

All Fired Up | EXARC

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Guests

Dragoş Gheorghiu (RO) and Femke Reitsma (NL)

Introduction

Pyrotechnology – the manipulation and control of fire – is one of the defining characteristics of humanity, and has impacted nearly every technology that we used in the past and study archaeologically in the present. Our guests Dragoş Gheorghiu and Femke Reitsma joined us for May's #FinallyFriday to shed light on this ubiquitous but taken-for-granted subject.

Transcript

Matilda: Hello, and welcome to #FinallyFriday. This chat session is run by EXARC, the society for archaeological open-air museums, experimental archaeology, ancient technology, and interpretation. My name is Matilda Siebrecht and today I am joined by two specialists focusing on pyrotechnology, aka fire. Femke Reidsma is a PhD researcher at Leiden University in the Netherlands. Her research into Palaeolithic fire use focuses on the effect of fire on the physical and chemical properties of bone and how these materials are altered after burial. She is developing tools to reconstruct heating conditions and fire function while taking into account the effect of preservation. Her work is predominantly lab-based using controlled experiments to investigate the influence of fire and pH from a geochemical perspective.

Professor Dragoş Gheorghiu is a professor at the Bucharest National University of Arts in Romania. His research into prehistoric fire use has considered the alchemical transformations that occur at archaeological tell sites when buildings were burnt in the past, as well as the energy consumption of

prehistoric kilns. His current work focuses predominantly on the proximity and the psychological aspects of fire use, particularly how it influences the senses and the links between fire and techno-shamanism.

So welcome to both of you. I have a quick question to start you off. So how did you first become interested in pyrotechnology? Perhaps Femke, you'd like to start?

Femke: Sure. I've always had a fascination with fire. I remember as a little kid just watching fires in the backyard and just being mesmerized by the flames, but also wanting to understand what it was and what it did to different types of materials. And then when I started studying archaeology, I was looking for a specialization that allowed me to combine the more humanity side of things with the more natural sciences side of things. And I think those come together perfectly in the topic of fire use. Matilda: Dragoş, how did you first get involved with pyrotechnology?

Dragoş: Fire exists behind any traditional technology and working with ceramics in the past, working with metals I realised that fire was practically absent from the archaeological approaches. I mean, I realized the absence of the natural use of fire and that's why I started to organize different sessions at the EAA trying to insist on the materiality of fire, on the instrumentality of fire and on the influence of fire on the psyche of people.

Matilda: You've already mentioned that fire is such an important part of any technology and it wasn't really something that was studied in much detail. Do you think that the importance of fire is starting to increase in terms of the archaeological research that's being done?

Dragoş: Yes. I realise in the last decade there is a rising interest in the study of fire as an instrument, separating it from its production because, until the last two or three decades, fire was approached only as a result, not as an instrument per se, I mean for itself. So yes, I think there is a growing interest in the archaeology of fire.

Femke: Yes. I definitely see that too in Palaeolithic archaeology, the last 10 years have seen a lot of increase in research on the origins of fire use, but also a little bit into what people might have done with fire, how it relates to different aspects of human evolution.

Matilda: So in your more recent work, you've already mentioned, you use slightly different approaches to the study of fire. You are both very focused on experimentation and the sort of scientific aspects, but Dragoş you mentioned that you're also interested in kind of the more psychological aspect of fire, shall we say, whereas Femke is very much focused on a lab-based biochemical analysis. What would you say are the pros and cons of these two approaches, so the sort of, shall we say, I don't know, experimental versus experiential approach?

