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Job Crafting in Low-Usability Automation Situations: Sustainability through Human Work Interaction Designs

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1 Introduction

A worker-centric approach to automation is important to the wellbeing of the workforce [2] and hence to socially, economically, and environmentally sustainable work practices [3]. Job crafting promises to deliver *sustainability through design*, that is, to influence workers' (users') decision-making and attitudes to work. Thereby, it will foster more sustainable work-lifestyles [1, 4] and create sustainable human work interaction designs. Job crafting supports workers in the bottom-up design of their own work to achieve work engagement [5, 6] and wellbeing [7–9]. By prototyping possible changes in work practices and worker-technology relations, job crafting can be a strategy for empowering the individual worker [10]. In contrast to top-down job design by management, job crafting is often union-supported [7]. It emphasizes workplace innovation over standardization [7] and has received increasing attention in small and medium-sized enterprises (SMEs) challenged by robotics and automation [11]. Job crafting shares some resemblance with notions like job design, job enrichment, and work customization that all aim to create wellbeing at work [7]. In this study, we report from a manufacturing company with low-usability automation (legacy, non-interoperable stamping machines), in which we aim to foster job crafting with a digital peer-tutoring training program [12]. The low-usability automation, combined with a high demand for digitally skilled workers [13], makes job crafting difficult in this situation. However, such a situation is not unusual because many companies have not designed their automation as a resource that facilitates job crafting [14]. Instead, many manufacturing SMEs use legacy and non-interoperable automation in their factories [11]. The usability of these systems may be quite ordinary [15, 16], though with variations depending on the task, the work shift, the people with whom the task is done, and other situational factors [15]. We ask the research question: *Is job crafting possible in a situation with low-usability manufacturing automation?*

2 Job crafting

Job crafting can be about self-initiated changes in one's tasks (task crafting), social relationships (relational crafting), perception of one's own job (cognitive crafting), and the time and place of one's work (time-spatial crafting) [7, 8, 17, 18]. A longitudinal meta-analysis of job crafting found that it is, in general, associated with an increase in work engagement [19]. Another meta-analysis confirmed this finding and also found that job crafting had a positive effect on wellbeing [5]. Furthermore, it appears that job crafting is positively related with work performance [20]. The job-crafting literature tends to agree that job crafting is, by definition, a bottom-up activity that happens on the worker's initiative. Thus, job crafting can neither be driven by management, nor can it be imposed as a job requirement [19]. However, job crafting can be encouraged, and it can be facilitated with training.

A meta-analysis has shown that interventions are moderately effective at increasing job crafting, work engagement, and task performance [21]. The interventions tend to take the form of exercises that involve real-life examples, group discussion, and an invitation for participants to formulate their own job-crafting plan [22]. As an example, the Job Crafting Exercise challenges participants to take a step back and think creatively about their jobs in a visual way supported by a booklet [23]. Relatedly, the Job Crafting Intervention is a one-day training session followed by a four-week job-crafting period, during which the job-crafting plans should be put into practice [24]. At the end of the four-week period, the participants attend a reflection session to discuss the outcomes and the implications for their work. The literature appears to suggest that job crafting is related to the workers' personality so that it is mostly proactive workers who engage in job crafting [19, 25]. This finding indicates that job-crafting interventions will benefit proactive workers.

3 Case and approach

This study was part of a regional development project, which aimed to improve the digital capabilities of SMEs in the Capital Region of Denmark through training activities in individual companies. The training activities were tailored to fit the needs and digital capabilities of the individual companies and their employees. We were responsible for a digital peer-tutoring training program that aimed to encourage and train workers to share their job-crafting solutions with fellow workers using low-fidelity videos recorded with a smartphone or tablet [12]. The videos could describe solutions to operational or collaboration problems, such as how to adjust a collaborative robot, solve an operational problem with a machine, or resolve a coordination issue between two workstations. Digital peer tutoring was designed to support job crafting, but there has also been interest in applying the approach to other types of knowledge sharing, for example instructional videos [12]. The training program was supported by an iPad app with instruction videos, quizzes, and example solution videos. In addition, the iPad was used for recording the videos that were created by the workers during the training program. The training program took four weeks, during which workers studied the material in the app and produced short (1-3 minutes) videos documenting the identification of work problems and the sketching, prototyping, and evaluation of solutions to the problems. Two project assistants facilitated discussions and video production.

