INTERVIEW WITH WOUTER SNOEI

Ángel Arranz: What were you beginnings at Game of Life Foundation?

Wouter Snoei: I think it was in 2003 or 2004 when The Game of Life Foundation was planning to go to Fraunhofer Institute at Ilmenau, Germany, to get a system. I was asked as a composer to write a piece for such a system, because apparently they thought I had good ideas about spatiality. I had been doing almost exclusively pieces in quadraphonics until them, so I was already busy with spatialization and also different spatialization techniques for quadraphonics.

AA: That was in the Institute of Sonology, was not it?

WS: Yes, and also after that, because I finished in 2000. So, I was already four years active after as a freelance composer. They asked me to write a piece, so I was immediately interested, because of course I like the idea a lot. It was the kind of ideal spatialization system, so even though I knew very little about it by then, I knew it would be a very interesting thing to work with. When we went to Fraunhofer Institute, I also saw the limitations of their interface.

AA: Could you describe a bit this system and this interface?

WS: The system was very impressive, of course. But I saw their interface and I did not really like it. Basically, it consisted in a big touch screen, in which you could draw movements with your finger or with a pen, probably. And then if it would be drawn wrong, then you had to draw it again, just all the time until you get it right. For a movie where zombies are entering the hall and leaving in the back that is probably enough as an interface, but for composition I thought it was way not enough: to compose complex movements, figures, et cetera. So, I started immediately programming something that would connect to their system where could generate movements from and export it to their system. I even requested their file formats, how they stored their files on xml-based file formats, sign an NDA agreement to not sell it to anyone. So, I made an interface for basic task generation for their system. And then, we went there again and it turned out that they were not interested in any deals. They were way too expensive, et cetera. But then, I also of course showed this interface to the guys of the Game of Life Foundation and they asked me: '*could you write a whole software interface for our own new system?* So, that is kind of how I got started into it.

AA: It was a kind of challenge.

WS: Yes, I think it took one and a half years to complete the whole thing, between 2004 and 2006. I had also many advices, for instance the support in this first development time of the physicist and composer Marije Baalman. Later, during the SuperCollider symposium in The Hague, celebrated in 2007, se wrote a piece for our system. Currently, she is not involved with Game of Life Foundation.

AA: Your interface was based on a prior system that Fraunhofer designed and somehow you obtained your own conclusions, your own ideas about improving some things. What were these weak points you saw in Fraunhofer?

WS: I was most interested in making movements, because that seems to be a unique thing about the Wave Field System, the fact that you can make convincing moving sounds. Their system could do that, of course, but their interface was really simple. That was the main point about it, because placing points in the space is not that difficult to do. And I wanted to couple it to a timeline engine also, because I wanted to be able to create compositions and play them back. I wanted to compose something in all possible detail. That is why I needed a better editor than the one they provided.

AA: Therefore, somehow there were not so easy ways to express compositional ideas. That was your complaint...

WS: ...and also because the reason why the Game of Life Foundation built the system was to enable the creation of new electronic music pieces. It was not meant for filmmaking or adapting existing pieces.

AA: What were the basic things you needed in order to start to function, according with your own perspective as a composer?

WS: Of course we needed the hardware. I did it together with Raviv Ganchrow. Specially, we chose together the computer part of the hardware. We had to choose which computers, which soundcards would work best. At that time it was quite hard to get soundcards that had so many outputs. Every computer had 96 outputs; that was the maximum at that time. There were some options, something like cards of 128 outputs. But they did not fit in our machines and they were much more expensive. Due to cost efficiency in those days, it was realistic to do it with these many channels. And there was the problem of the two machines having to be synchronized, because the system has to work as one. Actually this was one of the first challenges for the software to solve. We had a kind of OK solution for quite many years. Only recently we found a better solution, on which the new version is based on. It was a big challenge. We hade to learn the Wave Field calculations and also find out how to work in practice, because the documentation strangely is quite limited on this. The basic principle was of course explained in many papers, but how it actually sounds and also if you move sounds around the system, how they maintain a prominent level, that was something that we had to find out on our own.

AA: So, there were some previous stages.

WS: Yes, there were also another solutions that actually we did not like. There were solutions for example for the problem that if sound travels from behind the speakers to the front of speakers, you have this area where the calculations completely flips around from positive to negative. If you do not do anything about it, then if sound is moving you hear a click at that moment. If sound is not moving, there is not that problem. But most systems did not incorporate moving sounds.

AA: Putting sounds out the system was a kind of elongation of Professor Berkhout's ideal on how to generate virtual sources, starting from a physical point of view. So, that clicking problem seems to be a simple problem, although I guess it was redundantly problematic...

