REIKO GOTO

EDEN 3

FOUR CONVERSATIONS AT THE HEADLANDS CENTER OF THE ARTS

21 September 2008

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[?___]	Inaudible.
[0:00]	Time stamp.

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FOUR CONVERSATIONS AT THE HEADLANDS CENTER OF THE ARTS

21 September 2008

Present: Tim Collins
Reiko Goto
Christina Braun
Jackson Brown
Jeff Brown
David [?_____]
Åsa Hergard

[Please check speakers' names for accuracy.]

Tape 167 – Tim, Reiko, Jeff and Christina

Tim: Jeff, Christina, [and Jack] – thank you for coming. It is very exciting to have you here.

The name of the project is Eden 3. The argument that we are making is that Eden 1 was about living immersed in nature, Eden 2 was about creating agriculture and moving away from nature but assuming that nature would sustain itself in the background; industrial culture replaced agriculture; industrialism overwhelmed nature which puts us into what we view as the condition of Eden 3 where we are ultimately responsible for nature and we need to seek out new relationships to nature.

The bottom-line is, we can only make small contributions to these ideas, and what Reiko and I have decided to do is work on a research, slash, art project that *[explores]* the empathetic relationship between humans and trees and actually try to reveal some of the complex functioning of trees, and that all comes out of work that we are doing.

Just after 2000 we visited some long-term ecological research sites where they had forests all wired for physiological response to atmospheric chemistry and moisture and sun levels and those things. What was really interesting was when we went up in the forest with the scientists, the next morning as the sun came up, the sap rises, things started to happen, clouds go over and things started to happen. But unexpectedly, a

truck pulled up – a sixteen-wheel diesel truck sat there idling, and just as the CO_2 was coming from the truck, all of a sudden it set off all this photosynthesis and it happens instantaneously. It happens within seconds. We were all amazed. It was interesting watching the scientists react because they [?_____] after arguing that it was all quantitative science and there was nothing creative or artistic about it, all of a sudden you started seeing trees as no longer seasonal entities, but entities that are living in a dynamic relationship to the atmospheric conditions that we create by living our day-to-day lives, burning fossil fuels for our heating, for our transportation and, indeed, even from our respiration. If you breathe into a tree, you actually draw out its photosynthetic responses at some level.

[3:24]

What I am explaining to you is that everything is doubled up. As you see, we have two of everything and that is so that we can record air temperature and leaf temperature, atmospheric CO_2, leaf CO_2, atmospheric humidity, leaf humidity and through computer work comparing these things so that you have some sense *[of comparing the data]*. Average atmospheric CO_2 is about 300 parts per million worldwide. Within this leaf chamber where we have just got one leaf captured and sealed, that leaf, through its stomata openings, will actually pull CO_2 in (kind of feed on it) and it will drive its photosynthetic processes. So, if you have got 350 parts per million up here in the air, within that leaf, you may have 340 parts per million, you may have 330 parts per million as the leaf draws that CO_2 in and actually stabilises it within the body of the tree and actually drives its growth pattern.

[4:44]

This is a leaf graph. I'm just turning this on. It really hasn't settled down yet. The leaf is put in a bit of a shock when we first put it into this leaf chamber.

Jeff: Now the leaf chamber is sealed?

Tim: Yes, it's on its own, but the same air that is coming in here, is getting out through the CO_2 monitor, but also through here.

Jeff: Oh right – I was wondering, yes.

Tim: Yes, there is a constant flow of outside air going into it. So this is basically just a CO_2 concentration and you can see the outside area is red, and the leaf chamber is blue. The humidity – there is a big differential in humidity.

Jeff: Red is outside and blue is weak?

Tim: Yes, and what is interesting with this particular native oak, on a day when it is really warm, it really shuts down. It no longer releases moisture into the air which is why it is so [?_____].

[6:05]

We track our flow rate – [?_____]; the air temperature versus the leaf temperature and you can see that there is a couple of degrees differential. We have actually a thermometer that sits just underneath the leaf, so it is actually a little cooler in the leaf chamber than it is in the regular air. At some point we take a look at that.

