EAC12 Q&A Session 4

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So this is the question and answer portion of Session 4. I am Eric Marks. I am your emcee for this session, and I'll be asking your questions to our collective speakers. So good evening.

Let's start with questions for Scott since it ‘s the first ones up.

What kind of milk was used? Was it raw or pasteurized?

I used the standard grocery store pasteurized milk, homogenized. It probably comes from Holsteins cause it's not labeled. I have used, in the past, one time I used raw milk. And the difference with modern cheese making techniques between the raw and the pasteurized was... there was some present, but it was relatively minimal. I've also used Jersey milk and that gives a very different color because it's got more butterfat and there seems to be something different in the way that cows process the food they eat and the milk they produce. So, if I was trying to be completely accurate for the Roman era, I'd have to use a heritage dairy and I don't have access to that. So I just use the standard milk so that I'd have a consistent kind of milk to work with. I have used non-homogenized milk and that has a tremendously different effect where you get some parts of the cheese that is, has a lot more fat. But for the most part, it's just standard grocery store milk that you can buy. It's modernized and, and pasteurized.

Thank you. There's four questions for you. So this is number two.

Was calcium chloride added to the milk to counteract the effect of pasteurization?

No, because I didn't want to add another area of variability. Yes, I have reasonably accurate tools and measurement devices and all that, but even just a little bit of variation could add a level of variability to the process. And I didn't want to, I didn't want to add that in. I wanted there, if there's going to be variation, to come from the process I used rather than a variation in the ingredients I used. And the amount of difference from the addition of calcium chloride in terms of cheese production at this level is really quite minor. And I probably would have lost as much just from spilling a little bit. Then I would have gotten the additional production, calcium chloride from, you know, one quart of milk. Cool.

What kind of rennet was used? Have you experimented with any other rennet alternatives wild thistle, fig sap, et cetera?

I used the modern vegetable rennet. I've also used modern animal rennet, both in liquid form. There's a comment from Columella about using dried rennet the size of a denier. So that's probably a dried piece of sheep’s stomach. I've considered trying that. I actually know someone who raises sheep for meat and I could probably get some stomach from her and use it either frozen or dried, but I haven't taken that step yet. Again, I wanted to have the consistency. One time I used animal rennet and it was markedly unsuccessful. I think that the rennet may have been old, but the vegetable rennet has been very consistent. And again, I'm trying to keep to the variability to process rather than ingredients. I do know that Farrell Monaco has produced cheese using figs very effectively. And so I didn't need to replicate that process, because she had done that work already. And I'm currently looking at getting some wild thistle rennet, but I haven't taken that step yet. But the rennet I used was again to maintain the consistent set of materials to eliminate one area of variability.

Okay. Cool. So more experimentations in the future. Good. Question number four.

Is it possible to weave baskets that are near butter proof? Have you considered experimenting with baskets that have smaller gaps?

I would expect that if you're going to have a basket that was waterproofed, it would not be very effective to strain the whey out of the curd. You could cover it with tar and we certainly see that with tar bitumen [...], wax, other sealing devices. But the process of basket making is almost by definition, leaving gaps. You can have very fine woven basketry, but the images we have of Roman baskets don't show it that way. They appear to be, you know, have some open weave, which works quite well as a cheese draining basket. The modern cheese draining baskets have a fairly similar size opening, to the wicker ones that I used. One of the images of the Roman baskets might be a slat type basket where there's a series of almost looks like vertical strips that are bound together with a diagonal weave. My basket maker, I'm not the basket maker, I did the ceramics, my basket maker said that, that she didn't know how to do that. That she'd be willing to try that at some point, but she doesn't really know how she would accomplish that form and would need to practice before anything that could get to that level of complex basket making. But I suspect if you tried to actually waterproof a basket, it would become less effective at draining the whey than even the ceramic vessel. And what you'd want would be a waterproofed, woven material. And I don't think that would be that worthwhile, because baskets are relatively, short-term objects that you could keep for a long time, but you can also make them fairly quickly. So you wouldn't need to go through that level of effort. I use these baskets, you know, you know, several times each and there's no residual smell or anything from the baskets from the amount of liquid that it absorbed during the cheese-making process.

Okay, I have a question.

Roughly how long do these baskets last? Have you had them long enough to see any kind of wear and tear on him?