WS: Yes, we have to solve that in order to become usable as a musical tool.

AA: And Jan Trützschler was there in charge of synchronization.

WS: He helped me with the synchronization solution that we had back then. In the new version all this stuff was removed and it has a different implementation.

AA: So, in the evolution of recreating this Fraunhofer system, first was the hardware, then software, then programming, then synchronization?

WS: [*thinking with pause*] It was a kind of entangled to each other. I immediately started programming on the software end and Raviv was selecting the hardware. And at some point we did some tests with small arrays of only eight speakers and we could already test of software a little bit on that. So, it was really working all together, until the moment both, the software and the hardware finished at the same time. And then, it had to be put it together, be debugged and made to work. Of course you have to know the hardware parts in order to make the software for it.

AA: How did you people understand each other? Was it a kind of simultaneous coordinated work, or rather a sort of working in phases? Did you people isolate each of you in order to concentrate in tasks?

WS: There was a quite frequent communication, and we both had a word in each other's tasks. It was really a team of two, it was Raviv and me. Arthur was a kind of looking down from upstairs to see if everything is going right. Every e-mail we sent, we also CC it to Arthur and sometimes he had some comment on it. Raviv was more on hardware, especially on the design also of the cases and the trolleys, et cetera. It was really something that I did not have expertise, so I could just watch what he was doing and sometimes I say *'maybe you could do like this'*, but I could not really work on that as well. I was more in the software. I clearly knew a lot more about programming than Raviv did, although he did the initial, very basic implementation of the WFS algorithm. There was constant communication, mainly via e-mails. So, we worked at home and sometimes we met together, especially when the equipment was there.

> AA: *Was it important to construct a movable device? Actually I think it was a kind of heritage from a previous project of Erwin and Arthur, the igloo-like tent. So, what was in your philosophy to create something, in which you could take part, but using it in different places and going to different countries even? So, you would need a travel design in order to transport it, I guess, to install and to reconfigure it.*

WS: Especially the reconfiguring part was important for the software, of course, because every time it is set up, the measurements are different. So, you need to be able to enter that into the system in a clean, fast way.

> AA: *Is it possible to implement the system for fewer speakers or for more speakers than 192?*

WS: Yes. For less speakers is quite easy. For more speakers, of course you will have to build equal units. Theoretically, it could be possible, also to run the same software on a different system. This is already happening at Sonology's BEA 6 studio. There you have this old system from the TU Delft with the white panels. It is also running the same software as the Game of Life system.

> AA: *You met each other, and then you started thinking about to construct something in common in an effective way. Actually you minimized even the cost; taking as a reference the system at Fraunhofer, it is like less than the half. You constructed it and maybe you started to plan what to do with it. What was the first aesthetical implication? How did you want to work with it? What did you and did not want to do?*

WS: I wanted to write a piece for it, because that was what I was initially asked for, and in the end it also happened. It was a bit hard to do at the same time the development of the software and writing a piece. I think in the end the piece was not my biggest priority, strange for a composer of course! [*joking*]. The first thing I did with the system when it was finished was writing a piece. The piece had a lot of different approaches in itself to spatial composition. It was a kind of exploration of so many ideas that I wanted to try out, most of them actually ended up in the piece, also some of them did not. One thing I had in mind was to have actually a geographical map of the Berlin wall, so I downloaded a map and made and extracted a nice vector of it, and then transformed that into a movement on the system, so that you could hear the sound following this wall, some ideas about sounds on this side and sounds on that side. It was a kind of theme of the piece for me. And the end, the movement I extracted did not sound good at all, so I did not use it.

> AA: *I mean, you had had felt a huge difference between working your modest quadraphonic space during five years or something like this, and suddenly you had this big toy to create this piece. What did you feel about it? Perhaps you started to think something like* 'here it is possible to do something'.

WS: Well, I think what struck me was the complete clarity of all the sounds, when they are spatially divided, that is completely different from quadraphony. For example, you have much more sounds in a piece at the same time and all are perceived, than if you would have only a quadraphony. Actually you have much more complex pieces on the WFS system.

> AA: *Is this because is based on a physical ideal, rather than a psychoacoustical idea of sound.*

WF: Probably, yes. It is like taking away a layer of interpretation, basically it is more direct, I think. And of course the movements and the fact that you could have things, which actually go through the hall, so that you could put sounds close to the listener. In the beginning we all expected more of that effect. We expected it probably to be more spectacular, but there is still some physical impossibility. It works better than when you have only four speakers, then it does not work at all. You always hear the sound from somewhere around. In the WFS you can get some sense of sound being in the room, and sometimes it suddenly works as

if it is close by and it passes by. You get a strange feeling in your head. But this is not all the time: that is just not possible. So, we were a bit let down on that. We have tried of course to improve this effect...

