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A framework for evolving human-technology practices in startling times

Andrea Montefusco*, Ubaldo Borreani†

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Abstract

This conceptual paper proposes a new framework for integrating three essential but conflicting organizational design and evolution purposes. First, organizations must evolve to pursue the dual scope of shaping their context and adapting to its variations. Second, the same characteristics that guarantee efficiency hinder personal and organizational change and evolution. Third, organizations need to develop the human ability to pursue meaning dynamically, make sense of emerging cues and symbols they are unfamiliar with, recompose conflicting goals, and solve paradoxes. The paper aims to propose a conceptual framework to cope with these challenges, which are paradoxically intertwined. Our framework integrates results and models from three streams: the *four 'P's* approach by Degani and Wiener, Feldman's dual role of routines, and mixed results from decision-making and organizational learning studies. We also considered technology's role in supporting humans in dealing with unforeseen circumstances, learning, feedback, and managing surprising and startling scenarios. We seek to shed new light on the word practice, as it can fill the theoretical gap in interpreting how humans, technology, and context interact to manage complexity, making distinctions but avoiding reductive and critical disjunctions (Shotter & Tsoukas, 2014; Tsoukas, 2017).

Keywords: practice, complexity, humans, technology

* **Andrea Montefusco**, Senior Lecturer in Organization Studies, LUISS Business School, amontefusco@luiss.it
† **Ubaldo Borreani**, Senior Researcher, Huma:Int Srl, u.borreani@huma-int.com

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1. Introduction

The Covid-19 pandemic has displayed organizational vulnerability in dealing with complexity, shedding light on the gaps between procedures and practices in managing uncertainty and ambiguity. While organizations and regulators aimed at defining procedures, non-linear and complex phenomena have emerged subtle, challenging individuals' and institutions' sensemaking. The need for managing complexity, uncertainty, and ambiguity calls for robust individual and organizational contributions. The paper starts by considering technology's role in managing complexity, ambiguity, and uncertainty. Humans adopt technology to simplify complex reality and increase the predictability of organizational outcomes. That tightened connections between entities and generated multiple loops, which is necessary to correctly consider complex system behaviors in machines' control systems and management (Sterman, 2001).

On the one hand, that is what we want technology to do. On the other, the increasing machine's internal complexity prevents humans from representing the connection between actions, choices, contexts, and their impacts on the outcomes (Boy, 2020). So, we here have the paradox: when humans design technology to mitigate complexity, ambiguity, and uncertainty, they (necessary) raise the machine's complexity. That calls for reconsidering many basic assumptions still valid in business and practice. What is automation? What is the actual ability of a machine? Who controls the final results if the machine can make decisions autonomously?

The proposed framework sheds new light on how to answer these and other questions, proposing a new mindset for considering the meaning of actual organizational actions. Authors have emphasized that under complexity constraints, actions never are simple applications of procedures, nor is decision-making merely choosing between options to maximize utility (M. Feldman et al., 2019; Shotter & Tsoukas, 2014; Tsoukas, 2017). The proposed framework shows that the concept of practice helps clarify how individuals, teams, and organizations cooperate through and with technology to manage actual uncertainty, ambiguity, and complexity.

1.1 Complexity, ambiguity, uncertainty, and machines

As the words complexity, ambiguity, uncertainty, and technology have countless meanings, it is mandatory to set some boundaries for the analysis. The paper wants to show that the proposed framework contributes to human-technology *integration* studies. The discussion mainly discusses managing uncertainty, ambiguity, and complexity *with* advanced machines. The paper adopts March's definition of ambiguity and uncertainty. "Ambiguity refers to a lack of clarity or consistency in reality, causality, or intentionality." (March, 1994). The author provided further examples: "Ambiguous situations are situations that cannot be coded precisely into mutually exhaustive and exclusive categories. Ambiguous purposes are intentions that cannot be specified clearly. Ambiguous identities are identities whose rules or occasions for application are imprecise or contradictory. Ambiguous outcomes are

outcomes whose characters or implications are fuzzy. Ambiguous histories are histories that do not provide unique, comprehensible interpretations.". Uncertainty "[…] refers to imprecision in estimates of future consequences conditional on present actions." March then proceeds to highlight the limits of pure rationality theory: "Such theories assume (1) that it is possible to specify all the mutually exhaustive and exclusive states of the world that might exist; (2) that although it is not possible to specify precisely which state exists, some state does, in fact, exist; and (3) that the uncertainty about which state exists will be reduced by the unfolding of information over time. The idea is that there is a real world that is imperfectly understood. It can, in principle, be understood—at least up to some irreducible noise. Uncertainty is a limitation on understanding and intelligence. It is reduced through the realizations of history, search, and negotiation." (March, 1994). As defining complexity calls for an entire paper, as the debate in the literature is enormous, this chose to adopt the view of complexity proposed by Tsoukas (Tsoukas, 2017). Tsoukas's perspective considers the ability to keep the different components of complexity connected as crucial for managing it. While other authors end up in the same place (Csaszar & Ostler, 2020), Tsoukas's vision allows a novel frame to look at the role played by the conjoint action of humans and advanced machines in managing complexity. We take here two concepts. First, if humans have to manage something – a system, a phenomenon – that is complex, they can not rely on its simplified representation as a black box. That is why the representation validity space a) is dynamic and, more critically, b) exceeding its limits will likely generate non-trivial behaviors (Tsoukas, 2017). Second, to understand why humans can manage practical complexity, we must consider actions as continuously re-created in a continuous loop, where people do not simply execute their tasks but must always use discretionary (Shotter & Tsoukas, 2014). Humans have designed a plentitude of machines capable of discretionary actions. Such advanced technology relieves people of complexity, ambiguity, and uncertainty (Murray et al., 2020). All technology types have supported the replicability of tasks; consequently, technology development has come along with the increase in anticipating and predicting the future. Anticipation, prediction, and shaping reality have been crucial goals of organizations, though their conceptualization has varied over time (Flyverbom & Garsten, 2021; Gavetti et al., 2017; Wenzel, 2021).