I've only had these for a few months. So, I don't know what their long lifespan would be in or how many batches could be made from it. So that's something which I could find out. I suspect that I could potentially destroy one relatively easily if I used enough pressing weight. That was not my goal for this. But it would probably take quite a bit of wear before they broke down and were no longer usable, but I haven't had it long enough to be able to say.

Okay, thank you so much.

Let's start with questions for Bill. If you're here. The first one is: **Tell us more about how the Aymara people cook their potatoes.**

How they cooked the potatoes, you know, it's very interesting. And I alluded to this in the presentation. So I spent quite some time with both the Aymara and Quechua family and every single way that they cook their potatoes, no matter if they steam them or fry them or boil them or bake them, they always peel them, except for one instance. And this is really telling because, it's not like the potatoes that I had in the presentation, which is, you know, a typical, just sort of football sort of shape, orb that you can peel in about ten seconds with a peeler. These heirloom varieties of potatoes look more like a droop of grapes, in many cases with all a bunch of crevices and different, different shapes to them. And they peel them with a knife and it was quite an effort to peel all of these potatoes, no matter what they did. And it really spoke to the high level of toxins that the skin contains. So, the one case that they didn't peel a potato was when they actually ate it with the clay. And they say that's because the clay is that incredibly effective. It is that effective, to detoxify the potato before they eat it. So, most of the time, the Aymara and again the a group I was with, there was, you know, Lake Titicaca region, Bolivia, They typically will consume their potatoes, both ways, which is where they combine it with two different types of clays and eat it baked, or they will make

something called chuño blanco or chuño negro. And I didn't go into that in the presentation, but there's several different steps to that. They'll submerge the potatoes with the skins on, in the river. And this is only done by the families that actually live next to the river. So they'll submerge them in the river for a very long period of time. In the one case for about a month in the end, for the chuño negro, for the chuño blanco they'll keep them in the river for several months. They'll pull them out. And then they take advantage of their incredibly high altitude and they will go through a process of freeze drying the potatoes. So they'll lay these potatoes out on the ground that have been fermenting, soaking, and leaching in the river for periods of, you know, for a long period of time, they'll lay them out on the ground, allow them to freeze overnight and then the next morning they'll take these frozen potatoes, which otherwise are, you know, incredibly mushy, but now that now they're frozen and to get the skins off, they put them in a huge tub, add a little bit of water and stomp on them with bare feet. And it's incredibly cold to do this, right? Cause it's like stomping down ice, stomp on them and move their feet around to effectively remove the skins. Then they'll strain the skins off, put them back out on the ground and allow them to freeze dry over several days. And then they can store them for several years. And that makes the basis for their traditional potato dishes and these freeze dried fermented and leached potatoes are added to all sorts of soups and stews. And what's really interesting about it, in addition to safely adding a whole lot of nutrition and flavor, it also adds, because of the way the potatoes have broken down and they sort of even continue to physically break down into a liquid as a super stew. It acts as a thickener as well. So you get a very thick finished stew or soup as well as chunks of these potatoes. So almost always… to sort of put a bow on the answer: when they cook their potatoes, they almost always peel them and usually engage in some other form of processing to make those potatoes as safe and nourishing as possible.

Okay. You also mentioned leaching. The next question kind of deals with that too. It says:
Do they eat them with any kinds of other plants or herbs that might neutralize the toxins?
That's a fantastic question. They do. They do eat them with several other plants. Most of those plants they're using from what, and again, I was only there for several weeks, but from what I witnessed, plants don't make up a huge part of their diet. Plants beyond, root vegetables and tubers and corns and these sorts of things. And when they are there, they're wild and they're used sparingly. So I assumed they could, but I was there specifically, and they knew why I was there, to study how they detoxify these potatoes. And that was never brought up.

Okay. question number three.
Does the lacto fermentation process of the oxalates [tune] negligible quantities in the potatoes?
That is a fantastic question. So I am, as you can tell, I'm extremely interested in the way that our ancestors and people around the world still today, process vegetables, which in my mind are just, and in many cases, incredibly toxic and need to be processed before we consume them to make them as safe as possible. And in many cases, we have figured out ways of doing this. But the one toxin that I am having incredible difficulty finding ways of really getting rid of to negligible amounts are the oxalates. And there's several ways to do this. And very quickly the oxalates, you know, are, are under a microscope. They look like tiny shards of glass and they're incredibly dangerous to our bodies and they build up over time. And especially the way that we consume massive quantities of the same plant as modern humans, they can become a real dietary health issue. Spinach is one of the leading issues in our diets today with oxalates. Almonds, other sorts of things we eat massive quantities of because we think some is good, more is better. But potatoes are another. Potatoes have these oxalates. Now there is some evidence to suggest, to show, and we know that that fermentation does help reduce the oxalates. There's some evidence to show that by consuming, oxalate, high oxalate containing foods and dairy at the same time, the calcium in that dairy can bind to the oxalates and help some of it pass through our bodies without incredible ill effects. But I have not yet been able to

