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ENTROPY, GENERATIVITY, AND RUGGED FITNESS LANDSCAPES AS THE MEANS TO RATIONALIZE A PARADIGM SHIFT IN KNOWLEDGE MANAGEMENT

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ABSTRACT

Aim/Purpose	While traditional Knowledge Management (KM) continues to neglect the self-interests of knowledge workers as well as generative innovation potentials, it also seems unable to respond to rising complexities, opportunity divides, and entropies. This article follows up on a decentralized KM system-in-progress with a specific focus on how its alternative architecture seeks to address the shortcomings.
Background	It follows up on an informing perspective of client clusters and their target-fitness/ends-states by also taking account of contextual and means-related variances. The differing complexities of the resulting scenarios allow for making distinctions regarding the relationships and respective KM needs between mentees/informees and mentors/informants.
Methodology	The approach taken is conceptual analysis.
Contribution	The analysis advances the understanding of how the envisaged KM system would serve the informing scenarios better compared to the current status quo.
Findings	The novel system architecture serves the more constructive interconnection of individual and collaborative spaces by strengthening personal, institutional, and social digital curation and feedback across disciplinary and professional boundaries.

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Future Research	The example provided could serve as a model and assessment tool for integrating design and informing science approaches in the study of IT/KM artefacts.
Keywords	knowledge management, personal knowledge management system, design science research, informing system, digital platform ecosystem, generativity, entropy

INTRODUCTION

A design science research (DSR) project-in-progress is aiming for a concept and prototype system supporting a decentralizing knowledge management (KM) approach to strengthen the faculty and autonomy of individuals and self-organized groups.

By mapping the complimentary dynamics of twelve traditional organizational KM models in a three-dimensional information space, a currently neglected area favoring personal KM (PKM) has been presented earlier (Schmitt, 2019a). The respective gaps have been elaborated on in related articles arguing that the organizational objectives have continuously taken precedence over the personal concerns and motivations of knowledge workers (Schmitt, 2018b), that the prioritized protection of intellectual capital benefitting institutions has also been pursued at the expense of innovativeness and generativity (Schmitt, 2019b), and that – having been introduced in a time of information scarcity – traditional models lack the muscle to tackle today's world of ever-growing dynamic complexity, information abundance, and entropy which are further amplifying structural holes, invisible work, fragmentation, attention poverty, and opportunity divides (Schmitt, 2020).

The intensifying role of entropy in the KM context has also been recognized by closely linking an entropic perspective to the probability distributions of personal knowledge among people in dynamic organizational settings, to the computability of knowledge entropy for respective organizational states, and to the interpretation of related KM interventions as organizational entropy management (OEM) (Bratianu & Bejinaru, 2019).

From an informing perspective, this latter novel notion sheds further light on particularly challenging situations where informing systems are expected to meet the needs of multiple clients, many of whom may have quite different objectives in being informed. The related informing activities have been pictured as transitions between peaks in a rugged fitness landscape (RFL) (Gill & Mullarkey, 2017; Murphy et al., 2015) and, subsequently, been addressed in the context of the PKM project (Schmitt & Gill, 2019).

This article aims, firstly, to establish the common ground between the OEM, RFL, and PKM approaches and argues for a further differentiation of the organizational entropy management perspective. It, secondly, re-applies the rugged fitness landscape to extend a prior analysis of how the envisaged PKM System would serve the RFL informing scenarios better than current practices and how it may further evolve. The RFL scenarios are then extended further to differentiate the roles of social curation and feedback in regard to the PKMS services to be afforded over time in a dynamic knowledge environment.

We begin by introducing the OEM perspective and by presenting the four RFL scenarios in light of entropy considerations. We then briefly recapitulate relevant prior work of why and how a decentralized PKMS-type-approach is supposed to perform better than current practices within these contexts and newly extend the RFL matrix to accommodate current deficiencies and potential affordances related to social curation and feedback. Finally, we summarize our findings in a concluding section.

THE ORGANIZATIONAL ENTROPY MANAGEMENT PERSPECTIVE

In keeping close to the thermodynamic origin of the entropic notion and its correlated concept of disorder within a system, Bratianu (2019) equates well-structured organizations with machines operating routinely, efficiently, reliably, and predictably with limited degrees of freedom at a low level of entropy. As, however, social rather than mechanical systems, organizations aiming for low entropy rely on their management to instill order through formal structures, regulations, traditions, organizational culture, and command-and-control based on labor division and decision power distribution for productivity and efficiency.

Flatter hierarchies and networked organization allow, by comparison, for more flexibility, creativity, competitiveness, and innovation but also demand an empowered workforce and collaborative leadership styles tolerating higher levels of organizational disorder and entropy, particularly, during organizational change and transformations (Bratianu, 2019).

Bratianu's (2019) perspective on entropy considers knowledge workers (gas molecules exhibiting diverse microstates in analogy to Boltzman's probabilistic approach) as elements of an organization (vessel containing all gas molecules as a macrostate determined by the distribution of all its microstates with their natural tendency to achieve a more probable stable macrostate). He reasons that - in case of well-structured organizations – the number of microstates defining a possible macrostate is significantly smaller compared to the more flexible settings yielding higher level of organizational entropy to promote creativity and innovation.

As knowledge creation, acquisition, sharing, and loss phenomena change the organizational probability distribution of knowledge over time, states of organizational knowledge entropy can be expressed "using the Boltzmann formula: $KE = - C \Sigma p_i \log p_i$", with KE the value of knowledge entropy, C a constant which is an arbitrary positive number chosen to adjust to a certain framework scale, and a probability distribution $p_1, p_2, p_3, \ldots, p_n$ where n is the total number of employees with p represented by normalized relative values. "This knowledge distribution can be considered related or not to a certain space or geographic framework of the organization", while its "value of knowledge entropy (KE) can be a very good indicator for the knowledge distribution of a certain level within the organization, at a given moment of time" (Bratianu, 2019, p. 361, 362).