Dragoş: Can I say only two words before I leave Femke to speak? I want to say that both we agree on the importance of this subject. They are important, not only, in anthropology, but in archaeology and important in the current society because we completely forgot fire, fire was hidden by modernity. Modernity, say the last 2000 years, transformed fire into an instrument and the technological modernity of the last two centuries controlled fire in a way that fire is completely hidden. It was taken from our lives. Why is that important? Because it created humankind, humanity. Fire is the most important instrument to that design, that humanity as it is today. Femke: Yes, I'm smiling and nodding, which I realize does not do anything for a podcast, but I fully agree with that statement. It is still everywhere, I think, but it is more hidden than it was in prehistoric times. But it keeps us warm, it gives us light, it gives us a sense of a community. If you sit around a fire, it creates an ambience when you light candles in your house and I think it has had a similar impact on humans in the past. Matilda: That's an interesting point to make, and especially the fact

that perhaps now people are not as connected to fire as they would have done in the past. Do you think that that idea, that sort of fire as a connecting thing, do you think it's something that's coming back now, do you think that there's an increased interest in general society in fire as well as in archaeology?

Femke: I read recently that a lot more people these days have now wood stoves in their houses again and I think, with all of our modern technology that has less to do with keeping your house warm and more to do with sort of the feeling that it gives you, being able to see the fire and the heat and feel it in a more direct way than I guess you would when you're using radiators. So in that sense, I think people are sort of drawn back to the more primitive forms of fire, if you will.

Dragoş: Yes, it's true, but this is only one aspect of the presence of fire. In traditional society, fire was present in every activity. Now it's only for heating and for enjoying a nice moment in front of your cheminee. I'm not sure if fire as it was perceived in the past could be re-introduced in our contemporary lives, it's quite impossible. But this is a role of EXARC and of public archaeology to reveal some human aspects from traditional societies that are lost and to present to contemporary society. The presence of fire, of pyrotechnology in the life of people is very important for the future, let's say, studies and experiments of EXARC I think.

Matilda: So on that subject, speaking about experimental archaeology, I'll go back to this point that we mentioned earlier as well, the different approaches to the study of fire. Do you think that it is important to look at? I mean, you've already mentioned that, Dragoş, it's important to look at the sort of psychological aspect of fire use in the past. What are the pros and cons of looking at that aspect versus, for example, a very experimental lab-based approach? Femke, perhaps you could give your opinion on this?

Femke: So I can only really speak on my experience with lab-based approaches, but I think that the two approaches are complementary and that we're trying to address similar questions from different angles. And I think it's important to eventually combine these different approaches to get the fullest picture of how people might have used fire in the past.

Dragoş: Yes. I agree with you. It's like in anthropology, the emic and etic approaches, the observer and the actor. When you work with technology, you need to be an actor and to involve, corporally, okay. The agency is important in the study of technology. So, without your will, you introduce your body in the experiment and you think through the body sometimes, and this means that there is sometimes a subjective way of approaching the experiment. And this is related to experientiality, that in fact experientiality and experiments are two aspects of the same approach to a phenomenon, especially when you approach such a complex subject as the phenomenon of fire.

Femke: So how do you approach fire from that angle? Because I see fire very much as a chemical process, that can be used for a variety of different practices and indeed also has an impact on how people feel.

Dragoş: OK, I can give you an example, which is, I think the best example that can answer your question. When you work with a kiln you start to work being very conscious of your actions, of your activity and so you try to follow the chaîne opératoire in a conscious way. But after hours of working, especially in the dark, when you are alone and you have repeated this exercise tens of times, some people hundreds of times, at one moment, you are not conscious of your actions, of your body. Your body dictates stages of the chaîne opératoire and your body is in close contact with the processes inside the kiln. After years of experience you don't need to use thermocouples or instruments to measure what's going on inside, your body knows exactly what's going on inside: the temperatures,

the smell, the sounds produced by the kiln inform you exactly what is going on inside. The first time I carried out an experiment with a kiln without using thermocouples, I was afraid because I could not know when to stop the process of burning. And I remember that, once, I asked a very old potter how he knows that the process inside is over and how he knows that he is able to close a kiln, I mean, the operation is finished. And he said: 'when you see the wings of the pigeon'. And I believe it was sort of poetical..., a metaphor that I couldn't understand at that moment. And when I worked without thermocouples, after eight hours of cooking the pot inside the kiln, I saw the plates over the vents of the kiln that has the colour of grey, grey-bluish colour, like the pigeon's wings. So at that moment I realized that some phenomena could be described also in a poetical way, with metaphors. And I realized that the relationship with fire is very complex and it's also sometimes poetical. So, I think that experientiality and psychological experience should be also taken into account when somebody carries out an experiment with fire.

