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Augmented human-centered management
Human resource development for highly automated business environments

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ABSTRACT

Purpose – Digitalization and automation increasingly change, enhance, complement and substitute the human workplace. There is a crowding-out of human work by machines driven by underlying paradigms still rooted in scientific management and neoclassical economics. The focus is on technology which – unlike human beings – rapidly improves in fulfilling the requirements of an 'actor economicus'. In this dynamic context, humans are continuously requested to adapt to new structures, processes and systems which are supposed to be more efficient. The purpose of this article is to shift focus from management for automation with residual human work to what is called Augmented Human-Centered Management (AHCM).

Aim – The aim of this article is to derive an approach for human resource training and development that is suitable for a world with increasing digitalization and automation. It bridges the gap between human resource management and related disciplines that can contribute to this aim.

Methodology: Methodologically based on an integrative literature review, it is interdisciplinary in its approach and builds on work in computer science to outline the future context of Human-Agent Collectives (HAC). Further, it is informed by human factors science and by relevant literature from the fields of philosophy, economics, and strategy.

Findings – A conceptual framework for human resource training and development is derived that can support AHCM in highly digitalized and automated HAC.

Limitations – Only a first overview indicating consistency and plausibility can be provided. Pilot projects and empirical testing can be considered as next steps.

Practical Implications – AHCM is an integrated approach to human resource training and development for a world with artificial intelligence, ready for operationalization by human resource management departments.

Originality – The combination of existing knowledge from the disciplines of human resource management, human factors science, strategy, economics, philosophy and computer science leads to new insights.

KEY WORDS

automation, digital transformation, human-agent collectives (HAC), human-centered management, human factors, training and development

JEL Code: A12, B4, L2, M10, M12, M53

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1 INTRODUCTION

Many disciplines engage in the development of technologies that make our organizations more efficient and effective and that contribute to economic development. Economist Paul Krugman summarized the underlying rationale: "Productivity isn't everything, but in the long run it is almost everything. A country's ability to improve its standard of living over time depends almost entirely on its ability to raise its output per worker" (Krugman, 1997: 11). Recently, the debate around the future of work has intensified around a study by Carl Frey and Michael Osborne (2017) who examined how susceptible jobs are to computerization and concluded that as soon as 2030, 47 percent of total US employment are at risk. This goes along with substantial qualitative changes brought about by digitalization. According to Brian Arthur (2017) the 1970s and '80s brought integrated circuits which enabled fast personal computation, the 1990s and 2000s brought connection of digital processes and the 2010s brought cheap and ubiquitous sensors which in turn deliver "oceans of data" to make sense of. This has fueled the development of artificial intelligence, the development of algorithms which make associations between data sets to sense a situation and decide and act appropriately. "This sort of intelligence is self-organizing, conversational, ever-adjusting, and

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dynamic. It is also largely autonomous. These conversations and their outcomes will take place with little or no human awareness or intervention" (Arthur, 2017).

It is widely accepted that digitalization and artificial intelligence request new proposals from management in general and from human resource management in particular (Chui et al. 2018; Jarrahi, 2018; Davenport & Ronanki, 2018). Scholars and practitioners are challenged to derive suitable approaches to human resource development in a world with increasing automation and digitalization (Stone et al., 2018). Ever since the sudden stop of the insightful Hawthorne experiments, management science just like managerial practice have struggled to balance the drive for automation and replacement of relatively expensive human labor with an adequate development of human resources. A typical reaction is to pursue more and better computer skills (Crick, 2017; Peyton Jones, 2011).

With the rise of cognitive computing and artificial intelligence a paradigm shift is overdue: a shift from the era of rationalization and automation to a new era of collaboration between man and machine (Malone, 2018; Wilson & Daugherty, 2018). The proposal made here is to first and foremost develop human skills. To get there, it follows the footsteps of human factors science as initially developed for high risk industries (Salvendy, 2012; Kanki et al., 2010) and integrates these approaches with the requirements of so-called Human-Agent Collectives (Jennings at al, 2014) that due to technological progress currently emerge across most if not all industries. For both, theory and practice of human resource development, this is a new combination.

As it can reasonably be assumed that automation will continue to progress where technologically feasible and economically sensible, focus needs to be put on an appropriate development of human resources which does not only allow for best possible collaboration but also for desirable roles for humans in organizations. This article therefore proposes to shift the focus from management for automation with residual human work to what is called Augmented Human-Centered Management (AHCM). It establishes a conceptual framework which identifies and describes the competencies that humans need to develop to successfully participate in highly automated and digitalized business environments. This serves to close currently perceived gaps in how human resource management can support digitalization strategies (Fenech et al., 2019; Parry & Strohmeier, 2014) whilst keeping a human-centered approach (Bissola & Imperatori, 2019).

The conceptual exploratory paper is methodologically based on an integrative literature review (Torraco, 2016). This means that new insights for human resource management are pursued by reviewing and critically synthesizing selective literature from the above mentioned fields of human factors science and Human-Agent Collectives as well as from philosophy, economics, and strategy.

