Interview with two experts from the engineering department at GSI/FAIR (July 21, 2025)
Length: 2:15 hours, including presentation of results

Expert 1:

[On multi-user mode] How many people can use the application at the same time?

PM:

According to Photon [the multiplayer network used], theoretically more than 100. It depends on the bandwidth and the size of the data packets exchanged between users.

Expert 1:

Looking at it now, I think VR will be used more in creation and AR in the operation of systems.

Expert 2:

The first application idea I see for AR is maintenance. So, what you just showed. I stand in front of it [in front of a component] and I can watch a video showing me what I need to do to unscrew a cover. I can well imagine that this could also work for us—for maintenance or assembly, that is.

Expert 1:

[Expert 1 shares the screen and presents an application that is used in the FAIR project for planning/visualization purposes. This allows you to navigate through the point cloud scans of the plant in third-person view, and the 3D models of the planned machines are also displayed]. Everything you have presented applies both to the building equipment—you can see platforms, pipes, and so on at the top—and to the machine. I wouldn't even distinguish between what we have inside and what's hanging on the wall. What we have here on the left at waist height is the temporary fire protection. That will be removed later. But you can already see things hanging from the ceiling; that's the final fire protection. AR would then really be used when the plant is running to see what kind of platform it is or what's on it. Where does it go from where to where? That means the configuration would also be interesting. I can vividly imagine that these are all things that could be done. Right down to films for the installation, if we have special installations, so that this can be shown.

The important thing is that I have already noticed that when we discuss installations, we have to let several people use the systems. That's why I asked about multiplayer. What I also find very charming is this labeling, i.e., drawing and measuring: "Ah, we have to change something there." I'm also familiar with this from discussions about the building. If we had a scan like this and walked through the building with a group wearing glasses – "Oh, what's that?" "We need to mark that" – I think that would be very useful. Here on the right, for example, we have the ventilation system. You could also put a marker on it: "Who am I? What can I do?" I can write that in [Autodesk] Navisworks, but to represent it virtually in its entirety...? We're talking about a walking distance of just under 100 m [in the tunnel section shown].

PM:

Yes, you have a really comprehensive point cloud model.

Expert 1:

Yes, well, these are several scans that have been superimposed. And now the CAD model of the machine has been added. There's nothing there yet; it's empty at the moment. So that's the status we have at the moment. These are things here related to components, which I also found charming in your presentation. You see, I have a basic type here, I click on it and it shows me where the others are. I found that a very charming solution, because we are actually quite basic type-oriented or class-oriented in the whole thing. That's why I find it interesting. As I said, for me it's not just the building. For me, it's about the entire data management that goes with it.

PM:

I think that everything stands or falls with the data basis. With the geometry, it's great now, of course, the way you have it. You can also transfer the geometries from the planning stage to operation and assign [object] classes. That's how it is in Mont Terri, too, only there it was all done retrospectively.

Expert 1:

We don't have that at GSI. That's what makes it so exciting. What you've just seen is the beginning of the FAIR facility. At GSI, we still have to work on that. That means we're just getting started. [Expert 1 shares the screen again] This is a scan of an existing area. And at that moment, you ask yourself what's actually here. What kind of connection is this? It's a water connection, we now know that. We use these "balls" as references so that we can attach information to them. I consider this to be very important for inventory management. We can scan and then add the information later, which I also consider to be a very important point. I'll jump ahead a little bit here. Here we are in another area. With what we have at the moment, we can measure in the point clouds, but it may well be important to do this on site with glasses. I consider this overlap, i.e., the scan plus the on-site discussion, to be very important. And we have SAP as the database behind it. Then you would just have to access SAP.

Expert 2:

Regarding the question about the database: You said that you have introduced another intermediate level. I'm not sure what would really make sense in our use case. You can actually put anything you want into SAP. Even a video for assembly, for example, would certainly be possible. The question is how accessible it would be, because you have such a nice user interface and you can click your way through it. Can this be mapped via SAP? Can it be structured neatly and made accessible, or do you need something in between?

PM:

We would have to look at the API, i.e., the SAP programming interface. There will definitely be one. Just like with the Fulcrum database from Mont Terri, there is also a programming interface there. For security reasons, I didn't have direct access to it, but I was given an extract, which I manually translated into my data format. I also wanted to show what semantic web connection options you have later on if you store the data in the graph database as RDF triples and call it up as such. But yes, you can call up all kinds of things from Unity. Whenever a video, image, or PDF was opened in my use cases, it was retrieved live from a separate server. Of course, you can also do this with SAP. But you would have to ask yourself whether you want to keep the tree structure I designed or whether you want to follow the structure from SAP. Once you've decided on something like that, I think you can get the connection working very well.

