From forced Working-From-Home to voluntary working-from-anywhere: Two revolutions in telework☆

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A B S T R A C T

The COVID-19 outbreak has admittedly caused interruptions to production, transportation, and mobility, therefore, having a significant impact on the global supply and demand chain's well-functioning. But what happened to companies developing digital services, such as software? How has the enforced Working-From-Home (WFH) mode impacted their ability to deliver software, if at all? This article shares our findings from monitoring the WFH during 2020 in an international software company with engineers located in Sweden, the USA, and the UK. We analyzed different aspects of productivity, such as developer job satisfaction and well-being, activity, communication and collaboration, efficiency and flow based on the archives of commit data, calendar invites, Slack communication, the internal reports of WFH experiences, and 30 interviews carried out in April/May and September 2020. We add more objective evidence to the existing COVID-19 studies the vast majority of which are based on self-reported productivity from the early months of the pandemic. We find that engineers continue committing code and carrying out their daily duties, as their routines adjust to "the new norm". Our key message is that software engineers can work from home and quickly adjust their tactical approaches to the changes of unprecedented scale. Further, WFH has its benefits, including better work-life balance, improved flow, and improved quality of distributed meetings and events. Yet, WFH is not challenge free: not everybody feels equally productive working from home, work hours for many increased, while physical activity, socialization, pairing and opportunities to connect to unfamiliar colleagues decreased. Information sharing and meeting patterns also changed. Finally, experiences gained during the pandemic will have a lasting impact on the future of the workplace. The results of an internal company-wide survey suggest that only 9% of engineers will return to work in the office full time. Our article concludes with the InterSoft's strategy for work from anywhere (WFX), and a list of useful adjustments for a better WFH.

1. The work-from-home mode

The study of pioneers working from home (WFH) or doing home telework published in 1984 (Pratt, 1984) starts with a futuristic vision of the white-collar labor force working in home offices. Just 36 years later, IT industry players like Facebook and Microsoft made revolutionary announcements of new remote work policies and opened remote positions. Other companies like Twitter, Salesforce and Spotify make further steps introducing permanent work-from-anywhere and distributed-first policies based on the forced WFH experiences during the pandemic (Stoller, 2021), while a few companies like Apple struggle with returning to the conventional close to full time office work (Zetlin, 2021). Thus, it is paramount to understand what we can learn from the working-from-home experiences during the fight against COVID-19.

Work from home is a particular case of distributed work, a well-researched field that lifts the challenges and inefficiencies of distributed work (Herbsleb and Mockus, 2003). In contrast to distributed software development, in which employees work from remote offices, often in dispersed groups, WFH is carried out from home and often in solitude. The first studies on work from home originate in the 70s along with the declining costs of data communications and the influx of microcomputers into homes and offices (Pratt, 1984; Bailey and Kurl, 2002). Back then, the motivation for WFH was either related to energy shortages and the willingness to decrease the daily commute or an apparent gender-segregated motivation. The typical teleworkers at the

time included "self-disciplined full-time clerical women seeking income at reduced personal expense, managerial and professional mothers wanting to nurture young children without dropping completely behind in their careers; and male managers or professionals who value the part-time integration of work and family life more than they do a competition for further advancement in their organizations" (Pratt, 1984). Since then, many things have changed, like the accessibility and advancement of telecommunication services and equipment and the need for employee empowerment and improved work-life balance.

Quite a few companies today implement WFH as an element of flexibility, leading to a regular but partial practice (a few days a week) (Tietze and Musson, 2010) and some even as a general company practice (Dullemond et al., 2012). WFH is often associated with the perceived increase in productivity and job satisfaction, primarily self-reported by home workers, and a significant managerial issue (Bailey and Kurl, 2002). Managers repeatedly raise the question of whether "working-from-home" would not lead to "shirking from home" (Bloom et al., 2015). The typical "Theory X style managers" (McGregor, 1960) with a low perception of self-efficacy, i.e., who do not rely on their employees' ability to handle remote infrastructure, solve situations independently, manage time properly or work without supervision, have a skeptical attitude towards telework (Silva, 2019). The teleworkers also feel the mistrust, who confirm that their supervisors tolerate their preference for WFH unwillingly (Pratt, 1984). Some coworkers share skeptical attitudes towards teleworkers, thinking that the off-premises colleagues are not working full time, while others show acceptance or express awe, envy, jealousy, or resentment (Pratt, 1984). Yet, the current WFH is different from what we know from studies of distributed development and telework, since WFH is not a selective voluntary practice for the few, but a widespread enforced practice for everyone. Motivated by the willingness to understand the actual state and future of work from home, we share our findings from studying **the changes in individual productivity and work routines in the first year of WFH** after our case company closed their offices in response to the global pandemic.

2. Case company: InterSoft

InterSoft (a pseudonym used for anonymity) is an international software company with several hundreds of teams working in development offices in Sweden, the UK and the USA, delivering millions of lines of complex software code per year. InterSoft is a modern agile company with advanced ways of working that promote collaboration and teamwork. InterSoft cultivates the culture of self-management and increased autonomy with decentralized decision-making structures. Thanks to these aspects and geographic distribution, InterSoft has had the facilitating conditions and infrastructure to enable distributed work before the pandemic (usually associated with the ease of implementing telework and the positive attitude towards it (Silva, 2019)). In March 2020, all InterSoft employees in all locations were instructed to work from home, prohibiting access to the office spaces, initially for two weeks, which was extended several times during our study. In September 2021, the offices were temporarily and partially reopened for the necessary presence, closed again in the winter of 2021–2022 and reopened in late spring of 2022. Recently, InterSoft has announced a new policy to enable Working from Anywhere (WFX) and its plan to become distributed-first.

To support the transition to WFH, InterSoft launched a program for reimbursing home office equipment, acquired various remote collaboration software licenses in the early weeks of WFH, and organized numerous experience-sharing activities and fora. Company management exhibited high levels of trust in the individuals and teams' ability to cope with uncertainty and adjust to the situation.