The structure can be outlined as follows: The given challenges and context will be provided to the reader from two perspectives. First, the interdisciplinary scientific approach of Human-Agent Collectives is introduced to outline the emerging context of human and machine collaboration. Second, prevailing mindsets for organizational design rooted in economics and the theory of the firm will briefly be reviewed and linked to the phenomenon of the so called "irony of automation" (Bainbridge, 1983). On these foundations, a normative stance will be taken and the need for Augmented Human Centered Management will be discussed. The leitmotif of augmentation instead of the currently prevailing focus on automation will be introduced before a framework rooted in interdisciplinary human factors science will be conceptualized and discussed against the background of current and future human resource development challenges.

2 THE EMERGENCE OF HUMAN-AGENT COLLECTIVES

Ongoing and increasingly powerful digitalization means that machines are in the process of becoming actors in their own right. They do not only compete more often with human labor but, increasingly, they also influence human action, and as such sometimes enhance options and on other occasions limit options available to humans (Carr, 2014). This is well illustrated by the developments in game of chess: Following the defeat of the human grandmaster in chess by the supercomputer Deep Blue in 1996, Gari Kasparov was amongst the initiators of a re-definition of the game of chess who let humans cooperate with chess computers to compete with other man-machine teams in so called Freestyle chess or Advanced chess tournaments. It was found that strong human players or supercomputers were not competitive against relatively weak human players using standard chess computers when these organized their team effectively by implementing superior processes (Kasparov, 2008; Cowen, 2014).

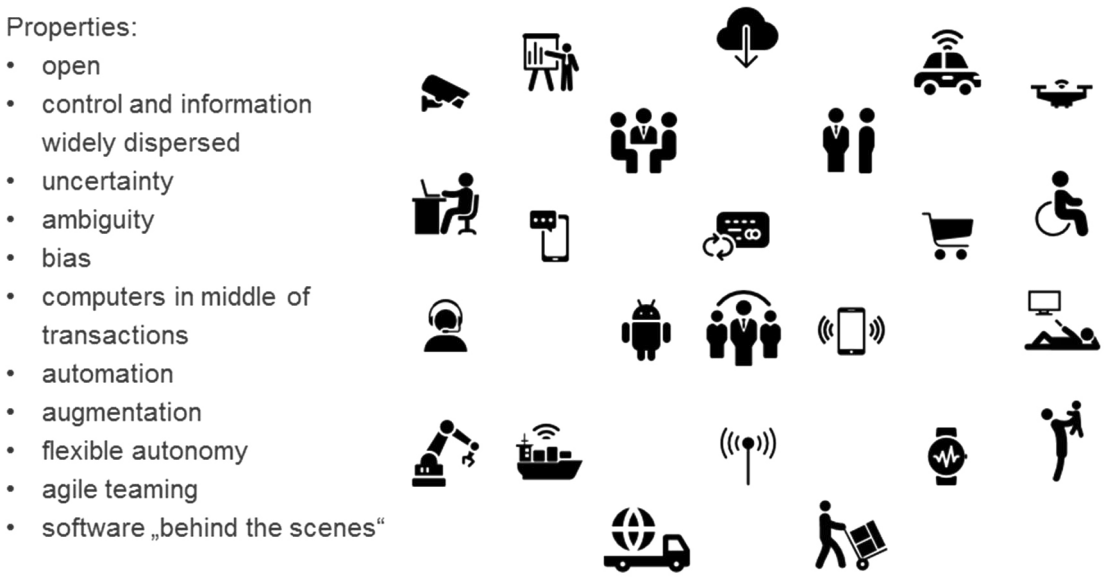
The game of chess is only one of many domains where people team-up with artificial agents to achieve goals. More generally, Varian (2014) observes that today computers are in the middle of virtually every transaction and traces this back to dramatic cost decreases in computers and communication. Jennings et al. (2014) identify socio-technical systems in which humans and smart software (agents) interact as Human-Agent Collectives (HAC). Just like a computer that is already in the middle of a transaction today, HAC now emerging in many industries are likely to step by step and with increasing influence shape the work and social environment for humans.

Examples from different industries are the crew on the flightdeck of a contemporary airliner that is assisted by software that relies on tens of thousands of sensors distributed across the plane (Yedavalli & Belapurkar, 2011), the farmer who is guided by precision agriculture technology (Kitouni et al., 2018), the product manager who uses conversational commerce approaches and who deploys software agents to interact with customers, the psychotherapist who works with embodied conversational agents to provide internet-based cognitive behavior therapy in preventative mental health care (Suganuma et al., 2018), or smart logistics management software that directs human labor in warehouses (Mahroof, 2019). Technological change considerably influences the working environment for humans. In HAC the roles of humans and agents co-evolve.

According to Jennings et al. (2014), the era of issuing instructions to passive machines is over and humans start to work in tandem with highly interconnected artificially intelligent agents that act autonomously. These environments are considered to be open and characterized by flexible social interactions. Here, "sometimes the humans take the lead, sometimes the computer does, and this relationship can vary dynamically" (Jennings et al., 2014: 80). The notions "flexible autonomy" and "agile teaming" (Jennings et al., 2014: 82) describe a short-lived nature of teams with a varying degree of human involvement and with authority relations that are not considered to be fixed but context-dependent. The pro-active involvement of machines in information gathering and filtering, analytical, and decision-making processes raises questions of social accountability and responsibility. Since software often operates "behind the scences" (Jennings et al., 2014: 85), its rationale and actions are regularly not readily available to the involved humans.