Expert 1:

We have a fairly strict data structure in SAP, which is predefined. We can't really get around that. [The expert shares the screen and presents the SAP application] At first glance, it looks like this. Everything has an article identifier, which is this number. And below that are the documents. You could now open the CAD model at the top; there are logs and so on. This is all standardized information about the components. We can also see the serial numbers and documents associated with them. It's all on one level. We also have a QR code with this number on everything. I could imagine using that to "jump" to the right place.

PM:

That's a great structure. It's very compatible.

Expert 1:

Everything from the FAIR project is stored this way. It's mandatory. There is also information about where a component is used and how it is located in the room. We have technical spaces and functional spaces in our tunnel. This [machine] here, for example, has a center coordinate and a size.

PM:

And you have that for every data record? Would every document know where it is placed, at which coordinates?

Expert 1:

Broadly speaking, yes. If you know how to navigate the system, yes. That is now the structure of FAIR. We still have to build that up for GSI. That's where the retrospective is important. When we talk about knowledge management, we at least have everything here that can be visualized in terms of knowledge about this component.

PM:

The main thing is that it is consistent. If you have a consistent structure for everything, and that's how I understand you, then you can also create a concept that covers everything.

Expert 1:

Exactly. That's certainly the case here. I could jump in with a few other numbers. The framework is always the same. The content is sometimes different.

PM:

That was also the case in Switzerland. I worked with different object classes there. The focus was on the drill holes, which have a specific data format. But then there were also experiment kits and the experiments as virtual objects. I defined a kind of separate container format for each object class, but the overarching concept is the same for all of them.

Expert 2:

What you also showed on the subject of visualization—and I see parallels here—are the boreholes in Mont Terri, which disappear somewhere inside the mountain. We will also have inaccessible areas. This is an application that would definitely be interesting because you won't be able to enter [these areas] for a very long time. And I can imagine that this would be interesting for both VR and perhaps AR. If you were standing there and wanted to look through the wall, so to speak, it would be pretty cool if that were possible.

Expert 1:

I'll show another short film [expert shares screen]. We are down here in an area that sees a lot of radiation. First, the scan; the whole thing is empty at first. But what we always have underneath is a CAD model. Disappearing things, that's really a point... Up here, you can see lots of cable trays disappearing, which of course we don't capture in the scan. But there's a model behind it where you can take a closer look. This is now an area of the beamline that is very narrow. You can see the building, which we also have completely in CAD. That's the other side, at the back. Now the scans overlap again, and we can't get to it anymore. And at some point, it could become very important to know where this hole at the back left leads to. We humans won't be able to get there anymore either. As you can see, it wouldn't work spatially.

PM:

It's very narrow. But in case something needs to be serviced, you still have to be able to get there, right?

Expert 1:

You can see these stones on the left and right. Other stones will be placed on top of them; you have to imagine it like Tetris. We stack the whole thing upwards. If we need to access it, we have to look explicitly... That's why your representation of radiation is actually an interesting thing, because this area will emit strong radiation, which is why it is built in this way. We open the segment and everything has to be removable from above. That's why we have these connections everywhere and the big crane up there. We have to wait at least a year before we can even start working on it once the beam has been applied. As I said, we have a CAD model for this. But now we're back to VR: "Ah, there's an outlet up there, where does it go? Show me how it continues."

PM:

This is a really exciting use case, especially because this is such a large area that I won't be able to access so easily later on. For Mont Terri, I was provided with an extract of boreholes for which geometry and semantics were available – there were about 80 of them. And in addition, I had the geometries of all the other boreholes. We discussed whether it might be too confusing to see too many augmented objects "floating around." The problem is that I can't locate augmented objects that are a little further away from me in my visible environment ( ), and then I lose track of everything. We discussed various measures, such as a kind of filtering so that only objects that are a maximum of 10 m away from me are visualized. Or you could work with a transparency gradient, i.e., everything I see up to a distance of 10 m is 100% visible, and beyond that, it gradually fades until I can no longer see it. In the end, this wasn't necessary for Mont Terri because I worked almost exclusively with the extract from these 80 boreholes. There were no situations where anyone said, "Wow, there are too many virtual objects here." But in your case, some of these ideas should be revisited to keep everything clear.

Expert 1:

We have to separate the construction information from the beamline. For the people working on it, the other side is always just a distraction. You really have to see it that way. For the construction workers, the machine is just sitting there, and for the beamline people, the construction is just the shell around it. Everyone looks at it with different constraints...

PM:

Sure, everyone forms their own model from the same environment.