Matilda: So coming from the other side then, Femke, what would you say are the advantages of a lab-based sort of more experimental approach? Obviously they do complement each other as Dragoş just said as well, but why do you focus on a more analytical approach?

Femke: So I like to take a fundamental research approach to things, because I want to understand the underlying processes. So I want to understand what fire does to different materials, how they change and then how they change in the soil, so that that information is no longer necessarily site or activity specific. That that data can then be used for Palaeolithic settings, but also for medieval settings or things in late prehistory and you can build upon that data, in my view at least, to then get to 'okay, but how did the people in these specific circumstances use and interact with the fire?' If we know how fire works, then we can take the next step into what did people do, and how might that have made them feel. But I think you always need to first understand the underlying processes because in the end, what we work with as archaeologists, are the material remains. So the information we get depends on what data we can get from those remains. And those are ultimately transformed, through a chemical process that is fire.

Dragoş: Yes, I agree with what Femke said. Yes, it is true. But as an anthropologist, and working on cognitive archaeology, I would like to understand the relationship of people from past societies with fire, not perceived through the modern mind. This kind of experiment I was talking about, I try to sensitize myself to be closer to the materiality, to the phenomenology of the past world. It is also a sort of archaeology to try to understand the relation of the human body with fire, with the pyro-instrument and with the processes. One very interesting aspect of working onsite is that you can carry out very distinct ergonomic research. You can study the ergonomics of the movement and also the ergonomics of the perception, of the view, how long you can look at the opening of the kiln, how close you can work to the kiln after a few hours of working.

Matilda: So indeed it seems to depend on the questions you're asking as to which approach you favour. I'm also just thinking, Dragoş, you work more with, shall we say recent history or prehistory sort of the Chalcolithic and early prehistory whereas, Femke, you deal with much deeper time periods, shall we say, the deep Palaeolithic and human origins, do you think this also affects the way that you approach fire or this subject?

Femke: Yes, I think that it does very much. I mean the further back in time you go, the less material is actually preserved. So within Palaeolithic archaeology, we are often forced almost to be smart in the way we get information out of the minimal amount of material that we do have, which I think sort of pushes us more into the natural sciences side of things. And we're also limited by the preservation and the incredible time depth because you have to paint your picture in broader strokes, I think.

Dragoş: If I compare my research with Femke I am very fortunate because I work with instruments that control fire in the kilns, with pits, with machines. I think that the updraft kiln that was used in the Chalcolithic in the Middle East and also in Southeastern Europe is the most sophisticated machine of that epoch. It's so sensitive and so complex in its simplicity. You cannot imagine..., it's an extraordinary invention. And if you look at the history of fire, you see that the design, the human design was to control fire and the updraft kiln is the apex of this fire control using a very simple instrument, using only clay and water. So I think that this kind of kiln was underestimated, it is one of the greatest discoveries of humankind. Believe me, after the use of fire, the use of the kiln is the first step in controlling fire, in human evolution.

Femke: I'm not sure if I entirely agree with that. You are making this kiln sound very attractive and I agree with you that it is a beautiful invention and a really nice way of... the power of man-made fire. I think there are some really nice pyrotechnologies in between though. For example, the production of birch bark tar, which also relies on control to a certain extent of the temperature and of oxygen availability, to create a new material that that relies on fire, but is not necessarily fire itself that then allowed humans to haft their tools in a different way or hold their tools in a different way, which I think is also a very important step in human evolution.

Dragoş: I agree with you, Femke, but the updraft kiln is so well-controlled, so... work once with an updraft kiln to see the perfect control of everything, the perfect control of air, which is not so well controlled in all of the previous technologies, in fact, the control of fire was the control of the air, air-draught. It is so modern, when I realized how such kind of kiln works, I was astonished to see that the modern design existed in the minds of people 6,000 years ago.