AA: Yes, probably you need to adapt a bit yourself as a listener, spending ten minutes in order to concentrate. It is not like an instantaneous way of approaching.

WS: You have to learn to listen to something like that.

AA: What would you do and what would not in a quadraphonic system after your WFS experience?

WS: Since I have worked with WFS I have become a lot more aware of the limitations of quadraphony. I do not try to do things that are not possible. But also I incorporate techniques from WFS technology in my panning algorithms for quadraphony and they now sound better than the ones I used before. Because the fact that I have been working into spatialization so detailed, I know better what is possible or impossible, and I also know tricks on how to make it a little bit better. So, I think that my spatial composition for quadraphony has actually improved.

AA: Could you describe a bit the program interface, the WFSCollider?

It is the driving software of the Game Of Life system, and has been under development since 2004. It started with what I call the WFS Path Editor, which was there even before Game of Life was planning to build their system. The software is fully written in SuperCollider, but now also available as a standalone application for OSX[1]. Until recently the software has been OSX only, but at current it is cross-platform compatible. The software both includes the graphic interface and the rendering engine for the WFS system, and it can also be used in "offline mode"; i.e. the graphic interface with a stereo preview of the result, to use at home when preparing material for the system.

The first version of *WFSCollider* was released as a library for SuperCollider in 2006. It was not called *WFSCollider* yet, but simply 'WFS Library'. It featured a timeline editor, on which sound files could be placed at a certain spatial position, or following a spatial trajectory. There was also the path editor, for designing spatial trajectories. The arrangements, which we call "scores" in *WFSCollider*, could be saved as xml files, according to our own xml format. As with the rest of the software, the format was completely open and files could also be generated with other programs. There are some examples of people generating wfs score files in Max/MSP. These arrangements could be played back on the system, only one at a time, with real-time control over level and, since 2007, global EQ setting. I was the main developer, and got help from Raviv Ganchrow and Jan Trützschler in the early stages.

During the first two years of the system, from 2006 to 2008, the software was developed further. The wfs calculations and crossfading methods were improved, the graphic interface extended and lots of bugs were solved. Then, for a few years development stood still. Ideas and practical experience developed further though, and by the end of 2009 a plan came for developing the next version of the library: version 2. For this purpose Sonology student Miguel Negrão, who had been working intensely with the system since 2008, was hired to work with me. The main goal of version 2 was to make the system controllable in real-time. Also we wanted it to be more flexible and be able to do sound processing as well. With the knowledge and experience from version 1, version 2 was radically redesigned from the ground up. Based on a new method of synchronizing the multiple computers of the Game of Life system, designed by an illustrious German programmer who goes by the name of "blackrain", we were able to create a much more flexible engine for the system.

After two years of programming the final version 2.0 is now almost finished. The Game of Life system already runs on the latest beta version by default, as it can also import and play pieces from version 1 correctly. Also the name WFSCollider was introduced along the line.

The program consists of two parts: the Unit Library and the WFS Library. The unit library holds the basic elements of the GUI, the timeline playback engine (including the synchronized playback on multiple machines) and the infrastructure for connecting different processes together. It is distributed also as a

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1 To get the application, please visit the following link: https://github.com/GameOfLife/WFSCollider/downloads

separate library, as it can be useful outside of the WFS system as well. The Unit Library is now also the base for Miguel's VBAP implementation, used on the SARC system in Belfast. The WFS Library functions as an extension on the Unit lib, adding the wfs renderers, the path editor and a lot of other useful wfs-specific additions. WFSCollider as a whole can be used to run any WFS system, not only Game of Life. It is already being used now at the system of Sonology (BEA6) and at the small system of the conservatory of Padua (and maybe at some other places).

The base of WFSCollider v2 is still the timeline editor. The objects that can be placed on the timeline are now called "chains" and they can hold a processing chain of multiple generators and processing units. It somewhat follows the paradigm of a channel strip, in which the user can freely insert plugins and generators. The items in the chain ("units") can be chosen from a set of standard definitions ("udefs"), including file players, synthesis engines, filters et cetera. The wfs virtual sources are also udefs, as well as the trajectory player and various real-time trajectory generators. These units can be chained sequentially or mixed together to one or multiple wfs sources, or other outputs of the system. All parameters in the chain can be controlled in real-time, and chains can be started and ended at any moment, independent of each other. The timeline offers similar flexibility; multiple timelines can play at once, the timeline can be paused while the currently playing chains still keep sounding.