This support and their future plans made InterSoft an excellent case for our study since many companies can learn from them. Besides, InterSoft was involved in another research study, and thus we were already familiar with the context and had access to various data sources important for our research.

3. Overview of the study

Our goal in this study was to understand how engineers cope with the WFH mode and how daily routines and productivity have changed during the transition months and later in the first year of the pandemic. The enforced WFH mode in our study is unique compared to prior studies of telework, which are biased towards voluntary teleworkers (Bailey and Kurl, 2002). We also address a common definitional issue of who qualifies as a teleworker since many previous studies focused on individuals following the practice only partially (Bailey and Kurl, 2002). Our study is driven by the following research question: **How are individual productivity and work routines affected by WFH?** To answer our question, we used the mixed method employing concurrent procedures (Creswell, 2003) by converging quantitative and qualitative data to provide a comprehensive analysis of the research problem. In our study, we combined data from various sources, including GIT commits, Slack posts, calendar invitations, and 30 semi-structured interviews with 15 engineers and three managers. The first 18 interviews were carried out at the end of April/beginning of May 2020. Interviewees were selected by convenience sampling to have representatives from the main locations, age groups, seniors and juniors in the company, and different family situations (living alone, with a spouse, with kids), as studied in prior research on teleworkers (Pratt, 1984). We have carried out follow up interviews with 12 out of 18 interviewees at the end of September 2020. All interviews were 45–60 min long, conducted by two researchers in English via Zoom. All interviews, but one, were audio-recorded. One of the interviewers led the interview, while the other took detailed notes. Later all interviews were transcribed. We had access to four internal company reports of the WFH experiences, which served as (1) input for identifying interesting questions and categories for our analysis, and (2) an additional source of company-wide inquiry, verifying some of our findings by representing a wider sample. Finally, we also had access to the results of an internal survey of the employees' preferences for WFH after the pandemic, conducted in early 2021 (see Fig. 6).

To answer our question regarding the productivity of software engineers working from home, we first generated initial hypotheses based on the quantitative analysis. These preliminary findings inspired the course of the interviewing. Interviewee testimonies were then sought to verify the initial findings (methodological triangulation). Our analysis strategy was descriptive in nature and focused on creating an understanding of the changes in the various aspects of productivity, combining the findings from a thematic analysis of the qualitative data with the quantitative data analysis. The qualitative data was analyzed with the help of thematic coding (Robson, 2011) in iterations, during which we classified behaviors, events, feelings, and activities that influence productivity. **Productivity** in our study is defined as a complex, multifaceted concept described across five dimensions (Forsgren et al., 2021): job satisfaction and well-being, performance, activity, communication and collaboration, and efficiency and flow, which served as higher-level categories in thematic analysis. Instead of using any single productivity measure, which all have been criticized (Forsgren et al., 2021), we decided to rely on a combination of quantitative and qualitative data that explains

the changes in each of these dimensions, comparing WFH to the work in the office. Therefore, we started our analysis with the productivity dimensions defined by Forsgren et al. (2021) as preliminary code categories, which were then expanded with the help of evidence emerging from the quantitative analysis and themes emerging during the qualitative analysis.

We describe our data collection and analysis in more detail in the following. Noteworthy, to ensure the accuracy of our conclusions, we applied data triangulation, combining quantitative data with the insights from the qualitative analysis of the interviews.

To assess changes in **job satisfaction and well-being**, we asked engineers and managers to explain their overall attitude and *job satisfaction* with their workplace at home, relationship with the team members, and tool support for various daily activities. We also looked at the work in unusual work hours through different activities (code commits and meeting invites) during the day. We compared the normalized data by engineer during 2019-03-11 – 2019-12-30 as the "office" control period and 2020-03-11 – 2020-12-31 as the WFH period. The differences in distributions in the two periods were then tested using statistical analysis following Mann–Whitney U test and Cohen's D (Mac-Farland and Yates, 2016; Fritz Catherine et al., 2012). Further, we asked whether the interviewees would prefer to work from home in the future or instead return to the office, as another indicator of job satisfaction, which was also complemented with the results of an internal survey. We also asked the interviewees to drive us through their daily routines. We checked for the signs of *well-being* such as a healthy lifestyle, overall happiness or, on the contrary, emotional problems (Bezerra et al., 2020).

To assess changes in **activity**, we looked at the count of outputs completed while performing work (Forsgren et al., 2021) by analyzing when and how much code engineers commit to the main branch in all version control repositories. We plotted commits and the relative distribution of commits during the day during 2019-03-11 – 2019-12-31 as the "office" control period and 2020-03-11 – 2020-12-31 for WFH. Data cleaning included filtering out the top 25% of the commits considering size, as likely automated *bots*. Differences were tested statistically using Mann–Whitney U test and Cohen's D (MacFarland and Yates, 2016; Fritz Catherine et al., 2012). We also calculated the matrix profiles (DeFilippis et al., 2020) for all time-series data to see if there were any notable changes in patterns.

To assess changes in **communication and collaboration** (Forsgren et al., 2021), we asked the interviewees to describe how their teams adjusted to the remote teamwork, how they managed to communicate and collaborate with team members, and colleagues outside of the team, and analyzed the changes in electronic communication using the Slack posts data in public channels with >10 members. We relate our findings to the research on connectivity (Kolb et al., 2012; Wajcman and Rose, 2011) which explores the appropriate levels of interaction and links between individuals and groups for effective performance.