find a way that satisfies at least what I'm looking for is a way to process plants, to get the oxalate stand to an incredibly safe level. And I will bring up one little anecdote that I think is important here. I spent a year in Ireland doing research and ate massive quantities of potatoes while I was there. And when I was down in South America the amount of potatoes that were eaten on a daily basis made the potato consumption in Ireland look like nothing. I mean, they eat massive quantities of potatoes every single day. And when I came back, I was speaking to a woman named Sally Norton, who's one of the world's leading authorities on plant oxalates at the moment. And I was telling her about my time there and what was going on and how amazingly transformative these detoxification methods were in my mind to potatoes and all this. And she says: "Well, they weren't doing much of the oxalates. Sure." I said, "I don't know. These people were really, really healthy." And she said: They didn't exhibit any health issues." She asked me if they did. And, and I said: "Well, no." And then I thought about it and I remembered, especially, with the Aymara family that I was with everybody there had some level of arthritis, that they were trying to mitigate, manage every night. And she was convinced that this is the result. And again, this is completely anecdotal, but it's worthy of a discussion. She was convinced that this is the result of the incredible amount of oxalates they consume on a daily basis.

That actually makes sense too. Question number four.

Presumably they could be sauteed instead of deep fried or even baked?

Yes, absolutely. The point of the frying was more that we were using animal fats and industrial nut seed oils, but the focus, the main part of that was the fermentation process and what that did to the potato to detoxify it. And one point I didn't spend a lot of time speaking about, but one of the issues with potato chips and French fries, is that when the starches in those foods hit hot fat or hot anything, they produce as a by-product acrylamides and acrylamides might possibly be the most dangerous, part about a French farmer, potato chips. And in fact, in certain States like California, you will see warning labels on the side of a bag of crisps or chips that talk about the cancer causing effects of acrylamides. And the acrylamides weren't in the potato, they were produced through cooking. And the nice thing about one of the added benefits of fermentation is that the food for the bacteria are the starches. So you're already, if you fermented the potatoes, by the time you're sauteing them or throwing them in a deep fat fryer, you are already winning that battle. There's a lot less starches there because they're eaten up by the bacteria, through the lacto-fermentation process. And there's a lot less acrylamides produced in the cooking process. But the short answer is yes, you can do the same fries by baking them or sauteing them, or even putting them in an air fryer.

Good. Good. Okay. And the fifth question would be:

What is the final nutrient profile?

That's a great question. I don't have that answer yet, but I will say I'm getting towards an answer there because we're in the midst of going through a processing facility, and getting approval to commercially make those potato chips and those French fries. So when I'm done with that process, I will have that information and I'll have it available on the website.

Okay. Question number six:

You mentioned one of the ethnographic takeaways was that potatoes could be eaten with small amounts of special clay. You mentioned that earlier. Can you say what that was again and help describe what am I to do?

Yeah. So Timothy Johns did some work, here, about 20 or 30 years ago with the geophagy processes that they're using in South America. And I believe he did some testing and found out that the clay they were using was montmorillo. Bentonite also works. There are several different edible clays that you can buy even online through Amazon that do the same thing. And these clays will actually bind

