Proceedings IFKAD 2018
Delft, Netherlands, 4-6 July 2018
ISBN 978-88-96687-11-6
ISSN 2280787X

Putting Intentional Organisational Forgetting to an Empirical Test: Using Experimental Designs to Measure Forgetting of Organisational Routines

Annette Kluge *

Chair of Work, Organizational and Business Psychology
Ruhr-University Bochum
Universitätsstr. 150, 44780 Bochum, Germany

Arnulf S. Schueffler

Department of Work, Organizational and Business Psychology
Ruhr-University Bochum
Universitätsstr. 150, 44780 Bochum, Germany

Christof Thim

Department of Business Information Systems and Electronic Government, University of Potsdam
August-Bebel-Str. 89, 14482 Potsdam, Germany

Gergana Vladova

Department of Business Information Systems and Electronic Government, University of Potsdam
August-Bebel-Str. 89, 14482 Potsdam, Germany

Norbert Gronau
Chair of Business Information Systems and Electronic Government
University of Potsdam
August-Bebel-Str. 89, 14482 Potsdam, Germany

** Corresponding author*

Structured Abstract

Purpose – The purpose of the paper is to present research designs that are suitable for investigating organisational forgetting. The overall and long-term objective is to encourage researchers to use non-experimental, quasi-experimental and experimental designs as well as computer simulations to test the idea of the benefits of forgetting for adaptation and change with high construct, internal and external validity.

Proceedings IFKAD 2018
Delft, Netherlands, 4-6 July 2018
ISBN 978-88-96687-11-6
ISSN 2280787X

Design/methodology/approach – We review the state of the art in management and organisational research and show options in how to use non-experimental, quasi-experimental and experimental designs for testing causes and effects of organisational forgetting by giving concrete examples. We emphasise experimental designs because they are declared the gold standard in management research. In that respect, we introduce the distinction between special-purpose and non-special-purpose settings. In particular, "learning factories" as a prototype of a special-purpose setting will be described, in which internal and external validity can be increased simultaneously.

Originality/value – Learning factories have emerged in the last 5 years to test new ways of manufacturing, for example, cyber-physical production systems and human–robot interaction "live", and to mirror a real production setting with a high physical and psychological fidelity. We suggest using learning factories as special-purpose settings to observe and investigate processes of organisational forgetting, e.g. for investigating the impact of forgetting routines, as routines are declared an important storage bin as part of the organisational memory.

Practical implications – We show how a learning factory can be used as an experimental "theatre" for investigating the impact of eliminating retrieval cues that impede forgetting of a routine that has become invalid and been replaced by a new routine in order to adapt to a changing organisational environment. This example can be used as a model by which to design experimental procedures to put organisational forgetting to an empirical test on a group level, and implies the advantage of making temporal aspects of forgetting visible.

Keywords – research design, special purpose setting, multi-actor routines, retrieval cues

Paper type – Academic Research Paper

1 Introduction

1.1 Organisational unlearning and Forgetting – more concepts than evidence

While the term *organisational unlearning* was introduced almost as early as the term *organisational learning* appeared in management research (Hedberg, 1981; Nystrom & Starbuck, 1984; Howells & Scholderer, 2016), the term *organisational forgetting* started to enter the stage of business and management literature some decades later at the turn of the century (e.g. Argote, 2013; Easterby-Smith & Lyles, 2003/2011; Martin de Holan, Philips & Lawrence, 2004; Martin de Holan & Philips, 2004; Martin de Holan, 2011).

Insight has grown that in order to successfully learn and change, forgetting and unlearning are required, in addition to knowledge acquisition and dissemination (Kluge & Schilling, 2004/2003; Nonaka & Takeuchi, 1995; Schilling & Kluge, 2009) and exploration and exploitation (March, 1991). The number of papers published on the topic

ISBN 978-88-96687-11-6
ISSN 2280787X

of organisational forgetting and unlearning has increased (see Kluge & Gronau, 2018) since then.

However, an imbalance between the number of theoretical papers including theories and their empirical testing has emerged.

1.2 Organisational Unlearning, Organisational Forgetting, and Intentional Forgetting in Organisations

The terms *organisational unlearning* and *organisational forgetting* seem to be used interchangeably in the scientific community.

