelerometer measures acceleration in 3 dimensions, roughly 100 times per second. So it's sampling quite quickly and it is feeling what is going on. There's tons of great things you could do here. So, myAnkle makes use of that. What does it do – if you hurt your ankle, you break it or you sprain it, something happens that needs fixing. You lose, a simple word for it is called balance, the complicated word is called proprioception, it's your ability to take information from your muscles that allow you to balance yourself. And you lose that and you should do physiotherapy to get it back if you've sprained or broken your ankle. Otherwise you're going to lose your balance and maybe sprain it again. Most people don't because you can still walk fine and recover and they don't want to go to a physiotherapist because it costs 100\$ an hour. So maybe we should get that in the phone. That was something Nirtal said, and what he does as a physiotherapist is he watches people walk and he can kind of tell how they are walking, if they are walking properly or not, and if he makes them stand on one foot he counts the number of times they touch down. Very, very subjective stuff, generally speaking, is how he measures how the ankle is recovering. He looks at that, he gives some prescriptions and some exercises and says go do these and then watches again the next week for the next 100 dollars you pay him. But notice this is not good, we're all ECE, we like feedback, we like good observation, some subjective measure of watching someone walk is not very good. And so, the idea here was to use the accelerometer to measure how much you wobble when you are doing things for which you are unstable. So you would stand on one foot, stick the phone in your sock and measure the average acceleration over that time. The clinical question became does it really measure stuff

and the answer was yeah, it actually does. [Jonathan tests the app by standing on one foot, while his phone beeps]. You'll notice my foot is wiggling, and I actually broke my left leg 4 years ago and I can still detect the difference between my right leg and my left leg. [Looking at results] Oh, I was not doing well there. So that was the measurement there, the average amount of acceleration was 0.43 and I've been doing better before that, my right and left foot were lower, lower numbers are better. So you can actually see these are old measurements for me and you can see my leg which broke 4 years ago and my right leg which I didn't break, and there is a measurable difference there. So, anyways, that's the app and what it does. One of our biggest questions with it is, what do those numbers mean? We don't really know and we know that they are not consistent across lots of different people, but we do know if you have a good ankle and a bad ankle you want to get your bad ankle up to how good your good ankle is. And we think we could use it clinically like that, but we haven't fully proven that yet, actually. This is actually a research vehicle, if you download this, it's on the Google Playstore, you can measure yourself and that data is sent back to our servers here and we collect it and we use it in our research if you give us enough information about yourself. So, Nirtal is still doing his Masters in Public Health, and trying to make those numbers mean something. So we're trying to move forward and turn this into a useable medical application. So that was one app, that app was actually from the first year I taught the grad course, which was in 2011.

This came a little more recently, also quite interesting. Elizabeth Glenn Guy was the 'apper'. She was doing her PhD in Psychology and Shobhit and Yvonne were in Computer Science. Their app was about addictions and their observation is that addictions ruin lives, that's an obvious one. So is there something, these things that come with us, these phones that come with us can they help us in some way. Elizabeth's idea was to do what's a very standard treatment in addictions which is your therapist will give you a journal where you can record your cravings, and the things that are driving you towards your addiction. And that gives you the ability to reflect on them and think on them and then maybe push them away, that's the thinking. So their idea was let's put that into an app and that's a good idea because instead of people asking you why are you writing in that book they're not going to ask you why you're punching on your phone because everybody does that, so privacy is better. But the phone comes with all kinds of other things. It knows, it's easy to select your emotions if that's what you want to record, it knows where you are, it can record that easily, it knows the time, you don't have to record all kinds of things so it's a really good idea to take that standard thing and turn it into an easy-to-use app. Good idea. What was really interesting, and this has happened a number of times in the course, as soon as they started talking about, in the course people make presentations everybody listens and thinks about it, as soon as they start talking about it they go wow this phone knows all these things about what you're doing, and it knows where you are and maybe it could predict that you were going to relapse, that you were going to go smoke, drink, gamble, take the drug, do whatever it is. And the best example is you're an alcoholic and you're walking by a bar and it knows you're walking by that bar and so it goes oh you're heading in that direction, can we do something about it? That was the interesting idea that kind of occurred to everybody all at once, could you intervene before they fall off the cliff and go relapse? That seemed like a really interesting idea, because we could write a program and try to intervene. The strange notion was if you're an alcoholic could it call your sponsor for you, it's a phone right, it could just call your sponsor and maybe get them to talk you down. Or, play a song, or send

you a text, or something so I think it's a really interesting question. We're trying to pursue this, as I'll say in a moment, but it was really exciting that with this new active machine, doing the sort of standard thing, we came up with an idea to do something that may be very powerful to help someone really push back an addiction. So this is some screenshots of where you enter your mood and what your urge level is. You can track these things and you can find out that in the morning you're feeling good, you have the cognitive ability to push an addiction away, and when you get tired you start to lose that. These kinds of things can show that happening and maybe help you think about how not to do it. This is their version of the app showing what would you like to do, you're about to relapse, would you like to text a friend or would you like to hear a mindfulness script. I actually have played this on the app, and it is Elizabeth, the 'apper', speaking and she is speaking very calmly and nicely and I listened to this and it really calmed me down. I wasn't about to relapse into anything but I really quite liked it [Laughter]. So it struck me as effective, actually.

