

Inside the Lab Podcast featuring Windlight  
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**Pastrami Linden**  
**Runitai Linden**  
**Torley Linden**  
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Hosted by:  
**Melissa Linden**

**Melissa Linden:** You are listening to an installment of Radio Linden "Inside the Lab Podcast" series. Today we are having a conversation with some of the people responsible for bringing you WindLight.

Welcome, I'm Melissa Linden and I work in the Public Relations and Marketing department here at Linden Lab. After months in First Look and release candidates, we announced on Wednesday that WindLight is now available for download.

The Second Life 1.19.1 viewer features WindLight's atmospheric lighting and other crucial stability, performance and feature enhancements. We thought you might be interested in hearing about how we arrived at this important chapter in Second Life's history.

So, joining me today we have Pastrami Linden, Torley Linden, Zen Linden and Runitai Linden. Would each of you introduce yourselves and tell us briefly what you're responsible for at the lab in relation to the launch of WindLight?

Pastrami, would you like to start?

**Pastrami Linden:** Sure. I am the tasty and delicious Pastrami Linden. And I have essentially been supervising a lot of the development and implementation of WindLight. I have been project managing a lot of the developers who have been working on it and now working with Torley and others to interface with the community and kind of serve as the glue within the whole project.

**Melissa:** Thank you. Torley, would you like to go next?

**Torley Linden:** Sure. Friendly greetings. This is Torley Linden and I've been doing a lot of the community communications, which means helping Residents get their bugs triaged to us and processing them so we can get them fixed really fast. I have been liaising with our graphics crew and the WindLight team also to just keep an eye out for what's going on the street.

And I have been updating the WindLight wiki page with information over time and doing video tutorials to communicate feature usage.

**Melissa:** Thanks Torley. Zen, would you like to go next?

**Zen Linden:** Sure. I'm Zen Linden and I've spent a good deal of time trying to make sure that WindLight runs on as many platforms as possible, as well as worked on a fair bit of the UIs.

**Melissa:** Great. Thank you. And Runitai?

**Runitai Linden:** Howdy. Let's see. I guess I was responsible for shoehorning as many 11th hour features into the project as possible, and delaying its launch. [laughs]

I worked on the water reflections, the new water shader with the help of Qarl Linden and BigPapi to do the volumetric fog in the water. And what else? Revamped occlusion calling, some infra-structure things - just general optimizations, avatar impostors. That's all that comes to mind.

**Melissa:** Well that sounds like quite a lot.

**Pastrami:** It was.

**Melissa:** Well thank you everyone.

**Runitai:** Well yeah, but that was BigPapi as me. He's not here so I'm going to try not to take credit for stuff that he worked on. [laughs]

**Melissa:** Well, thanks for being here everyone. Let's get started. First we'll do just a little bit of history. Can you tell us a little about Windward Mark and how the company became a part of Linden Lab?

**Pastrami:** Sure. This is Pastrami. I'll take that one. Basically we were a small video game company located here in Boston. And I was actually speaking, this was I believe in 2006, at Harvard Business School Cyberposium, which is this gathering every year of people who are involved in interactive media.

Philip Rosedale was actually one of the keynotes this year at the 2007 one. And I ended up speaking with some people who were involved with Second Life and with Linden Lab. And one thing led to another. We showed them our technology, like WindLight and Nimble.

And they decided that it would be good to put us in touch with Linden Lab. And so we met with some people at Linden and some talk went back and forth. A few months before we had never even, it had never occurred to us to work with Linden Lab or even develop anything resembling a virtual world. We were building a next gen FPS.

And they started talking with us. And we saw what the potential could be. And they said they wanted to acquire us. So, you know we kind of looked at each other and went, "Yeah, that's not a bad deal. Why don't we do that?"

**Melissa:** Great.

**Pastrami:** So here we are today.

**Melissa:** Awesome. So what was the motivation behind the development of WindLight?

**Pastrami:** Well, essentially what we wanted to do from the outset when we first started our company was to bring more high fidelity daytime

style rendering to graphics. So a lot of systems up until that time used standard OpenGL fog and really sort of darkish style lighting that was only meant to be used for indoor scenes, that wasn't very complex in its modeling.