Expert 1:

Exactly. If we look at this area here, we have all the cavities and so on in it. This is really the CAD model of the building, and it would be good to say that you are doing the appropriate knowledge management. It even goes so far as this: if we are here in this room, I can now click on the [object] here and some of the properties are displayed. The information is also in the database. In terms of data collection, we are well on track at FAIR.

PM:

It's also good that you are already familiar with viewing this combined information in an environment like Navisworks. For many people, it's abstract when you say you want to overlay geometry and semantics. But you are already very familiar with this view.

Expert 1:

Collision checks actually force you to do this. Then there is the aspect of technical hurdles and acceptance [of your application]. The whole thing requires a huge rethink because it affects the entire cooperation. The assumption is that everyone works together and everything is up to date. However, due to the generational change, it is becoming easier in some cases to work with VR, for example. And you have to look at the process chains: How do we plan both operation and maintenance and replacement? You have to look at that. And knowledge management means a cultural change. For me, VR is for construction and AR is for maintenance and planning changes. We have to plan digitally and our access times are getting shorter and shorter. Let's think in terms of buildings—you also come from the construction industry: The people who have to operate them are not the people who build them. That means distributing information at that point—Where am I actually? What is this?—is an important point. And then using that knowledge to operate it and also pass it on to the next person.

PM:

Yes, that's a real sore point, especially with the old nuclear power plants. The literature says that 70% of the design knowledge needed for decommissioning actually already exists after the planning phase of the plant has been completed. It's just not fully incorporated into the construction or operation. And of course, if you can manage this transfer digitally, it would be very useful. For the nuclear power plants that are now being decommissioned, we have paper plans from the 1960s and 1970s. Who can guarantee that the reinforcement actually looks the same as in the plans? Someone could have added more. If we perform activation calculations based on "incorrect" plans and arrive at different results than we measure on site afterwards, we have a problem if we rely solely on the planning basis. If we can achieve a better transition between planning, construction, and operation and ensure that such information is not lost, that would be very valuable.

Expert 1:

Acceptance is exactly the point. You rarely get people on board with reason alone; you have to remind them of these issues. In product lifecycle management, we discussed how much of the beamline needs to be dismantled during maintenance. No one knew anymore where everything fit together. Now you can tell people, "Remember? We spent four weeks discussing this, and we could have done better." Yes, that's where you have to get people's minds to go. Of course, we're very playful here, which means that all new toys are initially welcomed. Technical hurdles are the interfaces: What knowledge do we want to see? But you also have to differentiate this "by faction." Who wants to know what? If we display everything, we can't see anything anymore. Our facility management has different knowledge requirements than the beam optics department, for example. And those who operate and run the machine want different knowledge than the groups that manufacture the components. A small example: some people only think in terms of addresses, while others think in terms of functional positions. That's exactly what I meant earlier: how often do I still have this thing and where are the others installed? And the change in communication... Honestly, that only works "par ordre du mufti." You do it now and a few people have to set an example.

Expert 2:

Yes, that's another important point when it comes to acceptance. Actually, we first need proper as-built documentation, and it will be quite a while before we're ready. I also think that the whole maintenance case only makes sense once [the documentation] is well mapped out.

PM:

I can think of a few more technical hurdles, including everything related to the glasses and the infrastructure. [Expert 1], you asked earlier how many people can be in a multi-user scenario at the same time. I have to have glasses ready for everyone. Of course, you could use a pool model, where you have, say, 20 pairs of glasses in a central location and lend them out flexibly. But then, of course, I have hardware that needs to be taken care of. A second point is the internet: I need an internet connection to stream the semantic data.

Expert 1:

We already have Wi-Fi in the tunnel. It wouldn't be possible without special measures, but you're absolutely right. Testing components is another issue. We sit there, usually all on Zoom. One person rotates the model 25 times...

PM:

... and then the typical misunderstandings arise: "Yes, I mean the corner, and no, and yes..."

Expert 1:

Exactly. I asked around here how many people would be good at the same time. In that respect, I'm surprised by your estimate. At least four or five people involved in a discussion about a single component is realistic. A maximum of ten, I would say, any more than that wouldn't fit. Up to: "We'll record what you're listening to and looking at" so that the rest can watch it. We'll be coming to the facility less often than before, it has to be said. Once we've gone through the as-built, I see the information that's attached to it. What I also liked was attaching the information directly in the tunnel. Although I have to say that the information is rarely available in the tunnel. "Where's the key?" – that's OK. But yes, maybe it's just because I can't think of a use case for it at the moment. But I still think it's good.