So that was a course project and it just seemed so exciting and I've seen a few other people around the world also beginning to think about this. I saw some wonderful video notions, video ideas about how this kind of thing could help. It's caused a collaboration that Elizabeth helped happen with, the little tiny house down on King's College Rd, it's part of CAMH, that is the nicotine dependence clinic, they help you stop smoking. There are people there whose job it is to show you, to walk you and talk you through, therapists, quitting smoking. But they also do research in this area, so we've begun a collaboration to try to build an app that focuses specifically on smoking. We're not the only ones who've done that, but we may be the only ones who are collaborating with research experts in smoking cessation. And so, the first thing we've tried to do, and we have a prototype, the name of the app is My Change Plan, because that's the name of the book they hand you when you enter that clinic. It's called My Change Plan, it's actually a strange little book that talks to you about nicotine replacement therapy but also asks you to think about the things that trigger your smoking and all that and we've tried to put that in an app and we're now trying to figure out how to be more active about it. And we're in discussions that have been in a few focus groups with current smokers who have phones who are interested in maybe having their phone help them grow. So this has become research that is kind of interesting.

This is an app done with someone from OISE that was about teaching autistic children to recognize emotion. It's hard for them to recognize emotion in others and this is a game that teaches them that. Here are some screenshots of it. It uses the accelerometer to detect if they're getting mad and are about to throw the phone, it goes into another mode and the voice of the parents come and calms them down. It's a clever idea, actually, making use of that accelerometer again. This is something I love showing, it's just kind of cool, it shows the power of modern technology when it gets focused in. There's this great idea that originally came out of MIT, there are a bunch of apps that can do this, and I have one called Cardio. It makes use of the front facing camera, and watch what it can do. This I just like to show because it's very cool. Let me show it to you. I have a way to show it from my iPhone, just a second. Notice my face showed up there. It brings up a few things to keep my attention – there. It just measured my heart rate. How did it do that? By just looking at my face. My face changes colour when my heart pumps. Not so that you can see it but it sampled it over 10 or 20 seconds, there are a lot of

frames there with some clever algorithms and signal processing. The front facing camera was looking at me and it measured my heart rate and that seems about it right. My resting heart rate is actually about 56 bpm but I think when I'm talking to you it goes up to 74 – it's generally been accurate. And it is stunning in my view, it is superhuman. I can't look at you and see your heart rate. And by the way it has worked on black skinned people. I have tried it personally, there is still a colour change if your skin colour is black. It's really amazing and it's superhuman. This is a superhuman device, in that sense. It can see more than you can see. [Question from audience – What about Diabetes?]. There are external devices that do connect, that measure blood sugar and go into phones. I think it's still invasive actually. A good question is, is there a non-invasive way to do that. That would be nice, actually. That's up to the photonics people, actually, not us in computers. But, I love that app because it's so amazing that you can do that and each sensor has the ability to be enhanced by –well what was that enhanced by – it was enhanced by very clever computation. And if you saw there, actually, the latest version actually shows some kind of version of my heart rate . It's just really amazing, I think it's incredible and it's the edge of how we'll be able to put doctors into these phones, if we can start to measure stuff, like sugar content in blood, and lots of other things. So that's what that was about.

Won't go into detail on this one, this one was in last year's class. Nicole Smith is at OISE and is specializing in research on how to make better use of Power Point and media in lectures. So her idea, which is really cool, was to build an app that gives you feedback on how well you're speaking to people, in a presentation. The things they measured were, super quickly, they listened to the microphone and how fast you were speaking, and an alarm if you were going too slow or too fast. They used the compass to figure out what direction you were facing, if you spending all your time like this, not a good idea, so it measures you like that. And if you were fidgeting too much. And the question is well when do you tell the person about this – at the end of the talk? Well yes, if they're practicing, you give them stats. In the middle of the talk? Well you can't talk to them because as she says, I'm talking, I'm busy using my language processing centre, I don't need another input, but you can use the buzzer in the phone to go bzzzt 'you're facing the wrong way' or bzzzt 'you're talking too fast'. So, that's what they did. It's a clever app and they did some clever signal processing to get the speech rate and things like that. And the output looks like: this is the settings, you set how fast you want it to go. This shows speech rate and it says your average and your peak. This says what fraction of time you are facing which way . 89% facing that way, 11% facing that way. And then this is the fidget-o-meter. It says if it's at the top it's restless, then less fidgety and calm. I thought that was a really great idea and it's someone whose research field was exactly that and they decided to use these sensors to give you a sense of how well you're presenting.