The dynamic re-distribution of knowledge within the organization through sharing and intergenerational learning, accordingly, flattens the knowledge probability distribution and moves KE towards a more stable macrostate. KE increases by enhancing the innovation capacity via knowledge creation and acquisition (Bratianu, 2019). Since "any transformation of knowledge implies a change in the entropy of the universe considered (i.e., personal knowledge or organizational knowledge)", managerial interventions may increase "the probability of any employee to access needed knowledge, at a given time and in a given place" to raise the organizational entropy and positively influence innovation and firm performance (Bratianu & Bejinaru, 2019).

However, the starting points and objectives pursued by such informing and learning interventions matter in respect to the entropic considerations and are to be addressed in the next section.

KNOWLEDGE-BASED RUGGED FITNESS LANDSCAPE SCENARIOS

One approach to visualize the challenges potential managerial interventions are facing, particularly likely in dynamic environments, is the depicting of the respective informing scenarios as transitions between peaks in a rugged fitness landscape (Gill & Mullarkey, 2017; Murphy et al., 2015). Combining the states of (single and multiple) starting and possible ending peaks among (single or diverse) clients and targets/outcomes (Figure 1, left-and-right-hand side green rectangles) allows for the clustering of four distinct clusters C1 to C4 (represented by connecting lines) with distinct intervention scenarios (Schmitt & Gill, 2019):

- *C1 (green-bottom-left-to-bottom-right):* Need to determine a path that minimizes the duration and loss of fitness associated with the transition utilizing lectures, videos, or manuals by the informing agent.
- *C2 (green-bottom-left-to-top-right):* Moving clients 'set in their ways' to consider and/or pursue alternative peaks usually require assisting facilitators in order to shift paradigms and outside-the-box-thinking.
- *C3 (green-top-left-to-bottom-right):* Different paths to the distinct target may need to be established to accommodate the needs of different clients, self-paced learning with face-to-face tutorials as well as individual and/or group coaching approaches.
- *C4 (green-top-left-to-top-right):* This scenario is the most complex due to the inherent combinatorial explosion of potential informing paths to be considered. The way to address it (in the context of this article) is to create opportunities where clients take considerable responsibility for mapping out their own paths and are given the appropriate tools to do so.

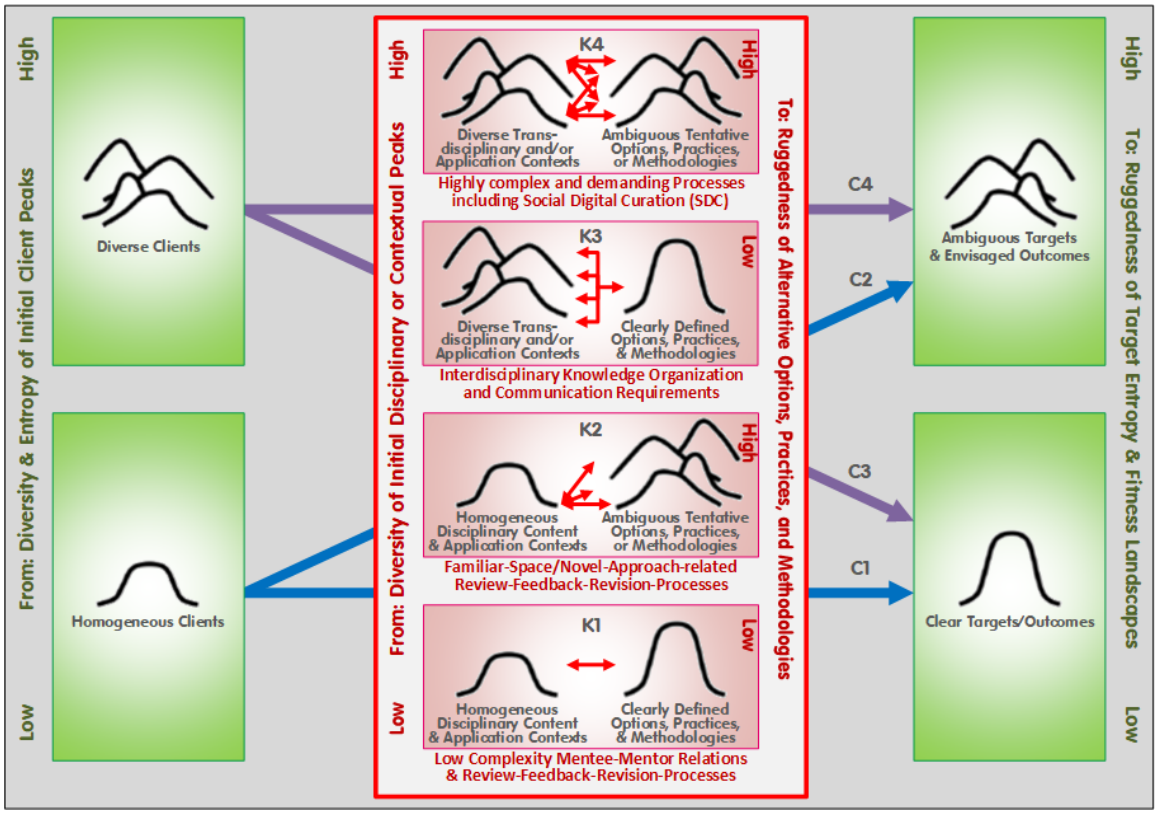

Figure 1 Clients, contexts, means, and ends of informing task scenarios from the informer perspective (outer green clients-ends-quadrants adopted from (Murphy et al., 2015)**)**

ENTROPY VERSUS RUGGED FITNESS LANDSCAPE SCENARIOS

While many of the scenarios are in need of following Braitianu's (2019) perspective and of raising organizational entropy for impacting positively on innovation and firm performance, the strengthening of success prospects may – at times – also require the exact opposite of lowering entropy, for example:

- *A C1 lowering-entropy scenario:* In May 2019, images taken by the Nepalese mountaineer Nirmal Purja (Cheung, 2019) attracted world-wide attention by picturing a long queue of

mountaineers waiting in line for their final short ascent to the Mount Everest. The context behind this image provides a good C1-case. In order to successfully climb Mount Everest (clear target), any participant of an expedition has to be already physically and mentally well prepared (homogenous client) in order to be acceptable for further training and guidance with a very narrow focus: firstly, to make it back alive and healthy, and, secondly, to – hopefully – make it to the top in the process. The objective is, hence, to minimize any differentials in the initial microstates of the mountaineers (compared to an ideal condition for survival and success), so the team is enabled to operate just as a well-structured organizational machine routinely, efficiently, reliably, and predictably with limited degrees of freedom at a low level of organizational entropy, especially in case of potential emergencies.

- *A C2 intervention strategy* may fit best with the entropy-raising approach described by Bratianu (2019) to transform structured organizations into more flexible network communities for meeting objectives of empowerment, innovativeness, and ambidextrous performance in pursuit of both exploitation as well as exploration.
- *C3-C4-related intervention* may try to raise entropy to further enrich the already existing diversities. They may, however, also adopt entropy-reducing strategies. During the initiation of an organizational change project, for example, the aim is to involve a diversity of organizational stakeholders and to set them on a path of fruitful collaboration. At this early stage, the priority is to bring everybody on-board and to establish a basis for a common mutual understanding without pushing (yet) any controversial topics which might trigger early conflicts and a premature failure of the undertaking.
- *Entropy-raising interventions in the most complex C4-scenarios* are also especially susceptible to the ever-growing dynamic complexity, information abundance, and entropy alluded to in the introduction (the next section addresses this - seemingly – entropic paradox).

It is foremost this problematic diverse-clients-ambiguous-targets (DCAT:C4) scenario (connecting the top-green rectangles in Figure 1) that the concept, design, development, and deployment of the decentralized PKMS intends to address. While a prior publication has already focused on the interdependencies between the RFL-DCAT and PKM approach in more detail (Schmitt & Gill, 2019), the following section summarizes these findings as a basis to integrate the OEM considerations as well as the subsequent social curation and feedback concerns.

THE ROLE OF DIGITAL PLATFORM ECOSYSTEMS (DPES)

The decentralized PKMS (Figure 2) is envisaged to being serviced by a central Digital Platform Ecosystem (DPE), generically defined as a meta-artefact which affords clients with highly diverse skills and ambitions to gainfully utilize its resources and generative potential in their personal and local contexts (Eck & Uebernickel, 2016).

The DPE's aim is not only to narrow widening opportunity divides (Giebel, 2013), but also to strengthen the quantity and quality of individuals' innumerable "nano-actions" which govern, if productively combined, any organizational (knowledge economy) and societal (knowledge society) performance, advancement, and viability (Wiig, 2011).

The proposed PKMS-DPE-solution "can be characterized as a social machine platform" that would offer its collective user community facilities for digitally capturing, creating, modifying, classifying, combining, and accessing atomic information structures (referred to as memes) and their relationships to be stored in personal and – if voluntarily shared - centralized repositories (Schmitt & Gill, 2019). Memes – originally introduced by Dawkins (1976) - may be comprised of content (e.g., parts of this paragraph, citations, or visuals), aboutness (e.g., article review, wordcount, or author's profile), structural connections (e.g., links between authors, papers, publishers, and references), intent (e.g., tasks to do), and monitoring (e.g., schedules, to-do-lists, or progress made) which may all be captured

based on the PKMS's standardized memetic format and associative indexing structures instead of following current document-centric storing practices.

