Mapping the underworld

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Intro VO: *Welcome to the Ideas Lab Predictor Podcast from the University of Birmingham. In each edition we hear from an expert in a different field, who gives us insider information on key trends, upcoming events, and what they think the near future holds.*

Lucy: Today we're with Dr Nicole Metje who is Senior Lecturer in the School of Civil Engineering at Birmingham University. Welcome, Nicole.

Nicole: Good morning.

Lucy: So tell us a little bit about what you do in civil engineering?

Nicole: I work on quite a number of projects and one of the most exciting projects is Mapping the Underworld.

Lucy: Mapping the Underworld, and what's that?

Nicole: Well it's trying to find and locate buried utilities because despite the fact that we get the water and gas and broadband all the time, it's surprising how difficult it is to actually know where the pipes are that supply the services.

Lucy: So this is the fact that we don't really have one map of what's underground in Britain.

Nicole: No we don't because we have privatised our utility companies, we have got lots of different companies and they all hold maps for their certain region. So if you want to look what's actually beneath the street just in front of your house you'll probably need to combine a lot of maps from a lot of utility companies.

Lucy: So this is ultimately what causes the problems, hold ups for traffic, things like that when people are doing roadworks because they have to dig around to try and find the pipe or the cable it is that they have to repair and they're not always sure where it is.

Nicole: Yeah, although I said you can get the maps from all these utility companies, it's actually surprising how inaccurate a lot of these maps are because they are quite old – not the maps themselves but the information presented on the maps – and at that time the location of the buried utilities might have been measured with respect to lampposts, street corners and so on and these might no longer exist.

Lucy: Because of course nowadays we've got GPS so you always know where something is.

Nicole: Yeah, nowadays GPS is really good and any new pipes we lay we can determine or the get position with respect to GPS. Having said this, it's not quite that easy in street canyons because you need a clear view to satellite and that's not always that easy either.

Lucy: So a street canyon is, for example, in a city where you've got very very large buildings either side.

Nicole: Yeah, very tall buildings where you see very little of the sky when you actually stand at the bottom at street level.

Lucy: So you don't get very good GPS readings even then.

Nicole: You don't, no. You need at least three GPS satellites in view to get reasonable accuracy.

Lucy: So at the moment we've got all these pipes and cables under the ground and we're not quite sure where they are so how can engineering help?

Nicole: Well what we are trying to do is although there are technologies available at the moment that can find and locate buried utilities, none of these are really foolproof. They don't work in all ground conditions, they don't work for all pipes because the pipes have different materials so you've got plastic pipes, you've got metal pipes, you've got cast iron, you've got reinforced concrete pipes and they all behave very differently. So what we're trying to do is develop this multi-sensor device to really find everything without the need for probing excavations.

Lucy: So it's finding whether the pipes are without digging a hole by having some kind of trolley type thing that you roll across the ground?

Nicole: Yeah, we are envisaging this as a sort of sit-on lawnmower type of thing eventually.

Lucy: Ok! [laughing]

Nicole: Or something that you can tow behind just a white van because in an ideal world it would go at traffic speed to not disrupt the traffic.

Lucy: So if a utility company wants to locate what's under the ground in a particular street, they would take this device, hook it up to a van, drive it along the street and they have a picture of exactly what's under the ground.

Nicole: That's the idea at the moment.

Lucy: That's what you're working towards!

Nicole: That's what we're working towards, yes.

Lucy: And ground conditions are quite a big issue?

Nicole: Ground conditions are really important because in the UK we've got different types of grounds and the most difficult one is clay grounds and we unfortunately have quite a lot of those. We've got the London clay, we've got Oxford clay, so there's various clay types.

Lucy: So why is clay such a problem?

Nicole: Clay is a problem because clay shields a lot of the signals so they can't penetrate that finer ground. Most pipes are at about one metre depth, sewers are a lot lower, a lot deeper, you've got optical fibre cables which are quite shallow but very very small and they are just extremely difficult to detect with the current sensor technologies.

Lucy: So this new device has to work in clay.

Nicole: It has to work in clay and one of the technologies that works quite well in clay is actually vibro-acoustics. So rather than using an electromagnetic signal it uses an acoustic signal, so it's like using a microphone and using a speaker and you vibrate the ground and you vibrate the pipe and that's actually quite a lot more successful in clay than any of the electromagnetic sensors that you normally use.

Lucy: So this drive-on lawnmower will have all the different types of signaling equipment?

Nicole: Yeah, the idea is that this drive-on lawnmower has a total of four different sensors attached to it. So the four sensor technologies would be vibro-accoustics, low frequency electromagnetics, passive electromagnetics and ground penetrating radar. Ground penetrating radar is used quite a lot at the moment anyway but again we think we can actually improve it by changing the type of frequency we use and also the way we use ground penetrating radar, one of the ideas is to actually put something in a pipe, you know, a little vehicle, a little robot in there, let it run though. You've got a receiver on the surface, you measure the signal and then you take the robot out of the pipe again and you remove it. So it doesn't stay there, so it's not there permanently.

