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How Has the COVID-19 Pandemic Affected Working Conditions for Research Software Engineers?

Caroline Jay, Tamara Lopez, Michel Wermelinger and Helen Sharp

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Caroline Jay[1], Tamara Lopez[2], Michel Wermelinger[2] and Helen Sharp[2]

[1] The University of Manchester, Manchester M13 9PL, UK
caroline.jay@manchester.ac.uk
[2] The Open University, Walton Hall, Milton Keynes, MK7 6AA, UK
{tamara.lopez; michel.wermelinger; helen.sharp}@open.ac.uk

Abstract. We report results from a diary study asking research software engineers to reflect on their experience of working during the COVID-19 pandemic in spring 2020. Whilst people reported difficulties with working at home (lack of space and equipment; increased childcare responsibilities) the majority were able to continue their work without major disruption. Communication changed significantly and variously, with people reporting better, worse, more frequent and qualitatively different interactions with people. Participants reported both improved productivity, and potential burnout. Overall, research software engineers found the switch to working from home fulltime straightforward in terms of performing the technical parts of their job role, but many found the changes to the organizational structures surrounding them had profound effects on their wellbeing, through improved flexibility and inclusivity, but also poorer social interaction and increased fatigue.

Keywords: Research Software, Scientific Software, Research Software Engineering, COVID-19, Resilience.

1 Introduction

All over the world, the COVID-19 pandemic has closed workplaces. In many professions, including software engineering, people have switched to working at home fulltime. Studies conducted in industry have shown that the pandemic has had a negative effect on professional software developers' wellbeing, and that women, parents and people with disabilities may be disproportionately disadvantaged [1]. Productivity has also been affected, and appears to be particularly sensitive to the quality of social contact people have [2].

This paper reports results from an adaptation of a Work Diary study [3] deployed between April and June 2020 to understand the changing situation in research software engineering work environments as a result of the COVID-19 pandemic. The study took place over an eight-week period, during which 17 self-identified research software engineers (RSEs) recorded their thoughts about the impact of the pandemic on their work

and lifestyles. Each weekly entry included a series of questions based on the agile software engineering retrospective, a technique used within agile teams to look back on previous work. The first week followed a basic retrospective format [4], asking participants to assess what went well and didn't go well, and to identify areas that could be improved going forward. To encourage ongoing participation, questions in subsequent weeks were adapted from creative retrospective plans designed by agile practitioners[1].

In this analysis, we focus specifically on the set of questions asked in week one, and questions that asked about changes in RSEs' working conditions given in weeks 1, 3, and 5-8. These questions were not asked in week 2, or in week 4, in which participants were asked to fill in a "happiness radar"[2]. The full set of questions and redacted/anonymised responses is available on Figshare [5].

2 Method

An invitation to take part was issued via various international RSE social media channels in two batches, resulting in 11 participants starting in the week commencing 6th of April, and six starting in the week of the 20th of April. In total, 17 participants responded to the invitation; 15 agreed to participate after the first week. Table 1 describes participant demographic data. Participants were sent an email each week inviting them to complete a diary entry for a total of eight weeks; data were collected through a survey deployed via JISC's Online Surveys.[3] The data we analyse here were responses to the following questions:

- Week 1
  - How has your work changed?
  - What has gone well?
  - Are there things that have not gone well? Please give details.
  - Would anything have made this transition better for you?
- Week 3
  - Can you give an update about any changes in your working situation?
- Week 5
  - What is the best outcome you can imagine when this is all over?
- Weeks 6 and 7
  - Please give us an update about any changes in your working situation as a result of responses to the COVID-19 pandemic.
- Week 8
  - Please give a final update about any changes in your working situation.

[1] Plans adapted from https://retromat.com and https://funretrospectives.com
[2] https://www.funretrospectives.com/happiness-radar-for-a-timeline/
[3] https://www.onlinesurveys.ac.uk/about/

Table 1. Participant Demographics. Roles and domains have been put into categories and participant number is not linked to protect anonymity.