To measure changes in **efficiency and flow**, the ability to complete work or make progress with minimal interruptions or delays (Forsgren et al., 2021), we asked the interviewees to comment on their perceived ability to stay focused and quantitatively analyzed interruptions introduced by meetings. Quantitative data comprised meeting invites accepted by engineers (incl. developers, data-scientists, and team managers), non-recurring and recurring. Data cleaning included filtering out meetings longer than 4 h as events that do not reflect the meeting habits, and meetings with less than 2 participants as self-bookings. We compared the daily routines and analyzed the changes in the average number of meetings, the average duration of meetings, the total time spent in meetings per engineer per week, and the total number of meetings scheduled per week during the "office" control period and the WFH period.

Notably, in this paper, we do not report any changes in **performance**. This is because we did not have access to reliable data sources to assess work *outcomes* such as code quality or customer satisfaction, as suggested in Forsgren et al. (2021).

We based our analysis on obfuscated datasets cleaned from the information that would allow identifying a person. The quantitative analysis was performed from the user's point of view, performing different actions (commits, meetings or Slack posts) happening in the user's time zone. Thus, the same events are accounted as occurring in different hours for users in different time zones, depending on their location, although happening simultaneously. The quantitative analysis of these datasets was performed using NumPy, Scipy, Pandas and MatPlotLib libraries for Python 3.7.4.

4. Productivity in the forced WFH mode

In the following, we capture the WFH experiences during the first pandemic year (w11-52 in 2020) based on interviews and the quantitative data collected from the company repositories.

4.1. Job satisfaction and well-being

Ergonomics: From the start of the pandemic, many employees realized that their homes did not provide sufficiently ergonomic work conditions. Almost all our interviewees reported working from the lap or a kitchen table and complained about the soon emerging back, neck and/or wrist pains. They used the company support to buy an external monitor, an office chair, an external keyboard, or other missing equipment. Many of the everyday routines had to be adjusted too.

Work hours and daily routines: The analysis of daily activities at InterSoft based on GIT commits and calendar invitations shows that engineers follow similar daily routines compared to working in the office, with a few exceptions (see Fig. 1). We can observe that engineers reach 10% of the daily production on average about 30–40 min earlier than when working in the office in 2019. As one engineer explained: *"I usually get up, take a glass of water, and just start working. It's what differs now – I don't take a shower or eat breakfast"* (Interview No 10, an engineer from Sweden). The end of the day has shifted, but those differences are less prominent. The amount of code produced after the work hours (18:00–23:59) in 2020 accounts only for **7,7%** of the total code produced. In fact, engineers on average reach 90% of daily production about 10–20 min earlier, which in total results in slightly extended work hours. When discussing the daily routines, some engineers confirmed that they worked longer days, at least in the early days of the pandemic. Some engineers said they could not distinguish between work and personal life and continued working late or exchanging emails and Slack messages in the evenings. A manager confirmed: *"I see a lot of people getting very tired"* (Interview No 11, a manager from Sweden). One practice we found to address this was a "hard stop", i.e., a preset time for logging off or turning off the computer. Many people who had a problem stopping working late said to have shifted to a stricter routine after the first 2–4 weeks of the WFH. Similarly, interviewees reported mimicking the transition from home to work, which helped improve motivation.

Physical activity and breaks Many interviewees complained about a dramatic decrease in physical activity, and some even about gaining extra weight. This was connected not only to working longer hours, but also having fewer organic breaks; not to mention the lack of gym exercise for many out of precaution or because of the lockdown. Lunch routines changed from an hour-long social activity to a short lunch by the computer (also
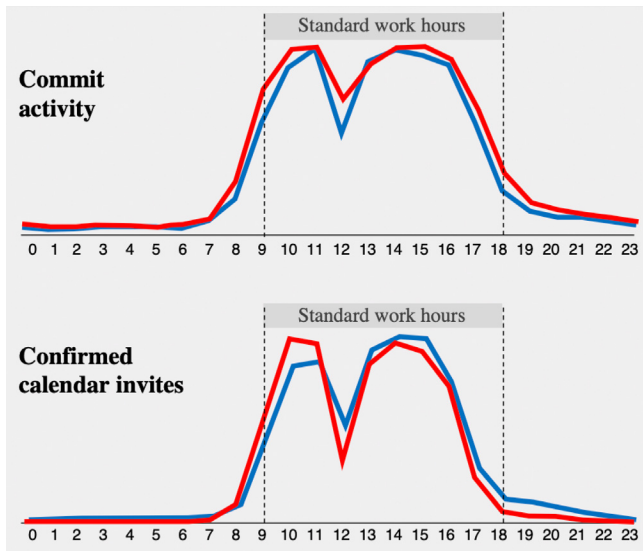
Fig. 1. Daily activity. The blue line denotes the average value during the office work (2019-03-11–2019-12-31), while the red line represents the WFH period (2020-03-11–2020-12-31). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Fig. 2. Changes in output (LOC, rolling average for 4 weeks).

evidenced in increased commit activity between 12–13 o'clock in Fig. 1) or even eating in parallel with a virtual meeting. Many engineers we spoke to further confessed that they are not good at taking breaks. The usual breaks and positive interruptions from colleagues at the office or invitations to grab a coffee or a snack in the kitchen were suddenly gone. Even attempts to have a joint virtual break are not always successful, as an engineer explains: *"If you write someone on email, "Hey, are you free?" There is always a delay, then you wait for 10 min, and then you are back to work again. It would be nice to take more breaks, but I want to take breaks and talk to people"* (Interview No 10, an engineer from Sweden). For many, staying at home, especially in solitude, meant that the walk to the kitchen or the restroom and back takes just a few minutes, after which you are back at the work desk. Thus, physical activity while working from home requires extra effort.

Loneliness: Emotional and social isolation often cause loneliness. Many of our interviewees admitted that their social life suffered from the lockdown or social distancing measures. Loneliness was especially tough for single expats who lived abroad from their families. However, not everyone experiences reduced social interaction as a problem. Some of our interviewees, especially those recovering from a recent burnout, enjoyed working in isolation, which was associated with having more control over their workday.

