Title

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Leadership resources are constantly adapting to the challenge of the dynamic and complex systems in which they must function. To understand the changing leadership types and to better guide the development of new leadership resources, we propose a two-dimensional leadership landscape that provides a perspective into past leadership resources and identifies new frontiers of leadership. In the landscape, one dimension is *where leadership occurs* – ranging from a single individual to the entire collective – and the other is *how leadership arises* – ranging from predictable – being based on the structure of the system, to unpredictable – being opportunistic and/or emergent. We call this the Where-How of Leadership Emergence (WHOLE) Landscape. While continuous metrics for placement of a leadership resource on the WHOLE landscape are suggested, for simplicity this landscape is divided into four quadrants; two of the quadrants are identified with traditional centralized leadership resources: 1) power-based, hierarchical and/or predictable leadership resources and 2) the opportunistic, unpredictable, and/or emergent hero or leader. This paper argues that the other two quadrants, those identified with distributed leadership, are the frontiers of leadership. The structured and distributed quadrant encompasses both familiar collective leadership systems (e.g., direct democracies) and developing systems based on information technology (e.g., prediction markets). The emergent and distributed quadrant, referred to as emergent collective leadership (ECL), is identified as the newest frontier of leadership resources, particularly for discovery of innovation in the most challenging dynamic and complex environments. As this paper introduces ECL, we address a variety of issues with ECL: its validity as a leadership resource, organizational conditions for its occurrence, individual and collective requirements for a functioning ECL process, and the embodiment of ECL solutions in organizational structures.

1 Introduction

The goal of this work is to use a leadership perspective to develop a context for recent advances in and provide direction for opportunities of collective decision-making – the process by which a collective knowingly or unknowingly solves a problem using collective intelligence. This effort examines the intersection of three trends of leadership over the last century: 1) leadership's greater reliance on diverse collectives, 2) research advances in emergent problem solving by the collective in self-organizing systems and 3) new collective decision tools based on information technology. From this intersection, we propose a landscape that defines the expansion of decision-making resources beyond traditional leadership types.

"Leadership in the Context of Emerging Worlds" (Scharmer, Arthur et al. 2002) presents a summary of the challenges of leadership based on interviews with 25 of the world's thinkers on leadership in organizations. This document captures 1) *how the world is changing*: "…there is something different about today's circumstances… The pace of change is somehow faster, the frequency and amplitude of restructuring and reforming are significantly greater, and the pathways of emerging futures seem to be less predictable than they were in earlier times" (p. 3); 2) *the new leadership challenges:* "In environments where small differences can cause powerful effects, the task of a leader is to sense and recognize emerging patterns and to position him- or herself, personally and organizationally, as part of a larger generative force that will reshape the world" (p. 3); and 3) *the opportunities of modern leaders:* "In the context of a complex, dynamic system, paradoxically, the individual and the local team become even more important as integrators and coordinators of functions that used to be taken care of by formal systems and mechanisms" (p. 4).

To aid in addressing these modern challenges to leadership, new resources, which may not be associated with classical views of leadership, need to be integrated into our perspectives on leadership. In the following, a review of the literature identifies the trends in leadership over the last century. After a review of prior leadership landscapes, these trends are then used to construct a broad landscape of leadership that provides context to prior work as well as future resources for leadership. The discussion section then addresses the implications of these new leadership resources.

A comment on nomenclature: a consistent choice of nomenclature is challenging, particularly when expanding the scope of leadership. We use *leadership resources* to describe observed and reproducible forms of leadership that are expressed by individuals, groups or information technologies (alternative choices: assets, options, approaches, styles). *Leadership theories* describe abstracted leadership resources, often developed in academia but also as packaged and taught (alternatives: models, forms, principles, techniques). A *leadership type* is a class of leadership resources, a logical clustering of related resources (alternatives: form, role, kind, style). A *leadership perspective* is an expressed or implied viewpoint that supports a particular type or resource. *Leadership systems* refer to all components and functions, including interactions, that comprise leadership in organizations. *Leadership processes* are the dynamic components in the system that enable change or development. A system can be decomposed into *leadership structures* (rules, prescriptions, regulations, laws, etc.) that change slowly, when compared to *leadership options* (choices, opportunities, etc.).