PM:

With this use case, I wanted to show that in the XR environment, you can not only view knowledge, but that everyone is also able to easily enter knowledge that may be implicit. If I think, "Oh, actually, only I know where that key is," then I now have a way to record that knowledge so that others can benefit from it too. Of course, it's difficult to compare with current knowledge workflows. We also have a wiki at the institute, but honestly, how many people contribute to it?

Expert 1:

But what also occurred to me at the same time are tasks during inspections. I think that's very useful. Simply carrying out inspections, making markings, and then being able to say that you have at least discussed this one measure with the regulation at this point. And then being able to continue working with this information is, in my opinion, a very important point. Of course, you have now retreated a little into the past with the nuclear power plants and their decommissioning, while I am looking to the future, i.e., the significance for operations. Simply going into the plant with two or three people, getting your bearings, discussing certain things – "Make a sketch, do you all agree?" – that would of course be a very useful thing to do.

PM:

I think that's a nice idea, that you can save a kind of scene and open it up again on another occasion. Then you could also switch between VR and AR. I could walk through the real environment with several people using AR, make markings, and then view them again later during a project meeting in the meeting room using VR.

Expert 1:

Yes, these are things that will come. Especially when I look at the old plant, we have a lot of paper-based information and still have renovation work to do. When someone asks, "The water pipe and the cable tray: what's on it? What's attached to it? Is it in the way?" – these are things I can imagine very vividly. I liked that in your presentation because it's classic operation.

[Regarding the target group for the application] For operators, yes. The general public, no. External personnel, no.

PM:

Let's discuss external personnel and imagine a classic nuclear power plant again. We don't have that many external personnel in operation, but now in decommissioning, of course, we do. They are all briefed and have a license to work there in the controlled area. There may be concerns that external personnel will not handle the hardware with care or that they will not understand everything. But in my requirements analysis, I have identified that there is a great deal of organizational and technical coordination required between the operator of a plant and its external personnel. Currently, a "silo mentality" prevails: shared folders with data are provided on an ad hoc basis and data is transferred back again. Ultimately, as the operator, I have to integrate this data into my structure. That is why I suggest bringing external personnel into the environment as well.

Expert 1:

Our experience in the project so far is that very few people structure the information the way we want them to. Not even by force. In my opinion, they will always need someone to sort it out for them. Especially the CAD models, of which we only get a fraction from our own company. We get them from all over the world, and you can specify what is to be delivered as much as you want. A lot of energy has to be put into making sure that the things are usable as we need them, i.e., that they remain importable and can be used.

PM:

Yes, I believe so. There are so many export options and attributes. I can omit or add them, and afterwards you don't know whether information is completely missing or has just been exported incorrectly.

Expert 1:

Yes, we'll look into that. We see that with some fonts that are used, there is no visible difference. The systems don't accept it, but they don't say why. We know that all too well. What's also important is positioning, the use of references. You always need someone to check the "hygiene" before you import it. Of course, you can let external personnel work with the system, but I would be very careful with "feeding" it. If you want it to work, someone who pays attention has to do it. On the subject of security – of course, something like this can only run internally. Always. It's not quite as [restrictive] for us, but if you look at a nuclear power plant, it should really only have a closed shell on the outside. This is a discussion that is now also moving through the scientific world, using the example of mini nuclear power plants.

PM:

SMRs, exactly.

Expert 1:

Exactly. I would be cautious there. You have to see how you can do it in terms of safety. I could imagine downloading the [content] in advance for a specific area. Maybe I'll get the content first via the QR codes in the plant. And on the subject of data protection: what's in the database has to be accessible. Anyone with an SAP account can open what I showed you in SAP.

PM:

Is there also personal data there?

Expert 1:

We wouldn't put that in there.

PM:

I'm asking because my concept has a very strong personal reference. Someone told me in an expert interview that knowledge without a responsible person, i.e., "anonymous knowledge," is basically worthless. I need some kind of contact person. That's why I've included the option in my data model to specify both an author and an (additional) responsible person for each piece of knowledge. Now, of course, the question arises as to how to deal with this if all these people can be viewed with their real names.

Expert 1:

We try to set such information in a function-related way. My real name would not be listed there, but rather "Engineering." If you want to know where the knowledge comes from, you should look at the specialist group. These are also the product owners, the responsible persons. And I would say that, due to the amount of data that then appears, you should always stay within the organizational units.

PM:

That's just thinking one level higher, but it's the same principle. When I start the application, I don't say what my real name is, but select my organizational unit, and everything I do is stamped under that area.