1.2 Is the human-machine agency robust? Some preliminary considerations

At the same time, contributions emphasized that meanwhile technology mitigates human limits, it empowers their effects severely (de Wit & Moraes Cruz, 2019; Kotchoubey & Pavlov, 2018; Lindebaum et al., 2020). Like machines, humans have tried hard to separate the ability they consider positive from their obscure face, while studies have shown that they come together, especially when the context is complex and ambiguous (Hollnagel, 2012; Tsoukas, 2017). What transforms strategic intent, policy, and procedures into positive practices is the same ability that, under diverse conditions, makes the capability derail. (Gary et al., 2017; Hollnagel, 2012; Levinthal

& Marengo, 2020; Levinthal & Rerup, 2021; Sterman, 2002; Zollo, 2009). Interpreting technology in the light of Tsouka's vision help understand an epistemological reason why the human-machine conjoined agency can end up in terrible failures, like the flight AF 447 accident (Oliver et al., 2017). Hyper-automatic technology reduces complexity by managing it through many interdependent control systems and sensors that, within the operation limits, ensure a robust discretionary ability. If machines are so robust, what are the risks? The Internation Civil Aviation Organization indirectly describes them: "It is impossible to foresee all plausible accident scenarios, especially in today's aviation system where its complexity and high reliability mean that the next accident may be something completely unexpected. Evidence Based Training addresses this by moving from pure scenario-based training, to prioritizing the development and assessment of key competencies, leading to a better training outcome. The scenarios recommended in EBT are simply a vehicle and a means to assess and develop competence. Mastering a finite number of competencies should allow a pilot to manage situations in flight that are unforeseen by the aviation industry and for which the pilot has not been specifically trained."(underline added) (ICAO, 2013). Discretionary machines reduce complexity by managing it instead of operators. Risks arise when a) the machines – though working correctly and according to the designed processes and procedures – need humans' help to decide and complete tasks, as the internal model is not fully reliable, or b) because the machines experience either failures or variations that hinder their ability. Authors that explored such situations found that the operators must be trained to reason in the joined complexity, as variables evolve fast after the machines stop managing them (Boy, 2020; Woods & Hollnagel, 2006). Modern planes filter reality, while pilots must continuously monitor the reduction and simplification of reality operated by their machines. Pilots must distinguish simplified signals and use them properly for their discretionary part. At the same time, they must be aware of the joined effects of the real world. A "stall warning" reduces its root cause to just a sound, while pilots must be aware of the intertwined possible causes that generated the actual stall. A modern airplane is able of preventing stall condition but if – and only if! - it is operating within limits(Oliver et al., 2017). Discretionary machines should help humans adopting a conjoint approach to complexity, instead that making them blind, by a correct design process (Boy, 2020; Pinet, 2016). The power of technology can give humans the capacity to distinguish without disjoining, but it calls for training operators to stay in the complexity. If that the case, discretionary machines can increase the human ability to sense and distinguish many signals, managing the emergent properties of the actual contexts.

1.3 The Practice's framework contribution

Our framework integrates results and models from three diverse research streams. The first source is the *four 'P's* approach (Degani & Wiener, 2017). This contribution, rooted in the human-factor research stream, and its authors defined the practice as something that can not be designed. Practice can only be observed because

"The term "practice" encompasses every activity conducted on the flight deck[1]: correct execution of a procedure, deviation from a procedure, omission of a procedure, the use of a technique, or any other action."(Degani & Wiener, 1994). The authors argued that adding the fourth 'P', i.e., the concept of Practice, keeps the diverse system levels coherent. As the second source, Feldman's contributions explored routines' dual role: stabilizing and transforming (Feldman et al., 2021). We argue that learning and feedback, especially in decision-making, are paramount for managing surprising and startling scenarios. Then we integrate various interpretations by decision-making, organizational learning, and recent advances in the role played by technology when supporting humans in dealing with unforeseen circumstances. The model can also contribute to better mapping the complexity of actual actions without reducing it by disjoining the diverse agency component of humans at work (Tsoukas, 2017).