with certain toxins. And in the case of these potatoes, they bind with the toxins and the potatoes. And when they're bound together, they're in a state that our human digestive tract doesn't recognize, so won't absorb and it passes through our digestive tract.... There's still some discussion about the oxalates, but the majority of these toxins will bind with those clays and pass through our bodies unaffected. And we can absorb the nutrition and use the nutrition properly. There are several things that were huge takeaways from doing this with them. Number one is that they had two different clays from two different sources they used. One they just described as grey, one as green, but they had very different flavor profiles. You know, you think about something like this as Oh, just the food processing strategy to get the potato in without somebody dying. But they actually selected the different clays because they impacted the final dish in different and very pleasing ways. And the second takeaway was that the youngest daughter of the family who, when we were all done, we finished all the potatoes, there was a little bit of this clay slurry in both containers left, one of the green and one of the gray, the consistency of almost like a really thin mayonnaise. And when we were sitting there cleaning up, she picked both of them up and with her finger, just like my youngest daughter does, when there's mayonnaise left in the bowl, she cleaned it all up and ate just the clay that was left. And it, again, it just spoke to the idea that this wasn't just something they were forcing down or doing because it was tradition. It was something that they actually enjoyed. And she certainly enjoyed that clay. So, geophagy is something that we see across most animal species, mostly for detoxification purposes, but also for certainly adding minerals into our diets. We see it a lot in ethnographic sources, especially with populations that have marginal diets or pregnant and lactating women that have increased nutritional needs. We see it with acorn processing in California. We see it in acorn processing in Sicily. There's even a traditional bread, I'm sorry, in Sardinia where the bread is made with clay, acorns and ash. And most of the processing is for the detoxification of these acorns. And many people think that's actually the precursor to polenta. Believe it or not, but geophagy is not uncommon, in the ethnographic or archaeological record.

Okay. question number seven.

What else can I make out of fermented potatoes? Do they have to be deep fried or boiled or is mashed, shallow fried or roast okay as well?

Absolutely again, you can ferment these potatoes, and then from that point forward, take it any direction that you like, and just treat it like a normal potato. There is, I forget the name, there's a famous restaurant in Copenhagen. Shoot. I forget the name of it, but I can find out, and we can get it out somehow through XR, but there's a fermented potato bread that became sort of the hallmark of this restaurant. And they would ferment it in a slightly different way. But one of the things we're starting to explore is actually fermenting the potato and then making a sourdough potato bread with it. But you could do anything you wanted, after the fermentation process is over. The most important part is that it's going through that fermentation process. And then remember, I know we're in a state of mind around the world and sort of the zero waste state of mind and I love that and the way we're thinking about using everything we can. But there are just certain things we shouldn't use. So, you know, especially with the leftovers of certain vegetables and vegetable water, if it's been fermented or if it's been boiled, you know. We've spent millions of years figuring out ways to detoxify certain vegetables so we can consume them. And quite often, those toxins are either water-soluble or break down through fermentation and the water was discarded, right? Because the bad stuff's in the water. So when you ferment these potatoes, listen, you want to throw it in your compost pit. Fine. You want to do something else with it? Fine. But don't throw it in your sourdough. Don't start using that water because you want to do zero waste stuff and cook pasta with it. Get rid of it. It's nasty, nasty stuff.

All right. Thank you so much. More questions are popping up, so I'll give you a break and I'll move on to Chelsea. All right, Chelsea, copper alloy can be different mixes of copper tin lead zinc. The physical properties vary considerably: melting points, viscosity, how brittle they are if hammered or bent.

Although this may be in your paper, what alloy did you use and how does this match to historic samples?

Ben: So to start answering the question: Yes, changing the compositions of these different materials definitely does affect the properties. For example, a higher tin content in the bronze would lower the viscosity and give you a much smoother pour, you could fill your mold a lot easier. But that also leads to less ductility when it's being worked. So you'd be more prone to cracking. You'd have to do a lot more intensive annealing during your working process. So yeah, changing the contents absolutely does affect the properties and we experimented with a couple of different compositions in our project. The one that we ended up settling on was about 88% copper, 11% tin, and about 1% antimony. we also experimented with just about pure copper, about 99.9%, and another composition of about 80% copper, 18% tin and 2% antimony. We had pretty varied results with all of those.

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And how did this match with historic samples again?

We had a lot of different sources for what their compositions actually were. So one example that we looked at was from Harvard university, and their sistrum was about 80% copper, 4% tin, 5% lead, 7% iron and the rest of it was a mix of other metals, nickel, arsenic, bismuth. Mostly just stuff that would be natural impurities from the ores that they used. We don't have a lot of great data on that. And some of the stuff we used, for example the [moco] sistrum is..., (Chelsea: it's from Crete) … a Cretan sample. Their bronze actually is about 95% copper and 2% tin. So something that we want to do in the future is we want to capture a wider range of compositions. So for this specific experiment, we were pretty limited as far as time and funding. So we only settled on these, these two similar compositions to try out.