Score files are now saved as executable SuperCollider code instead of xml, and all the udefs also consist of SuperCollider code. This enables users to program their own sound sources and effects to use on the system, which can even be done on the fly in the graphic interface. The path editor was also redesigned, and paths can be generated in a similarly flexible and modular system. The core of WFSCollider is programmed in such a way, that it can be expanded forever by those who know a bit of SuperCollider programming. Many new features can and will be introduced in the future, without breaking compatibility with the already existing work. As SuperCollider is open source, the code written with it is also open source by definition. Therefore Game of Life decided to make the whole program available for free at their website, so that others may use it and extend it.

> *AA: We could call it an excellent, quite detailed description, indeed. As soon as you started to work with it together with the WFS system, especially at the very beginnings, you probably thought that something lacked in that. What were your first improvements in the programming?*

WS: One thing is that there was a problem in the equations, which made sounds be louder when they were closer by the speakers. So, it was a kind of level bump when the sound was near the speakers, then the sounds were louder. And this somehow focuses the audience again on the place of the speakers, so this is wrong. We have made it better. In the current implementation the sound gets the loudest in an area of about two meters in the center of the room, and then gradually drops off to all sides, so that there is less focus on speakers. That was one of the first things I improved in the first year, as soon as we found that out.

After that development there were some other improvements on the effect some years later, when the TU Delft got involved with the system. They measured it once and there were still some problems with the implementation, especially with the cross fading between the arrays; that was not entirely as should it should be. So it was deciding which of the four arrays should sound when. They were sounding to often, when the sounds were here [*pointing with his fingers on the table*] and these arrays here should not sound and in resulted in a confused signal, what they called "mirror sources". So, that was also an improvement. And then, about two years ago, we started working on a completely new version, which also improves again the model, the equations have been used, but also make live inputs and live control possible. So that was a makeover for the system and that is now almost finished. It is already installed on the system, so it is officially better.

> *AA: When are you going to present this?*

WS: There date has not been set. Although of course it already runs in I think the old version, also never left the official Beta stage! [*laughing*]. This dramatically improves the compositional features for the system. While first we could only have "tape piece-like" things, where you could plan something ahead and then play it from start to end, now you can be more interactive with the system not only while working with it, but also during the performance.

> *AA: Somehow, you found a bridge between an instrument, that is, the WFS, and the abstraction. In which way the exploration of the WFS as a physical tool has conditioned you, both your development and your programming? So, it is an interesting situation, compared for instance to the lutherie at 16st century...*

People who constructed the instruments played the music too. That is the point. So, what was this kind of complementation in your case?

WS: My compositional view certainly gave certain directions to how the program became, because my points of interest of course were very clear from the beginning. This also probably made me forget some other directions that we could have been taken. The main reason for me to really work on this thing was to actually compose for it. I am a composer and I also do some programming, but basically I am a composer, so I created this software for me to be able to do this piece. And then, further along the road, I saw what other people did with it, and then expanded the software to accommodate it more. That is also for the new version; when it finished enough, I would like to do a live piece with the system. As a composer, that is what I am more really interested in right now. So, it is kind of powerful feeling to be able to adapt the system to my compositional needs. It sees sounds as a kind of objects in space, in a two-dimensional space, and the way that I see sounds is probably embedded in the system's software.

AA: Let us jump back almost ten years until 2003. You were at Fraunhofer Institute listening to a WFS concert by Hans Tutschku. What was that experience?

WS: We saw his concert in Ilmenau. I went with Erwin especially to see this concert. We were not, or at least I was not really convinced about how he used this system. He had this live band sitting in front of the hall. It was in cinema version, but the screen was off, and they were playing live, seemingly improvised music, maybe it was not improvised, but it sounds a bit improvised. Then, sounds of the instruments were kind of flying around the hall. But we did not really see the point, why it was flying around. Of course, the point was that there was a WFS system that could make the sounds fly in the hall, but it does not necessarily means that it should fly now. So, I did not observe a reason why I see the instrument there [*pointing with his fingers*] and hear the sound there. That was not made clear in the piece that we heard there. I think Erwin and me both shared that opinion.

AA: It is exactly the same that Daniel Teruggi told me during my visit to GRM in Paris: why to construct a very nice line for a piano, and then you begin to move it like this. The piano is static, you have a visual impact of the source and you are accustomed of it. If physics does not radically change in this world, because of magnetic disturbances or gravitational forces... that is going to be like this.

WS: Of course it can be done, if you have a piano on the stage and you want to hear the sound around, it should be a reason for it. Maybe you could use a kind of augmentation and the piano is slowly expanding, or something like that, I do not know. There was not clear reason in the former case. There are probably more pieces like that, where the WFS is just used because is there: that is a bit weak.