So WindLight was an attempt to bring physically accurate atmospheric lighting, where everything was lit uniformly using light scattering algorithms coming from the sun and the sky such that things wouldn't look as plasticky or just kind of pea-soup fog that they had before in video games.

**Melissa:** Thank you. Can someone describe at a high level what WindLight is?

**Pastrami:** Zen, why don't you take it?

**Zen:** What WindLight is? It's more physically based, atmospheric lighting in a sense. We tried to get how light is scattered in the atmosphere. We kind of fudged some of the science on it but basically the look is what we were going for and we think we got that. We wanted to make sure the sunsets were really good.

**Melissa:** Yeah. Absolutely, it's beautiful. So how was WindLight developed?

**Pastrami:** Well what we had done was each of us had our own expertise but we had to seek out some experts in the subject field. So we worked with people who were really, really good at atmospheric rendering and understood the physics behind what was going on.

And we also worked with people who were really good at doing optimization. So in a sense, taking these really complex ray-tracing-based algorithms that take a lot of computational power and could never be done in real time and, as we like to say, shaved 10% of the science and gained 90% of the speed.

So it was kind of a combination of ourselves and some physics experts and some real-time rendering experts, all working together.

**Melissa:** Thank you. Why was WindLight in beta-programs for so long?

**Pastrami:** Runitai, why don't you take this one?

**Runitai:** Well mostly its compatibility issues with OpenGL and Apple and GLSL in general. We were told at GDC this year that we are pretty much the only company in the game space, as much as we are in the game space, using GLSL.

And just one thing after another broke whenever we would modify any of the shaders to make them work with different hardware. Like a lot of what Zen's work was doing and a lot of work that BigPapi did was basically rewriting the shaders several times just to get them to run on all platforms.

And then of course, while they're doing that I'm introducing new features like avatar impostors. [laughs] I was like, "You know, it would be really cool if we went to 16-bit Index buffers and oh, why

don't I waste a lot of time trying this alpha optimization that we ended up at defaulting off." You know, things like that.

**Melissa:** OK. Pastrami, did you want to add something?

**Pastrami:** Basically we were - yeah, what was originally supposed to be new skies became sort of a stub for a lot of other things we wanted to do because we couldn't just implement something that required heavy shaders and just put up the viewer like that. We used this opportunity to really rewrite a lot of the core system and optimize and introduce things that would give Residents sort of a twofer, you know give them new features but also give them speed-ups.

Avatar impostors are huge example of that. Even people with low-end cards can turn on avatar impostors and get a frame rate boost. A lot of people with older cards are seeing the biggest increases in frame rate. So we just had the test on a really extensive series of hardware and it was just a lot of code that was getting rewritten.

**Zen:** Right, and with that many changes, it's oftentimes hard to regression test some sort of graphical rendering system as we had. And we had a lot of Residents of course who came to expect certain things would look certain ways.

And so we had to spend a lot of time debating and trying to figure out what the best way was to balance all of these needs with also developing the system.

**Pastrami:** Yeah, that's really true. One of the biggest issues we had was that the Second Life viewer, when we came on was using a lot of old style rendering techniques. And Residents had gotten really used to these.

And there was just no way to really head forward into the future, take advantage of the latest hardware while keeping some of these really sort of older models. So, things like the way shiny looks were a huge issue during First Look development.

Things like avatar lighting, which is still - people are going to have to adjust slightly to it because - I won't get into the details but the avatar lighting wasn't always done correctly in the old system. So it's kind of a very beautiful pill people are going to have to swallow because we had to update everything and get things working more uniformly, more correctly. And that was a big part of development as well.

**Melissa:** Could you talk a little bit more about avatar impostors?

**Runitai:** Sure. So basically avatar impostors will replace your avatar with an approximation of it, when it becomes small on the screen. The definition of small on the screen is tied directly to what your avatar detail lighter is set to. Basically it works by rendering your avatar to a texture so you get an image of what your avatar looks like from a particular angle. And then instead of drawing your whole avatar, it just draws that image.

And then as things get smaller and smaller on the screen, they get fewer and fewer updates. So if you're looking at a large crowd of people, everybody in the background is really only updating every 16 frames, or not at all if they're not moving. And the result is you render two triangles for an avatar instead of the usual umpteen thousand depending on how many attachments they have.