2. Concepts versus practice and its role in anticipation, astonishment, and reactions

Methods are crucial in most fields as they contribute to transforming concepts into practice. The evolution of science has shown that humans are in the loop of reality: as they understand it by their paradigms (Wray, 2011) through sensemaking processes. Sentences like "We must be practical [...] ", "yes, it is true, but in practice [...] " are just two examples of the concerns humans show at work and in their lives of this apparent dichotomy. Concepts and practice are not opposed to each other but are inextricably intertwined components of human life (Sandberg & Tsoukas, 2011). Managers shape the landscape while they attempt to understand and map their business context (Gavetti & Rivkin, 2007; Sterman, 1994). Studies show that organizational goals are conflictual sources of strategic behavior and political negotiation within firms (Levinthal & Marengo, 2020), while feedback often generates adverse learning instead of improving firms' adaptiveness and competitiveness (Levinthal & Rerup, 2021; Zollo, 2009). Recent contributions challenge the confidence we have put in procedures, processes, and static preparation to prevent crisis (Angeli & Montefusco, 2020; Phan, P.H., Wood, 2020), arguing that the ability of managers to build the future is more relevant than trying to forecast, through strategy, its immanent flow (Wenzel, 2021).

Our framework introduces an alternative way of looking at concepts and practice as integrated stages of the continuous evolutionary process that individuals have been running since the origin of firms. We argue that practices are not static descriptions as opposed to concepts, while practices emerge (Degani & Wiener, 1994) when humans turn concepts into artifacts (Schein, 2010). Humans try to realize concepts through procedure execution, decision-making to fulfill their discretionary tasks, and any other tentative of following up what they have in mind with actions conjoined with technology. The framework considers the concepts-practices couple

[1] The place where the crew fly the plane, often called *cockpit*.

not as static (cognitive) representation but as an infinite sequence of tensions between what individuals and organizations want, prescribe, or try to do and what they do.

Degani and Wiener proposed the fourth 'P' to solve issues in procedures design (Degani & Wiener, 2017) at NASA and aviation to ensure safety and standardization. Our frame wants to generalize and broaden this scope. Aviation and High-Reliability Organizations aim for safe and efficient standards in their service and try to eliminate any threat – if possible – by design. The frame proposes to regard the tensions between having something in mind and acting it as the fuel of an infinitive evolutive loop. Practice and concepts will never coincide by definition like any map can not coincide with the landscape, and even the best automatic control model can not represent the system completely. We argue that Practice fills a missing entity in design, training, and execution in management and organization studies.

The interpretations of routine roles by Feldman, Rerup, and Pentland falls in this optic (Feldman et al., 2021). With its concept of practice, the framework sheds a different light on the routines' studies as it explains why routines generate change and evolution. We also argue that our framework helps go beyond the good-bad practice dichotomy based on common sense. Hollnagel proposes this perspective to investigate and prevent catastrophic failures (Hollnagel, 2012), arguing that practices simultaneously are good and evil. The frame suggests that the awareness of the concept-practice tension allows individuals and organizations to manage the other evil couple: anticipation and reaction.

The paper has four sections. The first sets the research questions, linking them with the literature. The second situates these questions by examining the evolution of automation in aviation and its impacts on procedures and practices. The third describes the framework in three steps. First, we analyze the aviation *hyper-automation* case in light of our proposal. In the second part, we discuss how the new framework can contribute to answering the questions. In the last, we illustrate an example of an application. The fourth section examines limits and suggests possible further directions.

3. Concepts and practices: a novel perspective

Mintzberg and Westley shed new light on transformation processes, showing that they originate both from concepts or practices and that change is always a set of cycles (Mintzberg & Westley, 1992). They discriminate four cycles to represent different dimensions of transformation processes: contents and levels, means and processes, episodes and stages, and sequences and patterns. The authors ended up with three considerations of paramount relevance. First, considering transformation calls for examining its context. Second, change can be managed, i.e., it is not an immanent flow of ineluctable events that are consequences of either the past or some strategy. Third, the mechanisms that connect micro and macro change levels are crucial to managing the complex change process. We argue that our framework takes into consideration all these directions. Edgar Schein suggested introducing organizational culture as the

conceptual frame that influences actions and choices (Schein, 2010). Schein argued that managers and leaders must change the organizational culture, although they and the whole organization are in the loop. Schein proposed organizational culture as a normative model suitable for managing change and transformation. Mintzberg and Westley considered culture at the conceptual level (Table 1, page. 40) (Mintzberg & Westley, 1992).

We otherwise argue that artifacts are amid actions because this category contains *visible and feelable structures* and *observed behavior* (p. 23) (Schein, 2010). Schein ended up in a normative cycle for leadership to manage culture in their organization. It suggests that leadership must act on cultural dimensions differently over time, according to the various evolution stages (Part III) (Schein, 2010). We argue that, while it is an oversimplification that can fit only specific contexts well, the role of leadership's action on culture explicitly brought human agency in organizational transformation. Leadership accomplishes the active role suggested by Mintzberg and Westley, which is considered crucial also in the other streams explored below (Gavetti & Rivkin, 2007; Levinthal & Marengo, 2020; Zollo & Winter, 2002). Schein's approach suggests that leadership is in the loop of cultural evolution, which indirectly states that culture should evolve based on learning from evidence and feedback (Schein, 2010). Our framework integrates diverse approaches and proposes a novel interpretation of the cultural role and feedback loops in transformation and evolution.