As outlined in the paper by Kluge and Gronau (2018), our research group prefers the term *organisational forgetting* over the term *unlearning*, as we shared Howells and Scholderer's (2016) critique on the unreflected use of the term *unlearning*.

Our approach to forgetting in organisations proposes the need for business processes that deliberately impede the recall of certain organisational memory items in order to support an organisation's changed strategic goal achievement (Kluge & Gronau, 2018). We refer to *intentional* forgetting, which is defined as the motivated attempt to limit future recall of a memory item (Bjork et al., 1998; Johnson, 1994), e.g. motivated by an individual or group-level strategic goal. Intentional organizational forgetting is a motivated and planned suppression process of organizational memory items and the inhibition of the retrieval process in order to avoid memory items made available for current use (Kluge & Gronau, 2018).

In the following section, we outline the current state of the standards in empirical management and organisational research in order to illustrate possible options with which to empirically test the theoretical assumptions on organisational forgetting and give an example of our own research into intentional organisational forgetting.

2 General remarks and basic research strategies to investigate organisational forgetting and intentional organisational forgetting

The purpose of management research is to generate knowledge that is valid as well as relevant from a practical standpoint (Aguinis & Edwards, 2014). Research questions should be inferred from relevant theory (e.g. on mechanisms with which to support forgetting) and anchored in issues relevant to the practice of management (e.g. Change Management or Knowledge Management). Stone-Romero (2011) recalls that whatever the purpose of research into organisation and management is, the soundness of the research depends on the degree to which it allows valid conclusions regarding:

1) cause–effect relations (internal validity), e.g. the organisational processes and features that lead to intentional forgetting,

ISBN 978-88-96687-11-6
ISSN 2280787X

2) the correspondence between constructs (construct validity), e.g. whether a particular scale used in a questionnaire actually measures intentional forgetting,

3) the statistical estimates derived (statistical conclusion validity), e.g. whether correlations in a cross-sectional research design allow for conclusions on intentional forgetting, which is a matter of time,

and

4) the extent to which the found relation may generalise across different settings, units, treatments and observations (external validity), e.g. whether the organisational processes found to be responsible for intentional forgetting in a particular industry sector generalise to other sectors and branches.

In the following, we want to consider these aspects for research into organisational forgetting and illustrate how our research group investigates intentional forgetting in an organisational setting.

2.1 Non-experimental, quasi-experimental and randomised research designs to investigate organisational forgetting

Investigating organisational forgetting requires the development of a research design, the specification of the unit (individuals, groups or organisations) under investigation, and the choice between four options with which to study the relation between variables in order to investigate organisational forgetting: 1) non-experimental (e.g. correlational), 2) quasi-experimental, 3) randomised (Stone-Romero, 2011), and 4) through computer simulation (Runkel & McGrath, 1972).

Non-experimental designs. Applied to the subject of organisational forgetting, non-experimental designs include correlational, path analytical studies, and structural equation modelling of relationships, e.g. between organisational variables such as age, size, climate, and perceived forgetting. An example is the study by Cegarra-Navarro and Moya (2005), who used structural equation modelling to test hypotheses in the relation shown between individual unlearning, group unlearning on human capital, and performance (to name a few). A second example is the study by Becker (K. 2010) which used a questionnaire to identify factors that hinder or help the unlearning process during times of change. In both studies, a closer look at the items of the questionnaire and the formed scale raises serious doubts as to the construct validity regarding the construct of unlearning instead of changing, learning or even development. Additionally, doubts are raised regarding the use of a cross-sectional design, as unlearning and forgetting are processes of time instead of "snapshots" (an aspect of internal validity).

Especially for non-experimental designs, current technologies such as experience sampling in combination with more sophisticated statistical analysis, such as multi-level analysis, make it possible to gather data in a natural organisational setting over a longer

ISBN 978-88-96687-11-6
ISSN 2280787X

time period, which is relevant for organisational forgetting. Experience Sampling Methodology (ESM) allows for longitudinal examination of the nature and causal directions among the variables as temporal sequences as a necessary condition for inferring causal effects.