**Melissa:** Thank you. So let's dive a little bit deeper into what WindLight will do for Residents' experience inworld.

**Pastrami:** I will totally defer to Torley on this one.

**Torley:** [laughs] I'll gladly help with it. Sure. The word is love. I want you to go and Google for WindLight sunset. And there are thousands, literally thousands of pictures where there are Residents in love, enjoying Second Life or just hanging out and having a nice vacation wherever they are.

And all these sunsets and variations just add up to a fantastic everyday experience because I have seen and experienced so many Residents telling us and sharing with us that from their day-to-day time and what they do, there is just so much color and variety.

I think of Bob Ross paintings. And I think of beauty like that. And I think of Carl Sagan too. Carl Sagan spoke of billions and billions of stars. And here we are in WindLight with billions and billions literally of variations.

There is a lot more control that Residents both have on their own experience. And coming soon in the future there will be server-side controls so when someone goes to a nice island, it will automatically be set to these WindLight settings, whether it's very frosty snow, a setting with lots of haze or something that's more tropical.

And I have even used WindLight myself to sort of approximate some physical real-life setting. Like I did some tours and shots for the Maldives for the Guinness Book of World Records photos and those turned out very, very nicely - lush water as well. You can customize the water, not just the sky.

In addition, as part of this whole WindLight project, like was mentioned earlier, there is the glow. And that will be scriptable soon, which means there will be all these lush kind of ethereal effects. And there already are so many impressive creations.

So even if someone, even if a new Resident comes to Second Life and they don't know how to explain the physical modeling or the other sorts of quantitative and qualitative aspects of WindLight, nevertheless they can enjoy it. Just like you can walk outside in your First Life and enjoy the sunset.

So WindLight is very much a transference of this in a sort of a spiritual analog. And I see this as an emotional technology because someone comes in and they see the screen. And I have shown WindLight to people who know nothing about Second Life or computers, and they are like, "My gosh, this is beautiful."

So yes, I'd have to equate it with love.

[laughter]

[overtalk]

**Zen:** That's so much why I love doing this.

**Torley:** I have so much appreciation for you guys - you graphic gurus. My gosh.

**Pastrami:** That was going to be much better than my response. It was, "It makes nifty skies."

[laughter]

**Melissa:** So Torley, will that love be spread around to machinima makers as well?

**Torley:** Definitely it's already happening. Even at the very earliest stages of the WindLight First Look we had, we had these archetypical and prototypical animations and all these sorts of crazy little experiments coming out.

And it was funny because when WindLight went away for a while, when we were heads down testing it, I got so many emails from machinima makers saying, "Bring it back. Bring it back. I'm so dependent on it."

And of course we don't officially guarantee to support this feature until it's in the main viewer, which it is now. But I've just seen a lot come out already. I've been on YouTube browsing all these videos, where they are really using it to provide added suspense.

Like not only - there is a dark side to WindLight. It can make very sort of gritty looking atmospheres where you can turn up the haze. You can really set it so the sun has almost this - I sometimes call this evil, parabolic nature in the background where the scene is tinted red. It's just hard to describe in words. But you've just got to see these movies for themselves. So -

**Melissa:** Hello?

**Zen:** Oh no.

**Pastrami:** I think he exploded.

**Melissa:** It sounds like we lost him. OK. Let me grab him really quickly.

**Torley:** My apologies about that. For some reason we got disconnected.

**Melissa:** We thought you were so excited it just went off the chart.

**Torley:** I am really excited.

**Melissa:** OK. So we'll just pick up there. Why don't we just move on to the next question?

**Pastrami:** One quick thing Melissa I wanted to add.

**Melissa:** Yeah.

**Pastrami:** One of the things I'm really excited about too is, right now has a lot of people have experienced with WindLight, there are a lot of various sliders and parameters that you can change. And that will continue to be the case, especially with the day cycle settings.

And as you head into the future and develop things both to be estate settable and tradable as assets, I'm really looking forward to adding some form of scriptability into all these controls. So you can just imagine like a live DJing experience or something where the cloud cover or the sun exposure or any number of other parameters are sort of fluctuating in beat with the music or according to things that you are touching.