The open nature of HAC means that "control and information is widely dispersed among a large number of potentially self-interested people and agents with different aims and objectives. […]. The real-world context means uncertainty, ambiguity, and bias are endemic and so the agents need to handle information of varying quality, trustworthiness, and provenance" (Jennings et al., 2014: 82). The emerging overall picture is illustrated in figure 1.

Figure 1: Human-Agent Collectives (HAC)



Source: Own representation. Properties based on Jennings et al. (2014)

3 HOMO ECONOMICUS, ACTOR ECONOMICUS AND THE IRONY OF AUTOMATION

Across most if not all industries, managers persistently pursue productivity increases for their organizations (Drucker, 2001; Malik, 2010). This drive for efficiency has led to a focus on automation (Frey & Osborne, 2017). For decades, managerial practices have been informed by management theory taught at business schools to undergraduate as well as graduate students and on executive courses and programs. Management theory in turn substantially draws from economic theories like neoclassical microeconomics, the theory of the firm or transaction cost economics (e.g. Douma & Schreuder, 2013). Over the decades, this has led to a situation where the economic conception of the self-interested human being as boundedly rational utility maximizer is today widely reflected in the way how companies are structured and organized. Managers perceive their organizations to be populated by the so called 'homo economicus'. And stakeholders of these organizations perceive the

managers to even more closely correspond with this model of man. These developments have been reviewed and criticized as far as management education and development is concerned (Ghosal, 2005). And, for many years, high-profile issues like the cases of Enron, Tyco, BP's Deepwater Horizon, the Bangladesh factory disaster or the VW Dieselgate scandal stand for problematic practical implications of a drive for productivity based on contemporary managerial and economic concepts.

It does not come as a surprise that steps towards automation in business follow in the footsteps of the impetus economics has on strategy and organization. Where technologically and economically feasible, automation becomes a preferred choice on the route to higher levels of productivity. And a closer look quickly reveals why: 'machina economicua' promises to be the better 'actor economicus'. Algorithms can be programmed to follow the calculus of rational-choice and utility maximization under constraints and this has for a long time been well received by computer science (Huberman et al., 1988; Wagner, 2001). Whilst humans have been identified a misfit to the paradigm of the 'homo economicus' (Kirchgässner, 2013; Beinhocker, 2007), such deviations can be avoided with machines and automation.

The substantial incentives for automation in the past led to the assumption that it is desirable to remove humans from the value-chain whenever possible. However, such strategies repeatedly failed. Whilst humans are regularly considered to be weakest link in the chain, they are still tasked with crucial roles and often expected to monitor automation and to intervene in case of problems. For such phenomena Bainbridge (1983) coined the term "ironies of automation". A review by Baxter et al. (2012) showed that despite technological progress, the ironies of automation continue to persist. This poses a challenge to human resource development.

The dilemma of increasing responsibility in increasingly complex environments whilst being sidelined by automation does not sit well with how human actors are endowed by nature. In "The distracted mind", Gazzaley and Rosen (2016) show how humans when they, propelled by technology, aim to multitask and to be always connected fall victim to distraction and interruption. What can be observed is a "degradation of the knowledge worker (Wagner, 2017). And organizations which follow the paradigm of automation in many areas push human resources back into support roles which are compatible with the paradigm of the 'actor economicus' since this makes seamless integration with machines easier. The managerial approaches taken at the retail- and technology company Amazon.com Inc. in this sense appear to be symptomatic: "If you're a good Amazonian, you become an Amabot" (Kantor & Streitfeld, 2015).

4 IN NEED OF AUGMENTED HUMAN-CENTERED MANAGEMENT

The two previous sections describe a scenario where humans find themselves immersed in increasingly computerized and automated environments where 'machina economicua' takes over tasks and decisions. The pursuit of productivity gains and technological advances lead to a crowding-out of human resources which is constrained by the so-called irony of automation. There is pressure on humans to, against their nature, align with the 'homo economicus' paradigm. To put it bluntly, by pursing their market-oriented objectives, companies create organizations for machines. From a human resource perspective as well as from a general management perspective such a scenario can be perceived as problematic.

The alternative is to deliberately create organizations for humans (first) and (then) for machines. This would acknowledge the irreversible trend for automation but would imply a shift from management for automation to management centered around humans augmented by machines. I call such a concept Augmented Human-Centered Management (AHCM). It is rooted in humanism as defined by Erich Fromm as "a system centered on Man, his integrity, his development, his dignity, his liberty. [It is based] on the principle that Man is not a means to reach this or that end but that he is himself the bearer of his own end. It not just based on his capacity for individual action, but also on his capacity for participation in history, and on the fact that each man bears within himself humanity as a whole" (Fromm, 1961, p. 147, cit. in Aktouf & Holford, 2009: 108). Such a view can be perceived to be compatible with the integration thesis around which stakeholder theory has developed and which claims that it makes no sense to talk about business without talking about ethics and it makes no sense to talk about ethics without talking about business. This results in the conclusion that "it makes no sense to talk about either business or ethics without talking about human beings" (Freeman et al., 2010: 7). The fundamental ideas of AHCM are outlined below.