Years as RSE	Years in software	Role	Domain(s)	Education	Location
18	15	Manager	General	PhD	UK
3	8	RSE	General	PhD	UK
3	n/a	Research Software Analyst	Humanities	PhD	
15	15	Research Fellow /Tech Officer	Humanities	PhD	UK
4	35	RSE	General	Master	
5	20	RSE & manager	Physics	PhD	UK
6	9	Sr Research Fellow	Biology	PhD	UK
15	35	RSE	Physics	PhD	Canada
1	5	RSE/Data Scientist	Education, Health	PhD	UK
2	7	RSE	General	PhD	
20	30	RSE & manager	STEM	Post-grad	
1	11	RSE	General	PhD	
6	17	RSE		PhD	UK
1	4	RSE	General	PhD	UK
7	20	RSE	Biology	PhD (In progress)	UK
2	20	RSE	General	MSc	UK
4	8	RSE/Data scientist	Agriculture	PhD	UK

3 Results

We take a framework approach to the analysis, reporting the answers in narrative form under sections that map directly to the questions asked of the participants. We summarize responses and report issues that arose, but do not generally report the numbers of participants who raised them, as the sample is not necessarily representative of the wider population.

3.1 Participants

Seventeen participants filled out the first set of responses, and between six and 12 filled out responses in subsequent weeks. For 12 of the participants their highest degree was a PhD, and for three it was an MSc. Eleven participants worked in the UK, one in North America, and the remainder did not say. Participants reported having between 4 and 35 years' experience writing software for science (see also Table 1).

3.2 Responses

How has work changed? (week 1).

All the participants found themselves working from home and communicating with colleagues online. Some of the participants were set up for this as they already worked from home part- or full-time, and the change of location was not particularly disruptive: "Given that I already worked one day a fortnight from home, I had my personal setup ready to go. So the transition was pretty seamless." (P4). For those who previously went into work every day the change was more disruptive, because they did not have a suitable workspace: "Working from my living-room, without a proper desk or chair." (P6).

Some participants had to change their routines: "With a small child, I don't sit at my desk continuously during standard working hours, I start work earlier and work into the evenings." (P7); "Shorter working hours, more distractions and interruptions, more context switching between work and life outside of work." (P1). P3 reported there were "more porous boundaries between work and home time."

Contact with colleagues changed: "more asynchronous communication not just within RSE team (mainly via Slack channels) but also with project partners." (P3); "I spend more time checking in with my team, to ensure they are ok, they are managing their workload etc. I spend more time on slack." (P7); "I have much less informal contact with my colleagues." (P8). Work was more focused in some cases: "More short meetings. More focus on delivering paper outputs." (P14); "focus is now on production/outputs, instead of many distractions (i.e., I get less emails)." (P17).

The work itself did not change that much, however: "The research projects that I am involved in are all data-focused and so they have been able to continue while working from home i.e., nature of the work I am doing and workload has not changed." (P9), although there was a switch to work related to the pandemic: "We have been receiving many requests to help with computational projects related to the pandemic, requiring a rebalancing of work." (P2); "Project priorities have been changed. There are several

high priority Coronavirus projects." (P5). P4 reported that workload increased initially in terms of people wanting to maximize the use of the additional time they had: "Perhaps slightly higher demand from users when lockdown in UK/USA started who cite wanting to make the most of their time while stuck at home, but that tailed off very quickly when they worked out how the system worked and I fixed the initial bugs."

What has gone well? (week 1).

People reported increased productivity: "My productivity has been better than expected (compared to individual days of working from home in the past)." (P2).

Meetings transitioned online without difficulty, and additional meetings helped with morale: "team stayed connected with option to attend daily 'water cooler' meetings; senior management as well as RSE team director [attended]" (P3).

Simply managing to keep work going was viewed as a positive by many: "We have been able to provide much the same service as before. Home internet and collaboration tools seem to have held up." (P5); "All our work was done using collaborative tools anyway, so that's still going well." (P6). P7 viewed the adjusted work patterns as positive: "I have lowered my expectations as to what I can achieve. In the office, there are many distractions, at home when I do get to work I am focused on a single project. My husband and I have come to an agreement that we are happy with regarding balancing childcare and work.". P8 also enjoyed the opportunity to change routine: "I feel that I have much greater flexibility in how I structure my day e.g. I prefer to work a shorter working day over 6 days and I wouldn't have been able to do that previously."