Matilda: Both of you I know have looked in some way at the kind of transformations that occur during the burial of sort of burnt material or how fire reacts with materials in the past. Do you find that there's a big difference in the experiments that you've both done? Because I know that, Dragoş, you did some experiments with houses if I remember correctly, burning down houses, and then seeing how the remains were left and obviously, Femke, your research focuses on the transformations that occur during burial and during burning. Do you find there is a very big difference between objects, buildings, materials, before and after they are buried in the ground? So what we as archaeologists find versus what the original one would have been, perhaps Femke, you can start?

Femke: Yes, the simple answer to this is yes, there is a big difference and my research focuses mainly on the more invisible changes, so the chemical changes that happen after burial, that might not necessarily result in visible changes, but that will affect the type of data that you can get from your materials and that might also preferentially preserve materials heated to certain temperatures, and not have other materials heated preserve as well, which then of course creates a bias in our interpretations if we're not taking this into account.

Matilda: Do you have a similar experience with your experiments that you've done with that, Dragoş?

Dragoş: At a visible level, yes. I compare, every time, the object, I mean the architectural object that will be burnt down and the results and I try to put together the inputs and the outputs. I mean the beginning of the fire, the firing process, the direction of the air draught, the results of the rising of the temperature. Then, I try also to compare the material left, I mean the ceramics and the slag, with the initial material used to build the house. A lot of material which is not burnt will dissolve in time and will be washed by the rain and before this, the collapse of the walls could be observed but not all the time. So the results, the next excavation will reveal something completely different from

what you expect to find. There are some changes of position, of course, changes of materials or chemical transformations, the different levels of burning, of the clay and of the vegetal remains. The results are sometimes so unexpected that you have the impression that you are excavating something unknown and not the result of the experiment you already prepared before. So, transformation at a visual level and also at a chemical level that transformed in time the material. Sometimes you had the impression that the wall that collapsed did not burn, the material is not touched by fire and after six months you realize that the charcoal and the heat that existed transformed it into ceramics.

Femke: So, do I understand correctly that, in this case, fire to you was a taphonomic agent? Because in my work, the fire is the activity. And then I'm interested in the taphonomy that happens after the heated material is buried. So then, to me, fire is not a taphonomic agent.

Dragoş: Yes, indirectly, it is. I'm talking about the collapse of the different structured walls, ovens, ceilings, and this collapse is continuous during the consuming of the ligneous materials. When the vegetal material is completely transformed into charcoal, the first level of the taphonomy ended and the pressure on top of the new soil that will form on top of the burnt down walls will continue this pressure. Fire is only the initiator of a very complex phenomenon of the animals, the vegetation that invades, after one month, invade the place and transform the structure...

Matilda: Do you have anything to add to that, Femke?

Femke: I'm thinking, because our settings are so different. I agree that fire is indeed also a taphonomic agent, of course. It's nice to hear that in Dragoş' research, there's also a focus on what happens to heated materials after they're buried, because I think that that is often something that is overlooked. We sort of assume, because heated material tends to preserve better than unheated material, especially if we're talking about organic stuff, that it just sort of stays the same and doesn't go anywhere. And of course that is not what happens, and even if it does preserve, we shouldn't be assuming that it is in the original state that it entered the archaeological record in.

Matilda: Okay, on that note, I might do a final question before we open this up to our listeners. So what are your plans for the future for research or for sort of ideas, collaboration? And how do you think the EXARC community who are listening can help to make a difference in regards to the points that you discussed today?

Dragoş: I know the experiments carried out over the last decade by the EXARC people and I think that...an idea would be to insist on the emergence of an archaeology of fire. I think that if we insist on this idea, we develop more experiments related to the use of fire. And I think that EXARC should fight for this, the rediscovering of fire in archaeology.