So you can kind of move around an environment and do various things and have -I can just imagine particle emitters along with all the WindLight settings all changing rapidly and dynamically. And I think something like that would just be - that would really start putting us over the edge as far as things people have experienced either in games or any type of interactive media because something on that level, in 3-D would be really cool.

**Melissa:** That would be great.

**Torley:** That would rock so much. Like a Neo-Woodstock and the sun would come up and all the pyrotechnics would explode. And the crowd goes wild.

**Torley:** Yeah.

**Melissa:** Yeah.

**Torley:** Ooh yeah.

**Pastrami:** And watermelons everywhere.

[laughter]

**Torley:** I'm buying some of that. Num, num.

**Melissa:** So, besides all the visual things that we are going to see and the lighting, what else was improved along with WindLight?

**Runitai:** Let's see. Well we totally changed the way that we manage vertex buffers. I don't know how low level I want to get here but we cut the size of, we cut the amount of memory that we use for geometry down by about 25%. And we cut the number of copies of geometry that we have by half on top of that.

So geometry updates basically - when you are playing around LODs, streaming in, you should notice a lot fewer frame stalls. It should just be smoother overall.

What else? Occlusion calling got re-hauled. So now it's per frame accurate. It's still off by one frame but if you sit in a cube and spin your camera around, anything outside the cube will not be visible. If it's not visible, it's not getting drawn. So that will get rid of all those really huge frame stalls for when things just sort of eke in, barely visible on the edge of your frustum and thrash the PCI bus.

**Melissa:** So, for the layperson, are we talking about stability?

**Runitai:** No, this is all frame rate improvements.

**Melissa:** OK.

**Runitai:** Just trying to keep things, trying to keep the frame rates smoother. What else?

**Melissa:** What about stability?

**Pastrami:** Well you mentioned stability Melissa. So another thing too to look at, regarding stability itself, is a lot of the things that we did with Apple. Zen, did you want to speak to that?

**Zen:** Stability wise, for Apple? Sure. That was more BigPapi than me but it was largely working with them. There were a couple of bugs in the driver that we found. We had to reorganize the way some of our shaders worked. And it was a lot of back and forth between them helping us, finding ways we could optimize things.

And it took a while but it ended up working out really well. And stuff now runs - I think there is still one issue with one of the latest Mac Book Pros. But stuff runs on Apple pretty well now because they were really good at talking to us.

**Pastrami:** Yeah, because I know we had a number of problems using any type of advanced shaders on the Mac Books. That was just one of the many pieces of the epic saga. So frame rate and stability both went hand in hand.

**Melissa:** Great. How will WindLight affect performance?

**Zen:** Hopefully the goal is that it shouldn't or possibly improve. What we were trying to do was basically WindLight was extra features. And you have kind of a base level and you can basically add these extra features on top.

There are a few cases where we actually are a little bit slower on some of the midline cards. But Runitai has some optimizations that are coming down the pipe soon that I think will address that.

But other than that, in most cases your frame rate should be the same or better and you should have a whole lot of extra features that should look a lot better.

**Melissa:** And for people with older graphics cards?

**Zen:** We tried to do as much as we can for those. Some of the really old ones we kind of had to say, "Well, it's a little rough." Like for some

of the older Intel integrated graphics cards, some of the really early like TNT2s or early G Force cards and stuff, we kind of had to draw the line there.

But I know people who have had success running this with like GeForce 4MXs, GeForce 2s. And of course we don't have shaders on these things but it does run. And that's kind of what we wanted.

And actually I have seen a bit of a performance boost on Low due to all the optimizations that Runitai put in. So...

**Melissa:** Is there a place where people can find out more information?

**Zen:** There is some good information on the Second Life wiki. I probably ought to add some more info there on, especially some ways you could possibly tweak some of the preferences more.

**Pastrami:** Or talk to Torley.

**Zen:** Or talk to Torley.

**Melissa:** Torley, do you have some resources for us?

**Torley:** Pretty much the stuff on the wiki right now - go to [wiki.secondlife.com](http://wiki.secondlife.com) and just search on the left hand bar, search for WindLight. And that brings up the page. And it's still going to be updated as more stuff comes up.