The case company was a Danish SME with around 50 employees. The company produced precision metal components on stamping machines in large series of up to millions of delivered items for a range of sectors, such as pharma, electronics, and automotive. The company's production and quality-assurance processes were ISO certified and, in some cases (pharma), subject to external regulatory requirements. The stamping machines used custom-made tools to cut the products from rolls of metal band that were fed into the machine. Each production worker was responsible for 2-3 machines, including set-up, quality control, and fault correction. The peer-tutoring program targeted the production workers on the day shift, and the tool smiths who built the cutting tools. We met with the company six times over a six-week period. In Week 0, we explained the digital peer-tutoring program and were introduced to the company, employees, and production facilities. Weeks 1-4 were the training program itself. In Week 5, the program was evaluated. Two researchers, a consultant, and two project assistants participated during Weeks 0 and 5, together with management and workers from the company. The project assistants facilitated the training sessions for the workers during Weeks 1-4.

4 Results

There were 16 participants in the peer-tutoring training program. They had completed 3-4 years education and training (e.g., as automation technicians, production workers, and tool makers) on top of 9 years of basic education. The participants had worked for an average of 12.8 years (range: 0.3-34) in the case company and had an average of 13.5 years (range: 1.9-30) of experience with the stamping machines.

The participants were asked to fill out a job-crafting scale at the end of the peer-tutoring program (in Week 5). We used the scale proposed by [17] and further developed and validated by [8] as our job-crafting scale. It measured self-initiated changes in one’s tasks (task crafting), social relationships (relational crafting), and job perception (cognitive crafting). We added three new items (questions) about time-place crafting [7, 18]. The items were translated into Danish and subsequently back-translated to validate the Danish wording of the items. All items were preceded with “So that the job I do suits me…", and rated on a five-point rating scale from 1 (not at all) to 5 (absolutely). We named the enhanced scale the self-oriented job-crafting scale (SO-JCS).

From the theory we would expect a four-factor structure in the data corresponding to the four types of crafting. Indeed, an eigen value of 1 in the Scree plot suggested a four-factor structure that explained 79% of the variance in the data. However, the 12 items did not consistently load on the four factors, possibly due to the few data points. Therefore, we proceed by only discussing those items that loaded highly on the factors that they were expected to load on. First, for task crafting, Item 3 – the time and effort that a worker put into a task – loaded highly on the factor (.928). The ratings on Item 3 indicated that the workers focused on enjoyable tasks (mean 3.85, SD 0.69). Second, for relational crafting all three items loaded positively on the factor. Item 5 with the highest loading (.955) indicated that the workers invested in relationships to their favorite colleagues to a high degree (mean 3.92, SD 0.76). Third, for cognitive crafting, Item 7 that measured the workers’ perceptions of their tasks as important loaded highly (.898) on the factor, but the ratings on Item 7 (mean 3.38, SD 0.65) indicated that the workers did not put much effort into seeing their tasks as important and meaningful.

Finally, for time-spatial crafting, somewhat surprisingly since this was our home-made items, all three items (10, 11, 12) loaded highly on the factor (.865, .809, and .668). The ratings indicated however only mediocre efforts from workers to design their work so that they worked at their favorite machine (mean 3.00, SD 0.58) and in their favorite room (mean 2.92, SD 0.64); they did more to choose the hours that they worked (mean 3.68, SD 0.63). Overall, the participants tended to do job crafting (mean 3.53, SD 0.68).

Furthermore, to investigate the participants' experience of the stamping machine, we asked them to rate it at the first and last workshop. Among the instruments for measuring how systems are experienced, we chose the System Usability Scale (SUS) because it is widely used and easy to administer [26]. SUS consists of ten items, which are aggregated into a single score. The SUS items were translated into Danish and back-translated to validate the Danish wording. We also wanted to investigate the participants' experience of the peer-tutoring app. For this purpose, we asked them to give their SUS ratings of the app at every workshop. With mean SUS scores of 63 (Week 1) and 60 (Week 4), there was no significant change in the participants' experience of the stamping machine, $t(11) = 0.03$, $p = .97$, during the training program. Scores of 60 and 63 are in the lowest quartile of the corpus of SUS scores reported by Bangor et al. [27]. Thus, the participants experienced the stamping machine as a low-usability system. The peer-tutoring app received SUS scores of 59 (Week 1) and 55 (Week 2). SUS scores of this magnitude correspond to a system that is marginally acceptable [27]. In line with this assessment, during the two remaining workshops, the iPad was only used for creating videos; the peer-tutoring concept was instead communicated orally.

In addition, we documented all empirical sessions in written notes. This involved the start-up and wrap-up meetings with the participants and management (Weeks 0 and 5) as well as the four peer-tutoring workshops with the participants (Weeks 1 to 4). An additional source of qualitative data was the 76 peer-tutoring videos produced by the participants during Weeks 1 to 4. The qualitative data provided further insights into the effects of the peer-tutoring training program on different aspects of job crafting.