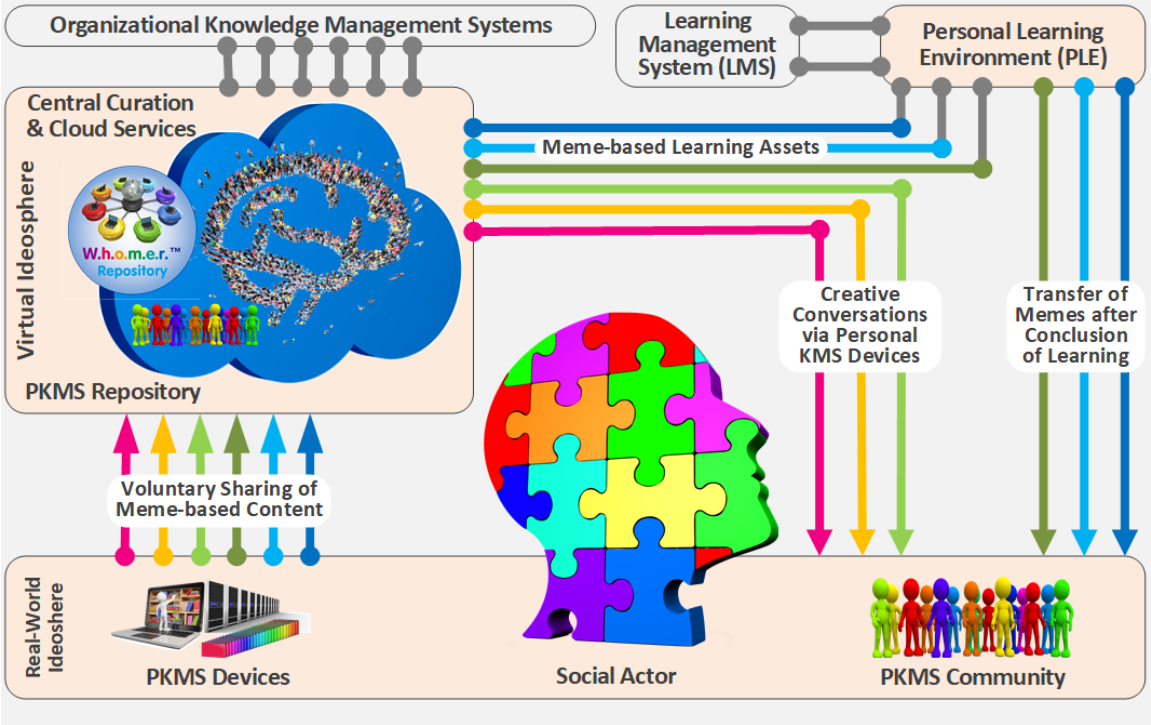

Figure 2 PKMS as a Digital Platform Ecosystem (DPE) (Schmitt & Gill, 2019)**.**

From a KM perspective, the ensuing centralized knowledge base (termed World Heritage of Memes Repository (WHOMER)) resembles a tangible accessible interrogatable instantiation of Popper's third world (Popper, 1978) where the meme-based knowledge and learning assets assembled by the user community are encapsulated – just like products in modern manufacturing systems – in as-built-genealogies.

As virtual memes are not expended when used or disbursed, their infinite usage potential via associative structural links allows for their transdisciplinary employment and the cutback of current unmaintainable levels of book-age-copy-and-paste-practices. The potential of reducing these attention-consuming redundancies in favor of attention-guiding traceability depends on the effective curation of the meme-pool (for accurate informing based on negentropic repositories) to be facilitated by community feedback and WHOMER services.

The seemingly entropic paradox between the positive OEM entropy and the negative PKM entropy is dissolved at this level of centralized curation (to be further detailed in later sections). The generally desired entropy of Bratianu's (2019) OEM perspective corresponds to the diverse and transdisciplinary related resources and their generative potential offered by the DPE to its PKMS community members to be utilized and further developed in their personal and local contexts. They may be linked to other, so far, unconnected (old or new) memes and subsequently shared within subsequent PKMS workflow cycles for continuous curation in line with the PKMSs' affordances, functionalities, and generative attributes (Schmitt, 2019a, 2019b).

The unwanted entropy referred to and sought to be eliminated or overcome by the curating services of the novel PKM approach (Schmitt, 2020) (partially also referred to as negative generativity, Schmitt, 2019b) prevent currently the productive utilization of the positive generativities or entropies; they are summarized with their negative effects (-) or potential positive advances in case of successful interventions (+) in Table 1.

Table 1: Causes and *Effects* of Undesired Entropy Clusters (Schmitt, 2020)**.**

	Public Knowledge-related Entropies	**Private Knowledge-related Entropies**
Discoverable Knowledge	Information Entropy *Information Overload (-)* *Attention Poverty, Mobility (-)*	Online and Publishing Realities *More rapid iterative Improvement (+)* *Innovation & Reputation Systems (+)*
Undiscoverable Knowledge	Structural Holes, Islands, Siloes Ineffective Utilization Deficient Awareness/Education *Innovation and Opportunity Divides (-)*	Invisible Work, Scaffolding Non-Linear Relationships *Unproductive Rework (-)* *Holistic Understanding (-)*

PROPOSING AN EXTENDED RUGGED FITNESS LANDSCAPE

Figure 1 (green quadrants and connections C1-C4) presents four scenarios suggesting distinct types of developmental paths to reach personal target fitness states. The middle section of Figure 1 also depicts four knowledge-related environments (red rectangles K1-K4) which substitutes the (homogeneous/diverse) client-axis with a contextual disciplinary/application-oriented perspective and the (clear/ambiguous) targets/outcomes-axis with a means-related options-practices-methodologies scale. The aim is to further extend and differentiate the personal states/paths (green clusters C1-C4 connecting clients to target fitness or ends) according to the range of potential contexts to be encountered and the means or tools at the clients' disposal. These further differentiated clusters are again employed to distill distinct *operation and intervention scenarios* from an informer's perspective (beneficial for educators, mentors, reviewers, and system designers) in order to guide clients' personal paths by considering matters of social curation and feedback. The aim is also to promote positive entropy (from now on referred to as generativity) and to avoid negative entropy (from now on just referred to as entropy):

- *K1 (red-middle-bottom) Low complexity review-feedback-revision-processes:* Need to determine a path within consistent disciplinary and application-oriented environments characterized by well-established means that minimizes the duration and loss of fitness. The support by traditional review-revise-engagements may be optimizable by better matching students/authors/mentees with supervisors/mentors as well as topics with reviewers by the informing agent/editor.
- *K2 (red-middle-2nd from bottom) Familiar-space/novel-approach-related review-feedback-revision-processes:* Adapting familiar homogeneous content and application contexts by employing alternative and/or novel means and approaches demands more intensive mentorship, especially in pursuit of alternative target and outcome fitness peaks.
- *K3 (red-middle-3rd from bottom) Interdisciplinary knowledge organization and communication requirements:* The need to tackle multi/inter/trans-disciplinary problem and/or divergent application spaces increases the complexity not only of tasks or paths but also of the respective knowledge organization and communication and, hence, the required mentorship which may has to be dispersed among several coordinating mentors. Employing well-established means or, at-least, approaches (e.g., design science research guidelines) and clear targets may ease the burdens in the mentees-mentors-relationships. Ambiguous targets (e.g., catering for multi-disciplinary audiences' consumption), on the other hand, may require bridging disciplinary divides in favor of collaborative spaces of common understanding. Informers are advised to decontextualize relevant content and methods (to create boundary objects, e.g., heuristics, frameworks, or templates) in favor of more viable generic approaches (1) to fit wider classes of tasks and problem spaces, (2) to accommodate diverse peers' interpretative as well as tailorable flexibility (Nick et al., 2007), and (3) to give clients the opportunity for repurposing and re-contextualization according to their personal and local circumstances.
- *K4 (red-middle-top) Highly complex and demanding review-feedback-revision-processes including Social Digital Curation (SDC):* The most challenging instances facing clients are referred to as 'wicked' problems defined as "open-ended in the sense that they are ill-defined and characterized by