Right. One of the major issues that we faced actually is most of this data is coming from XRS sampling, which only gives us really a qualitative idea and not a quantitative idea of the different materials in each part of the sistrum. And usually, when we do get any hard data, like the data from Harvard, [...], for example, they don't tell us what part of the sistrum they're sampling. So we suspect that different portions of the sistrum would have had different compositions, but we don't have enough data. And we haven't had any luck finding someone who will let us sample a sistrum. The second issue is compositions change through time. So we only really start getting true bronzes during the new kingdom. So like the reign of Thutmose III, when the empire is expanding into Syria, more materials are available, but we're looking at a wider range in our research. So we are experimenting with different compositions for that reason.

Okay, thank you so much, Chelsea and Ben. Okay. I got a question here for Katarzyna.

Could you give some examples of modern reactions to ancient fragrances? Are modern reactions to different scents similar and are they embedded in cultural expectations?

To answer the question, I would probably start with the very end. The market generally is quite full of modern, like oil-based perfumes that are so-called Arabic ones and African ones. And I think that this is what people expect. They expect something very loud kind of a scent, but, you know, when you go to like a modern perfumery like Sephora and you cannot breathe. So that's what people expect. Actually the reception of fragrances is very subjective. I have people trying the same perfume and everybody has a different opinion. Some people hate it. They say it stinks, it's like dirty socks, especially as far as any kind of a musky scent. But the musky scents are especially surprising because they're not popular anymore. I mean they were popular till like the beginning of the 20th century and nowadays true musk is pretty much no longer in yours. So I have people, it's very subjective,

some people love the same scent and some people hate it. So I can have a rating. I have ten people and one will say I love it. And the spectrum of liking or disliking goes from I like to I hate this, I mean, I cannot stand the scent. And I have to say that some scents, but a better [kind of a cozy], like, for example, the Roman… my myrrh, my cinnamon. It reminds me of a Christmas cookie, I think it's like in general the favorite. So people actually like the scents whether they seem to be familiar from daily life. And, yes, so I think that people's expectations are based on this kind of… that it will be a very strong scent. So [...] is actually delicate, and you will need to reapply, but it's more something to be smelled by somebody who is intimate with the person wearing it. And, so yeah, the range is ... I mean, I have so many people who are testing for me, they are volunteers, and actually I have more volunteers that I can provide samples. And I mean, every single scent gives me a whole range of answers from like to dislike.

There is a couple more questions. One of them is:
I love the fragrant beads. Is there enough evidence for earlier use of fragrance, like in the Neolithic? Have you tried any of that?
It's really hard. We know that pretty much the beginning of third millennium BCE in the Mediterranean region, the perfume of the standard fragrances were definitely made and they were in use. As for the beads, I think that the earlier fragrant beads that we have any like physical evidence and actually it's quite rare that we have them at all. It's actually from the predynastic Egypt. I haven't recreated [...] beads, but [...] pretty much made up of bitumen and some resins. I think that they identify a frankincense and myrrh in both. I don't know how far the actual making of perfumes versus dust, like putting some ebbs in the fire goes, it will be very hard to track when it actually started. We pretty much can say from the evidence when we have some kind of a production site, it's more like kind of industrialized under the control of a local authority. So we got to say, it's like definitely being referred to beginning of the third millennium BCE. There was definitely something and people were using perfumes at least for the elite use. But how far it goes, I think it will be very hard to actually pinpoint the actual date.

Okay, good. And finally, **there's a mention on the Discord server of kyphi and rose petal beads. Have you ever tried them?**
I mean, kyphi this is something like pretty much a standard, there are so many recipes and I am more into things that are very rare. There are many people who recreate different kyphis. And I mean, that was like at full recipes, Dioscorides. There are actually recipes in the Byzantine writings that were copied from earlier sources and kyphi at some point actually survives into the 16th century as a kind of antidote, Teriak. I'm pretty much, I'm more into the rare things.
The rose beads. So, I made the traditional Rhodides, the beads from Dioscorides recipe, and that actually I made the full version with the Iris rhizomes and coastals. And that was actually amazing. They really keep, I mean, if you wear them as a necklace, they really make your skin..., like you'll smell mostly the coastals, instead of your sweat. So they're working and this recipe actually made it into the Eastern empire tradition and it was pretty much later on used as a kind of a deodorant where you make those beads larger and like larger [...], and you use [...] like [...] bead and apply to the sweaty parts of your body. So it seems the use was modified over time. So yeah, I made them.