A second stream has explored how people build strategy and connect with evolution through dynamic capability. Gavetti and Rivkin explore how managers search for a strategy and highlight the loop linking action and cognition over time to connect physical and cognitive aspects. Like Mintzberg and Westley, they suggest that managers, through induction-deduction processes, connect their minds' representations with the firm's physical elements. Their *frame of reference* links the diverse search mechanism that informs decisions (figure 2, p. 432) (Gavetti & Rivkin, 2007). Zollo and Winter's informative paper propose a frame that explicitly considers the continuous exchange between practices and knowledge (fig. 2, p. 343) as a source of organizational learning. Explicit knowledge and tasks interact with tacit experience when people must fill execution gaps. They especially highlight the role of task ambiguity as a crucial source of (positive) dynamic evolution of capability (Hypothesis 3, p. 348) (Zollo & Winter, 2002). They center deliberate learning, situated in the frame of reference of evolutionary economics: like the other contributions above, Zollo and Winter suggest that the human mind and action play a crucial role in shaping organizational learning. Path dependency appears strong in their model while considering its impact through human deliberate choices and will. Our framework proposes a novel perspective on implementing the author's loop (fig. 2, p. 343) (Zollo & Winter, 2002), i.e., turning deliberate learning into action. Routines stream is essential. Organizations accomplish what they do mainly through routines. While some contributions argued that meta-routines accomplish change and transformation, Feldman and Pentland, on the contrary, have made evident that routines are the duality of structure and agency. The first represents the abstract ideas of routines, while the latter consists of actual performances of routines by

specific people (Feldman & Pentland, 2003). This duality explains both the central tendency and the variations of routines. The authors emphasize the human agency's role in routines. Feldman and Pentlands' proposal argues that norms and artifacts like standard operating procedures are part of the ostensive routine components, but it also includes a more general understanding of shared ideas about what has to be done. The authors highlight the unavoidable incompleteness of norms and procedures because they must be fruitful in diverse situations. In stable environments and regulated businesses like aviation, human agency is necessary to conduct operations (Degani & Wiener, 1997). Humans also improvise while executing typical tasks, as residual procedure ambiguity is necessary to go beyond human limits and ensure flexibility (Feldman & Pentland, 2003; Hollnagel, 2012). Later, Feldman and Rerup moved further, showing that routines change organizational schemata through trial-and-error learning. Trial-and-error connects routines and organizational schemata by evidence emerging from actions (Rerup & Feldman, 2011). Our framework proposes a way to implement this connection within the evolutionary loop of routines. Also, the framework holds together all the individual, team, organization, and context levels. We argue that it contributes to modeling the complexity of human-machine agency without disjoining and decoupling concepts that always come together in the actual operations. As described in section 1.2, problems arise when operators think the real world will always show simplified behaviors, while that is true only until the machine stops (Lindebaum et al., 2020).
The last thread we consider is feedback. Feedback is crucial both in generating and managing transformation. Studies that explore the risks of taking for granted feedback accuracy, validity, and reliability are growing and increasing their importance. The complex adaptive system theory states that no things are as sensitive and critical as feedback is, and a poor choice of feedback can compromise system operation and stability (Sterman, 1989). Some papers examine feedback aiming at improving organizational evolution and strategic behaviors. Zollo argues that poor feedback generates superstitious learning (Zollo, 2009), derailing organizational learning. Feedback is crucial to extricate structures from ambiguity (Levinthal & Marengo, 2020), while ambiguity hinders feedback quality (Levinthal & Rerup, 2021). Other studies explore how feedback helps to learn. Argyris and Schön, in their contributions, suggest that we learn through a double feedback system about the subject and the frame we adopt to examine and learn the subject, naming their model double-loop learning (Argyris & Schön, 1995). This model suggests that exploring only performance evidence as a feedback source is insufficient for learning (Rudolph et al., 2007; Schön, 2017). People should also explore their frames, values, beliefs, and the basic assumptions contributing to the interpretation as the basis for their choices and actions (Rudolph et al., 2007). Exploring frames is especially important in dealing with complexity (Angeli & Montefusco, 2020; Sterman, 2006). The framework adds a diverse perspective on obtaining feedback in an evolutionary context.

Though these streams have suggested diverse impactful interpretations, practical models, and methods to tackle the complexity of transforming innovation, transformation, and evolution concepts into actions, we argue that an integrated approach is still missing.

Our conceptual paper contributes to the conversations above, answering several questions. First, how can managers better connect novel concepts and insights that should inspire their company's future with the actual and past context? Second, how can they better connect macro- and micro-organizational levels in innovation and transformation processes to discriminate between tight and severe constraints and people's capacity to (double loop) learn and adapt their routines? Third, which dimensions should leadership focus on to influence transformative action, balancing forward exploration and performance feedback? Fourth, how can managers design and implement organizational learning processes that integrate innovation into the broader company evolutive loops? Fifth, how can managers build robust feedback processes to accurately and robustly inform the continuous adaptation of the strategic intent of their firm?