Work-life balance: Some interviewees complained about the blurred boundary between private and work life. Yet many reported an improved work-life balance. These were primarily family people who benefited from an increased presence in the family life and having flexibility for planning their work time — taking walks with children in the middle of the day or helping spouses when needed.

4.2. Activity

Code production: To understand how WFH has affected engineers' output, we analyzed the total lines of code committed to version control main branches per week — total for the company and normalized per developer, see Fig. 2. The figure shows relative differences in output between the pre-pandemic year (2019)
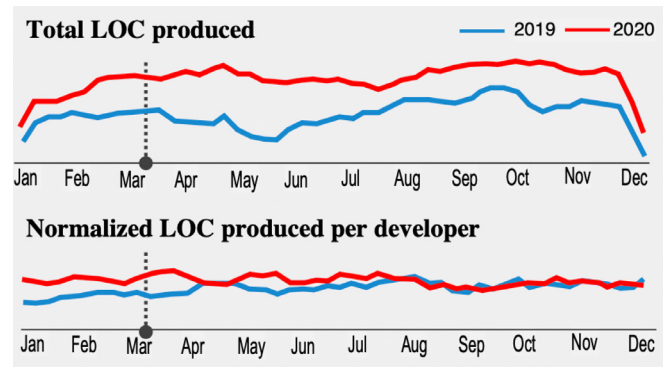
and the first pandemic year (2020), illustrated by a rolling average over four weeks. The total lines of code in absolute numbers in 2020 has increased, which could be because the number of engineers increased. Looking at the normalized, per-engineer, productivity we also observe positive differences. Statistical analysis using Mann–Whitney U test and Cohen's D (MacFarland and Yates, 2016; Fritz Catherine et al., 2012) determined that these changes are significant ($p < 0.05$) but negligible ($d < 0.5$), in practice, translating into just a few lines of code.

4.3. Communication and collaboration

Socialization and informal communication: Since pandemic WFH meant that people could no longer meet physically in the office, we learned that those in need of social contact sought to interact virtually. Conversations by the coffee machines and kitchen gathering traditions are deep-rooted in the daily routines of InterSoft. Spontaneous interactions are used to discuss work, resolve problems, learn something new or just catch up on non-work-related topics. While working remotely, all teams and departments have tried to carry out virtual coffee breaks at least once a week, although with mixed success. Many interviewees complained that the ease of socialization was gone, and there was often an awkward silence. Some joked that the extra motivation to attend coffee breaks disappeared with the lack of sweet pastry. As a result, the virtual hangouts often were said to have few participants. Not surprisingly, almost all interviewees independently reported that their daily stand-ups were prolonged to facilitate informal communication since these meetings became the main or even the only contact times, at least for some team members. Comparing the situation between May and September 2020, even introverts who were said to have enjoyed the "peaceful conditions" of working from home in the beginning of the pandemic, have started to miss social routines.

Team cohesion: Many engineers discussed that the level of socialization in the teams dropped. Some of the office routines that helped raise the team's mood and connect on a personal level have not reached the virtual space. As an engineer commented: *"It got boring - no fun stuff happening"* (Interview No 24, an engineer from Sweden). Thus, some revealed they had a feeling of becoming less connected with their teammates. Yet, there were also those who, on the contrary, said they felt more connected than before, because they could see the glances of the family life during the video sessions, which they had not seen before. Challenges with keeping the team spirit have become a regular topic during team retrospectives. Our interviewees revealed that their teams sought and quickly adjusted new approaches, such as regular video-game sessions, short virtual *"Hey, good morning"*
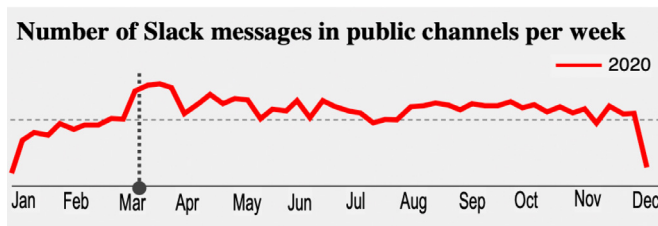
Fig. 3. Changes in Slack communication in public channels.

greetings, shared lunches, fruit breaks and afterwork in front of the video chat, to compensate for the lack of face-to-face interaction. Some interviewees said to have arranged a few team meetings in person – a picnic in a park, a joint lunch, or a walk.

Problem-solving We learned that spontaneous discussions are essential not only for socializing, but also for problem-solving. Our interviewees all echoed each other saying that there are no "over-the-shoulder" conversations anymore, for good and bad. On the one hand, this meant that one could no longer shout out a question and get a quick answer. Thus, engineers can be blocked for a longer time than usual. A recent hire explains: *"When I get stuck, I (usually) ask others about possible solutions. Now it is a little bit different. If I am unsure how to do (a task), I usually ping someone in Slack who has done something similar and have a brief discussion. If I need more ideas, I can ping the same person or post it on the team Slack channel. But you have to know who to ping"* (Interview No 5, an engineer from Sweden).

On the other hand, many felt less distracted by peers and benefitted from the uninterrupted flow (we will discuss this later). Solving problems individually, especially for novices, led to becoming more independent. In the end, some speculated that the effect of having a better flow and being stuck for longer might compensate for each other productivity wise. Finally, to facilitate spontaneous interaction, some teams scheduled drop-in channels.

Information sharing: When working from home, overhearing conversations in the office became impossible. Yet, since many "over-the-shoulder" organic conversations have moved to Slack chats, it became possible to follow the documented conversations if and when people chose to. The Slack records showed a spike around March 10, when WFH was introduced, and a significant increase in the number of slack messages in the public channels alone throughout the first pandemic year (see Fig. 3).

The way information is shared was affected by a lack of corridor conversations with colleagues outside the team. One engineer revealed that instead of meeting approximately 40 colleagues regularly, he interacted with only five of them while working from home (Interview No 2, an engineer from the USA). Similarly, the serendipitous opportunities to get introduced to unfamiliar colleagues have dramatically decreased.