AA: Probably it was like a kind of trial-error: let us try to start to see what happens with this instrument and then to observe if we could create some aesthetics or sound ideas. But it was in this current Ars Subtilior in the middle of strange times. In any case, you stood by thinking in a very different way from this experience at Ilmenau.

WS: It was a good thing that we stared at it, because we also noticed that at a certain moment you get used to the effect that sound is moving around. Then the effect is not really interesting anymore: it is just sound moving around. It does not make any musical tension or whatever, just moving around.

AA: You speak about doing a live application. I think already have a rather clear idea, but for you what is first, music or technology? Do you develop technology in order to make music, or because you are creating music, you develop some technology? Do you construct something in order to express music, or the other way around?

WS: I think it was first music.

AA: I know it.

WS: [*laughs*] Although in practice, of course, music only starts existing for real once the technology is there. I think that the idea of the music is first.

AA: What is your own conception on space while designing the instrument?

WS: What do you mean by conception?

AA: You came from using quadraphonics, so we were speaking about the feeling, about what your abstract idea is. While designing the instrument, WFS, probably it changed your own conception on space until that moment.

WS: Yes, or at least I got more clarified about how I see instruments. Of course I have to think about it more as well. Every sound that is being made also has a position where it comes from, so I see sounds usually as a kind of objects in space, even though physically it is not true, because usually a sound that is made by an object in space, it is not an object in space itself. So, I am still not entirely done with thinking about how to cope with that. But at least, on the WFS I think sounds are clearly like objects that have a place in space and have a certain behavior: for example, moving, expanding, contracting, et cetera. And I have become more aware of that fact since I have been working with the WFS.

AA: You bring up a very interesting question, that is sound is produced by something physical. What does represent for you the idea of working with speakers? This question is a crucial question among electronic music composers. Some of them say that my instrument is the speaker; some of them say 'no, this is not my instrument; my instrument is sound', or many other things. What is your personal idea on working with speakers?

WS: I always found a little bit of pity that there has to be speakers in between my sound and the audience, because they never work properly. But basically they are the instruments, although I do not think I see it that way when I am composing. I am thinking more in the objects, for example in the generators of my software that create the sound. I see that more as my instrument, the sound waves that I produce. Speakers of course could be different. You could use tiny iPhone speakers that produce the sound completely different, but then it is still the same piece. Although maybe not played that well.

AA: It depends...

WS: Yes. I have not specifically designed pieces for certain speakers, although of course I have designed pieces for WFS. But then it was more designed for the principles of WFS and not this specific system with those specific loudspeakers.

AA: And how do you design some specific pieces for specific spaces, using a specific instrument, as the WFS is?

WS: Not for a specific space. I could imagine it to happen, though. That is a more theatrical thing, I think, that one piece fits in a certain space. What I do for example is to take into account the acoustics of the space. For example, if I make an organ piece like I did for the Gaudeamus Week and it is being played in the Nicolai Kerk, which is a very big church with the ten seconds reverb, then I take notes of that and make sure that I cannot do really fast notes, because they will be lost in the space. And everything slows down a little bit. I already think of that when I composing for a certain space. I think I do have in mind for each piece I am making the space where it will be premiered, and adapt to it.

AA: I often show myself interested on making know the Dutch roots of all this stuff on WFS. Not to mention the big figure of Christiaan Huygens at 17[th]century, nowadays we were illuminated by the acoustical principles of Professor A.J. (Guus) Berkhout's holographic sound control. Diemer de Vries retakes the same principiae *centered on room acoustics, seismic signal processing and building acoustics. What was the impact of Diemer's opinions on this first design? What did you speak each other on this matter?*

WS: Diemer was advising us at some points. For example, when we had our first ideas about how to implement, then we went to Diemer, laid it out to him, and then he said: it should be done like this, and he had some questions about. These were really technical things. Although there were some things that were

not officially solved yet, it is solved for now on. So, he was a good advisor and he knew everything about was happening.

> *AA: And then it is the turn for aesthetics, as soon as you people started to compose for the system. Tell me please a bit about the first concert in 2006, with pieces by Barbara Ellison, your piece and Yannis Kyriakides'. What were your approaches? There were three people there; probably one with total expertise or starting to really doing things, but the other two guys faced the WFS as something completely new. How was that experience? How did they work on this new instrument as outsiders by-force, let us say?*

WS: I think it was pretty strange for them, also the whole setting with their system setup in Klokgebouw, Philips Srpt 5 building, Eindhoven, just where the STRP Festival happens now, in this building. At that time there was no drinking water, it was in this room like a kind of camping in the middle of empty buildings [*laughs*]: it was a monastery experience. We were for about two weeks in this large room; it was completely empty office room. It was a really strange place to work. I think it also influenced the pieces that I did there.