[6:29]

[This is sunlight] being picked up here which gives us a sense of what is driving in the system. I can show you other graphs that covered a full eight-hour day and you can see that when the sunlight dives, everything else starts to change in their relationships.

And then this is photosynthesis. It is interesting – this tree is really under-transpiring. No water is coming out of it at all. Indeed, it may be [?_____] [7:07] of water at this point. But from a photosynthetic point of view, it is still really active.

One of the things we can do is we can breathe into this. *[Demonstrating.]* This is the CO_2 monitor responding, and then the leaf is following right after. It is completely right on top of it. So we have just drawn it up over a thousand parts per million and, basically, the scientists say the trees are happy up to two thousand parts per million – so one of the really interesting things about fooling around with this was, we set it up in our living room studio in England and the first couple of weeks trying to calibrate everything. We could not get it to calibrate. It was cold, so we were doing it indoors. We kept talking to the scientists and they said, "It is ok. It should be fine indoors." But we kept getting these funny readings of six hundred parts per million on the CO_2 – and they said, "Well, open the windows." So, we had the windows opened, but it

still gave us 550 ppm – so they said, "How big is the damn room?" It was only ten by ten, and there was two of us, and we were driving it up just by sitting there and talking.

[8:37]

So you get that response, but you've also got a photosynthetic response and then it kind of bounces back – it is the tree saying, "Oh, wait a minute! I just want to …" It was happily using the CO_2 to drive its photosynthetic response and then it kind of loses the momentum.

[8:55]

This is one stage of the project which is really about getting the science right; getting the whole system to work. The bottom-line is, we've got months to try and get the system running. At first, when we explained to the company that we wanted real-time air and real-time leaf …

[9:18]

Reiko: Now [?_____] *[Inaudible]*. Right now the light is already [?_____] so there is not mush photosynthesis going on, so that is why it is showing up.

Jeff: But that is a response to CO_2?

Tim: It will depend upon … The impact from the cars is cross-dependent on which way the wind is blowing, what kind of car is going by – if a [?_____] goes by, much less response; you get a 1960 pickup truck and, particularly if it decides to park on the [flat down here and idles for a while], it is interesting that, for some reason, that CO_2 seems to back-up here and gives these huge spikes here.

[10:04]

The first step is to actually get the science right; get the data sets right. The second step which Reiko will present to you is where we've got the sounds rights. She spent weeks trying to figure out which sound file *[to use with]* the synthesisers – but trying to find sound files that work with the data that actually give some sense of what is really going on … She found a couple of files that were pretty [powerful], and what

we are struggling with over the last week – we are trying to get a real plant system going.

[10:39]

Originally we though we can get them all on one computer. We got programmers and musicians that are all working together in England and so now it is on two computers and it is really difficult to get them to work but, hopefully, by tomorrow this will [?_____].

Christina: Do the two computers work in tandem?

[10:54]

Tim: We get to work on two computers in tandem and then, rather than … You get a graph which will be a little tiny graph, but what you get is [a lot of] sound. So as you see the cars going by, you will hear the music goes up and down; you will hear a consistent beep under respiration as the car is going by. It just goes back and forth. Smaller spikes there.

[11:30]

What is interesting is, all the trees have a slightly different response. Some are better at taking up CO_2 than others; some are better at transpiration than others. Of course, the willow, being a wetland plant, it has no qualms about losing water easily. So, each one of the trees has a slightly different response and once we get the data consistent, and the sound consistent, we think we can actually create a kind of symphonic or a melodic forest exposition. [That is what we are aiming at.]

[12:20]

Reiko: Any questions?

Christina: So the final project could be anywhere? [You are calibrating and recording on computers and you can just show someone the visual, and then they hear good music?] *[Please check – inaudible.]*

Tim: This is basically sensing equipment.

Christina: So you need the light.

Jeff: [?_____].