Quasi-experimental and randomised designs. When causal interference is important, Stone-Romero (2011) pleads to conduct research that uses either randomised experimental or quasi-experimental designs that allow for ruling out threats to internal validity. Causal relations are considered *actual* when they are supported by sound randomised experiments and are *assumed* when based on evidence from non-experimental research (Stone-Romero, 2011).

To give an example of a quasi-experimental design, Martin de Holan (2011) proposed that the quantity and type of effort required to forget depend on the category of knowledge involved, as well as the relationship between the new knowledge and the old one (the distance between the new and old knowledge). Using a quasi-experimental design to test these hypotheses, one would require two comparable departments in an organisation that try to forget and in which the distance between the old and new knowledge is either far or near. Organisational members of both departments could rate the distance between the new and old knowledge and one could measure the rate or speed of forgetting and the speed of change in both departments over time. The results of the quasi-experimental design would then reveal assumed relationships between the independent variable (distance between old and new knowledge) and the impact on the dependent variable (speed of change). However, alternative explanations are difficult to rule out, as other variables, e.g. charismatic leadership or supportive group dynamics, that differ could serve as an explanation for the speed of change.

A *randomised experimental design* would need a *special-purpose setting* (Stone-Romero, 2011) for investigating the influence of, for example, organisational actions as independent variables and their impact on unlearning and forgetting as dependent variables in order to measure effects on the organisational level. A special-purpose setting might be a laboratory setting that is equipped as a production setting or shop floor, or an industrial site that is used for experimental studies. All of these facilities are special-purpose settings because they are created for the specific purpose of conducting research (Stone-Romero, 2011). Special-purpose settings cease to exist when research has been completed and they are designed for intentional manipulation of the independent variable.

A “learning factory” is a special-purpose setting with a high physical and psychological fidelity. The advancements of learning factories over the past years show that they can be used to impart knowledge in respect of very different research questions that require randomised experimental designs (Kluge & Gronau, 2018). Abele and Metternich defined five topics to be learned in a learning factory: production processes,

Proceedings IFKAD 2018
Delft, Netherlands, 4-6 July 2018
ISBN 978-88-96687-11-6
ISSN 2280787X

logistic processes, energy efficiency, design processes, and virtual/digital/organisational change (Abele & Metternich, 2015; Kreimeier et al., 2014; Prinz et al., 2016; Gronau et al., 2017). The option to engage in production processes within a real-world manufacturing environment allows one to transfer problems, e.g. of forgetting and adapting, to one's own operational challenges. Figure 1 shows the special-purpose setting of a hybrid factory (description below) at the University of Potsdam (Vladova et al., 2017). Evidence shows that relations found in special-purpose settings are also found in non-special-purpose settings (Locke, 1986; Stone-Romero, 2011).

Figure 1. Special-purpose setting at the University of Potsdam, which is used for the study on retrieval cues as described below

In contrast, *non-special-purpose settings*, e.g. those used for field experiments, are (in the first place) created for production or delivering services and are not intentionally designed for a research purpose (Stone-Romero, 2011). These settings, of course, would include all organisational characteristics and their impact on unlearning and forgetting in parallel, such as organisational history, culture and values, HRM practices, leadership, structure and technology, and would enhance high-context fidelity due to such naturalistic settings (Cheung et al., 2017). If we use a non-special-purpose setting for investigating the three phases of unlearning as proposed by Reese (2017, Phase 1: destabilisation, crisis, mismatch; Phase 2: discarding, weathering, interruption; Phase 3: experimenting, obsolescence, recovery), we could use two similar non-special-purpose settings, e.g. two production sites of one company in different countries, to investigate the impact of, for example, different leadership values that are displayed at these sites on workers' and employees' perception of the phases through which they have to go. The disadvantage of non-special-purpose settings is that they typically include non-representative samples and settings, use operational definitions of manipulation and measures of interest and cannot control for other confounding variables that are difficult to control over a period of time.

ISBN 978-88-96687-11-6
ISSN 2280787X

That means that non-special-purpose settings are more problematic when inferences regarding causes want to be drawn.