> *AA: I really believe you. Barbara tells us in a recent program notes for the piece she created for the WFS then, in 2006, entitled* A net to catch contingency. *She shortly relates some anecdotic experiences about working until late in the night during a certain number of days, riding a bicycle from a motel in the middle of a motorway outside of Eindhoven to a sort of apocalyptical space and sleeping during the day. So you were to there, set up the speakers there and then, did you compose the pieces previously?*

WS: As soon as we finished the software interface, I gave it to them as offline versions, like we do now. You can download and already work with it at home. It was also the case back then, although we had to install it manually in their machines. So, they had generated quite some material already and I think both had already constructed their piece when they went there for the first time... I think it was not that difference between us three; I do not think my experience was completely different from theirs. We had to find out how this actually works when you have you own sounds really moving in space. Of course it works completely different when you do it with headphones. It has a completely different impact and levels... We really had to find that out in about three weeks that we composed there. And of course the three of us saw the system in Ilmenau at Fraunhofer Institute, so we already knew a bit what the effect would be. So except that they had to learn to work with my software, there were not so many differences in how we experienced the system.

> *AA: While you work in your pieces, do you rely more in your perception or do you prefer to work the pieces from a very abstract way? What is your focus?*

WS: Most of the time I first try to imagine the piece. What I imagined in the end never ends up what it really becomes, but it is a starting point. Then, at a certain point I start sketching just on a paper. Then I start implementing the things that I have in mind as sound sources, and I usually change a bit how the piece becomes in the end. But I always have a certain ideal what I want to achieve, so I go work out to that. It is a long process; I get into all kinds of side ways and they end up more or less in this ideal. Sometimes I find out that the ideal is not realistic.

> *AA: Yes, the quality of the material, the sound itself, does it condition you in order to explore this spatial movements, or is the other way around? Maybe do you imagine some kinds of routes and then you decide to use certain kinds of materials? What does rule it? Is it space that says sound how it should be? Or is it the sound that inspires to you these different routes?*

WS: I think in the work that I made then, *Correlation*. The sounds and their routes were sometimes disconnected. I had some routes in mind and a sound, and then I combined those, not actually thinking these sounds to fit particularly to that route. Although for some of the sounds, especially in the second part, I became more and more aware of the connection between these sounds and the movements that they made. So, you cannot really experience it with the system itself, because it just existed for few weeks, you did not have the time to find it all out. And then, I started generating movements from the same *formulae* that I also generated the sounds from. So, they became more entangled to each other.

> *AA: Why* Correlation? *Why was the idea to correlate?*

WS: The title for me was always… it was my working title. Then, at a certain point, I decided it was a good title, because there is always many things that lead to the same word. I cannot explain in one sentence why the piece is named as well. For example, I have one piece named *Pulse*, but there is not a single pulse generator used in it. Still it is named *Pulse*.

AA: There is something interesting about the way you use space. You have different spaces. In WFS you could even design different perceptions of areas inside the set, even some kinds of reverberations… So, probably it is interesting in this way of working. I try to discover what was there, because Correlation *is very interesting title to maybe explore space in a very determined, concrete way, in which some parts are correlated to other, maybe because of the space, maybe because of the sound, maybe because of everything together…*

WS: It was not really based on the actual, theoretical principle of correlation; I did not use that in my piece. It is more feeling thing for me. It also has to do with this Berlin thing; the two sides, how they connect to each other, and also how they connect to reality.

AA: So, you organize the space somehow in different areas… That is very interesting to double the instrument…

WS: There are many parts in this piece when you have really two sides and some sort of line in the middle.

AA: When I was in one my first WFS concert in Leiden, I listened to a piece for church organ by Olivier Messiaen, from the Livre du Saint Sacrement, *I guess. I think the concert was the one with the Xenakis routing of* Concret PH, *I do not remember quite well, some people did special pieces; probably it was my second WFS concert. Suddenly the concert started just in a corner. It was organ sounds, but somehow I imaginarily related these kinds of sounds to each different tube of the organ, and in turn to each speaker of the involved array, because you started to listen to different sounds, especially the low sounds, in very particular points of this place. I think it was not completely intentional; I supposed it was a stereo recording, but a stereo recording so big, so that you could fill the whole instrument inserted in that. As soon as it was exported to this WFS idea, of using one single corner, it was really incredible. That is what I mean by using an instrument articulating different parts, different spaces: in a physical way too. So, are you concerned about these ideas on dealing with space and using the WFS really as a physical instrument?*

WS: I have learned all these years more and more that it is actually an instrument. At the beginning I saw it more as a system, where you can do things with sound in a sort of reality. Now I see it more and more actually an instrument. Maybe that is less than it was before, less than I saw it before, because now I also know the limitations and things what can and cannot be done. In the beginning I cannot idealize it as '*this is the new way of doing electronic music*', and I still would like if everyone would have such a system at home and do electronic music with it. But now I see it more indeed as an instrument. They can do also very subtle electronic music on it.