Femke: Well, I would like to be involved in, but also see more, collaboration between the different... and integration between the different types of experiments. And I think that's probably where the EXARC community could also come in. So combining the more fundamental research that I do with actualistic experiments and then continuing into, I guess, the more experiential things that Dragoş is now also interested in. I think that would be really nice if those things can come together in the future. And personally, I would also like to move a little bit from the lab into the field, again, to start applying what we learned from experiments to archaeological materials and then learn more from that.

Matilda: So we will now be having a live question and answer session with all of you who have been listening in to the discussion so far. We already have a couple of questions here. Our first one asks about time depth, so perhaps, Femke, you want to start with this one? How much of the attitude to fire do you think has changed from the Paleolithic to later times, not necessarily talking about kiln use versus other uses of fire, but more the attitude of the person behind the fire and not the way the fire is used itself. Femke: That is really interesting, but also I think difficult to approach from a Paleolithic archaeology perspective, because we have very little evidence of how people perceived things. That being said, though, I can imagine that fire became a more fixed thing in people's lives, as people started to use it more and maybe they also became less afraid of wildfire after they knew how to harness it and use it for their own benefit. Matilda: Do you have a lot of interests from non-specialists, so also non-archaeologists in your work?

Femke: Yes, definitely. I think fire speaks to the imagination of everyone and then it gets complicated quite quickly because most of my research happens in the lab and it's technical chemistry stuff. But most people are interested and excited about the stuff that I do.

Matilda: So they're more chemical ideas, but I suppose because, like you say, fire is such a sort of a fascinating subject, do you have..., I'm just trying to think of, in terms of, I suppose, as an archaeologist, we're always told that we need to do kind of sexy subjects in order to get funding or get interest in..., do you feel that fire is in that case something like that, or is there..., once people become aware of the more chemical side, do they lose interest or does it become more interesting?

Femke: It's a little bit of both. People get excited about fire. I think it's definitely a sexy topic. But it becomes difficult to imagine what the research is like once you start about talking about chemical reactions. So I try very hard to get people excited about that aspect of it as well, because that's also what really fascinates me about it: the link between this diehard chemical process and human behavior. Matilda: It was interesting to hear in the discussion indeed, that there's sort of different perspectives on what fire can represent as well. Roeland, for example, has asked a question here, in terms of trying to understand the people of the past through artefacts, so would you say that fire is seen as another kind of artefacts? Could you do material culture analysis on it in that way?

Femke: I think if you see fire as a tool, then you definitely can. And we should probably treat the materials that fire leaves behind as artefacts and study them in a similar way. Go more in depth into the heated bone, in the charcoal and the ash and what it can tell us about the lives of these people.

Matilda: It's always fascinated me just personally, in terms of how, I mean fire, like you say, is such a transformative thing and it's such an essential tool at some point, and so that first kind of a spark, shall we say, of inspiration, when people started using fire, must've also made a massive difference in people's lives back then. Femke: Yeah, definitely. So we always imagine that early hominins would have seen wildfires around and might've been scared of them at first and then slowly started to realize that they could maybe eat some charred nuts and stuff, and find some dead animals to work with there, and then maybe slowly worked their way up to taking some of the wildfire with them and using it in a different location. And then of course eventually they learned how to create it themselves. That must have been an interesting process to go through.

Matilda: Yeah, definitely. So another question here about teaching about fire. So how can we teach archaeology students? Most of them might not have played as much with fire as previous generations did. So how can the insights that you've gained through this flow back through archaeological teaching in the modern day?

Femke: I think if I were to design a course, it would combine lab-based experiments and maybe a little bit of chemical analysis with more actualistic experiments so that students could combine both and just see how they relate to each other and experience the fire, in like a campfire setting and try to use it for different tasks and then maybe go into the lab, and see the more technical side of what fire does to materials. And then start to think about how we can use these chemical processes to understand what people might've done with the fire.

Matilda: Spoken like a true lab-based scientist as well!

Femke: I cannot help myself...

Matilda: And in light of that, what would you say is the - because as you mentioned as well in the discussion the approach to fire can sort of come from..., not necessarily two conflicting sides, but two very different approaches, so there's the more theoretical side shall we say, versus the more physical side in terms of lab-based research - what's the biggest difficulty that you encounter in your research in general?