The term Human-Centered Management was coined by Maria-Teresa Lepeley (2017) summarizing a recurrent concern amongst economic and organization scholars including Adam Smith, Joseph Schumpeter, Elton Mayo, Abraham Maslow, Douglass MacGregor and Peter Drucker for human traits and needs. Early on, Peter Drucker identified that "the cohesion and strength of our society depend increasingly on the integration of the psychological and social needs of the knowledge worker with the goals of organization and of industrial society" (Drucker, 1966: 172). Yet, despite advances in management, Lepeley identifies a lack of Human-Centered

management since "within education, organizations, the economy, and broader society more attention continues to be paid to other interests beyond the needs and expectations of the people these institutions serve" (Lepeley, 2017: 7).

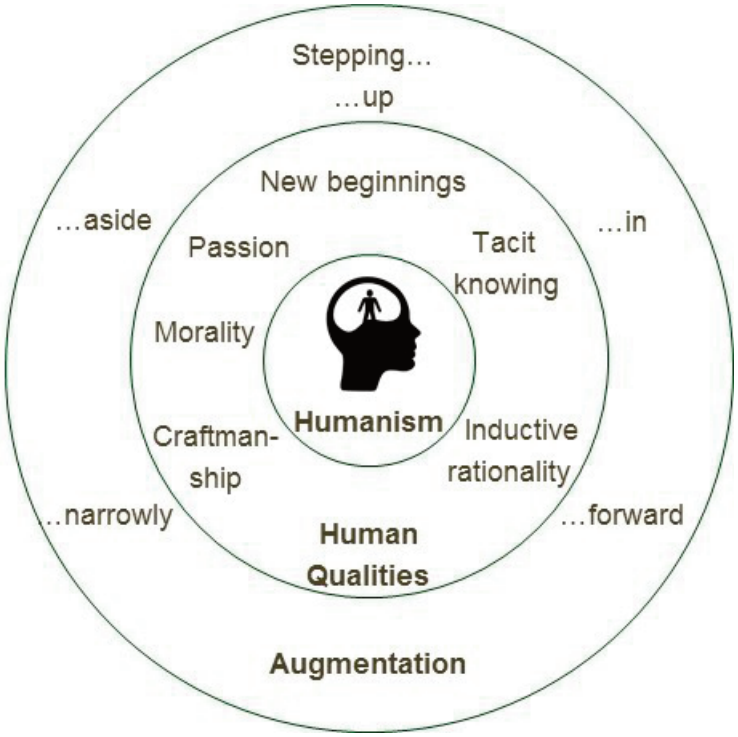
To get there, a broader perception of fundamental human qualities is useful. Accounts of the human being that go beyond the 'homo economicus' model of man regularly emphasize important human traits: Based on developments in behavioral economics, humans can be portrayed as inductively rational which means that we mix inductive pattern recognition with deductive logic (Beinhocker, 2007). A relevant aspect of this is the capacity for tacit knowing (Polyani, 1967) which puts humans in the position to know more than they can tell. Sennett (2008) explores human craftmanship which springs from synergistically combined activities of body and mind. Arendt (1960) stresses the human ability to make new beginnings which can be seen as a nucleus for innovation. And Frank (1988), in the tradition of Adam Smith and others explores the capacity for morality and passion.

Whilst such a broader perception of human qualities is certainly incomplete and requires more in-depth exploration, it further specifies who and what needs to be considered at the center of Human-Centered Management. If, in this sense "man is the measure of all things" (Aktouf & Holford, 2009: 101), clarification with regards to man's relation to technology is required. An approach that can be brought in line with a humanistic perspective on management comes from Davenport and Kirby (2016). They propose a paradigm shift away from automation (human replacement) and towards augmentation (human enhancement) and recommend to humans five strategies when working alongside machines:

1. Stepping Up: To work a level above machines and make decisions about augmentation.
2. Stepping Aside: To leave the current job to the machine and pursue a job that machines are not good at.
3. Stepping In: To monitor and improve a computer's automated decisions.
4. Stepping Narrowly: To find special area in one's profession that would not be economical to automate.
5. Stepping Forward: To create future technology.

The human qualities of inductive rationality, tacit knowing, craftmanship, the ability to make new beginnings as well as morality and passion represent enablers for these strategies as well as selection criteria for potential individual choices. Figure 2 summarizes the point of departure for AHCM as described above.

Figure 2: Point of departure for Augmented Human-Centered Management



Source: Own representation. Icon by Gonzalo Zaragoza

5 CONCEPTUALIZING AUGMENTED HUMAN-CENTERED MANAGEMENT BASED ON HUMAN FACTORS

In the light of the idea of AHCM, the widespread phenomenon of the irony of automation, the necessity to move beyond the 'homo economicus' paradigm, and the properties of emerging Human-Agents Collectives translate into a challenge for human resource development. How to best prepare human professionals for this fast changing and increasingly complex business and social environment? Which competencies are to be trained and developed?