Okay. I've actually made some rose petal beads too. **And I heard that they were from medieval time and they were used for making rosaries. And that's where the name comes from.**
So actually this rosary bead, there is one recipe that's in Nostradamus, but that uses mostly roses, but frankly speaking, we don't have any examples of beads surviving, pretty much besides the beads from the [...] dynastic Egypt. So all the recipes that we have are medieval, actually about late 15th century, beginning 16th century. All those beads, they have roses. Rose petals are only a very tiny ingredient in

a mix. The recipes for making fragrant beads actually involve a lot of resins that are often kind of a [filler] like, for example, black earth or some red earth to make those beads red, and a whole section of aromatics and Arabic [...] tragacanth gum. They were not really made exclusively from rose, but I think that these rose petal beads that people consider as rosary beads is something much later, it's a 19th century Victorian invention. The beads recipe that we have, at least the one that I track to the end of 16th century, they mostly contain roses as one of the ingredients. And the rosary. So for example, if we talk about the Arabic, early Islamic caliphate beads, they usually don't have rose petals at all, neither have the ones, for example, in China, they make a lot of the fragrant beads for prayer beads, for the Buddhist prayers. And those don't contain roses that often, they contain rose water.

Okay, yes, that makes sense. Especially if there was [...] the heat would bring out the fragrances. Thank you. I do have one more question for Myriam.
You mentioned three bellow operators and differences from arm strength. Was there a difference in bellow performance between the operators or did the performance more vary between bellow types?
There was both a difference in performance between bellow operators and bellow types. The young man was really much better than the other two. From best to worst, it was young man, old man, woman. And yeah, there was also a difference in efficiency between the bellows. The best bellows, well, the bellows which gave the best volumetric flow rate, were the pot bellows with valves and the other two were less efficient. But pot bellows with valve can be really different from one bellow to another, from one culture, one region to another. So that only shows what bellows with valves can do. And it doesn't show what it may achieve when the valve is inferior.

Okay. Thank you so much. **I 'm not seeing any more questions on the server. Do any of you all have questions for each other?**

Myriam: You want to talk?

Neil: Actually, I was just chuckling about adding a comment, Myriam, that you and I've been spending most of this time chatting in the side on this. It has been quite fun with Myriam's and my paper, because of the relationship between them even though we started from such different sides, seeing how the different bellows have actually behaved the way the numbers are in comparison to each other. I'm not sure that we have specific questions at the moment that we haven't just gone through in the last half hour on the chat though.

Myriam: **What was the pressure you measured? I didn't understand what this variable exactly was.**
Neil: Since we got no measurement at all out of it, I know no difference from atmospheric pressure. What I'm interested in is the interaction between the air flowing out and the load that normally one faces, right? When you're using a bellows to pump into an iron smelter or a bead furnace you're pushing against a resistance that should lead to a back pressure. And I was interested in measuring that, but again, instrumentation problems. What I'm working with is simply, was simply not sensitive enough to be able to tell me what pressure I was seeing.

Myriam: Okay. So that's your pressure. Yeah, that's something that was missing from my own experiment because I measured my bellows and my tuyeres. Yes. As if there was a complete system in itself, I didn't measure any agents back pressure. And I didn't think about what it would mean. It would mean with the fired furnace. So this part about your charcoal load, I found really interesting.

Neil: Yeah, it was quite fun from my point of view as well. I was quite surprised and still very confused about one set of consistent readings. Why eventually we see an uptick in the speed of the airflow. So there's a lot to experiment with there, not just for either of us, but for other people as well.

Myriam: Yeah. another question. You told me your theoretical output was the whole volume of the bellow. So do, with my own bellows, there are not completely empty, empty dear only health. And she'd when billowing down to it's more efficient, you bellow faster.
So is it different with Viking bellows? Do you completely empty them? Normally?

Neil: Well, theoretically one can completely empty them. The problem is that when you do it starts to impact the airflow because you're using a dual chamber design. You're looking to start chamber two before you quite finish chamber one. And then you want to start reloading chamber one again, before it zeroes out. And that raised the question of efficiency. As an intriguing question, right? If you think about in 10 strokes, I completely exhaust 14 liters on each side. Right? Times 10, I should give me 140 liters. What do I actually generate at the output end of the tuyere, given that we're always leaving these aside, given that. It's a lossy system, right? It's not like these are perfect seals. It's not like the leather where it's riveted onto the wood is absolutely non-permeable to air. So you're seeing a whole bunch of different places where the efficiency can go down. Hence it was a curiosity, a piece of curiosity, as well as a useful metric to look at what percentage of the expected air actually goes out.

