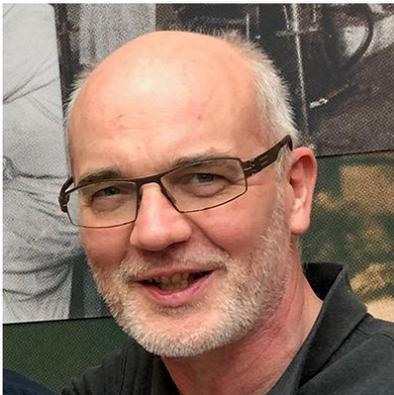## Interview with Frank Mittelbach

Paulo Ney de Souza

This interview took place on 7 August 2021, during the TUG 2021 online conference. Frank Mittelbach has been leading the LaTeX Project since August 1989, i.e., for exactly $2^5$ years at the time of the interview.



**Steve Grathwohl:** Welcome to the interview section of the program. Today we have Paulo Ney de Souza who's going to be interviewing Frank Mittelbach so take it away Paulo.

**Paulo Ney de Souza (PN):** Thank you, Steve. Good morning, Frank, good afternoon or good night, in fact.

**Frank Mittelbach (FMi):** It's about seven o'clock in the evening, so you can say anything.

**PN:** Nice to see you, man. How are you doing these days?

**FMi:** I'm doing well; can't complain. With the restrictions we all go through in the last one and a half year or more, but otherwise I'm doing fine.

**PN:** Are you completely done with HP? Are you completely devolved from that project now?

**FMi:** I decided in 2015... I stopped working as an architect at HP and resigned. And since then I'm only doing freelance work and largely devoting myself to research and LaTeX, yes.

**PN:** Well, start by telling me how does your day look like. How much time do you put in the LaTeX project, how much on other stuff?

**FMi:** Well, at the moment, not counting trying to finally finish the third edition of the *LaTeX Companion*, which is sort of a side project, I spend right now the whole time on LaTeX and the tagging project, which is huge, and, well, after that I have other plans going

in the same direction in terms of further research in typography and computer typesetting.

**PN:** Wow!

**PN:** My next question is related exactly to what you what you're talking about, I think, the first time I ever saw you talking, it was a talk in San Francisco at the end of the 80s, where you were complaining about LaTeX. I don't know exactly...

**FMi:** Is that the Stanford meeting, the one where...

**PN:** Yeah, the San Francisco Bay area, most likely Stanford.

**FMi:** At the end of the 80s, it must have been, I guess, the one where Don decided that TeX 3 comes out?

**PN:** Yeah well, I mean, I walked into the talk under the belief that LaTeX was the most wonderful thing in the world and I, and I go there and I see this *lunatic* complaining about LaTeX. I said what the heck is this, and it was, it took me years to process your talk, it took me literally *years* to understand, fully understand what was wrong with LaTeX, and you know now in retrospect, if I could see how correct you were, and I think that the drawback of that talk is that you inherited the LaTeX development, so you guys complaining, that's good.

**FMi:** That's more or less in fact what was happening, and I mean I was young, and so bold, and not seeing the consequences of all this, but, but basically I started working with TeX in the mid-80s or so, and discovered later a draft manual [of LaTeX]. It was before the book came out and I thought this was great ideas, and then I was trying to actually use that on the computers in the university and it died on me, because the computers didn't have enough memory to process LaTeX at that time. So I had to implement my own format based on the ideas that Leslie put forward in his manual. And that gave me a huge sort of insight into all these inner workings, because I had to make it even smaller than it was back then, as far as LaTeX is concerned. So with this starting point I and Rainer Schoepf, we sent an enormous number of bug reports to Leslie when we finally managed to get LaTeX going on the university Multics system. And then I got a chance to go to Stanford.