People enjoyed greater bonds with colleagues: "I've learnt more about my team of RSEs in two weeks than I did in the previous 12 months. Everyone has tried really hard to help each other out, despite confounding factors such as childcare." (P11). The inclusivity of some projects also increased: "[I had the opportunity to] to participate in some work-related projects and teams that was only possible remotely for me (through the fact that these activities are now moved online)." (P1).

What has not gone well? (week 1).

The physical working environment caused problems, with people lacking desk space, IT equipment, good internet connectivity and quiet space: "it's a month since I'm at home... my chair is starting to become annoying. I don't have space in my flat to get a proper setup. Also, not having a second screen is becoming annoying. MS Teams video conference on my Linux box works so-so. I can't see more than the person who is currently speaking." (P6); "Discussions that would usually use a blackboard are more difficult via Zoom." (P8). There was disruption from others in the house: "Busier than usual 'work place' with many interruptions from the kids. Pressure to make and serve food at a precise time in the day when kids have lunch break from online school." (P1).

Blurring of home/work boundaries caused issues: "too many meetings while also doing home schooling and adapting to new set up; adaptation to non-linear day" (P3). This also led to aspects of workload increasing: "I have found myself working more hours, partly due to finding it harder to distinguish between work and personal time when working from home (especially now), and partly due to extra work coming in.

Multiple calls every day are starting to become tiring, although it's better than no contact." (P2); "Getting to the work desk straight from bed is fun for the first few days, but can backfire. Some days I feel more tired as I finish the day much later than I would otherwise." (P10). For P5, communicating online led to both increased workload and increased isolation: "There's a proliferation of communication channels and it's stressful trying to keep up on all of them. Feeling much more isolated from the team. We have a daily video chat for afternoon tea but that isn't quite the same. I am probably working one hour earlier and several hours later each day. When your leisure looks like and takes place in exactly the same environment as your work it is hard to relax." This was particularly acute for P11: "Personally I feel burnt-out already. Longer hours. Actually more sustained time spent interacting."

Those in management positions were concerned about their teams: "In some team meetings, others are unmotivated which in turn makes me think my efforts are wasted. I have concerns that my team are not reaching out for help when they need it, and that I can't proof their work as effectively." (P7).

Would anything have made this transition better? (week 1).

When asked what would have made the transition easier, a better home working environment came up for those who did not already work at home. P1 reflected on their own psychological response: "Just internal stuff - trying to be more patient and calmer. I have everything else in technical terms to enable me to work from home."

P2 would have preferred not to have to shift work priorities: "Focus on existing projects delivery and research while leaving aside involvement in new project ideas." Additional support was also raised, in terms of financial/equipment (P2, P14), social (P9) and line management/job security (P12).

Can you give an update about any changes in your working situation? (weeks 3, 6, 7, 8)

In week 3, the majority of participants did not report significant changes. Some were remaining positive: "I am quite happy with my new routine and generally quieter life for the moment." (P5), whilst others were struggling: "My personal mental health is taking a battering in terms of decreased ability to focus and increased fatigue." (P5); "Burn out might be a real issue." (P10). P11 was experiencing the effects of poorer communication patterns: "Focusing (deliberately or not) on things that can be done remotely has led to neglect of relationships - ironically within our department rather than beyond. Probably because those interactions normally happen informally and as a result of co-location." P15 was moving jobs and P12 was worried about being furloughed.

In week 6 few participants reported significant changes. P11's department was being reorganized: "…partly justified by expected reduction in income due to COVID-19." P10 was "spending more time with children, have less time for work. More difficult to have spontaneous discussions with colleagues and collaborators."