Rather than taking a greenfield approach, the intention here is to learn from an industry that already decades ago identified comparable requirements for itself: aviation. In the 1970s, despite substantial technological progress taking the form of sophisticated support systems, commercial aviation experienced an ongoing high rate of flight accidents which culminated in the deadliest accident in aviation industry at Tenerife in 1977 (Hagen, 2013). Investigations into this and other incidents revealed human errors to be the root causes. In the following years, the aviation industry put a strong focus on developing human skills that would help people to more effectively team-up with complex technology and to make air-traffic safer. An integrated approach to training approach initially called "Crew Resource Management" (CRM) was developed (Kanki et al., 2010) to meet this real-world challenge. Since the first introduction of CRM accompanied by further technological progress, an agile teaming of man and machine in aviation has led to substantial and sustainable reductions in commercial air-traffic accidents (Federal Aviation Administration, 2018; Ranter, 2018).

CRM builds on the interdisciplinary human factors approach: "Human factors…focuses on the nature of human-artifact interactions, viewed from the unified perspective of the science, engineering, design, technology, and management of human-compatible systems, including a variety of natural and artificial products, processes, and living environments" (Karwowski, 2012: 3). A holistic, human-centered approach that considers cognitive, social, organizational, environmental, and other relevant factors is promoted (Salvendy, 1997). Besides in aviation, human factors have proven to be of value in many other real-world domains as well, like for example healthcare, rail, military, oil and gas, energy, manufacturing, consumer products, or software and information technology (Shorrock & Williams, 2017). Both, the track-record in demanding socio-technic environments as well as its conceptual foundations suggest that CRM-Training can be a useful starting point for human resource development that meets the fundamental needs in Human-Agent Collectives described above.

CRM-training is designed to help understanding, avoiding, identifying, and addressing human errors (Badke-Schaub et al., 2010). Particular emphasis is put on approaches that leverage individual performance through effective interaction with others (Kanki et al., 2010). Three phases of training are distinguished: 1. Initial awareness training to convey the essentials of human factors concepts and know-how. 2. Exercises and feedback in realistic settings for complete teams. 3. Refresher trainings in regular intervals based on various methods (Federal Aviation Administration, 2004; Kanki et al., 2010). Trainings are regularly composed of but not limited to the following building blocks: situational awareness, workload management, human error, communication, decision making, leadership and teamwork, stress and fatigue (ICAO, 1998; Federal Aviation Administration, 2004; Kanki et al., 2010). These building blocks and their potential relevance outside aviation are briefly reviewed below.

Situational awareness: Training in situational awareness helps individuals to comprehend current system and environmental conditions and to thus anticipate future changes. Emphasis is put on the capability of consciously avoiding complacency, watching over system and environment changes, and informing other team members of potential issues. In environments with humans and agents, humans are interconnectedly confronted with both, a natural and a digital environment. Consequently, the requirements regarding situational awareness are high. Due to increasing automation and augmentation this is a moving frontier. Driver assistance systems in vehicles are good examples for electronic agents helping with and contributing to situational awareness. But as accidents show, at the same time humans have to increase their effort to avoid complacency and -especially in professional environments – they will be required to develop their situational awareness for inputs from multitudes of electronic devices.

Workload Management: This concerns both, self-management as well as management of others. The purpose of CRM-training is to enable for good preparation and sufficient planning of the relevant work including relevant communication. To maintain focus on primary tasks, the workload needs to be prioritized and delegated effectively. For the interaction with the team members it is important to learn how to induce, give, seek, and receive task-clarifying feedback (Suffler & Xavier, 2011). When new information becomes available, flexibility and the ability to adapt the course of action is of relevance. Particularly in highly automated environments it is necessary to continuously monitor progress, avoid distraction, remain vigilant and, if necessary, respond without undue delay.

(Human) Error: To err is human. Thus, humans from early on in life learn how to cope with error. CRM-training professionalizes this ability, ensuring knowledge about the origins of error and enabling to differentiate types of error. With an understanding of concurrent failures and chains of errors as well as know-how about available resources and redundancies when dealing with threats and errors the competencies to manage errors are increased. This includes error prevention, resistance, detection and recovery (Hofmann & Frese, 2011). The complexities and dynamics of HAC create a dilemma that is likely to increase the demand for such competencies: On the one hand, humans show a tendency of blind trust in technical systems (Parasuraman & Manzey, 2010). On the other hand, errors are an unavoidable feature of complex systems, even advanced technology has weak spots and often does not react appropriately to unforeseen developments (Hagen, 2013).

Communication: In complex situations the perception of each individual involved can matter and effective communication is the key to successful cooperation. Therefore, CRM-training aims to enable free and open communication with active participation of all team members at the appropriate time. Participants practice the use of clear and effective language and work on their responsiveness to feedback. Mission critical situations in on flight-decks have shown that assertiveness and the ability to speak-up if required are important topics (Raulf, 2013). It is intended to create communication environments where plans are stated and ambiguities are resolved which is supposed to lead to multi-directional and interactive exchange of information. If not only humans but also agents are involved, humans have to be aware of differences between different types of actors.