2 Trends in Leadership Types and Perspectives

A reflection of the absence of a holistic understanding of leadership is the lack of consensus on the definition of leadership. Historical and current definitions of leaders include those who have power over others, those who have attained leadership positions within the structure of an organization through privilege, election or sustained performance, and those who provide better solutions to problems. Examples of forward-looking definitions illustrate how times have changed and are captured in a recent definitive collection of articles on "complex systems leadership theory" (Hazy, Goldstein et al. 2007). The introduction to the collection provides the following: "a convenient definition of leadership would be those aspects of agent interactions that change the 'local rules' governing the future interactions among agents" which "can be enacted through any interaction in an organization", and "Effective leadership occurs when the changes observed in one or more agents (i.e., leadership) leads to increased fitness for that system in its environment." Two immediate observations can be drawn from these definitions: 1) the first definition focuses how interactions of any "agent" change the "state" of the systems, rather than a focus of one leader (or a group) having influence over other agents – a radically different view of leadership, and 2) the second definition defines effective leadership in terms of increased fitness or performance. A review of the trends in leadership resources in the following discussion clarifies these observations.

The following are highlights of more comprehensive reviews of trends in academic leadership studies (Wildavsky 2006) (Jennings and Dooley 2007). While differing significantly in details, the reviews present similar broad trends. The dominant trend in leadership theories portrays a shift from leadership based on power (defined as asymmetry of influence) of a few over others to leadership based on performance (Allen, Stelzner et al. 1998). This shift reflects many societal and organizational changes in the last century. For example, society has shifted from reliance on sustained leadership structures (an extreme example being hereditary systems) to reliance on more adaptive, performance-based leadership structures. This shift also led to the blending of leadership and management that has complicated the leadership landscape (Allen, Stelzner et al. 1998). We will return to the issue of mixed leadership and management in the discussion section from a quite different perspective based on new leadership resources.

There are two direct consequences of the shift from a power-based leadership system to a performance-based system. The first is that some performance-based leadership systems may have little, if any, organizational structure to support the leadership position. The leadership of a hero is a classic example: a hero is one who emerges from outside the structure to become a leader. A more modern example is where a work team forms spontaneously to solve a problem within a tolerant organizational structure. Both the classic and modern examples are instances of *emergent leadership* (Goldstein 1998; Hazy, Goldstein et al. 2007). The term "emergent leader" is used to describe either the common use of emergent as the rapid, unexpected appearance of a leader from an existing organization (a structure) or the more technical use of emergent from the complex systems literature (discussed shortly). The second consequence is that performance-based leadership may be as dynamic as the environment within which it operates: optimal or robust performance may require a rapid change of leadership and of leadership types (e.g., Full-Range Leadership model of Bass and Avolio (1993), Transactional or Leader-Member Exchange Leadership theory of Dansereau, Graen and Haga (1975), Graen and Cashman (1975)). We will discuss the influence of organizational structure versus emergence and dynamics on leadership in the next section.

The second major trend in leadership theories is the shift from localized leadership to more distributed leadership. Localized leadership refers to leadership by an individual or small group. Distributed leadership refers to leadership by most members of the group that will be affected by the leadership decisions – essentially a collective analog of leaders leading themselves. For example, a direct democracy and a group led by consensus are fully distributed leadership systems. Distributed leadership requires significantly different resources than localized, power-based leadership, such as the facilitation of group decision-making, the nurturing of relationships, and the presence of a variety of social personality traits ((Scharmer, Arthur et al. 2002) Ecology of Leadership: Adapting to the Challenges of a Changing World - Allen (1998) Kathleen E. Allen, Stephen P. Stelzner, Richard M. Wielkiewicz).

The leadership landscape presented in this paper is based on these observations of the trends and their extension to new frontiers.

3 Leadership Landscapes: Charting the Way

A useful tool when first organizing diverse concepts is a landscape that places diverse concepts relative to each other. Concept landscapes, like their physical counterparts, can capture a progression of waypoints, possibly capturing where we have been, where we are, and maybe most importantly where we are going. In this section, we review prior leadership landscapes and then present the Where-How of Leadership Emergence (WHOLE) Landscape that is the central feature of this paper.

3.1 Prior Leadership Landscapes

One approach to a landscape of leadership theories was proposed by Wildavsky in 1989 (Wildavsky, Ellis et al. 1997), based on the observation that "the type of organization and the kind of leadership must be part of the same phenomenon". Wildavsky observed that in the absence of the consideration of the cultural-political type of an organization, the various types of leadership are as numerous as the uncountable "situations" that occur in organizations. This led to his observation that leadership theories become like "every native dish … a stew" – a mixture of available ingredients with no defined recipe.