Computer simulations are model-based descriptions concerning the consequences of theoretical assumptions and side effects in a fast-forward modus with which to observe interdependencies and complex interactions between variables and their dynamics. By using computer simulations, extreme and unusual system states can be observed which cannot be manipulated for ethical reasons in reality. Instead of a direct observation, consequences can be modelled and inferred from the simulation results. Finally, several simulation runs can be implemented to systematically vary system variables in different combinations (Kluge & Schilling, 2003/2004). For research into organisational forgetting, computer simulations could be used, for example, to model different forms of dynamic environments, several forms of interventions or organisational features that are assumed to support forgetting, in order to observe the speed of forgetting and the success of change and adaptation in the environments. In a simulation of Bruderer and Singh (1996), results of the simulation showed that replacing inappropriate organisational routines helps to quickly discover a new viable organisational form so as to adapt better to a fast-changing environment.

In the following section, we will describe an experimental study on a special-purpose setting in order to test cause–effect relationships in intentional forgetting in organisations based on our proposition on the relevance of retrieval cues.

3 The empirical investigation in a special-purpose setting

3.1 The theoretical background: Organisational memory, multi-actor routines, and retrieval cues

Our research builds on three general assumptions: 1) organisations possess a memory, 2) memory can be found in transformational processes such as routines, and 3) forgetting can be induced by the elimination of retrieval cues.

The first assumption includes the idea that organisations possess a memory that is comparable to human memory (Daft & Weick, 1984; Walsh & Ungson, 1991), which is found in transformational processes (Walsh & Ungson, 1991) such as routines. Researchers investigating organisational routines (e.g. Gersick & Hackman, 1990; Pentland & Haerem, 2015) or organisational forgetting (Martin de Holan et al., 2004; Martin de Holan & Phillips, 2004; Miller et al., 2012; Tsang & Zahra, 2008) stress the impact of routines on organisations' stability and lack of change. Nevertheless, it is not stated explicitly how this stabilisation works or how the adaptation of routines through forgetting can be used to support change and adaptation in relation to the environment.

ISBN 978-88-96687-11-6
ISSN 2280787X

Regarding the second assumption, organisational routines are "multi-actor, interlocking, reciprocally-triggered sequences of actions" (Cohen & Bacdayan, 1994, p. 554). As routines are the relevant sources of stability, reliability and speed of organisational transformational processes, routines are central to our propositions, as they additionally serve purposes of information and knowledge storage (Cohen & Bacdayan, 1994; Becker, 2004).

Concerning the third assumption, retrieval theories are used to actively support forgetting. Retrieval theories explain forgetting in terms of cue overload, cue availability, consolidation, and repression (Gronlund & Kimball, 2013; Nairne & Pandeirada, 2008; Roediger et al., 2010). We argue that the elimination of retrieval cues will enable the weakening of memory items and, therefore, forgetting, insofar as the memory items are not activated because the related situational, sensory or routine-related cues are not present.

3.2 A cue classification for the elimination of cues and hypotheses

Transferring the findings on the effects of the elimination of retrieval cues, we propose that three cue types need to be considered important in the forgetting of organisational routines and are directly related to the routines (Kluge & Gronau, 2018):

- Sensory cues, which are basal cues such as visual, olfactory, oral and tactile cues,
- Routine-related cues, which include actor-related, object-related, sequence of task-related and information-related cues, and
- Time and space cues, which include stimuli indicating the location (e.g. production site) and time (of year, week, day) of the execution of a routine.

Generally, we assume that sensory cues and routine-related retrieval cues of a former valid but now invalid routine need to be eliminated in order to stop the recall and retrieval of the old routine (Kluge & Gronau, 2018). In particular, in our research programme it is assumed that group-level forgetting depends on forgetting on the individual level (Hypothesis 1), that group-level forgetting takes longer than individual forgetting (Hypothesis 2), and that the exchange of an actor accelerates forgetting on both levels (Hypothesis 3). Forgetting is supported if all cues which might trigger the recall of a prior activity which is invalid at present are eliminated and if all cues that support the execution of the valid routine are made salient (Hypothesis 4), if a new activity can be performed without time pressure (Hypothesis 5), if the use of the currently invalid routine is penalised (Hypothesis 6a), and if the use of a valid routine will be reinforced (Hypothesis 6b).