Myriam: Okay. Yeah, I asked because I thought of my efficiency more as the volumetric metric flow rate, which was reaching the furnace. That was my main measurement for efficiency.

Neil: Yeah. Effectively to me, that's a volume metric measurement where efficiency is compared to what your bellows could have hypothetically produced. What was that relationship where you're getting 70%, 60% or in our case, significantly lower than that, of the hope for air volumes.

Okay. I do have a couple more questions that popped up. Neil, **I think you already did this, but comment on the bellows output to purpose**.
Comment on the bellows output to purpose. Okay. I'm assuming that is related to the charcoal conversation there. there is an in, because it's a semi-open semi sealed system, right? If you simply measure at the output end of the twin air, what percentage of air is going across? It gives you one number, but when you're pumping that air into a cylinder containing a well, an iron smelter, that would be a 30 centimeter diameter cylinder, 60, 70 centimeters, tall, full of charcoal. Right? That's a lot of resistance to that air flowing through. And as soon as you add that resistance, it increases the pressure of the air inside the bellows themselves. When you do that, every other place that air can leak out of those bellows is more likely to see that air leaking out due to that increased pressure. So as a result, you get very distinctly different numbers. When you measure a bellows in an unloaded environment versus a heavily loaded environment.

Thank you. Last question is for Barbara, **about the difference between experimental archaeology in the UK and in California.**
I think what's happening is, at least in California and maybe a lot of the United States, this concept of experimental archaeology is just kind of beginning to filter through. You don't, we don't see a lot of campuses that have experimental archaeology classes, per se. You know, you might have the odd undergraduate or graduate student that might get into an experimental archaeology project, but you don't see the classes. At least when I was looking for a PhD program, trying to find someplace here in the United States would be up for me. As far as experimental archaeology was concerned.

My experimental archaeology undergrad professor just retired a couple of years ago and there's no one to replace them. So I understand that completely.
Okay. A couple of questions. There's a couple of questions for Neil, on the volume uptick.
Could the increased pressure be affecting the gauge?
It is certainly within the possibility. It's one of the things I really liked about Myriam's paper is she went with the pitot tubes instead of an anemometer, which produces a distinctly different pattern. There's some real advantages there. So it could be that as the pressure is going up, we're in some way causing a flow change that is impacting the vane anemometer in a way that isn't obvious, right. Fluid dynamics is a fairly fun field all by itself. I wish I knew at the moment it's just... There's that weird uptick when you go to that final bit of load that I don't have a good explanation for at this moment.

I'm sorry, Neil. I can't hear you anymore...
Neil: Yeah, I dropped off as I finished up that thought, Eric, waiting for you to throw out the next question.

It says: **Is number two less likely... could the increased pressure be changing the seals, reducing air leakage?**
Yeah, it absolutely could. Right. You're... it's a system that has a lot of points where we could see leakage. I'm not sure why continuing to increase the pressure would decrease a leakage in other places, which is what we'd have to get to see the increase in velocity. But on the other hand, it certainly is within the realm of possibility.

Myriam: I have a question on that. **So when you increase the load, you increase the amount of charcoal between, I think your bellows and your anemometer. That's the load, right?**
Yes. That's the load.

Myriam: **And do you also increase the length of the tuyere or do you just increase the concentration of charcoal**
No it's literally swapping out a seven and a half centimeter empty tube for a seven and a half centimeter full tube. So the length remains the same.

Myriam: That was my question. I was just wondering if the length of the tuyere was always the same, because that might give rise to some differences. Yes.

Neil: Now there is an intriguing question that crops up, which is that by putting a load in there, you are interfering with the air flow and there is a... You were decreasing or increasing the distance between the last thing that disturbs the airflow and where the anemometer is, which could have an impact on the fluid motions, right? A vane style anemometer, which is what I was using should not be as sensitive to that as the newer temperature differential anemometer will be, but it is certainly a variable that comes into play.

Myriam: If your anemometers measure an average, and it's, well, basically something that skims. So, as you said, it's not sensitive, but if you use a pitot tube for the same purpose, it's sensitive enough that you would have to put some distance between the load and the pitot tube. So as not to get interference or random or current.

Neil: Yeah, I would agree that pitot tubes in particular are subject to that as is the temperature differential anemometer I want to repeat the experiments with now.

Thank you. I want to thank everybody for coming and thank you to our speakers tonight.