[12:51]

Tim: Wherever we can, we want to do it live and we want to set up … So this is for a series of temporary lectures. So, the next thing we'll work on next week are these little *plein-air* easels. The whole idea of that is – that is the way artists traditionally relate to nature and the landscape. They get set up on their easels. So, what we are setting up … I would argue that *this* is surely technology. Paintbrushes, welding rods, cast bronze are all technologies and so we are going to set up this little system which, with an extension card, we will be able to take out into nature and once we get the live system working, we should be able to 'hear' the tree conduct its photosynthesis and transpiration.

Reiko: Question …

Tim: It won't be photosynthesis [?_____].

[13:51]

Jeff: [?_____] the tree with plants? During the day they take in CO_2, they're releasing oxygen and moisture – essentially waste products of photosynthesis. Then I have heard that at night, sometimes the process reverses. [Are you doing night exploration?]

[14:13]

Tim: Why do you [?_____] grass? We have started to run night-time experiments and when we go back … It is a little harder in England – even the leaves on these trees weren't good, but the alder is starting to fall now.

Jeff: Yes, seasonal ..

Tim: But the ones in England, of course, are more affected by the northern climate because, where we are in England, it is actually north of here in terms of latitude.

Jeff: I think it is fascinating. I am *[amazed]* at the instantaneous element of it too because, so often, science seems to *[record]* cumulative effects and cumulative responses. You know, global warming even becomes this issue about how cyclical is it. This leads to questions like how much of what is happening in our environment (not just on a scale of an individual plant, but maybe the atmosphere) has an instantaneous response, telegraphing right throughout the world, all at once. To get back to the old expression, "Everything is connected". Somehow I feel undercurrents of that in this project.

[15:42]

Tim: The thing that interests us is, there is a woman in Minneapolis that keeps talking about aesthetics of health, and she believes that our aesthetic sensibility is socially constructed. It is something that we learn in discussion with others, and that we can learn to understand things in a different way. So, you guys can all tell when you are sick from a hundred yards away. You get in a car or you come out of a house and you are going, "Oh, something [?_____]" *[Inaudible – noise]* Or vice versa. If you have a pet, you can tell when the dog is not healthy. We can tell when our car is unhealthy; we can tell when our computer is unhealthy – and it is all because we have this intimate long-term relationships with them and we started to develop a [?_____].

[16:36]

So, what they are talking about is, can we develop a sense of health vis-à-vis living entities or *things* (if you will) and, of course, you as gardener, you see it probably more clearly than others, but part of the question we propose is, "Can we get people paying attention to trees in the cities through this seductive interface?" That is what we are going after. How to create some music or sound or voice for the trees.

Tape 168 – Tim, Reiko, Christina, David and Åsa

Tim: All of our work for years dealt with water or animals and wildlife. When we went to Pittsburgh, Pennsylvania, we worked with ecosystems – with forests and rivers for ten years. We recently moved to England and we have started to work with trees in a very specific way.

What we are interested in is the relationship between humans and other species. We ran around in the US a bit. We were actually in North Carolina University at Duke Forest and they have got a really interesting climate change project where the scientists have wired the forest for its physiological response to CO_2 and they actually tracked the forest's changes every day as they pumped the forest with CO_2 to a level that is expected in 2025.

[1:04]

What we have done is we have assembled some equipment that allows us to do the same kind of process. So we have got physiological testing equipment and over the last six weeks we have been collecting data. We have got nine trees – this is just one of them. We have nine trees.

What we do is, we monitor the air outside in real time for humidity, temperature and CO_2. We then have a little chamber that captures a leaf and the air is pumped into that leaf chamber as well at which point you can measure the difference in temperature, humidity and CO_2 between the leaf chamber and the real *[outside?]* air which tells you whether the leaf is consuming CO_2 and whether it is releasing moisture. That gives us a sense of the photosynthetic and transpiration responses of the tree.