Expert 1:

Exactly. Because names are a pain to maintain. That should be done via functions. And when we talk about knowledge management, it also makes sense not to assign everything to individuals, but rather to the organizational units. Otherwise, you're back to the nose [meaning a single person]. Of course, supervisors are then required to ensure that the "knowledge king" shares everything. There are enough people who jump around and think they are the only ones. And in terms of information: we are required to disseminate knowledge as widely as possible. That is our fundamental task as a research institution. We actually show quite a lot.

PM:

Once the first experiments are up and running, you will also have a Controlled area. Are you already aware of any restrictions or regulations regarding the use of hardware? In particular, mobile hardware such as XR glasses?

Expert 1:

We don't go anywhere where there is radiation. We're not allowed to. We don't go in there. The whole thing is sealed off by a personal safety system, even when the facility is running. And we, as ordinary citizens, are only allowed in once the radiation safety team has told us that it looks reasonably safe. We occasionally have cameras in there to monitor the radiation. But we know that it doesn't last long if it's constantly in there. We have residual radiation in certain places. The good thing is that we don't have a chain reaction. If the S trom fails, we sit there and wait for it to subside. There are also simulations of how quickly it decays. That means your example earlier of "How much steel is actually in the wall?" is an interesting one, because there really is more in there than planned. But I also find it interesting to record things with a time behavior there. We have permanent monitoring here, so we know what the levels look like if there is a bad spot somewhere. You could create simulations, for example, of what it looks like after waiting a year. Since we don't go in when it's dangerous, you can take the glasses with you. You may have to wipe them off afterwards. But that's like our bodies when we need to take a shower. We don't have to do that here, though. I wouldn't take them off in certain places, but would keep them somewhere on my body. But in terms of the basic concepts, you can take them with you.

PM:

OK, that's good. The restriction on bringing electronic devices into the controlled area of a nuclear power plant is mainly because you're not supposed to bring out any potentially contaminated items. One interviewee mentioned that some devices remain permanently in the controlled area at his plant, such as computer workstations. I could do something similar with a pool of XR glasses, but well, it's not so urgent for you.

Expert 1:

You have to imagine: if the [devices] are in the Controlled area, they will eventually be exposed to something. You don't know how long the stuff will remain active. And the second thing is that you are holding them close to your body. The harmful thing is incorporation—eye fluid and other stuff. And I wouldn't let these glasses, which have been flying around for a while, get so close to the body. That's why we scan and want to capture as much as possible. For FAIR, the chance that we will obtain knowledge management for the facilities is very good, because at some point we won't be able to access them anymore. We scan as much as we can. Even when the plant is up and running, we will go through it again from both sides to make sure we have everything. I can see our use case right now for your topic at GSI. Capture, attach information, and see where we are developing. We have old plants here, some of which date back to the early 1970s, and if we find anything else there, it will be a lot. Once we realize we have discovered the first pipe, we ask ourselves what else is coming. Yes, the next pipe. And so on... I see bringing in the retrospective, with what you are doing here, as an opportunity for the existing plant.

We are constantly thinking about who we should bring in from construction. They also have to take over what you are currently seeing. How do we get the knowledge about each other? There is a huge range of applications. When I look at this point – "safety and applicability in nuclear facilities" – you always have to look at who is allowed to stay where and for how long. At some point, will be ready to use the glasses for planning and retrospective analysis. If I take away the nuclear technology aspect, we are left with what it means for us in the old plant: constantly checking whether we already have something. Those who are already working on it have to do that.

PM:

On the subject of safety, I had an interesting discussion about the fact that although you can still see the real environment with the glasses, you no longer see it as you would normally. If I'm standing on a platform or on stairs, that poses a potential safety risk. Then the idea came up that for certain activities, not everyone needs to wear the glasses, just one person. That could be the safety and health coordinator (SiGeKo), someone you would also need to have on site during construction. This person is the boss, so to speak, wears the glasses, and can give instructions to people around them.

Expert 1:

Again, we like to play. Probably everyone will want to wear the glasses at first. But that's more of a process issue, you're right about that. You could designate someone as safety personnel to watch over the group, stairs, and cables. I don't think we'll be working with very large groups. Once everyone has tried it, the novelty will wear off. But having a few [glasses] with us would be an organizational measure. What inhibited me a little [when trying out multi-user mode] was that you have to reorient yourself as soon as you take off the glasses. If I'm traveling with five people and we take two pairs of glasses with us, they should be able to be passed around flexibly.

PM:

Yes, there is still room for improvement in terms of usability; it needs to be more fluid. Once all users are in the application, they also currently have to "communicate" whether synchronization [via colocation] is working. Otherwise, everyone has to restart the application. That's hardly reasonable for a larger group.

Expert 1:

That's what we can't afford. We are always urged to shorten our stay in these areas. It's not dangerous, but you don't want to be there for long. If we have to reset in the middle of it, that's obviously...