Wildavsky proposed that the proper leadership landscape (he used "regime models") is derived from the two-dimensional landscape used in the cultural grid-group theory associated with the cultural theories of Mary Douglas (Douglas & Wildavsky, 1982): where in a strong *group* the individual belongs to "a collective, that makes decisions binding on all members" and where in a high *grid* "the individual is subject to many … *prescriptions* of required behavior." Wildavsky then uses this grid-group landscape to show how the complex collection of leadership theories in the academic literature and the respective dynamics of each leadership system naturally arise in the different "regimes" assigned by the extent of the grid and the group variables. For example, the *egalitarian* regime–a strong group with few prescriptions–is the home for the charismatic leader, is prone to changes of leadership as the group changes focus, and is where blame for failure is placed on "the system" and not the group. By contrast, the *fatalist* regime–weak group with many prescriptions–is home for the despotic leader, has few changes in leadership (because the prescriptions or structures change slowly), and is where failure is blamed on deviant individuals that don't follow the rules. Wildavsky's analysis

concludes that organizational culture determines which leadership types arise and are effective and determines their respective processes – relationships, stability and mechanisms for change. We can generalize this conclusion relevant to the purpose of this paper, 1) often a leadership resource emerges and is aligned with the needs and challenges expressed by that culture and 2) because each leadership resource has associated strengths and weaknesses, when an organization chooses a leadership resource to address a need or challenge, the organization must also develop the culture to support the leadership resource. These are powerful considerations, particularly as information technology resources are being developed to support modern challenges and leadership. We'll return to this in the discussion section.

Another leadership landscape was proposed by Goldstein (Goldstein 1998) to highlight how emergent leadership is an essential, but underappreciated component of the leadership landscape. Goldstein defines emergence generally as "the unanticipated arising of new higher-level systemic patterns or structures functioning according to new laws and consisting of new properties". We concur with this definition if "unanticipated" is removed, because in our view emergence can be a stochastically predictable phenomenon from a developmental perspective – just as a shortest path is found reliably by a foraging ant colony. Because his viewpoint only considers leadership as embodied in individuals (rather than in interactions between individuals), his emergent leadership is the unanticipated development of innovation by an individual or small group. His landscape, called an "Organizational Structure Grid", has two axes (each divided in two): *Type of Structure* (hierarchical or participative) and *Source of Structure* (imposed or self-organized/emergent). The four quadrants are then used to define the relationship between the leaders and followers: 1) the hierarchical and imposed quadrant is a *command and control bureaucracy* – the relationship between leaders and followers is top down and rarely changing, 2) the hierarchical and self-organized quadrant is *informal leadership* – the leader-follower relationship is top down but leadership changes from the bottom up, 3) the participative and imposed quadrant is an *imposed team* – structure is imposed from above but authority is distributed, as in quality control teams, and 4) the participative and self-organized quadrant is an *emergent network* – where both power, including the structure used to sustain power and authority, are distributed.

We can generalize Goldstein's analysis into four conclusions. 1) As in Wildavsky's landscape, organizational structure strongly determines the relationship between the leader and group. 2) Structure (as Goldstein uses the term) can be expressed in a top-down or distributed/participative manner, and these different structures determine the information flow, responsiveness, and performance of the leadership. 3) Goldstein makes the similar observation as Wildavsky that novel leadership structures cannot be imposed, but must be enabled by the organizational culture or structure. 4) Emergent networks are the least understood leadership resource and the most threatening to traditional leadership. Emergent networks require a less vision-focused or goal-oriented culture and a more enabling or process-oriented culture, thereby facilitating bottoms-up emergent leadership. Goldstein argues that these networks offer new possibilities for adaptive organizational structure to address more complex and faster-changing times. While Goldstein's landscape is notably limited in scope (illustrating only 4 types of leadership out of many possible) his primary contribution to the leadership literature was to bring emergent leadership as a comparable resource as traditional resources, which we also endeavor to accomplish. We also build upon his analysis by broadening his description of emergent leadership to include non-embodied processes, as captured by the leadership definitions in Section 2.