Pairing: The practices of pairing and mob programming suffered similarly to all interactions that have been previously held spontaneously. Even big fans of pairing reveal that they hardly paired remotely. As an engineer explains: *"(WFH) is a barrier to doing pair programming or mob programming. It's easier in the office. We've tried it once since we started working from home, and I think it worked quite well, but I think it's hard. I am not sure why. I've tried to say that I want to pair, and then it's 'Yeah, sure. Let's do it after lunch'. And then things change after lunch, and then you don't do it. Maybe it's because we need to schedule this more explicitly"* (Interview No 10, an engineer from Sweden). Initially, many delayed the pairing in anticipation of an early return to the office. However, as we all realized that the pandemic would not

end soon, many interviewees said to try out available options. One solution has been to pair while doing parallel work with frequent synchronization. Another engineer explains: *"Now we sync several times a day, without sharing the screen. When needed, we say 'Are you free?' and either jump on a call or start screen-sharing"* (Interview No 1, an engineer from Sweden). Many have successfully used Zoom or Mural (a tool for remote collaboration). Interestingly, one engineer reported doing more pairing in their team during WFH. These were daily sessions (between the stand-up and the lunch, sometimes continuing after lunch) with an open video channel. Find more about WFH pair programming at InterSoft and another company in our dedicated analysis of remote pair programming (Smite et al., 2021).

Communication across locations: Many teams split across InterSoft locations are said to experience better times than before the WFH. As an engineer explained: *"Everyone is now on the same terms. […] Now I collaborate as much with [Location 1] people as with [Location 2] people"* (Interview No 8, a data scientist from Sweden). Meetings involving people from different offices are said to happen on an equal basis, with everybody dialing in. There are no obvious cliques in a meeting room and no location-specific disadvantages since the physical group division do not exist anymore. Some engineers even said that they perceive everybody (within the same time zone) to be equally accessible, removing the distance between offices and the building floors, and report increased connectivity with people they were unfamiliar with before. One interviewee from Sweden even reported being able to join a USA-based team for a period.

4.4. Efficiency and flow

Perceived ability to stay focused: Since the spontaneous interruptions from colleagues and some of the other reasons for taking regular breaks during WFH disappeared, many engineers reported feeling an increased level of focus and being in "the zone" (Forsgren et al., 2021). As an engineer explains: *"There is a great sense of productivity when you get into that momentum"* (Interview No 3, an engineer from the US). These were primarily engineers who worked on independent tasks and were familiar with their work. The downside of having the increased focus was that engineers felt exhausted earlier than normally. But the feeling of gained productivity still appears to be more important, as explained by the same engineer: *"It is not necessarily a bad thing. A more focused but shorter workday is nice"* (Interview 3, an engineer from the USA).

Meetings: Efficiency and flow require extended periods of concentration, which meetings can interrupt. A high number of meetings was found to cause stress during the pandemic (Bezerra et al., 2020). To understand what happened in InterSoft, we analyzed calendar invites (see Fig. 4).

When comparing the time spent in meetings in 2019 and 2020, we observe negligible differences in both mean values and 25%–75% quantiles (see Fig. 4). The comparison shows nearly a perfect match, give or take some seasonal events that fall into different weeks each year. The mean daily time spent in meetings in 2019 and 2020 is 89 min and 98 min per day respectively. The larger differences can be observed during the first few months of the pandemic and the vacation period. Both time booked for meetings and the number of meetings in 2020 is higher, which is also confirmed by our interviewees, who reported not taking the usual vacation. The mean number of meetings per day increased from 1.9 meetings in 2019 to 2.3 meetings in 2020.

Engineers explained that at the beginning of WFH, everybody tried to mimic the office routines and carry on with usual meetings, to realize that online meetings are much more exhausting.
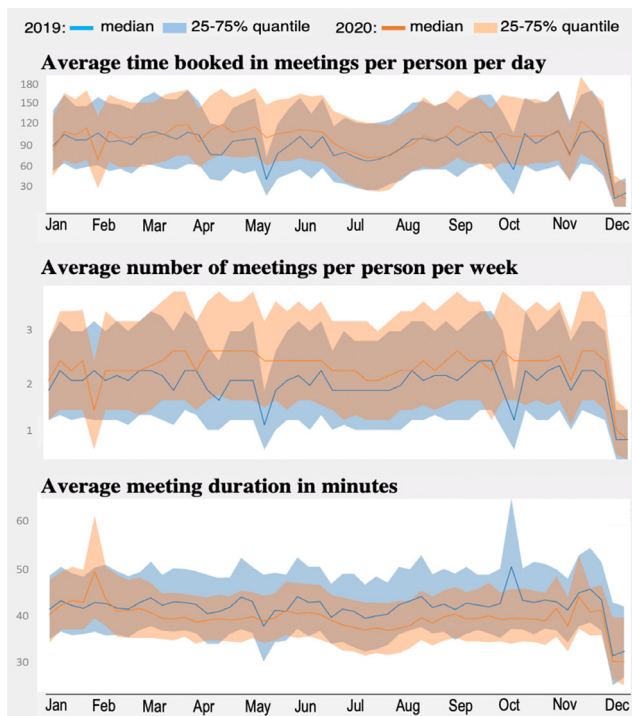
Fig. 4. Changes in work meeting characteristics.

Fig. 5. Changes in work meeting scheduling.

This was especially noticeable for those having several meetings in a row, since people are no longer changing rooms and switching between meetings requires pressing the "leave" and then the "join" buttons. Exhaustion is a possible explanation for why the meetings' duration became slightly shorter already in the second week of WFH.

We learned that to make online meetings more efficient, more time was spent preparing a better agenda and input for discussion (written proposals, drawings, documents for prior review). Another company-wide initiative was having one meeting-free day during the week.