PM:

... Yes, of course, if you develop the demonstrator application into mature software, you definitely have to address this issue.

Expert 2:

I have a question about this security issue: I actually thought that in AR, I would always just see something superimposed over the real image. Could it happen that I don't see a cable lying there?

PM:

Perhaps you noticed when you were wearing the glasses that they cut off a little at the edges. You look through two lenses, which simulates peripheral vision. However, the field of vision with glasses is not the usual approx. 180°, but less. Secondly, the real environment can be obscured by large virtual objects, although I can of course minimize the risk here with transparency effects. And one last example: Imagine you are standing on a platform and, for whatever reason, the glasses run out of battery and go black. These are all possible scenarios.

Expert 2:

So basically just the periphery and this case where I simply can't see anything anymore...

PM:

Yes, spatial vision is a tricky thing. Even with VR, spatial vision is "simulated." I'm actually looking at two screens 15 cm away, and because I'm no longer seeing "originally" stereoscopically, this could be construed as a safety risk. I think it's a theoretical risk for now, which is very closely related to the application and its actual use.

Expert 2:

Perhaps activity should be limited in certain areas. I wouldn't wear the glasses for heavy assembly work, but only to look at something beforehand.

PM:

The glasses are available in different designs. In our version, you can attach a battery to the back, which means they are no longer compatible with a helmet. The original version of the glasses may not be a problem, as they only have a simple strap at the back. Helmets are actually mandatory at Mont Terri, but as you saw in the videos, I was given permission not to wear a helmet at times, as otherwise I would not have been able to test the glasses. We couldn't find a suitable helmet at short notice, but that doesn't mean – especially with the possibilities of 3D printing – that wearing the glasses categorically excludes wearing a helmet at the same time.

Expert 2:

Well, okay. But what do you mean by safety?

PM:

Exactly what we just discussed: safety on the construction site, fall protection, spatial vision, occupational safety.

Expert 1:

Occupational safety, OK. So for me, that's applicable. Period. I mean, the unique selling point of your application is nuclear technology facilities, that's the important thing. On to the next point, "implicit knowledge": That's just one of those things... Acquiring implicit knowledge actually means a cultural change. That has nothing to do with your system. It's a cultural change when you say what someone does and why.

PM:

I agree with you. But if someone tells me to do this or that, it presupposes that there is a technical possibility to do so in the first place. When I develop an information system, I can never know for sure whether the user will use it the way I imagine. Of course, in the end, someone has to take charge and explain how to use the application. That's what my question is getting at: Does my application give people the right tools to, for example, enter knowledge? In the video earlier, I created a knowledge element. How would you do that without my application? And is the way I do it with my application possibly the better way?

Expert 1:

I think it makes sense to create the knowledge element in this way, because then you can take notes during the discussion.

Expert 2:

It could be a bit chaotic and unsorted, of course. Someone has to tidy it up afterwards.

Expert 1:

Here I go again: someone always has to check afterwards to see if everything is okay. The methods for acquiring implicit knowledge are, of course, a little different. You can only document them. Then someone has to rack their brains to figure out why that is. Otherwise, as for the potentially lower hurdles: it's a cultural change to pass something like this on.

PM:

Here's another example from offboarding: Imagine your long-serving employee is about to retire. It's easy to say, "OK, anything you think was important to you, you can write down somewhere or something." But no one can really verify this because no one else is familiar with the system. Once you have someone who is willing to do this, someone goes with them and their glasses through the facility and the departing employee explains what they were most recently working on. And if they can think of any interesting points off the top of their head, my information system could be the right environment for recording such knowledge as little notes.

Expert 1:

That's an ideal world, and it works. It's part of the culture that it's done this way. It has to be demanded and documented. If the instruction comes that someone should go through, and they want to, and maybe someone else goes with them and the whole thing is recorded, that's fine too. And in the end, it has to be processed again. Passing on implicit knowledge is a very important thing.

Expert 2:

Yes, it's just something that takes a long time. I'm actually familiar with this offboarding situation you describe. Even if there is time and the person is willing, they often don't know what to write down. Then I make 20 PowerPoint presentations—but it's really difficult to document the knowledge that has been accumulated over decades in a meaningful way. In my opinion, this is often only possible if someone works alongside them for several years and asks the right questions. Because the people who are leaving often don't realize: What do I know that others might not know?

PM:

Yes, exactly, it's about the "delta." And to do that, you would also need to know what the others actually know.

Expert 2:

Exactly. That's why it's a very, very difficult task. I don't know if you can do it by standing in front of an object and saying to yourself, "Oh, I'll write down everything that comes to mind right now."