In week 7 many participants did not report significant changes, but others were finding things challenging. P5 was still struggling with working conditions: "No changes really although my keyboard is conspiring against me and choosing a new set of keys each morning to ignore… We heard yesterday that our team will definitely not be back

on campus before the 1st September (and we probably won't be a priority then) so there is still a long way to go with home working. While on the whole I find it fine there are some days that I find it hard to settle down to make any real progress. I'm trying to plan around that so that I have smaller things to do on the days that my attention span is limited." P9 was worried about job security: "The working situation is currently the same as reported in previous weeks: Working from home for the foreseeable future with no end-date available. High level of job uncertainty with the university opening voluntary redundancy schemes and options to cut hours. Little contact (online) or communication with research project team or engineering team. Having to adapt to doing everything online including coding workshops and interviews. Ongoing benefits: Have benefitted from being able to structure my own day at home, working at times of day when I have most energy/can concentrate more. Main disadvantages: Not feeling part of a team (or organization)." Deteriorating mental health was also an issue: "All of us becoming reconciled to working from home for the foreseeable future. People still finding ways to improve their productivity, but underlying concerns particularly about burnout and intrinsic motivation remain." (P12); "Things just add up more and more. Plus headaches." (P13).

In the final update in week 8, whilst some participants remained sanguine: "Right now I still don't know how long I'll be working from home. I've settled that it could be a very long time and bought a nice desk and office couch." (P15), most responses had a neutral or negative perspective: "Productivity is affected with cycles of fragmentary unsatisfactory work and cycles of fruitful concentration." (P3). The situation was taking its toll mentally: "Physically: little change. Mentally: increased fatigue." (P11); "It's been months now and I feel like I am working > 110%. This can't be sustained." (P5). P3 tried to find ways of coping: "Balance and kindness to oneself are key."

What is the best outcome you can envisage when this is all over? (week 5).

Participants were primarily hopeful that the move to flexible working would become permanent, and that this would be properly supported: "Better remote-friendliness for RSEs, where people can come into the office or work from home as they wish. Better home office support from employers recognizing their duties to set home offices up safely." (P17); "Less travel, more flexibility in working, better use of available technology and better technology." (P14).

Some participants had experienced sufficient anxiety that their hopes were modest: "Still having a job. The economic effect on the university being resolved in 1-2 years (if this does not happen, the constant threat of redundancy/competitive atmosphere created by adverse funding environment would be really unpleasant)" (P9). P5 was more ambitious, wanting "A respect for scientific advice and the warnings given by science. In terms of RSE, more researchers involving RSEs and/or RSE concepts at the beginning of their research rather than having to be dragged kicking and screaming to GitHub to be put in the stocks in front of an angry public. Epidemiology is having its "ClimateGate" moment. It would be good if other fields were more proactive about incorporating RSE now rather than each needing to have its own crisis."

4 Discussion

Research software engineering encompasses a variety of tasks. The focus of the role is often on writing, documenting and reviewing code, and whilst these are activities that can theoretically be undertaken in isolation, this study exposes the essential supporting role played by communication. The changes to RSEs' interactions with others were many and varied. In one instance moving online was positive – someone was able to participate in a project remotely that had not been possible when the work had been done face-to-face. Increased communication enabled people to bond early on, but people missed the spontaneous discussions that occurred in person but were impossible to replicate online. Several participants reported that the amount of communication appeared to have gone up, but the quality had gone down. Sharp et al studied "dispersed" software development (where everyone is in a different location) from the point of view of information sharing [6]. They found that in this situation all relevant information needs to be shared explicitly, rather than relying on informal or ad hoc meetings; because of this, information is "transformed" or processed more often; and the responsibility of what information to share when and through which medium lay with individual team members. This need for explicit communication implies a heavier cognitive load and additional planned meetings and may explain both the sense of poor communication and the feeling of burnout.

As in previous studies [1, 2] we see that personal circumstances had a significant impact on participants' ability to cope with the transition. Those dealing with children or with an unsuitable workspace found the situation more stressful. Precarity of employment added to this, with people working at universities particularly worried about losing their jobs. The blurring of work-life boundaries made it hard for people to switch off, and some felt they were working at unsustainable levels.

In spite of these challenges, people were positive about the flexibility offered by home working, and with the exception of minor technical issues, were able to carry out core aspects of their role with minimal disruption. When we reach a point where people can return to the office, several hoped that the convenience and flexibility offered by remote working would remain. Software engineering work in particular is moving increasingly online, and it may be that the pandemic has showed what is possible – or accelerated what is inevitable. This research shows that a supportive working environment and good communication are key to promoting resilience in RSEs. Understanding the work processes and technical set-ups that are able to support this will be important for creating effective working environments of the future.

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