Lucy: There's quite a lot of this technology going on isn't there where if you can get access to a pipe you don't then need to dig up a whole load of road.

Nicole: Well that's the whole idea. If you know exactly where the pipes and utility services and cables are then you can probably use this technology, which is called "trenchless technology" a lot more. At the moment it's not come off as much as people might have expected, simply because of this uncertainty where current existing pipes and cables are. So once you know this very accurately and you know where there aren't any then you coulduse this much more widely and therefore reduce the impact on the surface and you don't have all these roadworks hopefully.

Lucy: Which everyone would be very happy about, I'm sure!

Nicole: It would be fantastic if we don't get stuck in traffic jams anymore!

Lucy: Well it won't be the end of traffic jams will it, let's face it, but it will be the end of hopefully endless cones and weeks and weeks and weeks of one-way traffic lights.

Nicole: Yeah, I mean one of the problems at the moment is that the current technologies can't locate the pipes very accurately so you might have a lot of holes dug unnecessarily. So we've been involved with one project some time ago where we've had a map and it was on one side of the street and we've dug various holes and it turned out that the pipe was actually on the other side of the road.

Lucy: And this happens an awful lot doesn't it?

Nicole: It does unfortunately.

Lucy: They're called dry holes.

Nicole: It's called dry holes where you actually dig without finding something, without finding what you're looking for. You don't find your pipe.

Lucy: And there's quite a high percentage of works which start off with quite a few dry holes.

Nicole: Yes, there's several million dry holes a year dug and that costs several million pounds to the taxpayer, so if you can stop that, that would be fantastic.

Lucy: But of course there's a safety issue as well isn't there? If you hit the wrong pipe that could put people that actually work on the roads in danger.

Nicole: Yeah, if you don't know what's there and you hit something that you didn't expect then it can be deadly. There was an accident in Belgium not long ago where somebody hit a gas pipe and over a hundred people were killed because it exploded. You have got small and large accidents; if you hit a high voltage cable as the operator - that's not good for you. If you hit a water pipe maybe not so much is going to happen but it's certainly going to cause a lot of people, households, to not have water and -

Lucy: Yeah, massive disruption.

Nicole: - a big clean-up operation as well.

Lucy: So this project will hopefully save us all time in traffic jams and save all taxpayers' money as well as making roadworks safer. What's the timescale because I know this has been quite a long project hasn't it?

Nicole: Yeah. Overall it's a 25 year vision, started off in 1996.

Lucy: So quite a long way into it.

Nicole: We're quite a long way into it. The current project to develop this multi-sensor cart, as we call it, is coming to an end at the end of 2012 so hopefully by the end of next year we've got a prototype which might not quite look like a lawnmower but something that we push along or pull along – at the moment it's push along – but then the next step we're really interested in is it's all right knowing where these pipes are but wouldn't it be nice if we had a way of actually determining what the condition of the pipe is and then we can plan our maintenance regime accordingly.

Lucy: So this is the so-called smart pipes.

Nicole: Part of it is smart pipes but also part of it is Mapping the Underworld 3 I guess where we're trying to use the current sensing technologies, maybe adapt it a bit but ultimately use a common vehicle, a platform again, and have some signals sent down but interpret these signals, not only to find the pipe but also to tell us something about the condition of the pipe and we've done first steps in the lab through Masters projects using GPR – you can see some damage to pipes, you can actually see it in the signal, but the interpretation is slightly different because you are not just trying to find it, you're really trying to look at the signature of the signal rather than just the signal itself.

Lucy: So this is research where we will, all of us probably in the UK, feel a difference, notice a difference when this comes into play.

Nicole: The impact is enormous. I mean we're engineers, we're working on it but it's the general public, it's councillors who hopefully get fewer complaints from their constituents and it'll be, yeah, the general public and everybody will hopefully feel a benefit. So watch this space.

Lucy: Yeah, that sounds fantastic. We can't wait! [laughing]

Nicole: We can't either!

Lucy: Dr Nicole Metje, thank you very much.

Nicole: Thanks a lot.

Outro VO: *This podcast and others in the series are available on the Ideas Lab website:* ***www.ideaslabuk.com*** **(http://www.ideaslabuk.com/)** *. On the website, you can find out how to e-mail us with comments, questions or suggestions for future topics for the podcast. There's also information on the free support Ideas Lab has to offer to TV and radio producers, new media producers and journalists. The interviewer for the Ideas Lab Predictor Podcast was Lucy Vernall, and the producer was Andy Tootell.*