Decision Making: Fundamental to any training in decision making is that participants learn how humans and agents arrive at decisions. On this basis they are trained to detect deviations from desired states, assess problems, generate alternative actions, identify risks and opportunities and select the best course of action, which subsequently is reviewed for the purpose of learning and necessary adaptation. Scenarios of individual and joint decision making are considered. In aviation, all of this is particularly relevant since no or poor decisions are a substantial contributor to most flight accidents (Bühler et al., 2013). Aviation just like HAC are highly automated environments. In such contexts, many tasks are delegated to machines and humans typically get involved only when decisions are required. This means that decision-making across a broad range of automated tasks and processes becomes the core-task and therefore an important skill.

Leadership & Teamwork: CRM aims to strike a balance between active team participation and retaining command authority. Leadership training therefore encourages the use of appropriate authority that ensures a focus on tasks and priorities whilst looking after crew member concerns and supporting others in completing tasks. Team resources are to be utilized effectively to achieve objectives which is enabled by the creation of a positive team atmosphere, by the ability to manage team processes and by developing team interpersonal relations. This requires appropriate knowledge of leadership (Stahl, 2013) and the ability to adjust leadership behavior to the respective situational context (Strohschneider, 2010).

Stress & Fatigue: More than machines, humans need rest. CRM-training seeks to equip participants with knowledge about the origins and the effects of stress and fatigue which allows them to recognize and to manage their personal resources. In HAC just like in aviation, humans are the only components that have not been developed to function around the clock (Ebermann & Murtha, 2013). Therefore, it is vital to exercise personal responsibility with regards to factors of stress and fatigue. Due to the human susceptibility to distraction and given that sources of distraction are omnipresent in computerized environments, self-determination and persistence are important qualities to be developed.

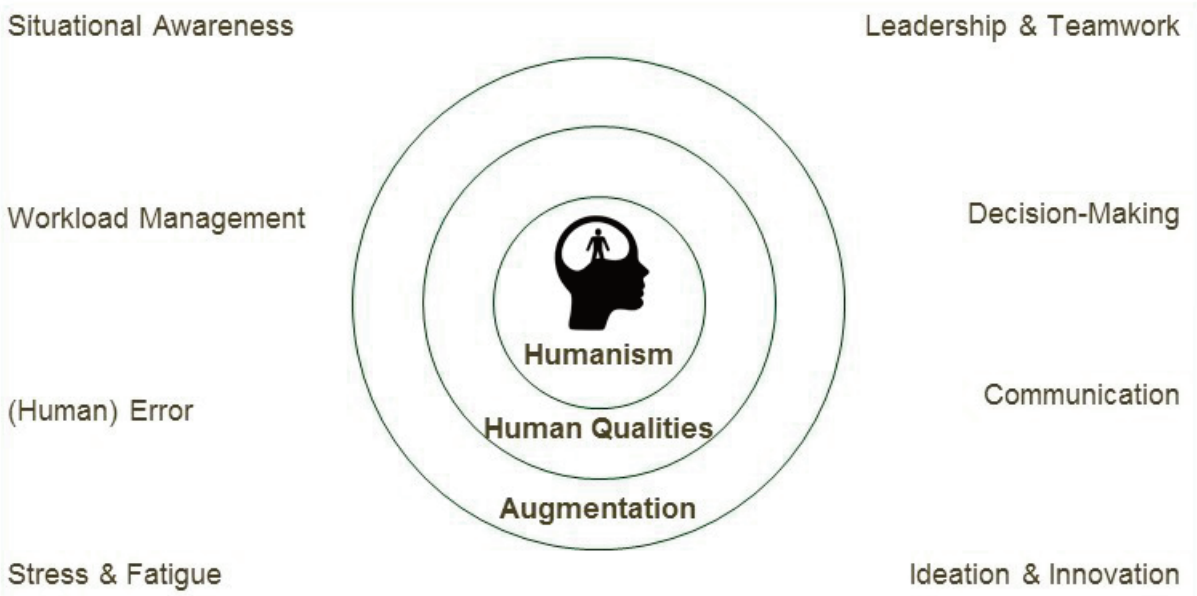
In conclusion, whilst CRM is human-centered, it is still biased in the sense that it focuses on managing errors and risks. Business environments, however, are not only characterized by risks but also by opportunities. The successful management of errors and risks results in quality, health, safety, security and less adverse effects on the environment whereas when opportunities are created and captured innovation takes place and organizational and business development can result. To achieve this, CRM can be complemented with

Ideation & Innovation: Ideation training that builds on contemporary approaches like for example design thinking, value proposition design (Osterwalder et al., 2014), gamification (Gray et al., 2010) and other concepts put the customer at the center and are inspired by the idea of human-centered design (Kelley & Littman, 2005, 2016). Participants are enabled to manage innovation processes from opportunity identification via idea generation and evaluation through to implementation. Conditions are created to achieve the "adjacent possible" (Koppl et al., 2015: 8) leading to innovations in the sense of a transformation of ideas into new/improved products, services or processes. creativity combined with its commercial application (Baregheh et al., 2009). Competencies like the cultivation of an innovation culture or the ability to build innovation around experience are developed

(Kumar, 2012). Evidently, there is a high level of synergy between the objectives for ideation & innovation and the competencies behind the above-named training categories of situational awareness, workload management, (human) error, communication, decision making, leadership & teamwork and stress & fatigue. This results in an implicit alignment of this additional category with the human factors approach behind CRM.