We also found that after going into the WFH mode, the time spent in recurring meetings increased (see Fig. 5) likely because spontaneous conversations that would happen organically in the office, such as virtual coffee breaks, socialization hours, or pair programming slots, in WFH became regularly scheduled. Our analysis suggests that while time spent in recurring vs. non-recurring meetings until the start of WFH was about the same, during the WFH, engineers spent on average 63 min per day in recurring and only 44 min per day in non-recurring meetings.

5. Transition to forced WFH: Dramatic change in work conditions

English dictionary defines a revolution as an important change in an area of human activity (Collins), or as a dramatic and wide-reaching change in conditions, attitudes, or operation (Oxford). The described transition to forced WFH with often unsuited workplace and with the lack of travel and face-to-face interaction of unprecedented scale qualifies as a dramatic and wide-reaching change in work conditions for many knowledge workers. Yet, our documented experiences from one company demonstrated that the change in operation is not that dramatic. Employees continued to deliver code and complete their daily duties, adjusting their routines to the WFH (see a summary of our findings

and tips in Table 1). We analyzed different aspects of productivity, including developer job satisfaction and well-being, activity, communication and collaboration, efficiency and flow.

Many associate WFH with increased productivity and job satisfaction: Generally, our results are consonant with related studies on WFH under COVID-19 that found pandemic productivity in software companies not much changed (Forsgren, 2020; Bezerra et al., 2020; Smite et al., 2022; Silveira et al., 2021) or even increased (Oliveira et al., 2020), and prior research suggesting that telework leads to increased productivity and job satisfaction (Bailey and Kurl, 2002). This is an exciting finding, since the general opinion about distributed work is that it is much less effective than co-located work (Herbsleb and Mockus, 2003). The difference between pandemic WFH and distributed work that has been studied before is that (1) now everybody worked from home, resulting in a level playing field, therefore raising the quality of distributed meetings and events, and (2) WFH teams are composed of members that are sufficiently connected as they have previously established close personal relationships (known as requisite connectivity Kolb et al., 2012) as opposed to traditional distributed teams with members who rarely meet (known as hypo-connectivity Kolb et al., 2012).

A WFH day resembles normal office activity with slightly longer work hours, fewer interruptions, more concentration We found that in the absence of office interruptions and socially imposed breaks (also found in Russo et al. (2021c)) as well as the result of the lack of commute, many engineers had longer work hours and managed to focus better on the current task. Longer work hours have also been found in the extensive study of GitHub projects (Forsgren, 2020), an early WFH study published by Bloomberg based on the first week's user activity data from the network service provider NordVPN Teams (Meakin, 2020) and an open survey of IT professionals (Russo et al., 2021a). Further, a recent study that measured keyboard usage in Microsoft (Microsoft.com, 2022) reveals that about 30% of employees experience a triple peak workday when working from home, i.e., an increase in keyboard activity in the evening. These studies warn about possible future burnouts. Our findings are more consonant with Cao et al. (2021) who found that the distribution of daily meetings, email activity and actions with files remain largely the same (Microsoft.com, 2022). Even if there is a third peak in the evening, our data suggests that the evening activities are not related to code commits. And the longer work hours in our study are on average no longer than 50 min, with about 30 extra min in the morning and 20 extra minutes of winding down the day in the evening.

WFH has dual impact on the work-life balance: On one hand, we found that many engineers, especially in the early months of the pandemic, complained about the blurred boundary between

Table 1
Overview of the findings: Impact of WFH on the different productivity factors and useful adjustments for WFH.

Productivity factors		Key findings	Useful adjustments for WFH and tips for WFX
Job satisfaction and well-being	Ergonomics	• Poor workplaces at home in the beginning of the WFH	• Reimburse home office equipment and basic services
	Work hours and daily routines	• Many start the day earlier (30 min on average) • Many extended workhours, especially in the beginning of WFH in the absence of commute home and limited personal plans (on average by 20 min)	• Mimic transition from home to work • Introduce a hard stop for the day (close the computer at a particular time)
	Physical activity	• Physical activity reduced to a minimum in the absence of office walks and gym routines during the lockdown • Lunch changed from a scheduled social activity to self-imposed shorter lunch, often at the work desk • Spontaneous breaks (coffee, chit-chat) decreased	• Replace virtual meetings with walk-and-talk meetings when computers are not required • Introduce routines for regular breaks
	Loneliness	• Some people felt lonely due to the lack of socialization during the lockdown and not as much specific to WFH* • Some people, especially those recovering from the burnout, in contrast, enjoyed the work in solitude	• Refocus 1:1 meetings with the manager from career development to personal well-being • Extend stand-ups to cover personal status updates and well-being (from 15 to 30 min).
	Work-life balance	• Better work-life balance for family people due to the increased presence at home and increased flexibility	• Leave the decisions regarding when and where to work to individuals
Activity	Code production	• Code production measures normalized per developer in 2020 are comparable with those in 2019 (significantly higher but only negligibly different)	
Communication and collaboration	Socialization and informal communication	• Lack of spontaneous conversations • Almost every interaction becomes a scheduled meeting • Afterwork and social activities changed from being regular, well-attended to less frequent and less attended.	• Schedule regular virtual events, such as video-gaming, coffee breaks, and afterworks
	Team cohesion	• Many teams divide tasks more, resulting in more solo work	• Organize regular virtual work sessions for the team
	Problem-solving	• Individual search for solutions or peer-to-peer queries via direct messaging instead of "I have a problem" shoutouts • Receiving an answer takes longer. • Ability to elicit help depends on having personal contacts • Increased use of online material over the help from peers.	• Organize drop-in video rooms available all day long for spontaneous discussions
	Information sharing	• Ability to "overhear conversations" is limited to documented chats and requires proactive search • Documented chats are available after conversations occur • Fewer interactions outside of the team • Limited opportunities to meet unfamiliar colleagues	• Document conversations in chat channels • Review Slack discussions to keep up with what is happening
	Pairing	• Pairing was delayed in the beginning of the pandemic and gradually increased, though staying at a low level. • Replaced by screen sharing, parallel sessions with frequent synchronization and special tools	• Ensure tool support for remote pair and mob programming
	Communication across locations	• Increased fairness and visibility for members of a distributed meeting, team or event ("level playing field") • More opportunities to join remote teams and events	• Keep equity between onsite and remote employees. • To increase cross-company cooperation, allow joining teams and events from other locations remotely
Efficiency & flow	Perceived ability to stay in the flow	• Better and longer focused time due to an increasing division of tasks and the lack of interruptions from peers • Interruptions from family members	• Organize extended pairing sessions to ensure discipline if having a problem working from home
	Meetings	• The number of meetings increased (+2 meetings/w) • The average duration of meetings decreased (−4 min) • Slightly more time is booked for meetings (+45 min/w) • Online meetings associated with an increased fatigue	• Start meetings with a short break • Prepare the agenda and input material for discussion • Introduce a meeting-free day once a week