[2:03]

What is really interesting is when we first presented [?_____] it happened like that. *[Clicking fingers rapidly.]* Like a car goes by and the tree started photosynthesis. If I breathe into the tree, you have the same reaction – the leaf actually responds very, very, quickly. Most of us think about trees moving every season, more or less and not much more movement than that. So the idea that they are really, really, dynamic really interested us.

[2:40]

The [?_____] has three phases in this section. One is all this data. This is a typical oak tree.

Christina: So the nine trees are different species of trees?

Tim: Oh, yes. We have nine native trees – oaks …

Reiko: We have [?_____], maple, alder, dogwood, oak, [?_____], I think spice bush and also burning bush. Burning bush was transpiring so much that the leaf chamber became wet. We could not use that *[data]*. It was raining in that leaf chamber!

[3:28]

Tim: Yes – the other one is aspen. This is really interesting – this is burning bush. [Justin], a landscape architect, is very keen to these things. It was amazing. We set this up and we had to go away for the day, and when we came back the leaf chamber was flooded and there was water pouring down the tube and if the water goes into the CO_2 monitor, it's [deadly] [3:49] [because it cost $150], so I took everything off. [So we just stopped testing that.]

[4:00]

David: Explain what is going on here. Just give me a refresher on photosynthesis – what is actually going on with this interaction process between the oxygen, the CO_2 and the tree. How does that work?

[4:15]

Tim: Basically what is happening is the tree is breathing in CO_2 and then, through the process of photosynthesis they turn it into sugars which actually flow through the plant, but in the process, as their stomata are opening and closing, they are also releasing fluids out into the air, and different trees release fluids in different ways. Basically, photosynthesis is the process that drives the transfer from CO_2 into sugar.

Reiko: And some need water to process CO_2 into making sugar.

David: And where does the oxygen comes from?

Tim: The oxygen is split off – it is a waste product.

[5:01]

[Talking together.]

Christina: So the essential part is the lungs – we breathe and oxygen [?_____].

Tim: Yes, the bottom-line is, there is no life on earth without [?_____] plants. That is our lifeline. Whenever we go to work, we are always interested in two things – one is the real physical and material impact on the world that we do not have to build. So that, at some point, we decided that we are basically sculptors and installation artists, but it was really hard to compete in the real world in meaningful ways and that is when we started to work with nature and nature's recovery as an element of the things that we are really interested in.

[5:50]

You get different responses … This is oak. This is from 9am until 5pm and you can see that the trees are really active before noon, and then they slow down. Here photosynthesis has shut down, transpiration has shut down – it peaks a little bit here, but then later in the day by 3:20 it is not releasing any water into the environment whatsoever (and the oak is known as a really [?_____] [6:30] plant). They react day-to-day in different ways.

[6:32]

What is interesting is, we got a data representation and we have got graphic art representations. Now, over the last two weeks, Reiko has been working to create sound representations and then the next step (hopefully this week – we are working on it on our weekend – it is not working yet, but tomorrow morning I think we will get it working) we will have live sound that will come out where we just put up the system and you will hear it and then we will start to develop the *plein-air* tree concert.

Do you have any questions?

Åsa: Is it different for different countries? Have you tried this in England?

Tim: We tried it in England.

Åsa: Is it the same plant out there?

Tim: England's transpiration … There are different plants in different places, but Reiko can explain this better than I can.

[7:35]

Reiko: The big difference is, here we either have a solid foggy day, or we have clear blue skies. In England the clouds are always moving, so the sun gets covered by the clouds, and then the next moment it is sunny. So *[the light quality]* is really up and down – that is a huge difference. It is a dry climate here too.

[8:01]

Tim: There is a lot more moisture, so the plants are more likely to transpire. What we've done is, basically, Reiko has moved five trees into the house and a few sit outside the backdoor and they come into the living room some days. It is a lot like what we have going on here, but when we go back … We finally got our plant physiologist slash ecologist interested in what we are doing. He scientifically proofed everything we are doing, and he has additional equipment and actually a plant physiology lab that he is opening up to us when we go back. The deal was that we could go to California for an honours residency if we give him our [air]. *[David laughing.]*

[8:46]

We have a system here that we hook up for five hours at a time. He has a system that is only hooked up for about five minutes at a time, and it is all backpacked and it has got a little spring handle. He has asked us that, if we can get this working with sound, could we get his backpack system working with sound.