AA: Economy of means, I guess: to do more with less. Let us continuing to talk about imagination from this acoustical insight: imaginary sources. From a composer point of view, it is remarkable to have system, in which you could create these illusionary sources, besides these physical sources. You spoke about a bit before about the use of WFS as an instrument. So, probably this is the other way around to deal with music. You have very stationary way of working sounds, for instance you can have the relationship of one speaker, one sound, or something like this. Then you have routes that make travel the sound. But you could create kind of phantom sounds; sounds that it is not even possible to locate in a physical way. How do you use this kind of materials? I would like to know your intentions on categorizing this reality.

WS: I am not sure about if you could make phantom sounds that could not occur in reality, because if you put sources around, you could also do that by putting a speaker of each source, and then it could be done. Moving sources might be a little bit harder, but still it could be done, although if you have a really fast moving source at a certain trajectory, then you cannot do that with a real instrument. I still see as a kind of virtual reality thing, so that you can place sound objects easily at will in a system, and work with them as if they were real sound objects. I do not see really a difference between actual objects and WFS-made objects, physical and non-physical objects.

AA: I asked that because the idea of Professor Berkhout: to expand the acoustical control beyond even its holographic propagation. Probably this is the only way in which WFS could work with perception. Normally, it is about a physical production of sound. Movement is based on delays, so the mechanism is quite clear. But the non-physical idea is based on perception, although it could work also with the same system. This escapes the control, let us say. It is possible to position some points out the system. That is clear. Is this controllable? When you somehow trigger this non-physical resources, what happens with perception?

WS: Immediately when you have these phantom sources, in our system you get the problem that they are not visually there, so you cannot relate them as a point in the space, just because you see nothing is there: it can be behind a wall, so it could never sound the way really behind that wall, but it is easily fixed by closing your eyes and wait in the dark. So even when you do not want it to, it is going to mess with your spatial hearing, because our vision actually gets more important for where we hear a sound than where we actually hear it. And also, there is another problem, and that is that our spatial hearing is not really good at hearing distances, so if you close your eyes and hear a sound two hundred meters away, you could not say. *'Oh, this sound is two hundred meters away'*. When you see it, you could decide it. The same problem happens with the system; you cannot really hear it. If a sound is moving away, of course you hear a Doppler effect. But if you have two points that are equally loud, maybe because the far away point is louder in itself, then you will not really be able to perceive that it is further away. Specially not when you are sitting still, because it will basically be the same waveform hitting you. So, there is actually no way of really hearing that is far away. When you start walking around, then you can have this perspective view, then it becomes more actually far away. You need to move around as a listener, so it is a completely different way of listening.

AA: But normal listening is also like this. You could detect some sounds according with your experience. I mean, if I listen to a fly, maybe close to my hear, then more far away… I have this experience in order to know that is really probably one meter, maybe more. But, when you go to a concert you are listening to new sounds.

WS: It usually works better with sounds that were recorded, just real sounds.

AA: For instance, the experience of ambisonics by using headphones, you could not probably determine the virtual distance, but you have a clear impression of it. And this distance probably disappears as soon as the illusion of proximity disappears, so it is related to that. But in the WFS is quite strange, because it is a recreation of sound movements and the sound all the time is quite clear. But how do you locate the sounds is quite diffuse, that is my impression. Depending probably on the velocity of sound, probably the intention, the gestures… I do not know. I think is not so clear all the time.

WS: Of course there is the problem of spatial aliasing at WFS, which makes the maximum frequency for sounds is 1.2 to 1.5 KHz. Above that everything gets diffuse and that actually works against making phantom sources, although our hearing is not also really so sensitive to facing differences anymore at that frequency. At least, it makes them more diffuse than real sounds. So, there is a limitation, if you want to cope with that you would need much more speakers. The fact that it is not 3D is also a limitation; everything happens in the same plane, even though there are tridimensional waves being generated. As soon as you have them out of this plane, it is kind of distorted.

AA: Exactly. It is as if you only have a slice of something, it is kind of perspective.

WS: Another thing is the reverberation. Normally if you hear a sound far way, you hear that it is far away by the fact that it has more reverb. We do not have that implemented in the system, that it automatically generates more reverb. We do not have any reverb implemented. We have some tests running, but now it is really heavy for the CPU. You can do it if you want, but you cannot have fifty sources with reverb traveling all over the place. It cannot do it real-time. But I have tried some things, where you have a fixed reverb on four channels while moving sources in and out of this area of four channels. The sources itself got softer with the reverb remaining steady. It can be quite more convincing when sounds actually traveling far away. You hear more distance in it.