Well, and then I gave this talk "What's wrong with all this?" I mean — we came from Europe. Basically, I came as sort of telling people why LaTeX is not a good thing. And also from Europe, we came in this year to tell Don Knuth that he really should take care of his cultural background, coming

basically, his grandparents and so, from Scandinavia and Germany, to actually take a little bit [of] care about something like diacritics, and so better than a 7-bit system could do. That was a big thing in the Stanford meeting, that we actually managed to convince Don to produce TeX 3, when he basically finally, sort of agreed that there *is* something that needs doing. The other thing that happened was that I personally then met Leslie and we had a long session there during the meeting and afterwards, and then he basically dropped the whole thing on me and Rainer and Chris, and that was the start of it ... so it was '89.

**PN:** So it was more a handover from him and from Leslie directly to you, so the community was not really involved, or was there much more that...

**FMi:** Before that time the whole development and maintenance of LaTeX, there was no development happening any more, but the maintenance, if there were bugs or so, you could send them to Leslie and Leslie would potentially do something or not about it. It was all done by him at that time, and he wanted to move on, and so he, I think he was in the end, he was quite glad about having somebody who says, things are wrong, but not just pushing them to him, but actually being prepared to take it on. So we then jointly with Leslie, that was the idea, and this is what we actually did. We jointly devised LaTeX $2_\varepsilon$: a certain set of extensions after, beside the stuff that I said needs fixing, like getting better font support, getting a lot of things done that was not in LaTeX 2.09, but we also jointly worked on specifying the abstraction for the color support; Joseph spoke about that earlier. This was implemented by David, but it was a joint effort between David, Leslie, Chris and myself to work on those specs that then became graphics and color packages as the new standard, and this is part of what then ended up in Leslie's book. So his last involvement with LaTeX was doing that second edition of the book and going jointly together to release, if you like, the $2_\varepsilon$-version. But the actual coding for $2_\varepsilon$, everything which was quite a substantial change from 2.09 to $2_\varepsilon$, he was not involved in that. He was only sort of a consultant at that time and after this he completely dropped out. He sometimes in the years after sent me a bug report because something in his research paper didn't work; he expected it to be or something like that and yeah, so this is the way it worked. In some sense I think this is a great way for him to do it, because a lot of people can't let that baby "grow up", and just need to stick to it without then actually sort of keeping up with it in some sense.

But he did that, I mean he gave the whole responsibility and everything over to us, and did not interfere with it afterwards, which is great, because that allowed us actually to do a lot of things which otherwise would have been basically not possible and probably LaTeX wouldn't be here anymore.

**PN:** Well, so, so let me ask you something else. I now have a better perspective of this whole thing and I kind of see things fall into place. You know color, with a talk by Joseph just a few minutes ago, and in things like accessibility and things like PDF reflow and so forth. So things are falling into place right now very nicely. Do you still have any complaints about LaTeX?

**FMi:** Oh, I have a lot of complaints! But yes and no, you're perfectly right in saying that things are currently starting off falling into place, and this is quite interesting because in some sense in the early 90s, so between the TUG conference, e.g., after the time we took over from Leslie and [then], we were thinking of producing LaTeX 3.

I mean LaTeX $2_\varepsilon$ was never meant to be, in some sense. The idea was, I mean, I went to Stanford and said this is all wrong, and this is wrong, and mathematics doesn't work, and they should be put into LaTeX, and not as a completely separate format,[1] which it was back then, and all these kind of things. So we had these ideas that you could produce a much better LaTeX, and we actually produced a much better LaTeX during the years 1991–92, and we actually had a new version of LaTeX that could compile its own manual.[2] The only problem was, the whole interview we're now doing wouldn't have been enough to get the manual compiled, which was only about 100 pages.

[[connection unstable for a few seconds]]

**PN:** You dropped...

**FMi:** [We had] a lot of [ideas and we implemented them]

**FMi:** but they were too early. There are about two decades [too early] ... (My Internet connection is unstable, can you hear me?)

**PN:** (Yeah, I can. It froze for a second and then it came back.)

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[1] Explanatory note by Frank: What is now the package `amsmath` was at that time a separate format called `ams-latex`, because it required NFSS (the New Font Selection Scheme), and that was not part of LaTeX either back then.