A final leadership landscape was proposed by Wielkiewicz (2000) to describe an additional perspective of leadership: personal stages of development for leaders based on an ecology of leadership theory (Allen, Stelzner et al. 1998). This landscape combines organizational-science and complexity-science perspectives and has two axes, each divided in two: hierarchical (low to high) and systemic/ecological thinking (low to high). Hierarchical thinking "is characterized by a belief that control and authority extend downward in the hierarchy and that organizational members should seek guidance from the level above them", a viewpoint aligned with Goldstein's "type of structure". Systemic thinking captures appreciation of interdependence within organizations (e.g., feedback loops, leadership arising instead of being prescribed) and desirable attributes of leaders (enhancing the flow of information, fostering relationships, assisting the emergence of shared purpose, and long term perspectives). Because of the breadth of inclusion of systemic thinking, there is no specific equivalent to it in other landscapes, but arguably it is a required skill of a leader participating in Goldstein's emergent network leadership. The primary contribution of the Wielkiewicz landscape was demonstrated in a study of the individual developmental nature of leadership (Komives, Longerbeam et al. 2006) which found that maturing leaders consistently move through the landscape in sequential and repetitive stages (corresponding to quadrants of the landscape) in the development of their leadership awareness and skills. Wielkiewicz's viewpoint was restricted to leadership embodied within individuals. We generalize Wielkiewicz's contribution of developmental leadership to non-embodied systems, and will argue for non-embodied emergent leadership as a natural developmental leadership resource in domains of high diversity and complexity.

The above leadership landscapes illustrate the following utilities: 1) significantly reducing the perceived complexity observed in leadership resources and theories, and 2) facilitating the matching of leadership resources to the nature of the organizational types and current challenges. In addition, specific landscapes provide the following insights: 1) emphasizing the importance of an alignment between the leadership resource and the enabling organizational structure, particularly culture, 2) providing understanding of how leadership resources develop to match evolving challenges, and 3) the growing importance of emergent leadership processes to address the complexity and rapid change of modern decision making environments.

3.2 The WHOLE Landscape

While the above landscapes are descriptive of past and present leadership resources, they are not intended to be guides for future resources. We posit that the proper leadership landscape that captures past trends can predict how leadership will develop in the future. Furthermore, by using the trend that leadership can be evaluated based on performance, we can extend the definition of leadership to include any process that increases system performance (either in quality or robustness). Emergent leadership is an example of a newly identified leadership resource that has the potential to increase performance. Goldstein (Goldstein 1998) argued that because embodied emergent leadership contributes to an organization's performance, it must be included as a conscious resource for leaders and organizations. Also, the review above of leadership trends indicates that the definition of leadership is expanding to include broader participation, and we similarly extend this trend. Finally, as stated in the introduction, information technology resources applied in very complex domains provide "leadership" that is consistent with modern leadership definitions (i.e., the

leadership results from interactions of agents by changing the future state of the agents to improve their fitness). One qualification is warranted: while the following presentation focuses on the performance qualities of leadership, care is taken not to exclude power-based leadership resources that may have limited regard to performance. Hence, while the emphasis is on performance, the presentation does not exclude prior foundations of leadership. Also note that in the following, the focus of leadership is on decision making and not the execution of the decision, which might be relegated to a managerial function or a mixed leader-manager function.

To extend the two trends in leadership, we propose a two-axis landscape defined by "*where leadership arises: degree of distributed participation"* and "*how leadership arises: degree of emergence,*" called the *Where and How of Leadership Emergence* (WHOLE) landscape. To define these axes and to make the landscape quantitative, a metric is defined for each axis. The *degree of distribution metric* is defined as the number of individuals required for a leadership decision divided by the total number of individuals influenced by the leadership decision. The distribution metric ranges from a small number for a single leader to unity if the entire group participates in the leadership process. A metric for the degree of emergence is challenging at best and is a controversial topic of research. For the current purposes, the *degree of emergence metric* is defined as the difference between the number of flexible, synergistic, or unpredictable interactions needed for the leadership decision and the number of prescribed interactions supporting the decision, divided by the sum of these two numbers. This emergence metric ranges from -1 for rigid, rule-based leadership to a number approaching unity for highly emergent leadership, with the understanding that some degree of structure is required even in highly emergent leadership.

A comparison with the previous landscapes in §3.1 clarifies the proposed landscape. Our degree of distribution axis is relatively straightforward and is included in the discussions of the prior landscapes, largely as an implied consequence of greater participation.