We argue that our framework contributes to answering these questions in diverse ways. At first, it proposes a novel way to better interpret the context and understand past strategic intents' effects, and their consequent events, on actual actions – i.e., practices – and transformation. It also introduces a simplified but not simplistic schema to represent the mechanisms that connect micro and macro change levels and orient the action. As the third contribution, our paper integrates some variables affecting transformation and reaction processes through a novel interpretation of the Four P model by Wiener and Degani (Degani & Wiener, 2017). It consents leadership to attain more accurate and authentic feedback, delivering informative directions for dynamically adjusting the firm's action and evolution. Fourth, the framework suggests a possible bridge connecting the extensive and the ostensive routine's dimensions. We argue that the interpretation of the Four Ps Model provided by our framework is a tool for making sense of the trial-and-error components of routine (Rerup & Feldman, 2011), gaining a way for addressing learning while giving performance feedback on both the implementation of plans and the evolution generated executing the practice.

4. The 4Ps model's conceptual role in the evolution of culture and routines in startling event conditions

We propose to see these models as a dual representation of the same objects that can benefit when applied in the integrated frame we are proposing. A deep analysis of these models is out of the scope of this paper, and we here discuss only the aspects connected with the proposed framework and its impact on innovation and the firm's evolution.

As discussed above, Schein argues that leadership must transform culture, which he describes as composed of three conceptual sets: Basic Assumptions, Values, and Artifacts (Schein, 2010).

Basic Assumptions chiefly influence individual and organizational cognition, and consequently, it is the source of almost every action humans perform in the firm. Basic assumptions significantly impact critical thinking ability, shaping anticipation and reaction capacity. Though Basic assumptions are pervasive, they are challenging to

discover as people are unaware of their continual influence on learning, understanding, deciding, and acting. The exact meanings of anticipation, forecasting, and reacting come from basic organizational assumptions, while hardly someone has deeply reflected or explored them on purpose. Therefore, updating Basic Assumptions is mandatory not only for attaining a stable transformation of behaviors but for constantly updating organizational anticipation tools and practical reaction ability at the individual and organizational levels. The word *updating* emphasizes that deleting – or unlearning - Basic Assumptions and substituting them with new ones is not a real option, as they are deeply interrelated. Leaders should facilitate continuous learning processes to integrate new meanings and frames and evolve Basic Assumptions over time. The black swan is sure an excuse for unpreparedness (Phan, P.H., Wood, 2020), but anticipation is often impossible, while reaction remains the only valid alternative. Reaction to real unexpected – i.e. external ambiguity, uncertainty, and complexity – calls for critical thinking ability (Angeli et al., 2021; Angeli & Montefusco, 2020; Kahneman & Klein, 2009; Klein, 2003; Mousavi & Gigerenzer, 2014). The framework allows people to learn critical thinking as they are aware of their practices as sets of intertwined artifacts situated in their contexts and connected with procedures.

Artifacts are the opposite of Basic Assumptions. Schein says they "includes all the phenomena that you would see, hear, and feel when you encounter a new group with an unfamiliar culture." (Schein, 2010). Schein also highlights that Artifacts include behaviors. Artifacts are challenging to decipher, though visible and feelable because the hidden set of Basic Assumptions has shaped them and influenced every cognitive act and behavior.

Values connect Basic Assumptions with Artifacts, as while the latter influence people unconsciously, the first is well-known by people who use them as guidelines and often quote them. Values are goals, ideals, and aspirations people are conscious of, though sometimes incoherent with Artifacts.

Wiener and Degani's 4Ps model (Degani & Wiener, 2017) has many similarities with Schein's Culture. We argue that the differences come from the different models' scopes. Schein offers an approach for managing transformation that points to general validity, ranging from small businesses to big corporations, and then its components and methods cover the macro organizational level. Schein's process is clean and linear, mainly if an organization transforms through planned stages. In contrast, when the organization does not merely follow a change plan, Schein's model does not help to dynamically develop anticipation and reaction ability.

Conversely, Wiener and Degani developed the 4Ps to address the transformation processes originated by technology transformation in the aviation industry. They started from field data provided by Lautman and Gallimore's study: pilot deviation from basic operational procedures caused 33% of the accidents that caused aircraft unrecoverable damages (Degani & Wiener, 2017). Wiener and Degani argue that designers and trainers have neglected a crucial category: the practices. While exploring the path from design to action showed that procedures are a cognitive category, though operators often executed them through tangible systems. Wiener and Degani added the fourth category and named it the "fourth P", the practices: "A

practice is the activity actually conducted on the flight deck. […] The procedure is specified by management-the practice is conducted by the crew. Ideally, they should be the same. The high prevalence of 'pilot deviation from SOP' indicates that no one can assume that operators will always follow any given procedure dictated by flight management." (Degani & Wiener, 2017). Wiener and Degani argue that "procedure-practices Δ (delta)" mainly originates in three collections. First, procedures, and consequently training, can not specify all details (incompleteness) and are imperfect. Second, demands and tasks can overwhelm the crew or brings unexpected situations. Third, individual factors like experience, beliefs, and technique sometimes bring individualism.