Expert 1:

But I see it as a possibility. I really see it as a possibility to write it down. And then you need a cultural change along the lines of: "Have you now written down everything you've done?" Not just for offboarding, but also for assemblies. If we get 60% of what you had in mind, we're more than good. It's always a cultural issue to demand that. We're not used to it either. And scientists in particular value their proprietary knowledge.

PM:

Yes, that's always the thing—after all, "knowledge is power"...

Expert 1:

... yes, and "not knowing anything doesn't matter" [laughs]. But as I said, it's a cultural issue. To enter and store something like that in a system, you have to think about how the knowledge needs to be categorized. You have to classify the knowledge that emerges. Is it about assembly, development, or the product lifecycle? "We replaced that twice in 1867 because it wobbled three times!" These are exactly the stories told by those who have been there longer. It would be helpful to have a catalog, a marker. "That's the product lifecycle," "Oh, but what he's talking about was development," or even "That was just yesterday's story, you can forget it." Now, of course, we're back to the sociological experiment of who gives what. But getting rid of it and saying, "Let's record this," isn't a bad thing. Every bit counts in this whole thing. You just have to think carefully about what information is actually implicit knowledge. What attributes are there, what class, what is the type of knowledge, which component do I attach it to...?

PM:

I think it's good that you emphasize culture so much and point out the connection to sociology. In the expert interviews for the requirements analysis, I always asked what incentive tools there are for knowledge exchange within the organizations or facilities of the interview partners. The answers varied considerably. It was often rightly said that money can solve many problems, but that a system that financially rewards employees for the targeted transfer of knowledge can be exploited. Then everyone says, "Here, it's me, I've passed on this valuable knowledge." So you end up building a wall around yourself again, and the overarching question arises as to what you are actually being paid your basic salary for. Some interviewees pointed to social recognition. Someone who is more willing to share knowledge is valued as an expert and may be more likely than others to be involved in an exciting project or conference. So there are many possibilities.

Expert 1:

The funny thing about these things is that we always discuss them as if we were a large corporation. That doesn't happen in an owner-managed company with ten people. The [owner] will quickly get you moving on this issue. "What, you know this and I don't?" He does that pretty quickly. I have a component encyclopedia in front of me, a picture book of components and names, so that we can standardize the names and designations. My goal would be to have two sentences below [each component] for non-physicists explaining what it actually is. It's actually my credo to pass on implicit knowledge as well. The [employees] suffer a bit because of this, because I have a sense of mission.

If I want to process knowledge into explicit knowledge, I have to categorize and process it somehow. You have to look at it closely. And for that, you need someone to sort it out for you. I always like to keep it that way during the onboarding process: "If you don't know something, ask!" And then we write it down. Especially process chains and so on. That's one of those points where you can also tackle and improve your own systems. Because when someone new comes in and says, "I don't understand a thing here," that's an opportunity to take things on board and process them. I admit that was a small chapter in my doctoral thesis. I tried to structure and classify the whole thing. But that always needs to be reworked. It's great that you can present it again at the end. But you need someone to deal with it.

PM:

Do you have a dedicated knowledge manager?

Expert 1:

No.

PM:

During the interviews, I got the impression that only very large organizations, such as the BGE, have one. Among other things, they have to think about long-term knowledge retention. This is actually a legal requirement under the Site Selection Act. They have a separate department for knowledge management, which provides tools for the entire federal agency, such as an intranet search function and Knowledge maps. But none of the other [interviewees] had this. They certainly didn't have their own department, nor did they have a dedicated knowledge manager. Instead, knowledge management is seen as a cross-functional task and has to be carried out by individual people in addition to their actual duties. Knowledge management is thus distributed among several people and is not "monitored" from above, as it is not a staff function.

Expert 1:

If you do something like this as a staff function, you obviously have to take complete control.

PM:

Yes, of course, then you need the appropriate authority. There will certainly be people who don't think that's such a great idea.

Expert 1:

Exactly. As I said, mapping and transferring implicit knowledge into explicit knowledge is an issue. Your system would of course be a very good thing there, but that too is a cultural change, and [its application] is only as good as the people who monitor what comes in. On the subject of "possible AI enhancements": that's a broad term...

Expert 2:

I think that's exactly the difficulty, distinguishing it clearly from other things. I imagine a chatbot. Ioni, the GSI mascot, asks me: "Aha, so you're interested in quadrupoles. Have you also thought about this and that?"