[2] Explanatory note by Frank: The famous LaTeX3 that was never made public back then. It only saw the light in 2020, where most of it was added to the LaTeX format as the LaTeX3 programming layer.

**FMi:** (Yeah okay, this isn't, this is not as old as the stuff we're talking about, but that's an old computer [here] right now.) Anyway, so we had all these ideas and we had to abandon them. I mean, there were lots of them, I mean basically what is nowadays known as cascading style sheets, we had that for LaTeX before it existed for HTML. But we gave it up, because it was just not workable in the context of this, so there was all these kinds of ideas were around and sometimes implemented.

But now, after, well, what is it 20, 20–30 years now, the problems that we tried to solve back then and only very partially solved was $2_\varepsilon$ — they are still with us, and what is now falling into place is, in my view, that a lot of these ideas are still extremely current. And so, by now, with computers being vastly more powerful, that you can do on your iPhone things that I couldn't have done with the computers I had back then. They are now sort of coming to fruit; I mean they blossomed over the years and, I think last year, I said [the ideas from LaTeX3 finally arrived after 30 years, without people noticing it, in][3] the layer underneath, inside the kernel, and we can actually start making use of it. Last year we built the hook management into LaTeX, which is now nicely being used in various packages already and it's used by us. A lot of the ideas from back then can now be actually implemented and used, and as part of the tagging project, a lot of those harmonizations and improvements will happen, because we will need that as part of making LaTeX accessible and what Jonathan Godfrey said, and rightly complained, is that LaTeX didn't change from 25 years ago to now in terms of what it could do in the sense of making accessible documents. That was just not possible in the past, and now it becomes possible and *is* possible. So, I have still a lot of complaints, but many of them will be addressed in the next few years, and this is now a good thing.

**PN:** It's really nice to see this information, I mean this. I hear complaints about people, you know about waiting for LaTeX 3, but I came to realize that, that I just need to be patient, because the changes that were required were enormous, and you can't stop a train that is moving and change the wheels while it's running. And so I came to appreciate over the years and I guess we'll just have to wait a little bit more and start, and I'm starting to use some of these packages which are coming out of the LaTeX 3 project and they all seem pretty nice and pretty round.

**FMi:** Yeah, I mean this is certainly something you have to take into consideration. LaTeX has a huge

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[3] Again a connection drop :-(

user base and, in fact, in the last years I think one can see that it is actually growing because there is quite a need for structured documentation nowadays and LaTeX is pretty much well placed to produce that. And if we are now getting to the point that we can actually produce structured output as well, not just nice looking documents that have great mathematics inside or something, and have all the cross references properly resolved, in contrast to some other systems, but now actually being able to have in some sense reusable documents, accessible documents, and so I think it has a very good place in the world and the future as well. My impression is that the user base is growing rather than lessening in the last years.

**PN:** Alright.

So let me ask you a question which is, I guess it's a matter of opinion as well. I mean programs like InDesign and Word are sort of fast implementing TeX goodies. You know InDesign and Word has had a plugin for math formulas for a number of years now, where you can enter mathematical formulas using LaTeX notation, and previously they would use their own algorithms to decide how the formula look like. And I get in over the last eight years or so, both of them have abandoned their own processing of the formulas and they have left it to TeX, and so we use this literally TeX algorithms to do the positioning, and InDesign right now is implementing microtypography and paragraph breaks very much TeX-like I mean the algorithms are out there, Knuth–Plass and so forth, are public, and so they're bringing it in so you have this instance of where you have microcosms of TeX within an interactive environment outside. Do you see a chance that we'll ever see an interactive LaTeX in the future?

**FMi:** A qualified "no", I would say. I mean we have to be careful of what we're talking about here. Something like the paragraph breaking or how to display a formula in terms of spatial relationships and so, these are algorithms which are very sort of localized.