We argue that most managers are fully aware of this gap. Nonetheless, introducing the practices as a category in management can be beneficial in two ways. First, it introduces an applied concept in the vast collection of artifacts. Second, practices positively link artifacts with values and basic assumptions in innovation processes. The policies are a concrete subset of the first, while the philosophies are conscious expressions of the latter.

We also argue that practices are components of extensive routines, while philosophies and policies contribute to the ostensive routine.

The links discussed above allow closing the evolutionary loop. First, it bridges the gap between Schein's model, which is valuable but hard to connect with the transformation of the task execution. Second, generating a positive representation that bridges the extensive and the ostensive routine components allows for keeping into account repetitive and cyclical patterns in task execution and better understanding the mechanism that affects the execution and evolution of the practice. Finally, we argue that the Delta between practices and procedure is – partially – an emergent component of the transformational potential embedded in routines.

The next sections explore how practices are the source of evidence-based feedback that informs the entire evolutionary loop.

5. Evidence-Based Training as the feedforward steps from procedure to practices

As explored above, the practices and procedures are different conceptual entities (Degani & Wiener, 2017). In Degani and Wiener's model, training can significantly contribute to procedure adoption, sustaining the transformation of practices coherently with the direction proposed in the innovation of philosophies and policies.

In the end, training contributes to generating and orientating the company's evolutionary loop. However, not all approaches to training can attain such a broad and impactful effect. Exploring the various training models is out of paper scope. Therefore, we only focus on the Evidence-Based Training model (ICAO, 2013), a crucial part of the proposed framework.

International Civil Aviation Organization introduced this model due to three main reasons. First, to deliver effective training for managing modern aircraft, characterized by complex technology, as described above. Second, to foster the 4Ps

model adoption as a standard. Third, connected with the previous one, to dynamically evolve the training systems connected with technological innovation and market demand, especially by observing practices in field operations and simulator-based training.

On the one hand, evidence-based training (EBT), mainly based on simulation scenarios, induces practices because it makes people directly experience procedures through inductive learning processes (Dewey, 1938; Kolb, 2015; Schank, 1995). On the other, through informing debriefings, EBT process achieves two other objectives. First, from the beginning, it makes people feel and understand that practices deviate from ideas, schemata, and procedures. Reaching this awareness is crucial, as that shortens the gap between the ideal world – vision and basic assumptions; philosophies, policies and procedures - and practices, facilitating the deliberate learning process (Zollo & Winter, 2002), and consequently, routines evolution through feedback (Dittrich et al., 2016; Feldman & Orlikowski, 2011; Rerup & Feldman, 2011). At the same time, instructors and facilitators collect evidence that contributes to feedback in the evolutionary loop. Thus, the introduction of practices as conceptual entities allows evidence-based training a dual role in the firm's evolution: actively and positively influences practice innovation while sensing possible breaches as soon as they emerge in (simulated) scenario execution. Not to forget, conducting and managing complex systems involves the use of different skills, integrating low discretionary activities with others that require complex evaluations (Rasmussen, 1983). As in EBT, patterns repeatedly emerge when people try to cope with ambiguous and uncertain procedures, instructors and facilitators can observe them. Though that happens in a protected environment, it shows the different ways people perform a procedure, i.e., EBT feeds forward, informing the construction of practices with procedures, while it also feeds back into the ideal world with *practices* (see Figure 1, block 5).

Schein primarily considers the psycho-socio-cognitive aspects of culture. In the book's fourth part, he proposes a conceptual model of how leaders can manage culture. This model is built around the famous unfreezing-cognitive restructuring-refreezing model, which includes the various organizational learning processes necessary to modify the culture. EBT also contributes to the process of cultural transformation. On the one hand, we argue that EBT sustains people while they strive to learn how to make sense of new physical artifacts – technological innovation - and operate according to the new procedures. As practices are a focal concept in EBT, instructors and learners cooperate to explore the "procedure-practices delta" in depth. O the other hand, we argue that feedback collected in evidence-based training contributes to informing the leadership about the actual transformation of artifacts and shedding light on the shift of basic assumptions and values.

6. Closing the loop: Evidence-Based Feedback based upon practices

EBT is the early source of feedback about the transformation process that managers can receive. The second source comes from observing the actual practices

(Figure 1, block 8), influenced by EBT, actual and past culture, and actual routines (see Figure 1).