5 Discussion and conclusion

Our data support that job crafting is possible in a manufacturing SME with low-usability automation. With a mean overall job-crafting score of 3.53, the workers in our study were job crafting at about the same level as participants in other studies. For example, Niessen et al. [8] found a mean score of 3.28 in a 466-participant study that did not include time-spatial job crafting and Lazauskaite-Zabielske et al. [28] found a mean time-spatial job-crafting score of 3.4 in a sample of 176 employees in an IT company. Contrary to Niessen et al. [8], the workers in our study did not put a lot of effort into seeing their tasks as important and meaningful. Instead, they focused on their enjoyable tasks and invested in their relationships with their favorite colleagues. Our qualitative data showed that the workers identified needs specific to concrete persons and had constructive ideas about how to solve many of the identified needs. Furthermore, the peer-tutoring program enabled conversations among the workers about the problems and their solutions. In this way, the peer-tutoring program was more like a co-design activity [29] than the training activities provided to support job crafting in other studies [19]. In addition to facilitating the workers' job crafting, the concept of peer tutoring also shaped it by pointing toward information sharing, such as in the instructional and refresher videos. We contend that the format of the peer-tutoring program helped the workers appreciate that they were producing something of value to themselves, their peers, and the company. These are important parts of sustainability through design [1]. The implications for sustainable human work interaction designs will be discussed at the workshop.

References

1. Mankoff, J.C., Blevis, E., Borning, A., Friedman, B., Fussell, S.R., Hasbrouck, J., Woodruff, A., Sengers, P.: Environmental sustainability and interaction. In: Conference on Human Factors in Computing Systems - Proceedings (2007). https://doi.org/10.1145/1240866.1240963.
2. Kaasinen, E., Schmalfuß, F., Özturk, C., Aromaa, S., Boubekeur, M., Heilala, J., Heikkilä, P., Kuula, T., Liinasuo, M., Mach, S., Mehta, R., Petäjä, E., Walter, T.: Empowering and engaging industrial workers with Operator 4.0 solutions. Computers & Industrial Engineering. 139, 105678 (2020). https://doi.org/https://doi.org/10.1016/j.cie.2019.01.052.
3. Giovannoni, E., Fabietti, G.: What is sustainability? A review of the concept and its applications. In: Integrated Reporting: Concepts and Cases that Redefine Corporate Accountability (2013). https://doi.org/10.1007/978-3-319-02168-3_2.
4. Zhan, X., Walker, S.: Craft as Leverage for Sustainable Design Transformation: A Theoretical Foundation. Design Journal. 22, (2019). https://doi.org/10.1080/14606925.2019.1613040.
5. Lichtenthaler, P.W., Fischbach, A.: A meta-analysis on promotion-and prevention-focused job crafting. European Journal of Work and Organizational Psychology. 28, 30–50 (2019). https://doi.org/10.1080/1359432X.2018.1527767.
6. Roto, V., Clemmensen, T., Häätäjä, H., Law, E.L.-C.: Guest Editors' Introduction: Designing Interactive Systems for Work Engagement. Human Technology. 14, 135–139 (2018). https://doi.org/10.17011/ht/urn.201808103814.
7. Scoppetta, A., Davern, E., Geyer, L.: Job Carving and Job Crafting - a review of practices (EU report). (2019). https://doi.org/KE-01-19-557-EN-N.
8. Niessen, C., Weseler, D., Kostova, P.: When and why do individuals craft their jobs? The role of individual motivation and work characteristics for job crafting. human relations. 69, 1287–1313 (2016). https://doi.org/10.1177/0018726715610642.
9. Geldenhuys, M., Bakker, A.B., Demerouti, E.: How task, relational and cognitive crafting relate to job performance: a weekly diary study on the role of meaningfulness. European Journal of Work and Organizational Psychology. 30, 83–94 (2021). https://doi.org/10.1080/1359432X.2020.1825378.