**PN:** Localized, uh-huh.

**FMi:** I mean that's fine, and in some sense it was always surprising that even though something like the paragraph breaking algorithm was out and public, nobody else, like Word or so, took it up, and Leslie told me the story that... I mean Leslie is employed by Microsoft these days as a researcher. He's not working for Microsoft, he's doing research paid for by Microsoft, if you like. But anyway, he was talking to the Word development and said, well why don't you do this? And see, here's the algorithm.

Why is Word producing this horrible output? And that department, the development people, they told him there's no market, we are not putting a complicated algorithm that produces problems for us to sort of maintain and everything into the product if the appreciation from the market is not there.

So the Word market was targeted at something, at least in their thoughts, where an improved typographic quality would not actually be an improvement. Now for something like InDesign that is different, and to my understanding, InDesign was using the TeX algorithm for line breaking already for some time.[4]

**PN:** Yes.

**FMi:** I don't know about the math formulas, but my understanding was they were using it for the paragraph breaking. But coming back. If you have a designer tool like InDesign, where you work page by page, and the focus is on getting, per page, the pages right, you certainly want to have very good quality in terms of line breaking and getting sort of a shot at that automatically in the best possible manner. But the focus was, working with InDesign is more individualization of pages, not focus of a structured document where LaTeX has this very big strength, which is describing the content in a reusable, largely reusable fashion, and that is quite independent of the underlying engine.

I mean, if you think about the history, then these ideas that Leslie put into LaTeX were actually coming from a system called Scribe, to a large extent. Leslie had a lot of new ideas as on top of it, and he made it popular. The way to describe documents as a structure is actually not, was not done in the system that had TeX underneath. [Scribe] had its own typesetting, which to my understanding was pretty horrible because it was more typewriter-like output if you like, if my understanding is correct, because the underlying engine to actually produce the print was not very good. But these are two different things, and if you think about a huge document like... let's take the book that I'm trying to finish for a couple of years now again: the *LaTeX Companion*, which has 1600 pages.

**PN:** Mm hmm.

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[4] Editor's note: InDesign was the first program to implement microtypography features (for ordinary text), such as font expansion and character protrusion, in the early 1990s, as part of the "HZ-engine". Peter Karow's memoriam for Hermann Zapf discusses this in some detail: Digital typography with Hermann Zapf, *TUGboat* 36:2, `tug.org/TUGboat/tb36-2/tb113zapf-karow.pdf`.

**FMi:** So that is not going to be interactive because there are dependencies from page one to page 1600, like the correct index at the end, and all these kind of things. So what you *can* have, I think, we will see maybe more is something like "instant TeX", where it appears to be more or less simultaneously updating. I mean, you all remember the talk by David Fuchs a year ago, I think, where he is working on a system where you compile real time, and you have the ability to get the pages you see very naturally, sort of being shown immediately when you make changes. Now that is sacrificing some of the power of what LaTeX does, and going beyond in this direction is certainly something that I would not be surprised to see that this is happening. This is still in essence a batch system. I mean, it's just the batch system that you, you don't really realize, because a lot of the batch processing goes in the background, on the stuff that you are currently not looking at, so it appears to you as if it would be instant, but from the core idea I would say batch orientation is part of the story, and therefore it is a different kind of thing.

**PN:** Right right. Nice to have your perspective on this. I try to look at this issue from the point of view of global and local, and interactivity is just like a... This is probably a change that happens very fast, and that you worried only about the local stuff, but the separation between local and global in LaTeX seems to be hard.

**FMi:** First of all, it is right now hard in TeX, but the moment you would have system variations of the TeX engine that actually may make this kind of instant result. I mean, Textures was trying to do that years ago which, again, I think it was before it [the world] was ready for something like this, but nowadays that could be a solution not too far in the future, when that appears to be instant, and then some system like LaTeX could adapt to that, I would say.

You get more like the feeling you are actually working on an interactive system. Okay, you enter in one screen, but you don't even have to. David showed in his example that you could actually enter in the output format, and it would correctly translate to the source, so he had a two-way, if I remember correctly.