Observing practices feeds back into the entire evolution process (Figure 1, block 9) and impacts transformation cycles, especially in technology-driven change processes, like digital transformation. We name this specific feedback *Evidence-Based-Feedback* because it emerges from reflecting on practices' observations. Reflecting on practices through EBT and EBF sustains the evolutionary loop in exploration and exploitation firms' stages. On the one hand, EBT *induces* practices because training teaches procedure, EBF collects pieces of evidence and contributes to generating informative feedback that informs the evolution, influencing blocks 1 to 4 and evolving the EBT itself (block 5). Observing the actual practices is of paramount importance. Acting at work, people integrate various procedures, intervene to complete them, and conduct and manage complex systems. They apply procedures through variations, small or large: Feldman and Pentland consider the *extensive* component of routines (Feldman & Pentland, 2003), Wiener and Degani call that *practice*. (Degani & Wiener, 1993, 2017). Only if we systematically observe the various forms by which a procedure is performed we find out its *practices*, i.e. the diverse actual ways people perform ideal routines, defined as ostensive, and procedures. The concept of Practice sheds new light on how ideas come into actual execution. Philosophy, Policy, and Procedures come into actual execution through human agency, creating practice while executing tasks. The concept of *practices* has finally instilled in designers and instructors the *awareness* that there is a difference between standard prescriptions and their execution. At the same time, practice is a source of evidence and accurate feedback if appropriate observation techniques are applied during training and task execution (Degani & Wiener, 2017; ICAO, 2013; Rudolph et al., 2007).

7. Practices as Output and Input of evolution processes

The concept of practices impacts the evolution of a firm's vision and strategy. The procedures are the initial step to materializing management expectations. Procedures describe how to perform actions using the available capabilities: machines, people, and other procedures. Evidence-based training receives procedures as input and contributes to generating practices as output. However, even the most complete procedural training can not "explain" what is not specified by the procedures because that has been deliberately left incomplete and free either by design or by incomplete knowledge. Training also can not compensate for errors, limitations, and inconsistencies that the procedure contains from the origin (Degani & Wiener, 2017).

The evidence emerging from observing the actual practices – partial output of training – is also an Evidence-Based-Input for training. Starting from differences and variations in procedure execution, Evidence-Based Feedback closes four different loops:

a. It impacts training processes (Figure 1, block 5), including skills updates, focuses on particular situations, and mission upgrades to make learning more effective

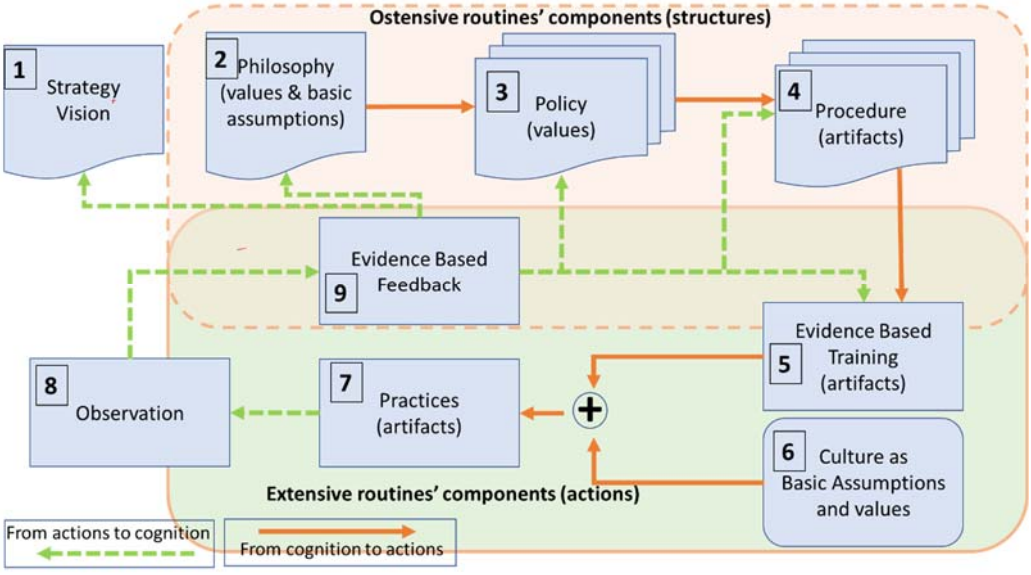
b. It suggests procedure updates when they cannot execute as planned, or a positive variation has emerged and been observed (Figure 1, block 4)

c. It moves the whole system evolution forward, either for fixing bugs or for improving efficacy and effectiveness (Figure 1, block 2→4)

d. It influences vision and strategy evolution, making executives learn gaps and opportunities to evolve capabilities (Figure 1, block 1)

We argue that the EBF contributes to raising the quality of feedback in the entire company, which many studies consider a crucial issue after the contribution of Zollo (Zollo, 2009). Recently authors have emphasized the complexity of attaining accurate feedback, especially in ambiguous and uncertain contexts (Levinthal & Marengo, 2020; Levinthal & Rerup, 2021; Marengo, 2020).