Femke: I think making that translation from the lab and very controlled chemical stuff to the archaeological record and human behavior is where it maybe gets complicated. Because then you have to maybe switch your thinking a little bit from the natural sciences into a more humanities-oriented perspective, which I think is also exactly where it gets interesting.

Matilda: So do you have anything to add to the earlier question that we had, Dragoş, about how we can best teach archaeology students about fire and its qualities?

Dragoş: I think that experiments could be an extraordinary educational tool to understand the instrumentality of fire. For the prerecording I suggested that EXARC be involved in developing pyrotechnology experiments.

Matilda: Do you, as a teacher yourself, do you see a lot of difference between maybe students who are from more recent times compared to older students in terms of their experience with fire, just in general life as well?

Dragoş: Yes, but not only with fire, with the materiality of the world. Recent generations discover traditional materiality, they discover clay, they discover ceramics, wood, stone..., abstract concepts for people living in urban communities. That's why, when I start to experiment with the students, I try to convince them to be in a deep relationship with the materiality of the world in this way, the materiality of the past and talking about traditional materials, clay, stone, metals. And I think that one educational experiment could be the rediscovering of the materiality of the past. Not only the technology, but to understand, to feel the materiality, to feel the weight of some materials, their texture, even their smell. So there's a difference between the computer generation, the digital generation and those who lived before. I think that this difference in mind can be observed if we compare the Gutenberg generation with the digital generation today. So there is a difference, of course, there's a difference in the sensoriality, in the perception of the materiality of the world. In this way people are separated from the past. Sometimes for contemporary archaeologists it's quite difficult to really understand the life of a community. His/her approach is theoretical and not in the field. And that's why I think that it is compulsory to introduce experimental archaeology courses for young archaeologists.

Matilda: Dragoş, do you also have a lot of interest from non-specialists and also perhaps non-archaeologists in the work that you do?

Dragoş: Oh, yes, of course. Artists are very interested to take part in experiments. They have a knowledge of how to approach materials, how to work with traditional materials. That's why they are sometimes the best experimentalists that can give you some hints and some new ideas how to approach a problem. Also old craftsmen, there's a few that still exist today, are very good teachers to approach materials. Of course the technology changed, the styling of the technology changed but I'm interested in the archetypes, in the archetypical way of approaching the materials of the past. So I think that artists and specialized people in crafts are very good helpers for the experimental archaeologist.

Matilda: That's an interesting point. Femke, I'm curious, have you done other similar kinds of collaborations, with other disciplines or other specialists in your own work? Perhaps not artists necessarily, but other specialists?

Femke: Not artists, but since my work is quite interdisciplinary in itself already, I get to work with archaeologists with different specializations, but also chemists, physicists, biologists sometimes.

Matilda: And do you find there's a big difference in the kind of interpretations that are made based on who you're working with?

Femke: Yes, definitely. You can tell which sort of side of the sciences people are trained in, in how they think about certain questions and how they approach the natural world, I guess. And it also very clearly shows that if you want to talk about the past you'll always need to have an archaeologist involved, because our way of thinking about the past is also unique to our discipline. So we shouldn't be leaving research about fire use in the past, for example, up to maybe chemists, or, I don't know, fire engineers. I think it's important to always also have an archaeologist to bridge the gap between all of those different viewpoints, because I think we as archaeologists are very good at that.

Matilda: Yes, it's a good mix of the two, like you mentioned earlier as well, which is nice. Femke, staying with you for a moment, how is your fire-related work seen by fellow archaeologists who work with, for example, what they would think of as more tangible artefacts, like flint and pottery... Do you feel taken serious enough and are there many colleagues who do similar work to what you do?

Femke: I definitely feel taken seriously. I think fire research within archaeology is a very respected field, even if it's still a little bit young. I'm not sure if all of my archaeology colleagues fully understand my approach. But that just means I need to explain it more maybe. So there are quite a few people who work on fire, but not a whole lot who take the approach that I do. But I think that makes for interesting discussions, approaching the same topic in different ways.