The last technical thing I want to talk about is the Bluetooth connection. You see the taxi drivers talking on the phone because they've got this earpiece in, but that Bluetooth connection is now being used to connect to a wide array of sensors that are outside of the phone. And there's all kinds of things coming out on Indigogo and Kickstarter, if you know what those are, that people are making. It's an explosion of interesting, external sensors that are going to be everywhere collecting all kinds of data. We are building one for the MyAnkle application. I have an undergraduate named Babeet Singh who is 3D printing a strap that we can put around an ankle, taking this device which has an accelerometer on it so that we don't have to do the stupid putting

the phone in the sock. That seems to be a better thing, he's integrating that into my ankle too. Here is a great little widget. Check this out, Node Sensor. This is a company that sells a platform and the platform, it's called a platform because this chunk here, has a Bluetooth radio and a 9 axis, so this base thing comes with a 9 axis sensor. You screw on the end different sensors, I'll show you the two that I have [demonstrating the device] – accelerometer, gyroscope and if I change the orientation the magnetometer will show me something about North, magnetic North, so you can see me doing that but you can also see the motion, so that's kind of cute. I like this one too, it's kind of neat. That's my hand shaking, so it's kind of a cute use of the orientation sensors. So that's in the base unit, let's go to this – Node Therma. So this measures temperature. So he is 25-26 degrees [To audience member] Open your mouth, actually [Laughter]. It's getting up there, should be a bit higher but it's getting closer to body temperature, so it's a nice little infrared temperature sensor, so that's kind of nice. That's kind of fun. And on the other side there is a climate one – Clima – and this measures lux over there, so we can make it go crazy by pointing it at that [at the projector light]. It just went up to 7000,4000 lux and then I covered it up and it goes down. Air pressure, humidity sensors, and ambient temperature. So, if you go look at their product, they sell lots of different things you screw on to the end of this, including something that measures the colour of paint in your house. And you can go and stick it up against that and then get matching paint colour when you go to the paint store. All kinds of cool stuff like that. Something that measures oxygen and a couple other things – CO₂, there's a bar code reader, a thermocoupler and you can build your own. So it's a clever thing, just one of many different things that people are building to attach to your phone that you can stick to things and pull data in that are going to be incredibly powerful, medically, and otherwise.

Here's one, last one, I like this one. This one is called Button TrackR, you stick this in your wallet or purse and your phone alarms if you get too far away from it. So that's a good idea. You should also put it on Grandma or Grandpa if you're afraid of losing them, sorry if that offends. And they have some clever ideas, like everything else, once you have that idea, they make use of the fact that the phone could make use of the last place it saw it. So you could ask your phone well where did I leave it? It knew where it was, the last place it saw it with the GPS, you look at a map and it tells you where it is, very clever. One other really clever thing they did was lose the thing and it goes off, if somebody goes by with a phone with their app running on it, it notices your thing, sends it up to the cloud and tells you where it was. And the way the company illustrated that was they bought a bike, a bait bike, they stuck one of these things in it and left it out to be stolen, it was stolen immediately. Ten days later somebody walked by it with one of their apps, they knew where it was, they went and knocked on the door and said can I have the bike back, please. They have a little video of that on their website. Very clever, actually. All kinds of great ideas occur when you do these things. So, in 2009 after I finished being Chair, I went on sabbatical to England and I learned how to program my iPhone. I programmed this app called TeamChooser, and it's purpose is if you play sports – I play ice hockey twice a week – and it's always hard to have fair teams. People always get mad at the people who picked the teams and when they're unfair, they get mad at them. And in hockey the classic thing is you often randomly separate sticks, sometimes that gets good teams, sometimes horribly balanced teams. So, what we do instead – oh, all of us here in nerd land, and we've been selected last by the team captains, and we know that's bad . So we should make an app for that, and that's what

I did. So I have an app where you enter all the people who are going to play and you rate them from 1- 10. That's tricky and it's very important never to tell people what their ratings are, even I got offended when I handed it to someone else to tell me my rating. So you don't do that. And then on game day, you select who is there, you tick off who's there. Let me show you – here's the app. So you select who's there that day, and you hit this button that says make teams, and it produces two teams, the Light side and the Dark side. The average score is 85.4 for the Light team and the average score of the Dark team is 85.5, so you get fair teams. And as it turns out it actually works, we've played in it and far more often than not, you get an even game, so it's tons of fun. I have to say one of the more thrilling moments in my life (I'm kind of geeky) was the first time we tried this, we were playing the game and I thought "Wow, this game is even". I just almost stopped playing, it was so thrilling, we made software that actually functioned, actually. Functioned, and did something useful, right then and there, you know, which hadn't been done before. Which is what has been happening when people make these new apps, there's tons of them.