[9:06]

There is probably three or four manifestations of this. One is a [formula] which Reiko will use for her PhD where we will have this temporary system which we can set up and run in urban settings, and then she will also be able to run off with the backpack and try lots of different trees, and you will get the sound coming right out at the same time.

And then, eventually, the scientist wants to build a couple of really intensive installations where we pick a couple of cities in the UK and Europe and we wire up somewhere between five and ten trees at which point, I think, you will get (and what

we are working towards) this kind of symphonic procession of sound and, of course, probably the best way to think about this is that we have been looking for sites to do this kind of work.

[?_____] asked us to do it in San Francisco, but we found the best place is in Newcastle which is actually a triangle. On this leg of the triangle, there is a regional bus stop, so there is always at least four buses idling there, and there are some huge old Elm and London plane trees there. On this side is a city bus stop with one bus coming in every fifteen minutes with the same grouping of trees and another grouping of trees there. On that side we can set up [?_____] [10:34] that we call responses with the trees on one side would be constantly reacting to CO_2, and the trees on the other side would go quiet, and then come back; and then go quiet and come back.

[10:43]

The other thing is, when people gather – like even us just sitting around, we create a lot of CO_2, so can drive up that reading as well.

Anything else? Shall I turn the lights off so that you can listen?

Reiko: After listening *[to the sounds]* you can put a few questions if you have.

Tim: So you have a five-minute piece or a two-minute piece?

Reiko: One five-minute piece and then one minute. The first one is oak, September the 6th in the morning, so the tree is almost like waking up and starts acting. It is only five minutes.

Tape 169 – Tim, Reiko, David, Jeff, Jackson

Tim: Reiko, what is that [?_____]?

Reiko: That is the transpiration and then the melodic one is the photosynthesis. It is morning, so the plant is gradually almost like waking up and start acting. It is only five minutes. So what you are looking at, right here – that is September the 6th. […]

The scientist who told us about the leaves said that the relationship between the leaf and the atmospheric movement is extremely important so when we put the leaf into

the leaf chamber, the leaf is still carrying the sensor of atmospheric movement, so it is acting the same. However, maybe one or two minutes later, the leaf realises that it is trapped – that there is no more atmospheric movement – so there is some depletion right here. It acts almost as though it is in shock or in panic. The leaf then realises, "Well, I cannot get out from this environment – so what am I supposed to do? So I'll resume normal actions."

[2:03]

Every time a car goes by (depending on the type and size of the car) and the direction and strength of the wind, and sometimes as people go by, the [?_____] is extremely high.

So, this is at the very beginning and only a small portion of the data. There are two flutes.

Tim: What about this piece here?

[2:36]

Reiko: One piece was recorded in England on 26 August in the afternoon on a sunny day at 3:45. We found out that the photosynthesis reaction was extremely interesting, so I am just going to play one set of data – that of the photosynthesis. It does not have an ending – it is kind of ongoing, but I'm only playing one minute.

[3:00]

Tim: Reiko has been trying to find the right voice that is representative. So that flute … She just kind of fell upon that. We had about thirty or forty different voices that she kept whittling down until she found one that she really liked. It was interesting, because once we found that flute, we called the musician and computer scientist and everybody and said, "Well, the flute really works well" and he just laughed. He said, "Last night I was reading the sine waves on a flute are not dissimilar to the kind of waves that are created by the data." So that is one of the reasons where there is actually a very practical reason why it works.

[3:44]

Part of the trick is also to get the scales right because it goes right off the scale in some places, so we are still pushing on with things now. We have a PhD student working on it, and he keeps writing and rewriting the software to try and get us a higher quality sound. He is the guy who said [?_____] *[inaudible]* [4:09] and it eight, nine, ten, eleven, one, two, three … And he works with us until seven at night [?_____].