10. Woods, D.D.: Commentary Designs are hypotheses about how artifacts shape cognition and collaboration. Ergonomics. 41, 168–173 (1998). https://doi.org/10.1080/001401398187215.
11. Ludwig, T., Kotthaus, C., Stein, M., Pipek, V., Wulf, V.: Revive Old Discussions! Socio-technical Challenges for Small and Medium Enterprises within Industry 4.0. In: Proceedings of 16th European Conference on Computer-Supported Cooperative Work (2018). https://doi.org/10.18420/ecscw2018_15.
12. Clemmensen, T., Nørbjerg, J.: Digital Peer-Tutoring: Early Results from a Field Evaluation of a UX at Work Learning Format in SMEs. In: Abdelnour Nocera, J., Parmaxi, A., Winckler, M., Loizides, F., Ardito, C., Bhutkar, G., and Dannenmann, P. (eds.) Beyond Interactions. pp. 52–58. Springer International Publishing, Cham (2020). https://doi.org/10.1007/978-3-030-46540-7_6.
13. Buonocore, F., Agrifoglio, R., de Gennaro, D.: The Role of Digital Competencies and Creativity for Job Crafting in Public Administration. In: Metallo, C., Ferrara, M., Lazazzara, A., and Za, S. (eds.) Digital Transformation and Human Behavior. pp. 87–97. Springer International Publishing, Cham (2021). https://doi.org/10.1007/978-3-030-47539-0_7.
14. Demerouti, E.: Turn digitalization and automation to a job resource. Applied Psychology. (2020). https://doi.org/10.1111/apps.12270.
15. Clemmensen, T., Hertzum, M., Abdelnour-Nocera, J.: Ordinary User Experiences at Work: A Study of Greenhouse Growers. ACM Transactions on Computer-Human Interaction (TOCHI). June, 1–31 (2020). https://doi.org/10.1145/3386089.
16. Meneweger, T., Wurhofer, D., Fuchsberger, V., Tscheligi, M.: Factory Workers' Ordinary User Experiences: An Overlooked Perspective. Human Technology. 14, 209–232 (2018). https://doi.org/10.17011/ht/urn.201808103817.
17. Wrzesniewski, A., Dutton, J.E.: Crafting a job: Revisioning employees as active crafters of their work. Academy of Management Review. 26, 179–201 (2001). https://doi.org/10.5465/AMR.2001.4378011.
18. Wessels, C., Schippers, M.C., Stegmann, S., Bakker, A.B., van Baalen, P.J., Proper, K.I.: Fostering flexibility in the new world of work: a model of time-spatial job crafting. Frontiers in Psychology. 10, 505 (2019). https://doi.org/10.3389/fpsyg.2019.00505.
19. Frederick, D.E., VanderWeele, T.J.: Longitudinal meta-analysis of job crafting shows positive association with work engagement. Cogent Psychology. 7, 1746733 (2020). https://doi.org/10.1080/23311908.2020.1746733.
20. Rofcanin, Y., Bakker, A.B., Berber, A., Gölgeci, I., Las Heras, M.: Relational job crafting: Exploring the role of employee motives with a weekly diary study. Human Relations. 72, 859–886 (2019). https://doi.org/10.1177/0018726718779121.
21. Oprea, B.T., Barzin, L., Vîrgă, D., Iliescu, D., Rusu, A.: Effectiveness of job crafting interventions: A meta-analysis and utility analysis. European Journal of Work and Organizational Psychology. 28, 723–741 (2019). https://doi.org/10.1080/1359432X.2019.1646728.

22. Laenen, J.J.: Continuous and autonomous Job Crafting support in the home-work environment, (2020).
23. Berg, J.M., Dutton, J.E., Wrzesniewski, A., Baker, W.E.: Job crafting exercise, (2013).
24. Van den Heuvel, M., Demerouti, E., Peeters, M.C.W.: The job crafting intervention: Effects on job resources, self-efficacy, and affective well-being. Journal of Occupational and Organizational Psychology. 88, 511–532 (2015). https://doi.org/10.1111/joop.12128.
25. Bakker, A.B., Tims, M., Derks, D.: Proactive personality and job performance: The role of job crafting and work engagement. Human relations. 65, 1359–1378 (2012). https://doi.org/10.1177/0018726712453471.
26. Brooke, J.: SUS: A "quick and dirty" usability scale. In: Jordan, P.W., Thomas, B., Weerdmeester, B.A., and McClelland, A.L. (eds.) Usability Evaluation in Industry. p. 189. Taylor & Francis (1996). https://doi.org/10.1201/9781498710411.
27. Bangor, A., Kortum, P.T., Miller, J.T.: An empirical evaluation of the system usability scale. Intl. Journal of Human–Computer Interaction. 24, 574–594 (2008). https://doi.org/10.1080/10447310802205776.
28. Lazauskaite-Zabielske, J., Ziedelis, A., Urbanaviciute, I.: Who benefits from time-spatial job crafting? The role of boundary characteristics in the relationship between time-spatial job crafting, engagement and performance. Baltic Journal of Management. 16, 1–19 (2020). https://doi.org/10.1108/BJM-07-2020-0236.
29. Sanders, E.B.-N., Stappers, P.J.: Co-creation and the new landscapes of design. CoDesign. 4, 5–18 (2008). https://doi.org/10.1080/15710880701875068.