Proceedings IFKAD 2018
Delft, Netherlands, 4-6 July 2018
ISBN 978-88-96687-11-6
ISSN 2280787X

3.3 Sample and general experimental setting

We measured forgetting on an individual and group level in a special-purpose production setting (unit of investigation, see Stone-Romero, 2011). The sample size was calculated by using G-Power, testing 858 subjects in 286 teams of three. The sample included students from engineering and business administration departments, as well as those recruited via social media channels, newspapers and by using flyers on campus.

The groups produced artificial knee joints as a team. Knee joints were chosen because they need to be produced at a very high-quality standard by following a predefined procedure and are unique for each customer. In our experiments, participants visited the special-purpose factory setting twice, in week 1 and week 4. Week 1 included the training of the participants in executing an interdependent multi-actor routine without errors and in a predefined period of time in a team of three workers. The routine of each worker included eight steps, each requiring a maximum of six action elements and a total of 33 memory items that form the routine under investigation. Fifty per cent of the routine needed to be forgotten in week 4. Each worker had his/her specialised role and task for which he/she was responsible. After week 1, participants needed to train in the execution of the routine in weeks 2 and 3 with the help of an app (Figure 2) in order to increase the storage and retrieval strength and assure that the routine had been well learned.

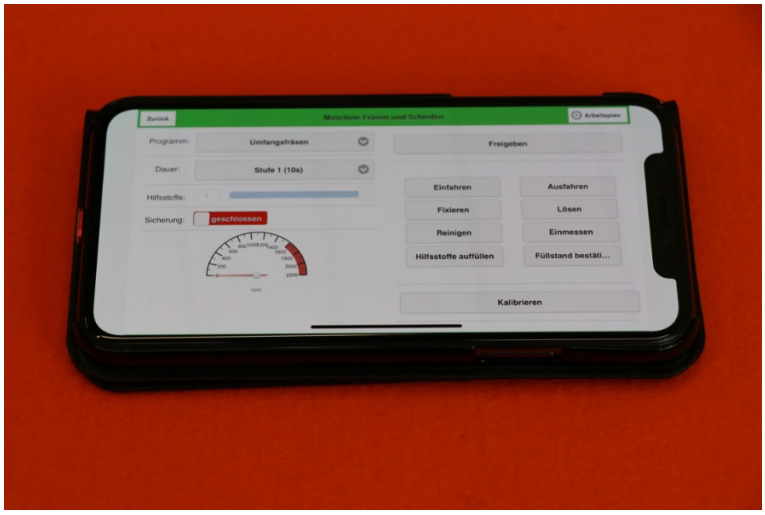

Figure 2. Training app to train the procedure

Proceedings IFKAD 2018
Delft, Netherlands, 4-6 July 2018
ISBN 978-88-96687-11-6
ISSN 2280787X

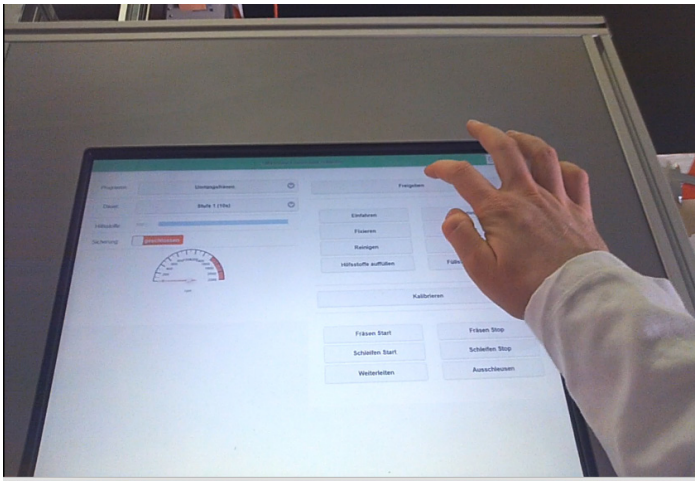

Figure 3. Interaction via the real interface of the demonstrator ("Cube") of the produced good in the special-purpose setting (see below)

By analysing the log files, we controlled for the training trials conducted and the errors made. In week 4, participants returned to the laboratory and expected to execute the routine in which they had trained in the previous three weeks. Unexpectedly for the participants, however, they were informed that, due to a merger with an American company, routines had been changed to some extent, e.g. by using American measures such as "inches" instead of "centimetres". Additionally, the independent variables (which in each experiment were defined by the independent variable under investigation) were introduced, e.g. through the exchange of a team member, the elimination of cues, and context conditions such as time pressure and a reward system. All material was standardised, e.g. by means of a video instruction, to avoid effects caused by different experimenters.