**PN:** I have to watch this talk. I haven't seen it. This is interesting to know.

**FMi:** No, it must be two years ago. It was an on-site meeting, it was the one, the last one that I attended in person, so it was two years ago. Last year was already pandemic. Yeah.

**PN:** I'll have to look for it.

**Arthur Rosendahl:** That was the meeting in Palo Alto. Sorry, right, it was the meeting in Palo Alto. You were there for a while, Paulo.

**PN:** No, I was there for, not for the whole thing, but I had to be out for like one day, and that may be the day that he spoke.

**FMi:** Yeah, check it. It was a question that was unrecorded. It's a pity.

**PN:** Yeah. Now I'll look for whatever he has written up and so forth.

I wanted to ask you about something else. You are also famous for a very big statement that you have used TEX on every single platform you dealt with, going back to VMS and Multics and Sun and Solaris and so forth.

**FMi:** Mainframes.

**PN:** And mainframes and... I would say *even* mainframes...

**FMi:** No, mainframes were the most problematical ones actually, because mainframes are EBCDIC, they are not ASCII, and TEX is very much ASCII, and they don't have a file system; well, not one to speak of.

**PN:** Since the mid-80s, when TEX made its way into PC and Macintosh, we have had a decent version of TEX on every single operating system there is. And the last 15 years I've seen tectonic shifts in operating system usage. Gartner right now says that 80% of the shipment of OS in the world are Android, iOS, and Chrome OS — Chromebooks. You know, none of them run a decent version of TEX. None of them run TEX Live, for example. Do you see implications of this for the future of TEX?

**FMi:** Again I would say *no*.

First of all, I think your statement is not quite correct because on iOS, at least, you get a decent enough TEX to work with, and that is not using TEX Live, but similar, so you can install your own packages on top of what is already provided and it comes with... Well, at least the last time I used it, it was already quite good.

**PN:** Quite good. It *is* the best one of the three.

**FMi:** Yeah, but the point of why I think it is a "no" is... except for tablets. Tablets are a little bit sort of in between. I think this is apples and pears.

I use my phone for an enormous amount of things these days. But a huge Excel field with 20 columns, and try to enter data in it from my phone, or stuff like that, and I don't think that a phone screen is in any way suitable to do programming. To do LATEX documents, that is more than just plain text. And I certainly think that on the tablet level there is a gray area where you can these days, and it will more and more become something like a laptop for you, both in size, as well as in capabilities, but then I would expect that something like, systems like TEXwriter, which I think is the one that I was talking about on iOS. Those and similar ones will show up to enable you to do something like a decent TEX system on such tablets as well. And on the iPhone, they would work on the iPhone but you wouldn't want to work with them on the iPhone. So the fact that you have 80% of all the sort of computer operating systems being sold nowadays being some of these handy[5] devices is one thing, but for programming or for doing graphic design or photograph handling, or what have you, I mean not for shooting the photograph — the iPhone is getting better and better and the other phones as well to do photographs — so Canon has a problem, and all these people. But if you want to postprocess the stuff you still like to have a decent screen size.

**PN:** Right.

**FMi:** ... I would say. I don't think that is going away, because it has more to do with the physics, and so the same I would assume is the fact when you're producing an article and you want to do research in parallel, you want to have two/four windows open to do things in parallel, and that means you're talking, you have a computer. I mean, I like to have a small laptop; most people say, how can you work on the 13-inch laptop?