> incomplete, contradictory, and changing requirements and complex interdependencies [and] that the information needed to understand the problem depends upon one's idea for solving it" (Rylander, 2009). The development of the PKMS concept, for example, fits this description.
>
> Due to the inherent combinatorial explosion of clients, contexts, means, and ends, a myriad of potential informing paths may need to be considered and reviewed. While the World Wide Web (of documents), the Semantic Web (of Data), or Social Media Platforms may be hailed to facilitate resolutions, they all are also affected by a range of inherent shortcomings and entropic concerns: replication, fragmentation, validity, integrity, granularity, traceability, indexing, accessibility, tailorability, editability, ease of mastery, ownership, transferability, generativity, openness, sustainability (Schmitt, 2017a, 2017b, 2019b). K4-scenarios are also hampered by current bibliographic classification systems and practices; instead of being grounded in the phenomena studied, they are "organized on a disciplinary basis [serving] interdisciplinary research and teaching poorly" (Szostak et al., 2016).
>
> The clients' conceptualizations and actions may well be highly contextualized as well as innovative and, hence, demand thorough understandings and responses from mentors and curators as well as sophisticated informing and feedback practices as, for example, 'Social Digital Curating' (SDC) defined as "a content creation process with unique cultural and social characteristics" to be utilized in collaborative and educational settings (Gadot & Levin, 2014) and in support of digital and media literacy as well as organizing knowledge flows from diverse sources to wherever and whenever it is needed (Cohen et al., 2013).

Although the PKMS-DPE is able to offer considerable support in the two K1 and K2 scenarios, today's key deficiencies primarily affect the K3 and K4 scenarios. Accordingly, it is here where the novel envisaged concept and system may contribute the most. It, for example, widens the accessibility and choice of transdisciplinary content via curated associations between cross-disciplinary themes and eases the repurposing of the granular (memetic) content components for new learning or knowledge asset creation. Captured boundary objects also offer guidance by affording authors a range of already decontextualized but interdisciplinary linked approaches and solutions tailorable to their local use and/or multi-disciplinary contexts (Star, 2010). The following two subsections are further focusing on curation at the individual, collaborative, and institutional level to provide a basis for detailing its envisaged PKMS-administered impact on the Cx-Ky-scenarios.

Curation and Informing to Support Personal Development

Curation traditionally "refers to the methods or systems that add value to and preserve resources" (Glushko, 2013) but has evolved together with the digital social, personal, educational, and commercial spaces "to encompass multitudinous and increasing forms of data-managing behavior" (Khan & Bhatt, 2019). However, while today's powerful technologies are able to locate ever-increasing amounts of digital information, they lack "effective tools for selecting, structuring, personalizing, [curating], and making sense of the digital resources available to us" (Kahle, 2008).

Individual self-reflection and self-curation

Accordingly, individuals are in need of "a 'place' or a 'space' in which to assemble and manipulate information resources for their own purposes, with flexible tools that they can adapt to their practices, skills, habits, and artistry" (Borgman, 2003) and that take advantage of today's generative opportunities where "the knowledge and skills of a knowledge worker are portable and mobile" (Rosenstein, 2009).

The PKMS-DPE-concept offers such a space by affording accumulating many individual unique memes over time for instant project benefit or potential future utility. While the magnitude of any one of the memes is small, continuous tailoring and cumulatively synthesizing them (via associative

structural links) facilitates classification and novel artefact creation (e.g., design ideas, learning or knowledge assets, or boundary objects).

Interludes for reflection and revisions are promoted by monitoring memes (e.g., schedules, to-do-lists, or progress made) and are further supported by dedicated frameworks published to support the concept's educational agenda (e.g., PKM for Empowerment (PKM4E), for Action (PKM4A), or for Development (PKM4D) (Schmitt, 2016a, 2018a, 2019a).

A decentralized networked PKMS-device, thus, enables "self-reflecting monologues of its user over life-long-learning periods of educational, professional, social and private activity and experience. In these conversations with self, the knowledge under review is biographically self-determined and presents itself as a former state of personal extelligence captured"; it affords the individual the means and autonomy to retain and build upon knowledge acquired, to develop his/her expertise for sustainable personal growth, and to collaborate "with fellow learners and/or professional acquaintances for mutual benefit" (Schmitt, 2014).

Collaborative informing, authoring, and curation

As these evolving grass-roots personal repositories sustainably preserve individual's creative energy and resources within agreeable levels of perceived inconvenience (time, effort, and self-discipline invested), synergies can obviously be realized by enabling "the same content to be used by multiple users for multiple purposes" and by making institutional and personal digital libraries "interoperable, such that individuals can download data for local manipulation, and can upload tagged data to share both content and metadata" (Borgman, 2003).

While rates of individuals' contributions to traditional institutional "document repositories remain low in most fields" (Borgman, 2010), the grass-roots collaborative bottom-up approach is expected to promote personal motivations and efforts resulting in improving the longevity and accessibility of content for further wider scrutiny, exploitation, and exploration.

Any meme-based (atomic or constructed) artefact shared may be subjected to Lane's (2011) "exaptive bootstrapping (EB)" dynamic by gearing it towards "cascades of changes in agent-artefact space" inextricably linked to innovations, organizational structures, processes, and functionalities. The five EB stages materialize in the PKMS-context as follows:

1. New artifact types [*memes and assets*] are designed [*authored*] to achieve some particular attribution of functionality [*backed by content and/or evidence to investigate, innovate, inform, or entertain*].
2. Organizational transformations are constructed [*utilizing existing structures, functions, and processes for diffusion (e.g., conferences, journals, books, web pages, self-publishing)*] to proliferate the use of tokens of the new type [*to ensure artefact's availability, diffusion, and understanding*].
3. Novel patterns of human interaction [*comprehension of content by audiences and ensuing discourses*] emerge [*modifying prior perceptions and/or triggering new insights*] around these artifacts in use [*by also promoting other referenced sources and related ideas*].
4. New attributions of functionality are generated [*by modifying the artifact's codification, container, and/or context and by reconfiguring it which may include new memes and relationships*] – by participants [*desk research*] or observers [*field research*] – to describe what the participants in these interactions are obtaining or might obtain from them [*newly devised content, blueprints, or physical models*].
5. New artifacts are conceived [*new memes or assets*] and designed [*virtual or physical embodiments*] to instantiate newly attributed functionalities [*informing*] which – by feeding back into step 1 – close the iterative bootstrapping cycle.