PM:

Yes, my thoughts are also moving in the direction of a chatbot. I don't know if SAP already has this, but there are now database systems that provide an integrated chatbot function. Of course, it's nicer to formulate a question in natural language – "Find me a specific data record for a given period" – than to scroll through boring tables. We're familiar with this from online shops like Amazon: "Other customers also searched for..." Then you get specific suggestions.

Expert 1:

I'll take it right away!

Expert 2:

Yes. Or, for example, if I'm standing in front of a dipole and need the number of the design model. Then I could ask [the chatbot]: Is there also a DMU model [digital mock-up] where the vacuum chamber is already installed? Is it available, has anyone done it before?

So I don't have to search forever, but an intelligent system tells me.

Expert 1:

I have to admit that I think this idea is great. I'm always sitting here with the SAP guys trying to pre-structure the searches. For many people, SAP is a big hurdle. Unfortunately, that's the case. So exactly what [Expert 2] just described: getting this information out of SAP based on use cases so that it's also smooth for the user. Without me having to know exactly where to look and where this information is located in the 25th place in the table.

PM:

Earlier in the video, you saw my combined search and filter window in action. The first step would be to implement Speech recognition here. Then I wouldn't have to type in that I want an overview of all objects that have a Knowledge element called "Sample 25"; I could just say it. In the background, I would have to map the voice command to the functions provided by the application. So it's a matter of determining which "virtual search field" is controlled by a specific voice command and which action is triggered in the applicati . For example, the navigation button could be omitted if I use the words "navigate," "navigation," or "take me to..." This mapping would not be that difficult. But you have to identify some typical requests – as you just described with SAP – that a user might make. So I go through all the possibilities and, in the final step, make sure that the functions can be combined with each other.

Expert 1:

That's probably what you need.

PM:

These controllers are easy to use. But you can type faster with a real keyboard than with this virtual keyboard.

Expert 1:

Yes, it just takes too long. We already discussed the issue of safety earlier: I'm standing there, I don't see something properly, and bang, I've crashed. But then it starts again [with Speech recognition]: German and New German plus Hessian.

PM:

Yes, that would have been interesting with the Swiss if I had worked with Speech recognition there [laughs]. But of course, you have to develop it in such a way that the application can be used by more than just people from Hanover.

Expert 1:

We are a research institute, so we are actually open to everything, and I am constantly being asked about AI in engineering. Until now, I've always had to shake my head. The only thing that came up that was funny was gesture-controlled design. I imagined the designer sitting there doing exercises in the office...

PM:

The Meta Quest 3 also has gesture recognition. It works, but you can't do much with it. You can simulate a mouse click with your thumb and index finger, but that only covers one button on the controller. The controller has more buttons, and you can't replace them with gesture control. That means gesture recognition already works as it stands – it sounds cool and looks nice in staged videos – but I've noticed in practical use that it's simply imprecise and annoying in the long run.

I have another AI approach based on RAG, or Retrieval Augmented Generation. This is similar to a chatbot with a kind of LLM, except that the knowledge base is local. This also makes a lot of sense from a security perspective. There are already some initial tools that allow you to try this out for yourself free of charge, such as Google Notebook ML. Since the LLM only accesses the data I have stored – which can be PDFs, videos, and so on – there is little risk of hallucination. Instead, I would receive feedback that my question cannot be answered based on the stored documents. This would also allow me to check the completeness and cross-references of data. Earlier, you showed me all the stored documents in SAP. Imagine you have a chatbot that only accesses these documents to answer your questions.

Expert 1:

I have an AI idea. I stand in front of the beamline and say, "Show me what I need to do if I want to remove this thing."

PM:

Yes, exactly. The application knows where you are and which object you are referring to. The link to SAP could then be used to analyze which documents are behind it and whether they contain enough information to answer your question.

Expert 1:

Exactly, that could be done with specified boundary conditions. That would be something for us: "Tell me what I need to do if I want to remove this thing." We have the models, we have the information... The conditions for assembly would still need to be specified, along the lines of: This can be removed or that can be moved a little to the left. But that's exactly our point. Now we're talking about implicit and explicit knowledge. With the question "How do I take this thing apart?", we're already in the middle of industrial engineering. This approach covers several points. Point 1: The system gives me the sequence. Point 2: We can store the knowledge for this.

PM:

And point 3: You can practice it virtually before you do it in real life.

Expert 1:

And then there's the combination with the glasses... I see ideas! Earlier, I showed a film of an existing system. We have a component in it. We are currently in the process of describing the assembly. It's an old part and the people who assembled it are long since retired. The more we deal with the content, the more we realize how complex the assembly is.

PM:

Great, then we've worked through all the points I suggested for discussion or evaluation of my application. Thank you very much for your time!

Expert 1:

You're welcome, it was fun!