Figure 1 – Closing the loop through the evidence-based feedback framework



Source: Authors' elaboration

8. Conclusions

The novel framework, based upon integrating diverse models with the concept of Practice, can improve the management of transformation processes to increase the anticipation and reaction ability in individuals, teams, and their firms. Introducing Practices as a conceptual and logical entity allows for more effective implementation of strategy and vision that evolve the anticipation and reaction ability. Based on

behaviors and events collected in the actual context, evidence-based feedback provides honest feedback to a firm's evolutionary processes. It also contributes to the discussion about routines', especially in clarifying the human agency's role in routines' evolution. As an output of training and input of Evidence-based feedback processes, Practices could be explored as an engine that can contribute significantly to the positive evolution of routines. Observing Practices and linking them with Philosophy and Procedures raises awareness of abilities, boundaries, and constraints of a firm's capability. Organizational reflection and discourse about practices may consolidate actual *work* processes while exploiting individual differences and continuously pushing for updating (Dittrich et al., 2016; M. Feldman et al., 2019; Rerup & Feldman, 2011). Regarding execution differences, people understand their variation range which is an essential step toward reaction ability. Conversely, exploring variations is necessary for developing the anticipation capacity. First, because anticipation – amid many characteristics - needs a) recognizing patterns from emerging cues, b) connecting them with possible action scripts, and c) evaluating alternative action scripts, valuing your teams if available (Kahneman & Klein, 2009; Klein, 2003); second, because the observation of practice and the variation analysis is a source of cues itself, as people often exploit their discretionary to adjust execution. Piling up variation over time can suggest that procedures – and frames – must be updated to anticipate unexpected phenomena, which cues have already been managed on the shop floor, even though operators have no spot for their coherence and connection. Human and machine cooperation appears in a new light here.

On the one hand, technology frees cognitive resources and correlates data most, facilitating operators in spotting cues and making sense of the broader incoming phenomenon or trend. On the other, algorithms suffer from their programmers' bias, so they subtly challenge humans. As the concept of practices includes the couple human-machine, the discussion before is still valid here, where machine practices must be explored in connection with the human ones, measuring their impact in variations and updating both the algorithms and the way humans cooperate with them.

Though our paper is conceptual, as experiments are still running in the manufacturing field, we argue that it can contribute to the discussions about feedback processes in innovation, transformation, training, and learning, for developing anticipation and reaction ability in humans and technology. It also offers novel perspectives on the role played by routines in evolution and innovation. The concept of practices and the framework can also inform reflections about digital transformation, human-machine integration, AI, and Augmented reality applications.

9. Research limitations

The first limitation is that this paper is conceptual, though it discusses an organizational component, the Practice, and some processes based on observation. It proposes a framework for considering practices as an emergent component, which evolves in systemic connections with the whole organizational system. Though we

highlight that the practice is what we observe watching people in actions, this paper only provides a theoretical description. We mitigated that limitation through two examples. The first describes the generic practice evolution in aviation ignited by discretionary machines. On the contrary, the second illustrates a specific case still impacting flight operations.

The paper has a second limitation as it sketches the connection between the aviation case and the other businesses only roughly. The paper discusses possible implications and impacts in relatively every section but without going into depth sufficiently.

The third limitation is that the paper misses experiments. We argue that the framework must be tested in real contexts where human-machine integration has a daily impact.

The last weakness is partially its strength. The paper does not limit to bring the concept of practice as it is in the Four Ps' model. Differently, the paper sheds new light on this concept as a possible integration of the diverse research streams that the paper discussed. At the moment, the authors consider that a weakness, as further criticism and discussions about the framework are necessary to arrive at a more robust, theoretical, and practical model.

10. Research implications and further developments

A couple of compelling questions arise. First, can the concept of practice proposed here be an ontological entity for analyzing human-machine integration by a systemic approach? Though Tsoukas contributions do not directly talk about this field (Tsoukas, 2017), we argue that the complexity view brought by this stream must be considered more in further studies. Research can investigate if the practice as a phenomenical entity can integrate the diverse descriptions that various streams propose for interpreting the connection between what humans have in mind about their actions, what they actually do and make, and how they use what they observe, measure, feel and sense for either evolving or just surviving, getting things done for another day. Can the concept of practice proposed here contribute to mitigating the reductionist theorizing described by Tsoukas? Studies that have explored the human-machine agency have always disjoint the entities they analyzed (Himmelreich, 2018; Murray et al., 2020; Zanatto et al., 2021). Though Feldman's approach to routines is crucial for exploring the social and individual dynamics that make human-machine practices evolve, scholars studying humans and machines have not dug into them enough.

Second, can the proposed framework help shed new light on the evolution of leadership in a human-machine integrated world? In this paper, we considered its role in company evolution, connecting both with routines and evolutionary economic studies (Feldman et al., 2019; Zollo & Winter, 2002). We also considered the microeconomic approach by Csaszar and Ostler (Csaszar & Ostler, 2020), the cognitive vision of decision-making under uncertainty and feedback (Kahneman & Klein, 2009), and its partially opposite, the gut feeling approach as in Gigerenzer

(Gigerenzer & Gaissmaier, 2011). Again, the dynamic system approach helps make sense of complexity, fostering the comprehension of the difficulties people meet in dealing with actual phenomena in practice (Sterman, 1989, 2000) and also shedding light on why managers and the company governance often make terrible mistakes (Gary et al., 2017; Sterman, 1994, 2006). The aviation experience tells people that leading, i.e., being the captain in command of a discretionary liner, falls far from the practice of command before this evolution. Moreover, we must reckon that integrating human and technology agency has dramatically changed managing and leading. Again Tsoukas questioned how we are looking at what leadership does in practice (Shotter & Tsoukas, 2014), and we argue that further studies must try to answer those questions considering the conjoined agency of humans and machines.

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