The speed and density of any iterative bootstrapping and curation cascade branching out depends, of course, on the content's popularity and pliability, but, as an essential pre-requisite, the respective

knowledge has at least been explicitly captured. Loads of today's generated knowledge, by comparison, is neither recorded nor shared resulting in "magnitudes of invisible work" (defined as the "gap between formal representations, including publications, and unreported 'back stage' work"; Star, 2010). Consequently, others are deprived from judging the merit of content without what has been referred to as its 'scaffolding' (Bush, 1945) and/or may have to re-spend the energy to investigate any absent subject matter on their own accord.

Instead, a PKMS-DPE-approach retains and synthesizes – once captured and voluntarily shared – the dynamically changed versions of content, aboutness, and annotations together with their structural connections, timelines, and user and usage profiles. Its generative potential and evolving novelty is, thus, grounded in an "exaptation" as asserted by tweaking (in line with []-insertions in steps 1 to 5 above) Lane's summary : "From the interactions between existing structures ([knowledge,] agents and artefacts), new [associations and] functionality emerge [which] may then become recognized by appropriately situated and motivated agents [(e.g., PKMS community members)], and (re)cognized as a [new insight] or new attribution of artefact functionality [(e.g., transdisciplinary applicability of boundary objects)]" (Lane, 2011).

Institutional informing and curation

Institutionally, initial KM and curation initiatives focused on viewing knowledge as a foremost strategic asset in need of being measured, captured, stored, and protected, followed by a more practice-based and community-centered approach leading to today's social media and cloud applications. To champion still neglected concerns, a future focus on iterative creative innovation processes is proposed which starts with the "reuse or new use of existing knowledge, adding an invention, and then creating a new product or service that exploits this invention" (Pasher & Ronen, 2011).

While the seven-traditional-schools-taxonomy (content-related: commercial, engineering, and system schools complemented by enterprise resource planning; collaboration-focused: cartographic, organizational, spatial, and strategic schools complemented by social media) has differentiated the scope of KM functionalities further (Earl, 2001; Schmitt, 2016b), these top-down centralized prohibitive institutional developments too often fail to gain acceptance from their workforce by ignoring most of their wider personal development aspirations. Social media providers are also doing considerable disservices to individuals by neglecting to confer vital affordances at the expense of their captured communities' attention, time, productivity, funds, and status (Cabitza et al., 2015; Mynatt et al., 1998; Schmitt, 2017a).

Bottom-up KM proposals favoring peer-to-peer content-sharing, expertise-finding, and connectivity (Pollard, 2008) and knowledge creation models able to tackle the accelerating information entropy and to seize generative potentials (Schmitt, 2019a, 2019b) have not yet materialized as institutional realities, and any knowledge worker is still denied even the most basic provisions that his/her personal digitized knowledge (1) always stays in his/her possession and at his/her disposal independent of changes in his/her social, educational, professional, or technological environment; (2) is based on standardized, consistent, transparent, flexible, secure, and non-redundant formats to safeguard its integrity and longevity; (3) may be shared to facilitate mutual beneficial collaborations within a community of diverse dedicated social actors and for a fruitful co-evolution with traditional KM Systems (KMS) and Learning Management Systems (LMS).

Interconnecting the individual, collaborative, and institutional spheres

These individual, collaborative, and institutional settings are affecting all Cx-Ky-scenarios including the more easily navigable unidisciplinary content areas (K1 & K2).

Crossan et al.'s (1999) 4I-Framework provides a psycho-social perspective to support organizational learning within these nested structures consisting of four dynamic feed-forward and feedback pro-

cesses (intuiting, interpreting, integrating, and institutionalizing). 'Intuition' takes place at the individual level by pre-consciously recognizing a pattern or opportunity. The resulting intuitive insights may be consciously shared, refined, and further developed within an interactive team setting marking the collaborative stage of 'Interpretation'. Transforming the potentially emerging shared coherent understanding into negotiated or mutually adjusted, wider coordinated actions characterizes the 'Integration' phase which may lead to embedded learning and organizational mechanisms and routines via formal rules, procedures, structures, systems, strategies, or safeguarded organizational memories and cultures at the stage of 'Institutionalization'.

By adding the fifth stage of 'Intertwining', Jones and Macpherson's (2006) 5I-Framework acknowledges and accommodates learning mechanisms outside an institution's internal boundaries with its external inter-organizational knowledge networks.

A further extension is to be suggested in a paper-in-progress with a complementing 6th I-level of 'Interfusing' to represent the societal level of the accumulated heritage of human knowledge as to be afforded by the PKMS's tangible, accessible, and interrogatable instantiation of Popper's (1978) third world.

CX-KY-SCENARIOS AFFECTED BY THE DIGITAL PLATFORM ECOSYSTEM

Before focusing further on the K3 and K4 contexts, the DPE's technological approach needs to be briefly reflected on in order to show how its underlying interactions and transitions embody the dual processes of sensemaking and sensegiving for balancing exploration and exploitation.