[4:20]

Reiko: This time there is no flute. This is a different arrangement of the data, so we did not use the flute.

Tim: This was one of the earlier experiments before leaving back for England. Reiko was working with the computer scientist and the musicians two or three days a week, and then the plant ecologist would come in one day a week to review everything we have been doing. He brings extra equipment and tested everything we have been doing the previous six days.

[4:55]

It is funny. When he first came in, he looked at the data and saw all the spikes, and his response was that there had to be electronic problems. Trees do not do that. And we're like, "No, no, no. There are spikes as the cars go by." A spike comes up when a car goes by. He said, "See, that is an electrical problem." [?_____]. *[Inaudible.]* Sure enough, a car goes by and we keep getting spikes and he said, "There are cars going by!" [?_____].

[5:48]

[Playing sounds – wrong file.]

Tim: The computer program was all handmade by the musician and the PhD student. They are constantly fooling around with it, and there are lots of little settings – I don't know how to set it (yet). Reiko got pretty good at setting it, but every time when you want to hear a playback, you have to … It is basically a visual programming language and you have to put all the pieces back together to be get it to play back. It is a little time-consuming.

[7:05]

[**David:**] Can you explain how the musical sound of the flute and the [?_____] that came off the leaf – is that what makes the sound?

Tim: It is the data that comes off the leaf – very specific data. We are basically looking at a photosynthetic response and photosynthesis is basically calculated by comparing atmospheric CO_2 to leaf chamber CO_2, so if the tree is consuming the CO_2 in relationship to temperature and humidity, then we get a numerical calculation that then tells you what the rate of its photosynthetic response is.

[**David:**] [But when you get an overdose of CO_2, what is the response in the tree?]

[8:12]

Tim: Well, it is interesting. The trees actually respond really productively up to 2000 parts per million. Anything over that stresses them out. Jeff, Christina and Jackson were not here earlier today. We actually blew into the intake, and you get like a thousand parts per million just from my breath.

[3:39]

One of the things that we will do when we get back to England is we will probably set it up at the university which is on a six-lane ring-road and I am really dying to see what the response would be. [It should be pretty significant because it is basically backed up by all the cars going by.]

[8:57]

[**David:**] And is the leaf chamber [?_____]?

Tim: That is the thing that is sticking up from the [?_____].

[**Jeff:**] I found that over the years there has been a lot of sculptures and music that have been generated by forces in nature. You know, there is some kind of wind device [?_____] [?_____] He has tapped into the wind to get some body rate and to get sound.

[David] Or the wave/flute surround.

[Inaudible.]

[9:40]

[**Jeff:**] I am really intrigued by how you [?_____] this high-tech and maybe somewhat convoluted approach to extracting a force of nature – a process of nature – and converting it into a sound quality.

I'm wondering if there isn't a deeper motif here? I mean, that is all very pretty and poetic – but I am just kind of wondering – you know, you are working with CO_2 levels and it is something we are all really concerned about these days as we hear about global warning and so, this is not quite as pretty as the wind blowing, but I was just trying to get a little bit of what your motivation is here.

[10:47]

Tim: Well, there are two things that we are interested in. One is [?_____]. *[Inaudible]* about aesthetic [?_____]. The trees are kind of like a canary. They tell us about the CO_2 rates because we do not know what is our own physiological response to atmospheric chemistry. So there is that element.

The other thing is, I feel that this sort of groundless questioning of climate change … In a real way, it just never occurred to me that every car going by has an impact; every man walking by has an impact. So, part of this is to create those kinds of relationships.

And the other thing is, just to create an empathetic relationship between trees and human beings because they are the source for the oxygen that keeps us alive on the planet. It is about understanding the symbiotic relationship through, what for us is a feedback system – an interface – and then just to bring it home emotionally.

