I: So, what have been your main responsibilities in the Vogas project?

R: Okay so I'm running JLM, the company that is potentially building the instrument for the Vogas project. So our task was to assembly device which consists of the sensors from the Technion, the sensors that our partners in Sweden had been preparing also together with us, and then the IR instrumentation plus a number of extra sensors that we've added from our other breath analysis devices and we built a whole unit that consists of breath sampling device, small computer internally, that controls all the sensors, records the data and gives the user interface.

I: Well, moving on, what kind of challenges have you faced during this project? This would be technical limitations, ethical considerations, anything that has been a challenge to solve.

R: The Vogas project was really having a lot of unfortunate circumstances. I mean doing breath analysis during corona times is really difficult. Plus on top of that, we have distributed array of partners, with partners in South America, in Israel, in eastern Germany, in northern Europe, eastern Europe. So that is really one of the main issues in the project that due to the corona we couldn't really travel and support the instrumentation as we wanted to do it. And this is a complex instrumentation that we have built. So shipping this instrumentation, get it working in the different sites has been quite a challenge in keeping systems up and running.

I: I can imagine. Could you elaborate from a technical point of view, what goes into designing a device like this?

R: If you are building a complex instrument like that, there are so many different parts that you need to consider. Each of these sensor technologies have their specific needs and requirements, and you need to design an instrument that caters to all those different needs. So that is one of the challenges in making some of the complexity of the instrument. The other complexity comes from building an instrument that needs to be used in a medical setting with nurses and patients and you know, it shouldn't be a lab instrument that requires a lot of manual handling. So you need to build an automated system that integrates all of this. On scientific parts that are out of the hands of researchers and stability and the robustness of the device is sometimes not as good as you would like to have it in such an environment, so that is posing a specific challenge in this environment.

I: Well, as the third question, what have been the main lessons that you have learned during this project? Findings, conclusions, results, maybe just lessons learned.

R: One of the lessons that we really have learned is that good support to the partners is really crucial. Good support requires personal involvement and persons on site to help with the complex technology and that was one of the main roadblocks we had

within this project. There's of course a plethora of technical things and technology that we have learned about. We have now much better understanding of our technology in some of the chemical sensors that we have not been working intensively before with. Also the integration aspects of these sensing technologies and how to combine them. There is a lot of knowledge that can be gained in a development of such a project. Aside of the practical challenges, bringing such technologies into real-life use at a hospital.

I: Well, thinking of the present and looking to the future. How do you think that digital health tools such as Vogas or other similar ones can improve health equality?

R: I think this is very obvious that with better information and the information that is quickly available, and can be gathered pain freely from the patient, there is a lot of benefits for the health care systems. It's improvements in the quality of health care. It's cost reductions if you have information quicker it can reduce waiting times. You can quicker take counter actions and if the cost is low enough, it also allows you to do better screening, to do better care before diseases develop into a bad state. So the need of diagnostic tools that are both convenient and cheap enough and connected so that the information is available quickly and could even be given into the patient's hands so that they can help with the diagnosis without having to go to the doctor all the time. That can be really a big benefit. And in the Vogas project you have learned so many different aspects on what that technology could mean that even if we faced a lot of challenges in the project, we've gained a lot of knowledge.

I: Absolutely. And as the final question, actually it's a two-part question but it's something that might be interesting for people not familiar with the Vogas project, but my understanding that these breath analysis tools are fairly recent innovation in your areas, is correct?

R: Yes and no. I mean, yes breath analysis is a very active research activity, that has gained a lot of interest in the last ten years I would say. However, breath analysis, smelling the patient, is something that even the old Greeks knew that it plays a big role in identifying diseases and a lot of this comes through the breath. Smelling the breath is something that a practical doctor, who had not available advanced technology that we nowadays have, had to rely on for centuries. So it's not a new thing from that point of view. The new thing that we do is try to build instrumentation that can help with that and that can improve the quality of such an analysis.

I: Right. So, for a layman how would you explain how does this type of breath analysis work. To my mind you're sort of building a virtual nose to a computer that can analyse the breath.

R: The simple view to look at it is that you're building an instrument that is essentially smelling the breath that you are exhaling. Of course, you're getting then into the

complex matter of what constitutes this smell. In the human breath you find a lot of different VOCs that come from our normal metabolism in the body, but they are also affected by diseases you would have. Looking at this complex pattern of different chemical markers that we do find in the breath can reveal a lot of information of our body. One of the big challenges in such a project is that we need to identify what information means what. Gathering data is also a big data problem and how to correlate that with diseases and health state. That is now actively worked on over the world with all the different breath analysis instrumentation systems, complex ones, simple ones, but I think it's a matter of time until we see a breakthrough there and it is used more widely. There are some breath analysis technologies that are already in use, where you're measuring breath to identify metabolic states. You can for instance test for certain bacteria in your guts by ingesting some food that the bacteria will then digest and as a result provide specific patterns. There is already technology in use for breath analysis that is commonly done. But improving and going to the next step is really the challenge and that is why we are building such complex instrumentations to test drive all the different technologies that are in the field.