AA: I am curious about if there was an idea of adaptation with the real spaces. You go with the WFS in order to play a concert, and for instance you discover that the place is quite dry. Virtually it is not a

problem, because the system adapts well, especially to dry places. How to create a mechanism that could adapt itself to the real space? Probably it could be useful to have preset for reverberation that could adapt the instrument in a general way in order to have a response more accurate, more warm, and so and so forth.

WS: There are samples of systems that can cancel out reverberation of a room. You have to do measurements per speaker of what is coming in, and then to do an inverse convolution. I only get it working in like 'two-persons around' systems. If you move the speakers only two centimeters, then you have to measure again. So, it is not really realistic for a mobile system. Normally, we can only add reverb, not remove it. Although, for example we have this venue in Spain, L'ull Cec, we noticed because the walls were quite far away. It was quite dry room, so there were less sub; even at a certain point an extra subwoofer was added to fill it up, while in normal rooms, that is not really a problem. But of course, with every speaker you have the problem of sizes in rooms, and that is not different for our system. But we have an equalizer that you can compensate the frequency curve of the room, which we use often for concerts.

AA: What about the 3D WFS? Are there some ideas?

WS: Not specifically for our system, but I know that are, for example, some systems kind of wall of speakers surrounding the audience. For our system we have been thinking of adding a grid above in the ceiling, not as close together, but spaced a little bit further. Raviv, the loudspeaker builder and designer, he did a system like that at Institute of Sonology, before he was in involved with this system. Apparently, that worked quite well, even though it was officially not WFS, because they were not close enough together. From that angle our hearing seems to be less sensitive; it is just to get a little bit an idea of elevation. So, that could be something that a certain point could be added to the system.

AA: It is a difficult challenge, I guess.

WS: Yes, it is. Technically of course it is possible.

AA: So, that confirms me that it is not necessary to use too much speakers, only a sort of smaller shower, in order to obtain altitude.

WS: I also know from the IRCAM system. The new system they are building in their large hall is that they combine ambisonics, as 3D system, with two-dimensional WFS. Apparently, they use that 3D ambisonics more for reverbs and the 2D system for the sources, as far as I understood.

AA: What about certain improvements about how to implement harmonic content, in order to make even clearer how the sound is located. There was a recent idea from IRCAM as well. This idea is like I have a flute, you could not listen the same sound of the flute coming from your front or from your rear.

WS: Oh, yes: directionality.

AA: There are differences in the harmonic components. Are you working on it?

WS: Not working on it yet, but I have done some research on it and I am going to propose to the Game of Life Foundation before the end of the year to do an extra adaption to the software to get that to work. The sources on our system are currently of omnidirectional, so they send out the same sound to every side, which is not really a thing that would happens in nature very often, Most of the sounds have at least some sense of direction, directionality. Apparently, at IRCAM they already have this implemented. We saw this when we were in Padua; they have a really tiny system in the music school there. We went for a couple of lectures; then I heard that also a couple of IRCAM's guys were there. They rendered some stuff for this little system there, so I could hear a flute player with directionality, moving back and forth over the audience. I could actually hear that sound was not pointing at you, but still it was at the same location, so that could make a source rotate and only sense sound in a certain direction. And the main thing that you did not hear is that acoustics sound different. Officially, when a source is not pointing at you, then you hear more reverb of the actual room, and it is also works in WFS. I think what they do is just simply limit the angle, with the combination of a few spherical harmonics, as an ambisonics-like calculation. So, I have been interested to also incorporate that in our system. I think it can be done. It does not take that much extra processing power, I

think. It is just amplitudes being changed. And then you can for example do multiple layers of the same sounds with different frequency components; on top of each other with different spreading of directionality. And I also know that they have what they call it xxx source. That is a source that on one side the amplitude is positive and on the other side is negative, and also there is this line in the middle that has zero amplitude. Aapparently, if you would do such a sound in the middle of the room, and rotate it a little bit and put a gong sound on it, you get a very really realistic gong, because that also is a xxx. It is working by no adding reverb, just with the interaction with the room itself. And it also appears that, if you have such a sound pointing sideward, so that you have the signal line exactly in the middle, if you would be really in the middle of this signal line, really in between, that you would have not direct sound at all, only the room's reverb. Actually it is really a strange, funny experience. So, I would love to have those features in our system as well. Probably, it would add a new layer of possibilities, not only for a realistic flute playing, but also for interesting, strange electronic new radiation patterns.