work and personal life associated with the extended hours of work in the evening and poor work-life balance. At the same time, we found that many enjoyed being close to their families, working in the upgraded home offices, and even moving to better accommodations further away from the office, something that was not possible due to the daily commute. Besides, the shift from the constant connectivity in the office to the remote connectivity by choice might have also contributed to the feeling of increased control over social interactions and distractions, as suggested in related research (Kolb et al., 2012). Related studies also indicate that the ability to choose when and in which order to address the incoming messages and requests, prevents engineers from feeling overwhelmed or intimidated by the volume of communication (Wajcman and Rose, 2011). This explains why not all engineers feel isolated or lonely when working from home, as we found engineers who had recently been burned out in our study

to benefit from WFH conditions. Similarly, other researchers suggest that the lack of social contacts will not necessarily make everybody feel lonely, but only those having a high desire for social relations (Wright and Silard, 2021).

WFH can be challenging, especially for highly collaborative work: Yet, a critical finding in our study is that WFH is not challenge-free and might not be for everybody. This is evident also in the surveys of perceived productivity in WFH, which suggest that some are doing better while others are doing worse (Ford et al., 2021; Smite et al., 2022). Our results suggest that not everybody feels equally productive working from home. Work hours have increased, while physical activity, socialization, pairing and opportunities to connect to unfamiliar colleagues have decreased. These findings are in line with other studies reporting a decrease in communication, brainstorming and social interaction with colleagues (Ford et al., 2021; Miller et al., 2021).

The effects of remote work on collaboration networks have also emerged in an extensive study of individual communication networks in Microsoft (Yang et al., 2022), which suggests that the shift to WFH made collaboration networks more heavily siloed across organizational units, and more static with fewer new ties. Furthermore, our analysis of the Slack data provides additional evidence quantifying the increase in asynchronous communication (Yang et al., 2022), which can be seen as an overhead of remote coordination. Interestingly, the gains in productivity associated with the better flow when working in isolation in the absence of office interruptions as reported by our interviewees, has been debated in research that highlights the importance of constant connectivity and looks at the frequent calls for attention as normal behavior instead of distractions from work (Kolb et al., 2012). We also found the negative effects of decreased connectivity, for example, being stuck longer when experiencing problems or solving complex tasks. In fact, some participants in our research considered the increased flow and decreased connectivity to have canceling effects. While there is a belief that one can learn to facilitate organic communication virtually using computer-mediated tools (Wajcman and Rose, 2011) and our study shows that engineers at InterSoft have made many adjustments to improve their WFH experiences, spontaneous interactions, connectivity and connectedness, approaches to problem solving, information sharing and rich group awareness (up-to-the-minute understanding of the members' whereabouts and their actions (Kreijns et al., 2007)) have all suffered despite the rich tool support provided by InterSoft.

Online meetings — more in amount but shorter, better planned but less spontaneous, and more tiring: Finally, we add new evidence to the debate about the burden of online meetings. Like related studies (Ramachandran, 2021), interviewees from InterSoft reported online meeting fatigue. Our evidence from studying calendar invitations substantiates related survey studies and archival analyses reporting increased number of meetings (Ford et al., 2021; Miller et al., 2021; DeFilippis et al., 2020) and decreased meeting duration (Ford et al., 2021; Russo et al., 2021c; DeFilippis et al., 2020). The average differences for the time spent in meetings are negligible and amount to less than an hour a week. However, our analysis also shows that some individuals (25%) have had up to 30–60 additional minutes booked for meetings per day. Similar findings are reported by deFilipis et al. who studied digital communication of 3,143,270 users during the first 3 months of the pandemic (DeFilippis et al., 2020). Interestingly, in contrast to (DeFilippis et al., 2020), the time spent in meetings in InterSoft initially increased and only after the fourth month of the pandemic declined, which emphasizes the importance of studying long-term effects of WFH.

One may wonder whether InterSoft is special in any way, and whether our findings apply to other software companies. We studied a large company that operated in a distributed fashion before the pandemic, thus having tools and infrastructure to support remote work but has not practiced working from home on the scale comparable to that during the pandemic. What might be unique about InterSoft is the widespread use of agile ways of working and increased team autonomy and employee engagement, which might have also helped with the transition to remote working. Thus, we believe that our findings are likely to be applicable to other international companies that rely on agile methods and decentralized authority.