Matilda: So Dragoş, same question for you. How is your fire-related work seen by fellow archaeologists?

Dragoş: I work on two levels, the scientific one..., which is accepted, it is published by journals and the books on pyrotechnology or experimental archaeology. And also, the second level is the spiritual, experimental, experiential level, which today is not yet totally accepted. Sometimes, in a very serious book, one chapter about experientiality is accepted probably at the end of the content. So, experientiality is not yet a discipline totally well seen by the hardcore of archaeology, but slowly it will be accepted, because unfortunately today in European archaeology, anthropology is not so well-implemented and experientiality in fact is a sort of experimental anthropology and I think that in

the near future papers and research on experientiality will be more important than today. So part of my research, which is scientific and is measurable, related to the materiality that can be measured, yes, it's quite well-accepted.

Matilda: I'm curious, actually, Femke, do you have any experiences or are there any situations where, because your work is so scientific, it has been... not necessarily rejected, but maybe not given as much interest as other related subjects or something? Do you have the opposite kind of bias in any way, or have you not had you that experience?

Femke: Yeah, I definitely have. As much fun as I think my research is..., I recognize that it is less flashy and catchy than maybe some other topics that more easily speak to people's imagination. I think fire does, but then as soon as you start talking about the underlying processes of preservation and chemical transformations, it's not maybe as 'newspaper headline-worthy' as some of the other things that we all do, because it's just more difficult to imagine what it means. But that has definitely been something that I'm fighting against also, to make this more cool.

Matilda: Fair, fair, fair. We have still a couple more questions. We have one here from Roeland, our great director of EXARC, asking about, could we, for example, set up a series of simple field experiments, in a dozen or so sites or open-air museums? EXARC would be happy to help this. Do either of you have any suggestions of what kind of field experiments might be possible for, maybe for people who are listening in, who have an open-air museum or who want to run a field school, what kinds of experiments would you suggest? Maybe Dragoş, do you want to go first?

Dragoş: I suggest for the beginning the discovery of the materiality of the past, the first step, to discover the materials, to be in a relationship with them. And then to experiment simple technology related to these materials. I think that this could be a first step for beginners, for students and for the large public. And then a selection of this material, this technology related to the local cultures. In this way people could understand archaeological material culture of the past through the technology of making.

Matilda: So obviously, Femke, most of your experiments are involved in the lab and you mentioned before that you think it would be good for students to do more lab work, but do you have any ideal situations where you yourself would do field work, or can you think of some nice experiments that could be incorporated into lab work?

Femke: So I would like to, in the future, work on the link between lab-based experiments and actualistic experiments, so test some of the observations that I've made in a lab in a field setting and then see how those variables behave in a more realistic setting, maybe with different fuels or trying different tasks, like cooking or tar production or heat treatment of lithics. And then just measuring temperature and analyzing the materials afterwards and comparing that to the lab-based results.

Matilda: And I guess the nice thing with both of these suggestions is, like you said Dragoş, it doesn't have to be archaeologists necessarily who have to undertake them, you could do it in different ways, which would be nice. This relates a bit to the next question by Caroline who's asking: what would you both wish to see from your part of the field of archaeology, so fire research, experiential research, lab-based research, in the near future? So what directions would you like to see taken? We've sort of talked a little bit about this already, but maybe you could expand your thoughts on the subject?

Dragoş: I would be interested in the near future to see the experiments carried out in other parts than Europe. I mean in Africa, in Asia, also to see the last few technologies used in fire, used by traditional societies that will be changed by globalization. It will be maybe something for EXARC to start a research of the last pyrotechnologies in the world that will be replaced soon by new, modern, contemporary technology.

Matilda: Okay, thank you. Femke, do you have anything from your perspective?