Our degree of emergence axis is more difficult to map to prior landscapes. While Wildavsky's 1989 lexicon does not include emergence or self-organization (largely because these words were not part of the cultural theory lexicon at the time), he does for low-grid systems refer to collective processes that "organize [themselves] without a binding source of rules" – certainly an acceptable definition of self-organization. Hence, Wildavsky's grid/prescription axis is complementary to our emergence axis (high-grid, low emergence to low-grid, high emergence). A comparison to Goldstein's landscape is on face value challenging due to differences in definition of structures. Goldstein's definition of structure includes "emergent structures," based on the viewpoint that emergent global features, which result from interactions between components, can be called structures, because they are sustained as long as the interactions persist (we concur with this view). Because these emergent "structures" are global "expressions" and not global "rules", we identify these global emergent "structures" as discussed by Goldstein in the high emergence (but our low structure) portion of the axes. Examples are provided below which further illustrate the interpretation of the emergence axis.

Wielkiewicz's systemic thinking includes aspects of emergent leadership, such as the attribute of leadership arising instead of being prescribed and of assisting in the emergence of shared purpose, but generally he associates systemic thinking with localized leaders, rather than a potential property of the whole. Finally, a major difference between the prior landscapes and the WHOLE landscape is that we include non-embodied leadership resources, and open the opportunity for leadership based on interactions, particularly those enabled by information systems and in more complex

forms of emergent decision making that may not be associated, or even understandable, by any individual or group – a concept developed below and in the discussion section.

While our landscape is continuous (a leadership type can be assigned anywhere according to its two metrics), for simplicity of discussion we divide each axis into two halves as in Figure 1, establishing four quadrants. To illustrate the utility of this landscape, different rows or columns are discussed, identified by the quadrant numbers (e.g., Q1-Q2 is the column on the left).

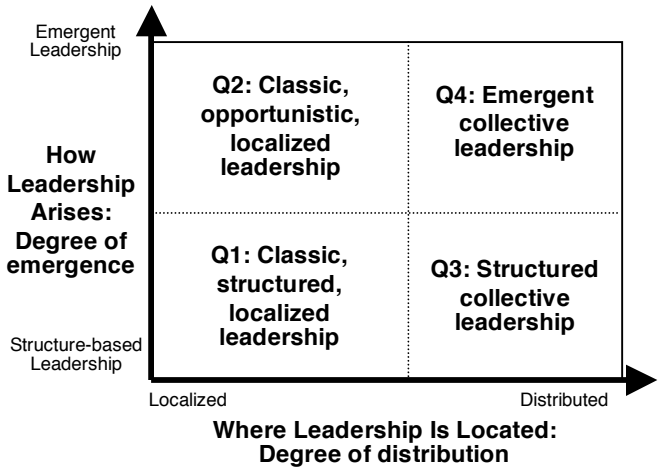

Figure. 1: The Where-How of Leadership Emergence (WHOLE) landscape that captures past, present and future leadership resources – divided into four quadrants for simplicity. The "Where" axis describes to what degree the entire group or collective is involved with making the decision. The "How" axis describes to what degree the leadership is determined by the structure/rules of the system (and is therefore predictable) versus the dynamics of the systems (and is therefore emergent, opportunistic and/or unpredictable).

Classic leadership resources (Q1-Q2). Because the traditional view of leadership is few leaders with many followers, the column for localized leadership (Q1-Q2) is called "classic" leadership. The bottom-left of this column (Q1) describes leadership in organizations where leadership in all its qualities (position, selection, operation, roles, options, etc.) is determined by the formal rules (or more generally, fixed structures because some may be tacit) of the organization, and therefore captures many of the early theories of leaders influencing followers within the social/cultural/organizational structure (power-based, innate traits, situational, transformational, leader-member exchange). These fixed structures can either be from the dominant controlling group (using Wildavsky's group description) or from organizational prescriptions (using Wildavsky's grid description). Moving across the bottom of the column in Q1 are leadership structures that include formally greater numbers of participants, such as oligarchies, hierarchical systems, and team leadership.