6. Transition from forced WFH to voluntary WFX: Dramatic change in attitude

The futuristic future portrayed in the study of WFH pioneers published in 1984 with extensive practice of work from home (Pratt, 1984), which was also forecasted in a more recent study of telework (Silva, 2019), has turned into reality. Along with other progressive software companies, InterSoft announced their Work-from-Anywhere (WFX) policy that allows employees to choose how often they prefer to be in the office or at home, even permitting them to move to a country of choice (with some restrictions). An internal survey of 1408 R&D employees at InterSoft reveals that 91% of employees choose to continue working from home at least one day a week even after the pandemic, nearly 40% commuting to work only a few times a month, and 7% choosing to work from home entirely, leaving only 9% of employees who prefer to return to the previous predominantly office work routines (see Fig. 6). The testimonies of the interviewees included in this paper explain these results. Our results support that the better-than-expected WFH experiences caused a shift favoring WFH (Barrero et al., 2021). In InterSoft these were ensured through investments and adjustments to establish a well-functioning WFH. In fact, successfully adjusted daily routines in WFH are found to be significant positive predictors of well-being while working from home (Russo et al., 2021b). InterSoft's practice of walk-and-talk meetings, extended stand-ups, virtual gaming evenings, virtual social events, and extended pairing sessions (see Table 1), are all examples of useful adjustments, and complement related studies (Santos and Ralph, 2022). Another likely driver of the decision to continue working from home could be related to the wish to avoid daily commute, as in the case of telework pioneers (Pratt, 1984). Several of our interviewees from large cities in Sweden and the USA had already moved to more spacious but remote accommodations, which increased their life quality and well-being, but decreased their motivation to return full time to the work in the office.

Similarly, the increased flexibility and improved work-life balance experienced during the WFH certainly impacted the willingness to spend at least a few days a week working from home. In other words, InterSoft employees are not returning to "the old normal". As one manager commented: *"Would I go back to the previous normal working from the office version where I go five times per week – I would say – No. If I would stay forever and not go to the office – I would say it would be manageable, but a hybrid version would be better"* (Interview No 21, a manager from Sweden). Evidently, the hybrid work policy is a compromise that is likely to help retain staff, since enforcing the office work policy or full time WFH policy these days would upset large groups of employees.

Neither positive experiences with WFH during the pandemic, nor the chosen future policy is unique for InterSoft. Similar WFH experiences have been found in Brazilian software companies (Bezerra et al., 2020), Microsoft (Ford et al., 2021) and GitHub projects (Forsgren, 2020), to name a few. Policies of long-term or even permanent working from home have also been established by companies like Facebook, Twitter, Square, Shopify, and Slack (Stoller, 2021). Apple is the only well-known example of a company returning to "the old normal" to date. The company restricted the flexibility experienced under the pandemic and only agreed to let employees work from home two days a week, with limited exceptions — the decision received great resistance (Zetlin, 2021).

Regarding the nature of the future workplace, we can with certainty assume that it will not resemble the pre-pandemic office-centered work. The results from InterSoft employees' preferences for continuing WFH combined with our detailed productivity analysis suggest that if letting people decide how they want to work, companies may experience an increase of productivity. This is because those who have felt hindered at home will likely return to the predominantly office-based work, while those who have been productive working from home are likely to continue working remotely. It is fair to believe that after another adjustment
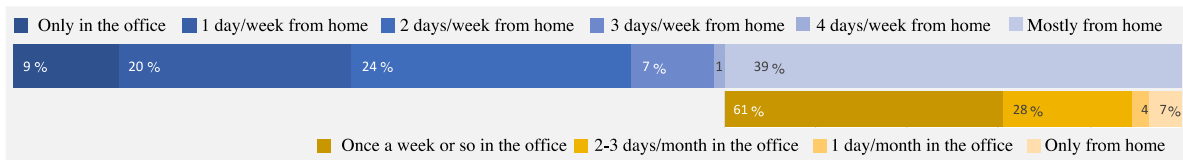
Fig. 6. InterSoft employees' choices of working from home vs. from the office after the pandemic.

period, both engineers and teams will establish yet new routines for hybrid working, which is an important future research direction. These adjustments shall be directed towards the following challenges and concerns emerging from our study: decreased pairing, limited socialization activities, poorly attended events, decreased connectedness and connectivity, and prevalence of isolated opposed to collaborative tasks. Another important challenge to address is the hybrid team practices. While aligned office presence among team members ensures experiences of pre-pandemic office work iterated by all-remote experiences similar to the pandemic working, the misalignment of office presence will likely surface the challenges of partially dispersed teams. These include preferential behavior towards members of one's subgroup, a less effective transactive memory in the team, weaker identification with the team, divergent viewpoints leading to conflicts, and coordination problems (O'Leary and Mortensen, 2010). When remote members are few, the chances of being treated unfairly grow and they are likely to receive less interesting tasks (Bailey and Kurl, 2002) and not being involved in decision-making (Šablis et al., 2018). Similarly, companies shall find new creative ways to sustain their networking and cooperation culture that was previously cultivated through constant office connectivity. Our study shows that during the first year of all-remote pandemic working company-wide collaboration has significantly decreased, as also evidenced in the Microsoft study quantifying the company-wide contact networks (Yang et al., 2022). Thus, companies will require new virtual networking activities and events, or even or mandatory office-based events. In fact, the interviewees in our study repeated that WFH has not had a significant impact due to the strengths of the already established relationships. After spending a year apart, some of them admitted that meeting in person is vital. As an engineer explained: *"We still need to meet in person. Otherwise, you lose touch. You stop seeing the person behind the screen"* (Interview No 20, an engineer from Sweden). The hybrid future will thus hopefully ensure both, the superior efficiency of uninterrupted working from home and the superior socialization opportunities present in the office.

CRediT authorship contribution statement

Darja Šmite: Conceptualization, Investigation, Visualization, Funding acquisition, Formal analysis, Writing – original draft. **Nils Brede Moe:** Conceptualization, Investigation, Writing – review & editing. **Eriks Klotins:** Investigation, Data curation, Formal analysis, Writing – review & editing. **Javier Gonzalez-Huerta:** Investigation, Data curation, Formal analysis, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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