Femke: I would definitely like to see science-based archaeology become a more integral part of just regular archaeology teaching, so that we can train more archaeologists to be interdisciplinary in this way. And I really liked what Dragoş said about also going outside of Europe, more ethnoarchaeology would be great. So maybe excavating some hunter-gatherer fires, and seeing how that relates to our experimental data, because of course these people know much more about how to apply fire in their daily lives than we do.

Dragoş: An extraordinary idea, Femke, thank you. A project of EXARC could be to study the last hunter-gatherers' use of fire around the world.

Femke: That would be great!

Matilda: That would be very cool, yes.

Femke: Sign me up!

Matilda: I think we have one last question here. Referring back to what we talked about earlier in terms of the digital generation, do developments in computer technology change the approach that you, either are taking now or might take in the future, so big data crushing, artificial intelligence, things like that?

Dragoş: All the modern world change our mind and our perceptions about fire. So probably I exaggerated with the digital generation. All the modern generation are separated from the culture of fire. I rediscovered fire when I first did real experiments in the field. I was fascinated by fire because I saw fire only as a sort of a negative factor of the society, arson, burnt fields et cetera and this was a modern idea to transform wildfire into the enemy of the society. And in the field, when I started the first experiments, I discovered a fascination of fire, like Bachelard wrote in his extraordinary book about fire, discovered the spirituality of fire and in time what he describes, discover also some other aspects that cannot be measured unfortunately, today. I mean the techno-shamanism. I discovered that working with fire you can also hypnotize yourself and to be in a special relationship with fire that will be perceived as a presence. In this way I was able to make that approach, about alchemy and the old texts that describe fire as a sort of sacred presence. We modern people lost the sense of sacredness and working with fire I discovered the respect towards a deity but today it's called the phenomenon of plasma, hot plasma. In fact, it's something that I cannot understand, even with my modern mind, a transformation of matter in front of you with a huge amount of heat. This is magic and magic unfortunately cannot be accepted and understood by the modern mind.

Matilda: I think that's a really good point. The relationship between magic and science and how that's changed over the centuries is definitely been something that has affected how we see the world and how we do things.

Dragoş: The most ancient gods were the gods of fire and technology's gods in the Indo-European mythology were replaced by some as solar gods and a new generation of deities. But the first gods were the gods of pyrotechnology, Hephaestus for instance, and in the northern part of Europe also

the smith had a sacred role and was a divinity.

Matilda: Definitely. Like you say, it's always had a very important role in our society indeed. How modern technology is affected is an interesting concept. Femke, obviously, as a 'scientist' scientists, shall we say, your aim, I suppose, is to be more objective and have more logical methodologies in place for those kind of experiments. Do you find that things like artificial intelligence, computer technology are hindering or improving your research approach?

Femke: Well, right now they're not involved in my research approach, but I do see a lot of potential. So I deal with a lot of chemical data, gathered with different analytical techniques and then I compare the reference data to the same type of data from archaeological materials and that comparison involves quite an amount of data and interpretation. And I think that's where maybe machine learning could come in and we can automate that process and make it a little bit more objective, as you said, so it becomes easier for people to determine the temperature and the oxygen availability of their heated materials. That would be a great development. So if anyone wants to help me with that... Matilda: And although..., as you said earlier, we'll still need people, right? We'll still need archaeologists to interpret that data...

Femke: Yes, of course and a tool, whether it be one in the real world or a virtual one is only as good as the material or the information that you feed it. So yes, this is not to make any of us obsolete.

Matilda: I think you would be shooting yourself in the foot if you were saying that at this point! Well, that I think is all for today. Thank you very much to Femke and to Dragoş for joining us. And thank you very much for sharing your experience and your expertise from two slightly different approaches. Even though you share a common subject, it's always really interesting to see the different approaches that can be taken. I definitely learned a lot, I'm sure our listeners did too, so thank you very much. If you would like to become more involved with EXARC, why not become a member? Alternatively, you can make a small PayPal donation through the website, to help support EXARC and its endeavors. You can join us on projects such as that we've been talking about today. Who wouldn't want to travel around the world and learn about fire! So it could be a possibility if you join us here... See you next month for another episode of #FinallyFriday!