Figure 3 summarizes the elements of the comprehensive human-centered approach to augmented human resource development that serves to pursue both, less crisis and more opportunities and innovation. With the context provided here, equipped with a more universal mission and complemented by new elements CRM makes the transition to Augmented Human-Centered Management. Deeply rooted in well-established CRM, AHCM benefits not only from the contribution of the individual components but especially from the synergies that arise from the overall composition. This is particularly relevant since human resource development in one area (e.g. communication) reinforces development in other areas (e.g. leadership & teamwork or situational awareness).

Figure 3: HR-Development Pitch for Augmented Human Centered Management



Source: Own representation. Icon by Gonzalo Zaragoz

6 DISCUSSION

The step by step development of the concept of AHCM in this article was undertaken with the aim of enabling the creation and development of organizations for humans (first) and (then) for machines which is rooted in humanism and includes

1. successfully coping with the properties of human-agent collectives (Jennings et al., 2014),
2. improving our ability to deal with the "ironies of automation" (Bainbridge, 1983),
3. avoiding a "degradation of the knowledge worker" (Wagner, 2017), and
4. building on (augmentable) human qualities that go beyond the 'homo economicus' model of man.

The components of the training concept for AHCM are derived from human factors science. This ensures an inherently humanistic approach: As postulated by Fromm (1961), the humans involved are bearers in their own end. As such, human traits like inductive rationality, tacit knowing, craftmanship, the ability to make new beginnings and the capacity for morality and passion are addressed and developed as part of the training. This also means that following the concept of AHCM, active and systematic efforts against a degradation of the knowledge worker are undertaken.

Part of the concept is a paradigm shift away from automation and towards augmentation using the directions proposed by Davenport and Kirby (2016). In general, the augmentation paradigm provides orientation to cope with properties of HAC like flexible autonomy and agile teaming. It guides division of labor and requests technology to support humans individually and as members of organizations. More specifically, training priorities would have to be set in accordance with the roles individuals hold in organizations and their respective augmentation strategies. For example, for someone "stepping in" (i.e. monitoring and improving a computer's automated decisions) situational awareness as well as stress & fatigue training may be more relevant than ideation

& innovation training whilst for "stepping forward" (i.e. creation of future technology) the latter training category may be most relevant.

Training for AHCM based on CRM promises to strengthen both, key individual competencies and competencies as a team which are important to adapt to properties of HAC and to mitigate ironies of automation. In effect, relevant training outcomes can be an enhanced potential to deal with complexity, better situational awareness for influences of machine actors and automation and improved decision-making competencies when software prepares information "behind the scenes". Another reason why AHCM shows a good fit with managerial and work requirements in HAC is that it is designed to leverage individual performance through effective interaction with others including machine actors. This is indirectly confirmed by a study undertaken by Shanks et al. (2015) who found that technological progress and the rise of artificial intelligence particularly requires skills in creative collaboration, people development and coaching, social networking as well as creative thinking and experimentation. Kolbornsrud et al. (2017) conclude that with increasing relevance of machine actors, humans will in the future have to further improve social and networking skills, focus on judgment work, in most domains work like designers and treat machines like colleagues. Again, this matches the training categories presented above.

At this stage, HAC, if anything, are at an early stage of a highly dynamic development. However, what can be expected from the future does already cast shadows into the present and translates into real-world challenges in human resource development that AHCM would have to start coping with now. Deloitte's regular surveys on human capital trends summarize the practical requirements across industries. These are also reflected in studies by KPMG and PWC (Deloitte, 2017; KPMG, 2017; PWC, 2015; see also Wang, 2018). KPMG (2017) in particular emphasizes that intelligent automation will impact the HR operating model and that accordingly, improving line managers' people management capabilities has highest priority and that the top area of future investment is talent management. All of the above mentioned studies highlight that organizations need people who contribute as follows:

1. Devise and operate in agile, network-based structures instead of traditional hierarchical organizations,
2. empower and support teamwork and knowledge sharing,
3. enable a productive and engaging work experience for oneself and for others,
4. promote and foster creativity and innovation,
5. understand the role that people will play in an automated world,
6. initiate intelligent automation to free staff to perform more strategic work,
7. leverage digital technology, for example for analytical, evaluation and decision-making purposes,
8. examine the boundaries of work between humans and machines and design human work accordingly,
9. enable new forms of collaboration between people and technology,
10. engage in continuous learning.

When comparing the concept of AHCM against these current practical challenges, it is striking that it does not only selectively support people in meeting the abovementioned requirements. Rather, the synergetic composition that benefits from the long-term evolution of the underlying CRM-concept ensures a highly systematic support. But, that the modules integrate well and are highly complementary is only one aspect. An interesting lesson-learned from CRM for human-resources development professionals is that whole crews and not only (top-) managers or high potentials are exposed to the training. Going through the same experience, absorbing the same knowledge, being confronted with the same requirements and expectations opens-up the opportunity of shaping shared mental models and contributing to a common culture, a culture of Augmented Human Centered Management.