Today at my office hours, incidentally, one Resident asked about the possibility of having more sort of GPU configurations and expected performance as well as any sorts of suggestions for us. Because we really do look at that feedback and we've done a lot of follow-up. So yeah, I'd say that's the central information hub for WindLight.

**Melissa:** Thanks, Torley. We talked about this already a little bit, but are there any other cool things you want to tell us about you can do with WindLight?

**Torley:** Something that I've really noticed over time was that existing content - like something say from 2004, some of the really old crappy looking things - they look a lot better in WindLight. And you don't even have to tweak anything. Just by the nature of having more physically accurate lighting and the new stuff that's being made, especially something like sculpted prims.

When you take sculpted prims and you put them together with shiny and with glow and with WindLight - I mean not overdoing it - but when you use those new features in combination, it creates this cohesive whole which is so amazing and beautiful. I've seen these gorgeous sculptures in-world. All sorts of really elaborate creations that draws on the strength of WindLight and also other complementary features to come up with something that is just like Second Life like you've never seen it before. Literally and visually.

And another thing that I've certainly seen is a lot of the glow stuff. There are certain places in Second Life now where they're creating kind of glow galleries. Meaning that you go to a black box, a big black box,

Spiral Walcher is a great Resident who's done a lot of this. And within there's glowing objects.

Then, in addition to that, you can step outside the box and there's recommended WindLight settings. Right now currently it's not estate side yet, but it will be, meaning it will be automatic. But for now, yoo-hoo, that will be exciting. But for now you change them manually and when you step out it's really transcendental.

It's just really beautiful and sometimes there's just no words, you just look at it. Look at your screen, even though it's a little screen. But hopefully you've got a big screen, you just look at it and you smile. It's so vibrant. And especially even better if you're there with friends. And you experience it and you share those experiences and you take pictures and you put them up. That is gorgeous.

**Pastrami:** I wanted to actually, from a different perspective. Torley I think's talking about for the entire viewer and what you can do with it. I was much more closely associated with WindLight itself, meaning the atmospheric shading. So I want to speak to that for a second.

I think what's really cool as far as what you can do with WindLight itself, with the various sliders and settings, it's really good for two types of people, I've found. It's good for those who are really into hyper realism and it's really good for those who are very much not. And this has played out between Torley and myself. So I am a, this is Pastrami speaking here, I am a hyper photo-realism nut. I mean, I love going for photo-real stuff. I always have. And Torley, not so much. [laughter]

What's funny is I had done so much work even before we started integrating into Second Life, back at Windward Mark, about trying to tweak every little parameter to get photo-realism. And when we first came to Linden Lab, Torley started going to town with this stuff. We first laughed at the first couple things he was producing because they were so far from it.

But then they started taking on a nature of their own. Then suddenly people started seeing all of these crazy, crazy settings that Torley had come up with. We kind of looked at it and went well, this is really kind of a - I don't want to say double edged sword because that's the wrong analogy - but let's say a double bladed sword. Where you could really do two really amazing type of things.

So I'm the big realism guy and I was setting up all the presets and the day cycles to look really good. So FYI, I think 5:20 or 5:30 PM is the best looking time on the day cycle. And then Torley would create these Martian watermelon, acid trippy crazy things and they both looked cool.

There were all these screen shots coming out from the community, some using Torley's settings or people had done that looked like Torley's. And some that were absolutely photo-real. So that's one of the things I really like, because it's very rare in computer science in general where you get to hit two fields at once. It's always one at the expense of the other. I think with WindLight you really get to hit all the bases with it.

**Torley:** That's such a great way to put it, Pastrami. And once we have; the tools are out and the wonderful thing is, I have such a passion for spreading the word. Like what our graphics gurus know behind the scenes and getting that knowledge out to Residents. So then they feel empowered. Then they learn how to use the tools, and then they learn how to create their own settings. Whether they're photorealistic or really surreal, and then they share that knowledge forward.

That both creates value for WindLight and the community itself, when people are able to appreciate such a gorgeous and amazing diversity of beauty. Whether it's a crazy out there planet which is something out of Star Wars. And that really enables too, people who want to create alien atmospheres for so long, they now have that power. As well as people who felt before that the world looked too flat and they want it to look more like something like Tahiti or Hawaii or a favorite memory from their childhood vacation. They can do all that with WindLight and more.