[11:56]

We experienced this in 2000 down in North Carolina. We found it interesting and [?_____]. *[Inaudible.]*

[12:08]

My mom was sick in 2006 when we first got to England. It was interesting because my dad called me and said we should come right away. It was just before Christmas. He said she is really bad. So I just dropped everything and I went. She got days when she was good, but she had days when she was really bad. They were saying that she wasn't with us. But I could read her physiological response with ECG and all of this. And I can read them pretty well because I [?_____] for over ten years. It was interesting because, here she is and the nurse says, "Oh, she is sound asleep" or, "She is just not with us at the moment." And then my dad would come down the hall and he would say hello to somebody (he is noisy, as I am) and all of a sudden her pulse would quicken. You could see all these things. Even though the nurses were saying she is so deeply sedated, she responded just like that and I just realised, this was another example of a technologically mediated relationship with somebody that I knew really well. It was very emotionally powerful for me.

[13:32]

I just realised, ideally, once we get this program up and running, and the technology will fade into the background at which point it is really just the trees and the sound in the environment. If we had a live system running and a car goes by and then we also hear it *[mimics sound from sonic device]*, and if we can set it up with a number of trees, you would hear a number of trees responding, and if there are a lot of them, you would hear *[TC is mimicking louder sound]*. I think it would be a pretty interesting experience.

[14:12]

[It is also tied in our relationship to our parents, and the relationships we have with them as they slip [?_____].] *[Inaudible.]*

[**Jackson:**] I have another question. Does one second of your music equal one second of data collected?

[14:37]

Tim: Yes.

[Jackson]: So it is exactly proportional?

Tim: Yes, although, the other thing we are looking at … It is interesting. When we set this up, Reiko and I had clear ideas of what we were talking about, and the longer we worked at it, the more we realised that things happened that we had not expected. The scientist, Trevor Hocking, came in and he talked to us about the leaf's ageing over one season – how, when they first come out, they are really green and they are supple and full of chlorophyll. By June and July they are getting a little tougher. He actually talks about their cuticle layer getting thicker, less curvy back in May, and then by September they are starting to shut down. It is interesting. He describes this thing that occurs over a five-month period and he said, "If you guys could actually record one tree, eight hours a day (or just in the sunlight period), for that whole season, and then you could take it and squeeze it into like a two-hour data set and put music to that, you would actually hear the lifespan of that leaf."

[15:53]

Reiko: Something we cannot do is we cannot make one straight tone. We cannot do it because the pump is pumping the air. That is the zero point – 008333 – and every second is a point, so it always sounds like a pulse – pup, pup, pup, pup – because the pump is pushing the air. That is why you hear 'pup, pup, pup, pup'. And then the same sound, but for a longer duration, we can hear it a little bit longer. So the flute creates a longer sound more like a melody.

[16:34]

The reason we are changing the original sound of the flute to something else – sometimes photosynthesis is like a scale of zero to ten or twenty – a very [small] range, so we can hear the melody, but transpiration range is close to one thousand, two thousand, to three thousand – so the sound can get so high that we can't hear it, so we needed to pitch it down in order to make it audible. That is also going on. There is maybe a technological solution …

Tim: That is what Matthew is working on at the moment.

Reiko: Yes, to compare different data ranges.

Tim: We have to nudge one up, and nudge the other down so that they still have the same basic relationship, but it will be within the range that we can hear with our ears.

[17:34]

But in terms of your question, one minute of sound is one minute of data, yes.

Reiko: Another thing is, CO_2 in the air and in the leaf – because air goes through the leaf chamber, it is slightly different – it is not exactly the same.

Ok. The first one you heard was the transpiration. The transpiration was extremely high at 3:30 pm. So we are going to *[listen to]* photosynthesis now.

[Sounds playing.]

Tape 170 – Tim, Reiko, Jeff, Christina

Reiko: It is 3:45. The sun was still very active and the transpiration was up and down, [and then the grey area (this is the area) …] Photosynthesis is really [nil]. It is not happening despite the sun still being very high. We could not believe that the system was not working at all. So we thought that this was an interesting moment to transcribe to sound.