7 CONCLUSION

This article highlighted that managerial focus on productivity growth and automation based on traditional concepts like the 'homo economicus' points towards the creation of organizations for machines rather than for humans. Whilst machines can be made to fit the 'actor economicus' model the observable trend to force humans into a 'homo economicus' role has to be questioned. Based on the humanistic ideal that man is the bearer of his own end, the creation and development of organizations for humans (first) and (then) for machines is envisioned. This requires a broader perception of human qualities as well as a focus of human resource development on exactly these qualities. For computer technology to adequately support this, focus needs to shift from automation to augmentation. By identifying the achievements of human factors science in general and, in particular, of CRM-training in the domain of aviation, it was shown that in order to cope with these ambitious goals, human resource development does not have to start from scratch. Based on decades of research in human factors science and experience in high-technology

environments characterized by ongoing man-machine interaction, the concept of AHCM training and development could be derived. Compared to traditional CRM-training that is traditionally focused on risks, it also incorporates creativity and innovation to enhance entrepreneurial potential by identifying and pursuing opportunities. The discussion showed that training for AHCM addresses competencies and skills needed to deal with the dynamics and complexities of HAC, that it can improve our ability of dealing with the ironies of automation, that it serves to avoid a degradation of the knowledge worker, and even more generally, it contributes to the mastery of current human resource development challenges perceived by practitioners in the field.

In summary, the following specific analytical and conceptual advancements could be derived:

1. A necessary shift of managerial focus is from management for automation to management for and with augmentation is identified. This requires a specific approach to human resource training and development.
2. Human resource training and development benefits from perceiving increasingly digital work environments as Human-Agent Collectives (HAC) and from explicitly taking into account 'ironies of automation'.
3. A human-centered approach can be achieved by adopting human-factors oriented training methods.
4. A degradation of the (knowledge) worker can be avoided if human traits like inductive rationality, tacit knowing, craftmanship, the ability to make new beginnings and the capacity for morality and passion are considered.
5. Namely by taking care of ideation and innovation, human-factors training that traditionally focuses on risks can expand into the sphere of opportunities.

Embedded in the integrative literature review provided (see Table 1 for summary of main sources and topics), a specific, consistent, and comprehensive proposal for Augmented Human-Centered Management training and development for an increasingly digital world with artificial intelligence could be provided.

Table 1: Literature review: Overview of main sources and topics

Discipline	Topic	Description on the vignette (sending)
Philosophy	Humanism	Arendt (1960), Frank (1988), Fromm (1961), Polanyi (1967), Sennett (2008), Spitzeck et al. (2009)
Economics	General	Krugman (1997), Douma & Schreuder (2013), Kirchgässner (2008)
Economics	Technology & Future of Work	Arthur (2017), Beinhocker (2007), Cowen (2014), Frey & Osborne (2017), Gazzaley & Rosen (2017), Jarrahi (2018), Koppl et al. (2015), Varian, (2014), Wagner (2001 and 2017)
Computer science	HAC	Huberman et al. (1988), Kitouni et al. (2018), Jennings et al. (2014), Mahroof (2019), Suganuma et al. (2018), Yedavalli & Belapurkar (2011)
Computer science	Ironies of automation	Bainbridge (1983), Baxter et al. (2012)
Strategy & Management	General	Drucker (2001), Freeman (2010), Ghoshal (2005), Lepeley (2017), Malik (2010), Osterwalder et al. (2014), Stahl (2013)
Strategy & Management	Artificial Intelligence	Carr (2014), Chui et al. (2018), Davenport & Ronanki (2018), Davenport & Kirby (2016), Kasparov (2008), Kolbjornsrud (2017), Malone (2018), Wilson, & Daugherty (2018)
Strategy & Management	Human Resource Management	Bissola & Imperatori (2019), Fenech et al. (2019), Parry & Strohmeier (2014), Stone et al. (2018),
Human factors science	Foundations	Badke-Schaub et. al. (2012), Salvendy (2012), Hagen (2013), Hofmann & Frese (2013), Shorrock & Williams (2017)
Human factors science	Training	Badke-Schaub et. al. (2012), Bühler et al. (2013), Kanki et al. (2010), Ebermann & Scheiderer (2013), Federal Aviation Administration (2004 and 2018), Gray et al. (2010), Baregheh et al. (2009), ICAO (1998), Kelley & Littman (2005 and 2016), Kumar (2013), Lewrick et al. (2017), Parasuraman & Manzey (2010)

Source: Own representation.

This initial proposal faces clear limitations. Only a first overview indicating consistency and plausibility could be provided. Whilst it is probably fair to say that the ideas on augmentation provided by Davenport and Kirby (2016) are still in their infancy, the human factors-based CRM-training benefits from almost 40 years of ongoing development and experience. Future research is needed to fully develop the overall concept, to strengthen its theoretical foundations and to empirically test it in practice. A case-based approach in research and practice appears to be promising here, especially since the properties of HAC are and will stay in the process of developing very rapidly.

What is intriguing is that, upon reflection, many human resource development departments may detect that the programs and trainings they currently offer do already contain a number of those components presented here. A resulting 'brown field' approach to AHCM can consist of the clarification of the mission, vision and values of future programs combined with a suitable re-orchestration and supplementation in line with the concept.

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