It is problematic in some cases, which is why I also have a big desktop computer, for stuff where a laptop doesn't work. My argument is it's the balance between nice and light, and I can sit outside in the garden with it. But I wouldn't go down to a phone, so the 80% yes, that is the way the world goes, but that doesn't take away the 20% of the professionals doing certain kind of jobs, and I think stuff where TEX plays a role or LATEX plays a role will be in this 20%, and this is not going to change, Then it will go into the online side. I mean something like Overleaf is taking more and more proportion of what processing of structured complex STEM documents, is going to happen. But again, Overleaf on the iPhone or on your Android is okay. As long as you can just dictate, and your text is not more complicated than that, that may be a future, that you don't have LATEX or something. You just dictate your thing and the

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[5] Explanatory note by Frank: handy = "mobile device", a German/English false friend.

artificial intelligence puts your tags in. And I don't know, maybe 10 years from now, who knows?

**PN:** What I meant more, the intermediate formats, more like the tablets, and so forth. For example, you know the Chrome OS is running on very large laptops right now and Microsoft has this line of computers, their Surface laptops are tablets that work as full Windows computers.

**FMi:** Yeah, but those are not the 80%. I think that's the whole stuff, and now I agree with you. I mean this proportion comes up, and this is a certain niche or maybe it is becoming more than a niche, but then it wouldn't surprise me if the TEX community, or one of the other Open Source projects that ports it onto that more as a commercial one. I mean, some of those tools that we have seen on iOS in the last few years were not for free; for ten bucks or something, which is fine. I mean some developers have to live, sometimes, so we shouldn't be too concerned about that. But getting a decent system onto that if the other physical parts fit. So that there is a need. I mean that's the point; you have to have a need, if you have a laptop or tablet which is big enough to actually do this kind of thing. And, yes, I would think if enough of those show up, and we will see that also at some point in time, as an engine, a supported engine. My guess.

**PN:** Well, Jerzy wants to join the conversation. He has a question for you.

**PN:** *LATEX Companion* 3 and LATEX 3, how are they related?

**FMi:** First of all, I already said last year we try to abandon a bit the word "three" because that came back from the days when we were young and were thinking we can do this in two or three years, and then found out the problems are so hard and the computers so slow that we couldn't do it. This kind of LATEX 3 that we had in mind back then is never going to happen.

What is happening, as I announced that last year, is we will go and take the whole LATEX community on a journey with very many safety nets to modernize LATEX rather than building a second system which then nobody's going to use because it takes too long a time to be as a system on its own usable. So there *will* be something like a modernization going on right now, and it will not take another 30 years. We are now in a position where we can actually make these kind of things.

And the three in both cases is just because I only have time about every 10 to 15 years to write a book. And it's good that these books actually stay

current for that long period of time — we can't really say that the *LATEX Companion* 2 is still current, but it's still not completely useless, so. . .

**Jerzy Ludwichowski (JL):** Yes, it's still handy in many cases, but yes, one has to resort to watch online for packages because they update, and so on.

**FMi:** Potentially.

**JL:** Yeah.

**FMi:** But this is going to change. I don't want to make promises, see. The book is in its last stages, and last stages, that still means it goes to professional copy editing and it goes to professional indexing, and I have to do the layout after the copy editing because everybody knows that whenever you touch a system like LATEX, TEX, changing a couple of words, everything changes in the line breaks. So there's still a lot of work to do in parallel to all these projects that I *actually* want to do. But the majority of the work is done, which was hard enough. I went through 5000 packages on CTAN, documentation by documentation, made notes about what is good, what is not, tried things out, checked what has changed in various things. By the time I got around with one chapter, then five chapters later this was no longer current, so I had to do it again, because it was just a huge, huge undertaking, but I think it gets around. . . well, how should I say, it takes too much time sometimes, but. . .

**JL:** It's a moving target, isn't it?

**FMi:** Yeah, yeah, sometimes it's a moving target, which is why it is good to get a book out, because then. . .

**JL:** A reference point, yeah.

**FMi:** It's a reference point, and people accept that. When we talked about it and decided, Oh, you know a lot of those things when the *LATEX Companion* 2 book came out where we're improved because I tried to explain them. When I couldn't explain them I talked to the author of the package and things sort of got sorted. But then the book was out, and so the documentation said the package can do this, and this, in this form, and these kind of things then stayed, because they were a record through the book. Because of doing the same, though, with the *LATEX Companion* 3, but not putting the book out. . . I mean I started it in 2018, I think, so it's quite a long time ago. I cannot really tell people not to change their minds when I'm not being able to do my promise after having sort of talked them into doing something to improve that further.