Tim: What is interesting is the tree wakes up in the morning. Obviously, the tree does not wake up because it does not sleep, but it goes from its evening no-sunlight, relatively humid environment to a period where sunlight is shining and photosynthesis starts; respiration begins, transpiration begins. It is really dynamic in the morning, and then, as it heats up, the whole thing starts to slow down a little bit. It goes into siesta mode.

So Reiko was fooling around with the data. Was that [?_____]?

[1:25]

Reiko: No, it is some kind [?_____] that the [sound artist] gave me. It is not [?_____].

Tim: It is interesting. We have two sound people working on this. One is a traditionally trained German musician who has one way of thinking about it, and then

we have this PhD student who is a member of the British Laptop Orchestra who has a very open-minded way of thinking about this. So there is a constant tension between the two of them because the third person we have working along with us is the scientist. Basically, he wants to hear a data relationship in the sound that we are creating. We are going to sit them all down when we go back and go over our list and see what can we agree with, and what we can't agree with.

[2:12]

Reiko: I think that during this residency programme we found [it worked the other way round]. I mean, the data-collecting started in real time. One day we gather the data, and then the next day I am listening to the sound. So, without looking at the data, the [sound guy] said, "Oh, this is a really interesting sound. What was happening out there? What was the time? Did anything happen?" I find that a more interesting way rather than reading the data.

[3:00]

Jeff: *[Inaudible.]* The leaves are different parts of the same tree. Some are at the top, in the sun, in the shade – because I know from their physical appearance that leaves can be very different, so I imagine that *[their responses may be as well.]* You can have a whole orchestra just on one tree.

[3:30]

Reiko: Yes. Last week a friend of mine was here and she did not know coyote bush. Then we looked at it and read out the [?_____] – the male and female. The bush is small, so if we use it, we could use a male coyote bush and then a female. Are they going to [react] the same? (In the same area, next to each other.)

[Talking together.]

Tim: Yes, so it is questions like that that are coming up. It is interesting. These guys took an interest – I gave a lecture at Wolverhampton and this colleague was in the audience. It was interesting I saw him smiling and shaking his head as I was talking. [I could not stay for the questions and answers as we were going to have lunch.] He has got greenhouses; he has got his own forest laboratory; and he got excited about

this because all of his work occurs over two- to five-minute periods. He does not want to affect nature by his process of analysing it and our thing is, we want to see how we affect nature, so we are analysing over five to eight hours which is something that … As he puts it, "[The literature does not ever go there."] And he says (for very good reasons) – he says, "But the responses you are getting are really, really, interesting." So he is interested in it from a scientific point of view and he thinks he can get some money from public science in England.

[5:22]

Christina: So, Reiko, the last piece we heard was just the photosynthesis, and the first piece just transpiration?

Reiko: They were transpiration and then photosynthesis. The transpiration range goes up to thousands, so you do not hear a melody, more like pop, pop, pop, pop.

[5:50]

Tim: What we are pretty clear about at this point is the data will be both transpiration and photosynthesis, so the sound pieces will focus on both responses.

Reiko: And right now, I am choosing something, it is [?_____], but they don't want [?_____]. You will just experience how the trees are reacting.

Tim: We will be choosing the voice. Once we have chosen the voice, it is up to the plant …

Reiko: Yes, right. We are in their environment. Right now we are still *[finding out]* what is going on.

[6:37]

Tim: [Yes, we are just sending it up like crazy.] Before we left, we had [?_____] computers and we resurrected it from the [dead]. We came here with three computers; we killed another [?_____] last Monday, and we had three really difficult crashes yesterday. So I spent yesterday [?_____] on the latest computer which is brand new because the software that these guys have written is really experimental, and it just goes south from time to time. It is a little nerve-racking. We get ready to

leave, and then they crash my computer. Reiko calls. I'm crazy at work – trying to do my own work – and then she phones me and goes, "Matthew killed your computer, Tim." So I talk to Matthew on the phone (he is 23 years old). He says, "I don't know what I did!"

Reiko: Killing computers is better than killing trees.