3.4 The special-purpose setting at the University of Potsdam

The trade-off between a realistic experimental environment and the possibility to control the influences on the experiment led to the design of a special-purpose setting at the University of Potsdam (Figure 1). The Research and Application Center for Industry 4.0 provides a hybrid simulation within which hardware equipment (i.e. transport systems, manufacturing robots, QR scanners) is enriched with software components (Gronau, Theuer & Lass, 2012). Participants can experience physical, visual and audible effects of their interaction (Gronau et al., 2012). Using industrial components and footage from a real production environment, it is possible to re-enact modified real-world processes, in our case the production of knee joints.

ISBN 978-88-96687-11-6
ISSN 2280787X

In the special-purpose environment, machines and workpieces are simulated as software components running on "cubes", small computers with three displays (Figure 3). Machines possess an interface for participants to start and monitor certain production steps, e.g. selecting a production program. The interaction is followed by audible or visual effects or the start of a physical component, e.g. the robot arm. Relevant environmental information is delivered for input by various sensors (Gronau et al., 2012). A transport system connecting the machine cubes allows for the representation of various factory layouts with sequences, parallelism or repetition (Gronau et al., 2012).

Workpieces are configured with specific parameters, i.e. their 2D or 3D model, dimensions and category. These parameters change during the production process. Participants can hereby see the effect of their machine interaction and obtain feedback on the production success. In this immersive experimental environment all interaction can be recorded. Certain aspects can be controlled in the experiment. It therefore strikes the balance between a realistic setting and a controlled environment.

3.5. Dependent variables measuring organisational forgetting

As dependent variables, we measure individual forgetting by means of log file analysis and identifying errors in the sequence of routine execution (elements of the invalid routine are executed) and by means of gaze data, as all participants wear eye trackers to identify whether participants “look for” certain information of the invalid routine elements. We also measure objective switching costs and change costs (Gersick & Hackman, 1990), in terms of longer reaction times and more errors (i.e. Gilbert & Shallice, 2002), which we also read out from the log files. We additionally measure subjective switching costs in terms of lower self-efficacy, reduced perceived control, and frustration. To measure group-related forgetting we measure group performance and errors on the group level, gaze data related to looks between the participants to coordinate the multi-actor routine, the overall time in which to forget the invalid routine, and the overall time in which to execute the now valid routine as a team without errors. We additionally measure person-related variables such as demographic data, memory, fluency, and presence.

Results of the first experiment will be presented and published by the end of the year (Schüffler, Thim, Gronau & Kluge, submitted).

ISBN 978-88-96687-11-6
ISSN 2280787X

4 Conclusion

The purpose of the paper was to show possible ways in which to empirically test assumptions and theoretical models on organisational forgetting and unlearning with high validity. We described a special-purpose setting in which to test hypotheses concerning the role of retrieval cues and their elimination in a randomised experiment. As outlined in the introduction, this has advantages, e.g. testing actual cause–effect relations with high internal validity, a representative sample, and a sample size that allows for statistical validity and sophisticated methods. However, there are also disadvantages, such as limitations grounded in the selection of the unit of analysis (in our case groups) and in how far the results can be generalised to large organisational settings. We tried to maximise the advantages of control in a randomised experimental design and of generalisability of results in terms of external validity by using a special-purpose setting that represents an organisational setting and an immersive shop floor layout.

Due to the fact that in an experimental setting, only one independent variable should be manipulated at a time, we conducted four experiments sequentially in order to understand the entire and complex picture of organisational forgetting and change by adding piece by piece to the big puzzle. Nevertheless, eliminating retrieval cues is only one approach to explaining the nature and speed of organisational forgetting — many more variables and their relations are ahead and to be discovered.

Acknowledgement

The project is funded from 2016–2019 by the Deutsche Forschungsgemeinschaft (DFG), project numbers KL2207/6-1 and GR 1846/21-1.

References

Abele, E., & Metternich, J. (2015). Learning factories for research, education, and training. Key Note Paper. *The 5th Conference on Learning Factories*. 8th July. Bochum, Germany.