The upper portion of the classic leadership column (Q2) describes what is generally meant in the literature when "emergent leadership" is used: how new leaders emerge from a group that 1) are individuals with unique innate or learned

traits who exploit a leadership opportunity – a hero (Plowman and Duchon 2007) and/or 2) arises from self-organizing processes among many followers that support an emergent leader outside the system (Goldstein 1998). The quadrant Q2 also describes leadership resources that are not embodied in individuals, but in interactions between individuals. An example of this non-embodied leadership is presented by (Lichtenstein, Uhl-Bien et al. 2007) in their presentation of the dynamics of adaptive leadership – "a dynamic that transcends the capabilities of individuals alone; it is the product of interaction, tension, and exchange rules governing changes in perceptions and understanding." We will return to the interactive expression of emergent leadership below and in the discussion section. The essential observation is that the origins, the predictability, the location and supporting processes of emergent leadership are fundamentally different than for structure-based leadership.

Structure-based leadership resources (Q1-Q3). The lower row extends the structure-based, localized leadership resources to structure-based, distributed resources. This extension represents the trend toward inclusion of greater numbers in leadership processes, as described in Section 2, including the limit where all individuals participate in collective decision-making. A common argument that is expressed for why quadrant Q3 cannot be a leadership resource is the belief that leadership requires followers: if everyone is a "leader" then there are no followers. A counterexample is a direct democracy – where all individuals participate in "leading" the whole. Hence, the actions of leading and following may be temporally shifted such that the same group leads and then follows. Another counterexample is where a "leader" plays a facilitator role to enable the group to reach a collective decision. In this example, the decision maker is the group and the facilitator/leader is ultimately also one of the followers of the leader. Part of the confusion around leaders and followers is the lack of distinction between the timing of making the decision and execution of the decision; the later action can often be delegated to the followers or, as commonly done, by management. The above counterexamples illustrate that our vocabulary, like leader/followers, is inadequate for modern complexities of decision making and leadership.

Another potentially challenging aspect of Q3 is how leadership can result from the symbiosis of human and machine (Johnson, Rasmussen et al. 1998) – a type of non-embodied leadership: information technology (IT) resources where "(t)he behavior of all human participants plus the algorithm used to aggregate that behavior generates the system's solution" (Rodriguez and Watkins 2007). Public versions of these resources have demonstrated better performance than any other prediction methods, including experts. For example the Iowa Electronic Markets correctly predicted the number of electoral votes by which Bush would win in the 2004 Presidential race, and out predicts other polls 75% of the time (McCrory 2004). These collective decision making system resources are a type of leadership, because highly competitive companies such as Hewlett-Packard are acting on the decisions of these resources with minimal or no review (Watkins and Rodriguez 2008). This viewpoint may challenge traditional viewpoints of leadership, but these technology-based resources in Q3 qualify as leadership resources because in complex environments that are not transparent to human inspection, they consistently yield better decisions than solely human-based systems and are aligned with the definition of leadership presented in the Introduction (they result from agent interactions, change the future state of the system, and improve fitness).

Collective leadership resources (Q3-Q4). The right-hand column describes leadership resources that cover the structure-based, collective-decision leadership resources (Q3), described above, to the *emergent collective leadership* (ECL) resources (Q4). This column represents the logical extension of the trends observed

above in leadership: performance-based resources that utilize more individuals. These define the new frontiers of leadership resources and the areas that require active research to better understand the nature of the resources, their utility, and what processes enable them. We fully appreciate that significant research is needed, but some observations can be made based on research to date.

One might conclude that ECL is simply the intersection of emergent individual leadership (Q2) and distributed leadership (Q3), as discussed above. But, ECL is an example where the whole is greater than the sum of the parts, because additional leadership qualities arise for ECL that were not previously discussed. The following examples of ECL illustrate these unique leadership qualities.

Consider a common example of an emergent system within complexity studies: food foraging by an ant colony using pheromone trails. As a collective, ants consistently discover and exploit the shortest path between the food source and the nest. Remarkably, when the shortest path is first "discovered" by the collective, no single ant actually takes (embodies) the shortest path – the shortest path is a composite of the diversity of individual paths of the collective. Hence, the shortest path is an emergent solution of the collective and is not embodied in any individual. The fact that no individual embodies the optimal solution supports the earlier discussion on the utility and challenges of non-embodied emergent leadership: if no individual embodies the "optimal" solution, how can we choose an individual as an optimal leader? This observation has profound repercussions on traditional approaches to developing leaders – such as hiring the best or rewarding the highest performer. If the best is not embodied in an individual, how do we hire or reward an individual? An even more challenging observation is that the shortest path is not even a solution that is understandable by any ant in the collective; instead, *the idea of a shortest path is an emergent concept of the collective and the discovered shortest path is an emergent solution of the collective*. We discuss the practical challenges of this possibly philosophical statement in the Discussion section.