Figure 2's bird-eye-view depicts a social actor as a member of the PKMS user community (bottom-right) with his/her decentralized PKM device (bottom-left), the shared-content and centralized-curation WHOMER services (middle-left), and the Personal Learning Environments (PLE) with its e-learning functionalities (top-right). Adding to the broader DPE context are the interactions with the traditional Knowledge and Learning Management Systems (top). This concept aligns to the scenario of a decentralized KM revolution where creative conversations and curation cascade among empowered autonomous individuals and self-organized groups allow for emerging distributed processes of collective intelligence which in turn feeds back to their grass-roots personal and local settings (Levy, 2011; Schmitt & Gill, 2019).

Curating and interconnecting across disciplinary and professional boundaries

Accessing and making sense of the fragmented content and sources representing the analog and digital world record follows an increasingly complex and time-consuming trajectory. Transforming its dispersed ideas effectively into emergent concepts and innovations involves ever more cumbersome analytical and synthesizing processes. While an abundant digital capacity is available, traditional filters and authorities (e.g., peers, editors, publishers, and librarians) have lost their grip and a rising share of content is diffused before verified and free of theory, quoted sources, and cited evidence (Weinberger, 2011).

While computational filters and algorithms fill the curational gap to some extent, these 'services' may well be based on questionable intentions and flawed criteria resulting in subjective or false instead of objective and truthful content. "Without prudent filtering of information by its credibility, misinformation becomes infiltrated into curation work, thereby changing the meaning and knowledge that is produced. As misinformation becomes more pervasive, discernment and discrimination become increasingly difficult – and more necessary" (Khan & Bhatt, 2019).

Tackling this misinformation effectively is, however, hampered by current copy-and-paste-practices. Frequently, memes or content-snippets are continuously re-purposed but are neither linked nor versioned. They continue their lifecycles independently and, time and again, without verified traceable source, with erroneous modifications, in an obsolete state, or as misleading partial out-of-context

fragments. "Instead of digitally embedding and reusing parts of digital documents via structural references", copying and pasting also unnecessarily prolongs the book-age paradigm of over-simplistically modelling digital documents as monolithic blocks of linear content" (Signer, 2010).

The links currently being available are the world-wide-web's unstructured one-directional forwarding links (where the citing sources are hidden and only used as criteria in search engine results), the scholarly search applications' high-granularity document-to-document references (as cited in the reference sections of publications which may occasionally be complemented by page numbers), and the semantic web's low-granularity fact-and-data connections (to provide machine-processable accessibility to non-human agents via markup languages or RDF statements). While associative indexing (Bush, 1945) not only allows for bi-directionally traceable meme-to-meme links at an appropriate level of DPE's constructivist agenda, it would also serve the need to deal with today's proliferating "structural holes".

These structural holes (Burt, 2004) refer to unrecorded or not yet identified (but potentially beneficial) ties between knowledge clusters (e.g., memes, approaches, specializations, disciplines); the theories of organizational learning and knowledge creation, for example, "have been pursued as independent themes for almost two decades" (Brix, 2017). Their lack of connectivity contributes to undiscoverable public knowledge (islands and silos) (Szostak et al., 2016) and inhibits informing and methodological capabilities to better tackle complex transdisciplinary 'wicked' problem spaces. Associative indexing and its curated integrity bridge these divides, and while its enhanced traceabilities would foster more fruitful academic 'fishing' and writing expeditions, the more productive DPE output would also contribute to calls for a wider sharing and faster diffusion of ideas, sources, data, work-in-progress, and preprints for the benefit of more rapid iterative improvement (Nielsen, 2012).

Accordingly, curation within the EB-cascades alluded to needs to encompasses the "practices of harnessing preexisting content, transforming it through the application of criteria which assess and promote belief, and then directing the resultant packet of filtered information to a new audience [as] an act of knowledge creation" with "curators as potential agents of change" (Khan & Bhatt, 2019). These changes are administered through the DPE's affordances to support value-adding actions of selection (refining and reducing), arrangement (displaying, simplifying, contextualizing, presenting, and explaining), and preservation (Bhaskar, 2016) which also cut across professional and disciplinary boundaries. Being confronted with the interlinked and high-granularity rapid-re-bundling EB-cascades of meme-based content detailed earlier, the DPE further responds to the needs of advancing attention-conserving consumption and curation techniques to deal with the inherent information abundance perceived as overload.

Micro-macro-micro informing across the spheres of the 6I-Framework

Since DPE-actors are engaging individually and freely, their 'nano-actions' and 'micro-behaviors' may over time result in emerging 'micro-macro-effects' to affect their community in its entirety. Subsequent 'macro-micro-feedback' might, in turn, affect the actors' 'micro-states' to produce self-organization and synchronization (leading to the generative or (positive) entropic consequences alluded to by Bratianu, 2019). However, keeping abreast with and inspired by one's dynamically changing community can also be demanding and perplexing; individual actors may, hence, benefit from 'collective' micro-macro-micro informing or educational interventions (Mella, 2017). A Generative Collectives' Future Study (van Osch, 2012) confirms these needs by advocating "ambidextrous" open platforms capable to simultaneously evoke and enable operational efficiency (through structure for coordination and integration) and generative capacity (through tailorability for flexibility and fluidity).

Informing and guiding ambiguous tentative options, practices, methodologies

The role of boundary objects in providing less experienced users with direction to approach complex problem spaces has already been alluded to.

The same applies to the methodologies of cumulative synthesis and exaptive bootstrapping which form the very foundation of the PKMS approach to promote the innovativeness of researchers and entrepreneurs alike. Having accrued a critical set of memes (interlinked content including functionality attributions) may trigger the "perception" of a problem or opportunity as an unsatisfactory or "incomplete pattern" prompting the "setting" of an appropriate "stage" for further iterative cascading research, development, "acts of insight", until the "emergence of novelty" followed by "critical revision" and "mastery" (Usher, 1954). Not every meme captured or generated may be of immediate utility, but what might be considered to be irrelevant or misguided at a given time may turn out to be valuable later, and vice versa (Garud et al., 2016).