Aguinis, H., & Edwards, J. R. (2014). Methodological wishes for the next decade and how to make wishes come true. *Journal of Management Studies, 51*(1), 143-174.

Argote, L. (2013). Organizational forgetting in L. Argote (Ed.), *Organizational Learning: Creating, Retaining and Transferring Knowledge* (pp. 57-84). New York, NY: Springer Science+Business Media.

Argote, L., & Guo, J. M. (2016). Routines and transactive memory systems: Creating, coordinating, retaining, and transferring knowledge in organizations. *Research in Organizational Behavior*, *36*, 65-84.

Becker, K. (2010). Facilitating unlearning during implementation of new technology. *Journal of Organizational Change Management, 23*(3), 251-268.

Becker, M. C. (2004). Organizational routines: a review of the literature. *Industrial and Corporate Change, 13*(4), 643-678.

ISBN 978-88-96687-11-6
ISSN 2280787X

Bjork, E. L., Bjork, R. A., & Anderson, M. C. (1998). Varieties of goal-directed forgetting. In J. M. Golding & C. M. MacLeod (Eds.), *Intentional Forgetting: Interdisciplinary Approaches* (S. 103-137). Mahwah, NJ: Lawrence Erlbaum.

Bruderer, E., & Singh, J. V. (1996). Organizational evolution, learning, and selection: A genetic-algorithm-based model. *Academy of Management Journal, 39*(5), 1322-1349.

Cegarra-Navarro, J. G. C., & Moya, B. R. (2005). Business performance management and unlearning process. *Knowledge and Process Management, 12*(3), 161-170.

Cheung, H. K., Hebl, M., King, E. B., Markell, H., Moreno, C., & Nittrouer, C. (2017). Back to the Future: Methodologies That Capture Real People in the Real World. *Social Psychological and Personality Science, 8*(5), 564-572.

Cohen, M. D., & Bacdayan, P. (1994). Organizational routines are stored as procedural memory: Evidence from a laboratory study. *Organization Science*, *5*(4), 554-568.

Daft, R. L., & Weick, K. E. (1984). Toward a model of organizations as interpretation systems. *Academy of Management Review, 9*(2), 284-292.

Easterby-Smith, M., & Lyles, M. (2003). Re-reading Organizational Learning: Selective memory, forgetting and adaptation. *Academy of Management Executive, 17,* 51-55.

Easterby-Smith, M., & Lyles, M. A. (2011). The Praise of Organizational Forgetting. *Journal of Management Inquiry, 20,* 311-316.

Gersick, C. J., & Hackman, J. R. (1990). Habitual routines in task-performing groups. *Organizational Behavior and Human Decision Processes*, *47*(1), 65-97.

Gilbert, S. J., & Shallice, T. (2002). Task switching: A PDP model. *Cognitive Psychology*, *44*(3), 297-337.

Gronau, N., Theuer, H., & Lass, S. (2012). Evaluation of Production Processes Using Hybrid Simulation. In K. Windt (ed.), Robust Manufacturing Control, Lecture Notes in Production Engineering (401-413). Berlin: Springer.

https://lswi.de/homepage/potsdam.nsf/0/6E9C08E644C5AA20C1257AFC0046560E/$FILE/WI_2012-12.pdf

Gronau, N., Ullrich, A., & Teichmann, M. (2017). Development of the Industrial IoT Competences in the Areas of Organization, Process, and Interaction Based on the Learning Factory Concept. *Procedia Manufacturing*, *9C*, 294-301. DOI: 10.1016/j.promfg.2017.04.029

Gronlund, S. D., & Kimball, D. R. (2013). Remembering and Forgetting: From the Laboratory Looking Out. In W. Arthur, Jr., E. A. Day, W. Bennet, Jr., and A. Portrey (Eds.), *Individual and Team Skill Decay.* The Science and Implications for Practice (pp. 14-52). New York, NY: Routledge.

Johnson, H. M. (1994). Processes of successful intentional forgetting. *Psychological Bulletin, 116*(2), 274-292.