The second example is the Bali water distribution system (Lansing 2006). Along a typical river, small groups of farmers meet regularly in water temples to *locally* manage their irrigation systems. What is remarkable is that the distribution of water is globally optimized by these local rituals to large changes in the total water flow, ensuring water for everyone along the river – essentially an emergent solution to the "tragedy of the commons" dilemma. Interestingly, there is no evidence that the local rituals were designed to have global optimization. While it is an outstanding research problem of how such an ECL system evolves, the two essential observations are that 1) by each group focusing on their own problem, the system self-organizes to a global optimum – to the benefit of all and 2) the local groups are not aware of the global optimization, nor how it works.

A final example that also illustrates these two observations is Adam Smith's metaphor of an "invisible hand" (Smith 1776) for free markets: where an emergent collective regulation and benefit result from individuals pursuing their own self-interests. This popular example captures the emergence of a global feature that is not expressed at a local level. As in the above examples, the process that provides this emergent collective benefit is not traditionally called leadership. Interestingly if the same public good were provided by the government or a leader, either directly providing the benefit (but it would no longer be emergent) or by creating the conditions for the global benefit to occur, it would be called leadership. This example directly challenges our concepts of leadership where different aspects of a system can

express the same outcome, but in one case we attribute it to an invisible hand and in the other we give the "hand" a label and laurels. Another aspect of this example, and one we will return to in the discussion section, is how Smith's metaphor has become quite controversial, particularly where it has shown to be corruptible or has become a identifier of different market ideologies. We might expect ECL to exhibit these same controversies.

For completeness, we note that the emergent performance of the collective is coupled to the abilities of the individual, because unless the individual has some ability, the collective processes cannot optimize the synergy of the individual solutions (Johnson, 1998). Unless the ant or the local farmers can perform at some level of ability, ECL is not observed. This observation has ramifications for the implementation or enabling of ECL in organizations, as addressed in the discussion section.

Emergent leadership resources (Q2-Q4). The upper row captures the range of resources for emergent leadership from localized to fully distributed, all expressing the unstructured appearance and function of emergent leadership. Similar to structure-based leadership resources (Q1-Q3), this row captures the observed trend in leadership from localized to distributed leadership. But, unlike the discussion of the importance of the development of structure-based collective leadership in the literature, e.g., (Hazy, Goldstein et al. 2007) (Rodriguez and Watkins 2007), the literature appears not to address the development of the emergent individual leader (the hero) to the ECL; we speculate that this is because the development path to ECL generally is upward in the WHOLE landscape. A simple example of ant foraging illustrates this point. In a low-complexity foraging problem (e.g., the food is close to the nest, connected by a simple path), a single ant can discover the optimal path and be productive and share that leadership with others – a Q1 resource. Additional ants add labor to the task but do not improve the solution. But in more complex foraging problems, the "leadership" of a single ant is useless, and only the collective can "lead" to the optimal solution, via a Q4 resource. A Q3 resource – the addition of more ants without an emergent solution – is not an alternative. Hence, the development path to address more complex foraging problems is upward (Q1 to Q4).

Another reason that the academic community may not have developed the literature along the Q2-Q4 resources is the fundamental lack of understanding of the processes and utilization of these resources. A simple example illustrates our profound ignorance: the collective system that you are using to process these words – the brain - is an emergent collective of neurons. We are just now understanding simple functions of the brain, such as visual cognition, and are far from understanding more complex functions, such as abstract cognition. This challenge of understanding and utilizing ECL is addressed in the following section.

4 Discussion

In this section, we discuss some implications and issues that arise from the WHOLE landscape, focusing on the type of emergent leadership introduced in this paper, ECL. We begin each discussion with a question of interest. We note that the equivalent questions for the structure-based collective leadership (non-emergent, but non-embodied) are being actively explored in organizations (as discussed above for row Q1-Q3 in Fig. 1) and academia, driven by the demonstrated leadership of these resources and the need for specific understanding or theory. The same may also be true for ECL in the near future, possibly after additional utility of ECL is discovered. While the exploration of ECL is nascent, many issues are already apparent, some purely semantic (What is leadership?), and some deeply philosophical (Is it still leadership if the leadership decision is not understandable by the followers?).