So yes, it is a changing target, and which is also why it's good to finally come to a close, because then it is no longer a changing target, it's more like a point of reference.

**JL:** I was, I asked this question because perhaps it's good to make an official statement that people don't confuse those trees.

**FMi:** Okay, well. . .

**JL:** I am waiting for, for the 1600 pages or so, to get my hands on, but I'm confident. I understand that LaTeX 3, in the sense like the language and the system, is evolving, and it cannot be frozen into the book or the book frozen into it, but that doesn't. . .

**FMi:** Well, this is, this is definitely independent. The work that we're currently doing, I already documented the new hook system because that is ready. It is part of the book.

Everything that has gone around in the tagging world around good "getting accessible documents", that will have some major improvements and functionality coming along in the next years. This is not going to be in the book. I'm not going to wait for that. That's not important. The focus of the book. . .

**JL:** "Accessibility Companion". Yeah, that's a, that's a thing to be done.

**FMi:** That could be a small, small booklet. That is fine, but, but the point of the *LaTeX Companion* is to be a companion to your normal work, and this is what all these packages or, let's say, selection of the packages, those that I thought is worth having at your fingertips. For example, one of those from every sort of area. Like the last *Companion*, the aim is to be in itself sufficient most of the time to do whatever you want to do in terms of LaTeX. This is not so much about the inner workings and the improvements of design, it's more about all these packages that are out there.

**JL:** Thank you for the explanations.

**PN:** Thank you for this wonderful interview, Frank.
Does anybody else want to join the conversation or has any other questions for Frank?
Well, with that I'd like to. . .

**JL:** Invite him to BachoTeX.

**PN:** Ahh!

**FMi:** I hope it's going to happen next year again.

**JL:** Yeah, yeah. Chances are probably not zero. Hopefully the pandemic will let us get there. We might restrict the audience like being vaccinated or some such. Be on the safe side.

**FMi:** That's the. . . Okay, this is, this is what in my case, for myself, it's sort of the biggest sort of restriction right now. I was fortunate enough that I, because I decided to resign from, say, industry work, and so I was not affected by the pandemic in that sense. I did work from home already at HP for 10 or 15 years because I was doing international work so that would not have changed anyway, but what I really missed in the last years was the sort of personal contact, by email and by phone or Zoom or something, and things like those conferences. I mean I haven't been on any since 1919,[6] and then this.

**JL:** As Paweł Jackowski puts it, the ideas are being created between heads. So if you have those heads together in one place, and people don't go away, then there are chances for ideas. New ideas or solutions and things like that. And it's nice to hug people.

**FMi:** Yes, and to have a joint beer. And all these kinds of things that I'm currently missing. So I'm sitting here with a glass of water, that's all.

**JL:** And a glass of beer underneath the table.

**FMi:** I am not telling.
Okay. Thanks, Paulo, nice talking to you would love to see you in person, but if you are speaking, you have to put your unmute button.

**PN:** Yes, no, nice to see you in person, nice to be such a good sport for an interview like this one. And I sincerely hope to see you all and BachoTeX is probably the best environment for all of this.

**FMi:** Oh yeah, that is absolutely lovely.

**PN:** And now just the time that you have to be able to talk to people outside the talk settings. It's absolutely wonderful and I hope I'll have the courage to make that trip the next time that happens.

**JL:** Thank you.

**PN:** Thank you, thank you.

**Steve Grathwohl:** Thank you, Paulo and Frank. That was wonderful. I too hope to see all of you in person next year somewhere.

**FMi:** Yeah. We haven't seen each other for a long time.

**Steve Grathwohl:** Yes, yes. It's been challenging for all of us.

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[6] Explanatory note by Frank: of course I meant 2019 :-)