And this app has actually allowed me to learn the iPhone ecosystem. It's on the app store, we used to charge one dollar for it, it's interesting, we charged a dollar for it because someone else was charging for an app that made random teams. We actually put some thought into this, we must charge a dollar, but now it's free, by the way. And the other day, I noticed that the guy who helped with this, with the user interface, he had got into making it free for a little while, and then not making it free and he noticed that we would get a spike in people downloading it, and it had lapsed back into being a dollar the other day, so 4 days ago I changed it to be free again. You want to see what happened? Sales and trends – the apple website tells you how it's doing. You can see the day - on the day, it shot up from nothing to over 1000 – wow, that's crazy. So, 3 days ago I made it free and then a lot of people downloaded it. Wow, that's interesting. Something really weird happened in the last day because I was at 678 and now. We are at a total of \$197 over 5 years. It costs \$100 a year to have the right to have your app on the iPhone, so I'm in the hole. So there's one more really worthwhile thing to tell you about all this which is – you always want to know if somebody is using your app because you don't know if they're using it. You know that they bought it, but you don't know if they're using it. But it turns out there's this free software, from lots of companies, one of the main ones is called Flurry. It takes exactly 10 minutes to take Flurry software and put it into your phone and it will tell you all kinds of things about who's using your app and a little bit about where they are, like, it will tell you a bunch of data about the kind of phone they use. They'll tell you and will make it trivial for you to send back anything, for me to send back, anything I want to send back. If I wanted to take the scores that people put for their friends and keep them, I could take them, there's nothing stopping me from doing that. The message I want to send is kind of an aside in this, you probably think and are aware that when you are on a website, of course you're being watched, it's somebody's website, but what you probably didn't know is that every app you buy, you are also being watched. And everything you say can be and is easily and trivially sent back to the people who made the app. And I can show you for example, one of the things I do send back and I disclose this in my information, is whenever anybody pushes the button, 'make teams', it sends back an event that tells me the name of the game that they're playing, so I play Friday Hockey so it says Friday Hockey but it's kind of fun to see what England is playing. There is a game in England that I know is called Monday Footy and that's because they're playing soccer, as they

call it. So we can look in this event log and somebody, not very long ago, at 7:31, edited this name of a player. You can see, there you go, Footy right there, that's got to be somebody in England. And this is the stats on the thing they selected. So I was interested to see that, I wrote a tiny bit of code, and sent it back. Every app can do this, send back information like that. So you're being watched in your apps, and you're being watched in a way that you'll be shocked to know unless you've kind of followed this stuff. So, look at this - this is something about my audience – their interests, their personas, age and gender, nowhere in my app do I ask you how old you are or what gender you are. But yet, when I click here on gender, it says a bunch of things and it says, well, it looks like 64% of users are male and 36% are female. How does it know that? Anybody care to guess? So, Flurry is in 75% of all apps, so on my phone it knows not just my app but every other app that I have. I have a pattern of apps if I'm male or female, there is a pattern of apps depending on your age, so they will guess the age of my users are, based on the pattern of apps they have. So, 130 of the users identified were 13-17. The pattern of apps gives away things about you, this is the world of Big Data and this is them taking that data and figuring stuff out about you. So, not only are you being watched, you are being watched way more than you possibly thought you could be. So, beware. By the way, I think it's awesome that I can get all this information back as a developer; I'm completely appalled as a consumer of this.

So, I'm just about done. And all I'll say to finish is, you know, where does all this lead? I hope you realize that these are amazing devices, that making an app is a very creative process, it's what we try to do in that grad class, and what happens when you jump into an app and inhabit it, new ideas come out, and that's exciting to see. So, that's why I think apps have only just scratched the surface and, the exciting thing is, if you put it into a phone, these are scaled to the rest of the planet. So, if you can put a doctor into the phone, or a piece of a doctor into the phone, then everybody gets a doctor. And that'll change the world and if you could put a psychiatrist in the phone, that's something we really need, that can really help change the world. And so, I think there's lots to come on that front and hopefully you found this interesting. If you go to my website, or just google me, you can find the grad class and there are videos of the final presentations and demonstrations there. Mike Delorme here actually made one of them [in audience]. What was your app like? "We did the one with nursing at Woodcare" Oh yes, that one had a great idea – talk to him about that one. And, you can go look at this research centre that I've launched, it's kind of based on that. It's called the Centre for Inter-Disciplinary Mobile Software and Hardware, looking for interesting things that come out of this kind of thinking. So, thank you. (Applause)