Kluge, A., & Gronau, N. (2018). Intentional Forgetting in Organizations: The Importance of Eliminating Retrieval Cues for Implementing New Routines. *Frontiers in Psychology: Organizational Psychology*. DOI: 10.3389/fpsyg.2018.00051

Kluge, A., & Schilling, J. (2003). Organizational Learning and Learning Organizations: Theory and Empirical Findings. *The Psychologist-Manager Journal, 6*, 31-50.

Kluge, A., & Schilling, J. (2004). Lernende Organisation [Learning Organisation]. In H. Schuler (Hrsg.), *Organisationspsychologie – Gruppe und Organisation* (S. 845-909), Enzyklopädie der Psychologie, Göttingen Hogrefe.

Kreimeier, D., Morlock, F., Prinz, C., Krückhans, B., Bakir, D. C., & Meier, H. (2014). Holistic learning factories – A concept to train lean management, resource efficiency as well as management and organisation improvement skills. In Procedia CIRP, Volume 17, issue C, *Proceedings of the 47th CIRP Conference on Manufacturing Systems* (pp. 184-188). Windsor, Ontario, Canada. DOI: ELSEVIER 10.1016/j.procir.2014.01.040

ISBN 978-88-96687-11-6
ISSN 2280787X

Locke, E. A. (1986). *Generalizing from laboratory to field settings: research findings from industrial-organizational psychology, organizational behavior, and human resource management*. Lexington, Mass.: Lexington Books.

March, J. G. (1991). Exploration and exploitation in organizational learning. *Organization Science*, *2*(1), 71-87.

Martin de Holan, P. M. (2011). Agency in voluntary organizational forgetting. *Journal of Management Inquiry, 20*(3), 317-322.

Martin de Holan, P. M., & Phillips, N. (2004a). Remembrance of Things Past? The Dynamics of Organizational Forgetting. *Management Science, 50,* 1603-1613.

Martin de Holan, P. M., Phillips, N., & Lawrence, T. B. (2004b). Managing Organizational Forgetting. *MIT Sloan Management Review,* Winter 2004, 45-51.

Miller, K. D., Pentland, B. T., & Choi, S. (2012). Dynamics of performing and remembering organizational routines. *Journal of Management Studies*, *49*(8), 1536-1558.

Nairne, J. S., & Pandeirada, J. N. S. (2008). Forgetting. In H. L. Roediger (Ed.), *Learning and Memory: A Comprehensive Reference,* vol. 2, pp. 179-194. Oxford: Elsevier.

Nonaka, I., & Takeuchi, H. (1995). The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation*.* New York: Oxford University Press.

Prinz, Ch., Oberc, H., Kreimeier, D., Kuhlenkötter, B., Reuter, M., & Wannöffel, M. (2016). Learning factory concept to impart knowledge about engineering methods as well as social science methods. In The learning factory: An annual edition from the network of innovative learning factories (pp. 13-16). http://rubigm.ruhr-uni-bochum.de/Veroeffentlichungen/The_Learning_Factory-2.pdf, retrieved Sept. 2nd 2017

Roediger III, H. I., Weinstein, Y., & Agarwal, P. K. (2010). Forgetting: Preliminary considerations. In S. Della Sala (Ed.), *Forgetting* (pp. 1-22). Hove, East Sussex: Psychology Press.

Runkel, P. J., & McGrath, J. E. (1972). *Research on human behavior: A systematic guide to methods.* Holt, Rinehart & Winston of Canada Ltd.

Stone-Romero, E. F. (2011). Research strategies in industrial and organizational psychology: nonexperimental, quasi-experimental and randomized experimental research in special purpose and nonspecial purpose settings. In S. Zedeck (Ed.), *APA Handbook of Industrial and Organizational Psychology*. Volume 1. Building and Developing the Organization (pp. 37-72). Washington, DC, APA.

Tsang, E. W., & Zahra, S. A. (2008). Organizational unlearning. *Human Relations, 61*(10), 1435-1462.

Vladova, G., Ullrich, A., & Sultanow, E. (2017). *Demand-oriented Competency Development in a Manufacturing Context: The Relevance of Process and Knowledge Modelling*. 50th Hawaii International Conference on System Sciences (HICSS). IEEE, 2017, 4424-4433.

Walsh, J. P., & Ungson, G. R. (1991). Organizational Memory. *Academy of Management Review, 16*(1), 57-91.