A further level of guidance is rooted in the PKMS's educational agenda which seeks to re-purpose accumulated meme-subsets to create learning assets for LMS execution (the development of a KM e-learning course based on the memes sets of the PKMS publications is currently under way; it further adds to the micro-macro-micro interventions mentioned). Unique affordances of this feature would include, for example, transferring essential memes of the learning assets to the learners' PKMSs for retention, repurposing, and tracing complementing memes in the DPE's repository as well as providing settings of non-linear learning paths to afford learners appropriate choices.

Further micro-macro-micro 'collectivity' informing is envisaged to include sophisticated research and reputation metrics (based on the DPE's advanced granularity, traceability, and generativity attributes) as well as promising leads and emerging trends (way before link-based search algorithms are able to fuel attention towards exciting new developments). Moreover, in utilizing the as-built-genealogies' traces, linked meme siblings (and, by extension, their authors) may be informed about state changes of their parent memes (e.g., update or expiry notifications, endorsements, retractions, withdrawals, or detected falsifications).

Other informing and counselling facets complementing the system's affordances would cover the support of affiliations between individual PKMS community members including, for example, student-supervisor, mentor-mentee, or author-reviewer/editor relations. These dialogues would have to be kept confidential just like the self-reflecting memes concerning personal tasks, diaries, plans, concerns, and evaluations and, hence, are opening up possibilities for future research projects.

DISCUSSION AND CONCLUSIONS

This article used the three notions of the rugged fitness landscape, harmful entropy (negative generativity), and generativity (positive entropy) to structure the differences between current traditional top-down KM models and systems and an envisaged novel decentralized bottom-up networked personal KM approach.

It argued that today's knowledge management is severely compromised by unsustainable rising entropy and an ineffective utilization of the explicit accumulated world record. While the former is "threatening the finite attention individuals' cognitive capabilities are able to master" (Schmitt, 2019c), both are suffering from a deficient awareness and education and the lack of adequate tools.

The explicit record has been termed 'extelligence' to position it as the externally stored counterpart to the intelligence of the human brain/mind tasked with understanding. Together they are driving each other in a complicit process of accelerating interactive co-evolution where curated extelligence archives of cultural experience and know-how "can be accessed by any individual who knows how, and can be augmented by any individual who knows how" (Stewart & Cohen, 1999).

This knowhow has to derive from the awareness, education, and suitable tools available, and the exemplifications in this and prior articles have demonstrated how a PKMS-DPE is envisaged to make novel inroads in this regard using generativity and entropy as guiding principles (Schmitt, 2019b, 2020).

Strangely, many of the last decades' influential KM-related books approaching curation issues do not even refer to 'entropy' (Arbesman, 2012; Bhaskar, 2016; Borgman, 2010; Glushko, 2013; Jenkins et al., 2018; Pauleen & Gorman, 2011; Rosenbaum, 2014; Sawyer, 2012; Wenger et al., 2009) although some address the abundance and overload effects caused by it. The reason may lie in the tenacity of traditional knowledge creation models, all introduced in a very recent, now antiquated past of information scarcity (Schmitt, 2019b) which discarded alternative ideas as exemplified by the 'Memex' (Bush, 1945), 'Xanadu' (Nelson, 1991), or attention management (Simon, 1971) because today's accelerating never-before experienced attention-consuming information abundance was beyond their maker's comprehension. Current technological development priorities (Big Data, Internet of Things) can be expected to add further unrestrained snowballing entropic consequences.

Redundancy increases the chances of matters to be found, but hampers – in today's information-rich world – the unearthing of further matters of interest. Available suites of tools allowing knowledge workers to become curators themselves (Bhaskar, 2016) share – in the authors' view – a common flaw: they all claim to solve the excessive-redundancy-problem by offering competing siloed repurposed-content which unleash even more disconnected replication where the truth is drowned in a sea of irrelevance (Huxley, 1932/2010) and where valuable curative 'nano'-contributions are unable to impact the totality of the related copies in circulation.

Moreover, these information-obese environments are boosting biased cognitive selection strategies which favor content "that is more likely to be searched for, attended to, comprehended, encoded, and reproduced" and tend to amplify polarized views (belief-consistency and confirmation bias), downside risks (negativity bias), herding undermining better judgement (social information bias), and spurious correlations impairing objective assessment (predictive information bias) (Hills, 2019).

However, the symptoms of information obesity are not primarily technology-driven but by the way knowledge production, curation, and consumption is designed and organized by us. Currently, individuals "are largely not free to make their own knowledge, to develop for themselves the filters through which they can individually establish information needs, find relevant information, evaluate it and apply it in their value system. Both their working lives and personal lives [are] subject to intense [environmental] pressures, through which minds and habits are shaped, [automated, and immunized against change.] And so, our minds grow fat and indolent" (Whitworth, 2009), and outdated paradigms prevail.

In contrast, the expansion of private meme stocks by associatively linking personally relevant input streams affords members of the PKMS-DPE community to curate and 'visibilize' their work by voluntarily shared output streams. The WHOMER central knowledge base at the receiving end of the decentralized local individual updates aggregates the content together with its own historical record and novel high-level 'micro-macro-micro' additions. As one of the steps, every meme and connection is vetted to (1) identify and eliminate duplicates (in such case, identical memes from different sources are merged while their relationships with diverse meme sets and usage histories are consolidated to keep all information), and to (2) keep a reference record of every meme shared, even if it might be blocked from dissemination due to, for example, legal, ethical, or falsification reasons (any identical meme uploaded in the future is, hence, identifiable to trigger appropriate actions). The consolidated and centrally curated multi-disciplinary content updates the single unified Popperian-Third-World-equivalent WHOMER repository alluded to which automatically enriches the contexts of the members' personal input streams and/or can be queried by the PKMS community.

These personalized processes are performed according to individual curators' understandings and subject perceptions with subsequent automated socialization practices to inform the PKMS community referred to already as 'Social Digital Curating' (SDC).

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