**Melissa:** Thank you. Thanks so much for your excitement and your passion. I'm wondering what's next in store for the team and for the graphics in Second Life?

**Runitai:** One of the nice things about taking so long to rewrite the graphics engine with WindLight, is we've been able to sort of put in a lot of current generation graphics programming capabilities that were not fully taken advantage of yet. So now we have a working GLSL pipeline, we can put pretty much any shader we want in there. We have render to texture. We have render to depth-texture. We have the ability to render the scene out from multiple camera points.

So that opens up the door for things like real-time shadows. For things like per pixel lighting with a much lower barrier to entry than we've seen before. So moving forward, I'd expect to see more rapid progress on the graphics engine. I wouldn't expect it to be another year before the next graphics engine update. But currently almost all of our resources are going into stability. We've got to lower the viewer crash rate.

**Zen:** Yep. That's what I'm focused on right now. As well as the rest of the WindLight team and stuff. So, yeah, we crash way too much. And yeah, this needs to drop.

**Pastrami:** But, but, but, but, because I know this is the type of stuff people are looking for. People who have been talking with us during office hours or looking at the blog post, everything that you guys as the community want to see is really on our road map. It's just a matter of how long.

For example, more robust materials, which will include things like normal mapping. And things like a particular package which might make foliage go quickly, and that's all I'm going to say. Nimble, which is the volumetric cloud system which some of you guys have seen, that we developed at Windward Mark Interactive. Real-time shadowing, Runati had mentioned. Let's see, what else. Yeah, those are really the big ones.

**Zen:** Many, many lights in a scene.

**Pastrami:** Right.

**Runitai:** Yay, deferred rendering.

**Runitai:** And it's really amazing. I took a week a while ago, and it ended up turning into three weeks because I had some success and got really excited about it. Just saying, well what if we just took the renderer, stood it on its head and said well, I'm going to use some crazy, off the wall lighting scheme called deferred rendering and try to turn on all the point lights. So not just the six closest.

It didn't take long at all to prototype and the results were pretty compelling. Unfortunately, it only runs on GeForce 8, but still the architectural change was minimal. [buzz] Oh, that's the pager.

**Melissa:** Well, congratulations on a job well done. I'd just like to thank everyone for being here today. Did anyone want to add anything else?

**Pastrami:** Torley, send us off.

**Melissa:** Yeah, Torley, you want to close it?

**Torley:** Please, if that's all right. When we first began this - and it's been a long road because even before Windward Mark joined Linden Lab and we did this WindLight project - long ago there was a killer skies project which was on the books. It was on the books for several years and it didn't get done. Now with WindLight, it's become a reality, so in that it's been a dream come true.

The other thing I wanted to mention is it's been very funny because WindLight was first announced; it was a sudden, very drastic change of course. But one blessing to having had so much time over the last stretch of months is that Residents have come to love and get used to WindLight.

It's very funny because earlier we would hear a lot of complaints about, "My skin looks awful with WindLight." But now, when I was just checking out some of the skin stores today, there are skins that people are advertising that are optimized for WindLight.

So there's a societal change, this whole... It's a climate shift, not in the environmental sense, but in terms of how people think and how people psychologically perceive virtual worlds. And of course this is a first for Second Life or any virtual world to have this sort of realism. So we're just so, so happy. And I'm just such a, I'm such a big fan of you guys. I really am.

It just makes me weep with joy when I browse through Flickr. Sometimes at night I will load up like literally 20 Flickr tabs with all these tags for each of WindLight pictures. Like there are sunsets and fog ones. And I will just have it set to auto play so I won't be touching the mouse and I will just look through all of them.

It is this amazing plethora of imagery coming in. It gets overwhelming and it soaks through you. But then I go to sleep and I wake up and I feel inspired about what we're doing here at Linden Lab and Second Life for our community. Something like that, yeah.

[laughter]

**Melissa:** Perfect. You nailed it. You nailed it.

**Runitai:** Awe, shucks.

**Melissa:** Thank you to the WindLight team for talking with us today and thank you for listening to "Inside the Lab."

**All:** Thank you, Melissa.