Is emergent collective leadership (ECL) really leadership? This question directly addresses the dismissal of ECL as a valid leadership resource based on definition alone. At the heart of this question is semantic versus functional questions about leadership that take the form, "my definition of leadership does not include your utility." For example, I reject the idea that leadership can be non-embodied because my definition of a leader is a person or group (e.g., embodied). Semantic versus functional disagreements are often dynamic as the utility of leadership changes when new leadership resources are identified. In these transitional times, we as researchers may be slow to recognize new leadership processes that are growing in practice, and once recognized, may not accept them as leadership until they can be harnessed and reproduced. Arguably, newly discovered but currently accepted leadership types over the last century existed from the beginning in social systems, but possibly were not recognized as leadership because the new resources were not dominant, easily visible, or reproducible. Similar challenges arise in the current study. Unlike many of the prior developments of leadership theories over the last century, reflected by the trends presented in Section 2, the distributed, emergent, and non-embodied aspects of leadership may be the most challenging to observe, quantify, and reproduce. While the community must ultimately answer if ECL is a valid leadership resource, the following questions attempt to uncover what is known about ECL (what it is, what enables it, and what it is best for) and what are the challenges to its use and development.

Can leadership really be non-embodied, existing only from the interactions of people? Section 2 presented the arguments and literature references for extending leadership into distributed and emergent resources, but this question for non-embodied leadership was not directly addressed. A common response to this question, and to the leadership definitions presented in the Introduction, is that focusing leadership on the interactions of people rather than on the people themselves is an obvious point because leadership is a social process that fundamentally is about interactions; however, this interaction focus is of little utility at best and a naïve application of complex systems studies at worst. An in-depth treatment of this question is beyond the scope of this paper, but some observations can be made.

The previous studies of leadership that included non-embodied resources (Goldstein 1998; Scharmer, Arthur et al. 2002; Lichtenstein, Uhl-Bien et al. 2007) could be argued to parallel the roles of explicit and tacit knowledge in organizations, popularized by Nonaka (Nonaka and Konno 1998), often captured by the popular phase: "if GM only knew (explicitly) what GM knows (tacitly)." Tacit knowledge exists across an organization, and even when known and utilized, may not be easily expressible or reproducible. Similarly, some leadership resources are tacit, capturing the same features and challenges. Therefore, one way for researchers to challenge the leadership community is to define leadership as interactions between people, just as the organizational knowledge community has stated that tacit knowledge is more abundant and often more important than explicit knowledge. Applying this perspective in the current analysis, non-embodied leadership exhibits both explicit and tacit aspects. The "explicit" non-embodied leadership resource is the information-technology-based decision making systems discussed for Q3 of Fig. 1. Because these use the unique properties of the Internet, they can be studied explicitly, unlike more traditional types of collective leadership (e.g., democracy) where the decision process relies directly on direct human interactions. The "tacit" forms of non-embodied leadership are associated with the ECL resources in Q4, and because

they are emergent, and from a complex systems viewpoint, they are closer to the types of systems associated with complex systems studies, with all the associated challenges.

Another aspect of this question is philosophical in nature, but does have organizational implications. We restate the question: "Does leadership include processes that result in improvement of global performance but where the individual, who is part of the process, is unaware of, and more significantly, may not even be able to comprehend the leadership outcome?" Certainly many classic types of top-down leadership result in actions that are not understandable from below, but in emergent solutions, the solutions are not initially understandable by anyone. Is an emergent solution to a challenging problem really leadership if no one is aware of the "leadership" that provides the solution, as for an ant in foraging solution, a neuron in the brain, or a group of local farmers in the emergent Bali water management? While there are no easy answers to this more philosophical question, the emergent problem definition and solution are analyzed without the burden of a leadership perspective in a prior study (Johnson 1998). The analysis can be summarized in a simple observation: from a global perspective a solution by any other name is still a solution, and our confusion is often because we lack a global perspective to perceive and understand the solution. The more complete answer is that there is much that we do not understand about emergent systems, particularly social systems (Sawyer 2005), and understanding will come with further research. We address more practical organization implications in a later question on how an emergent solution can be exploited and become embodied within an organization.

What can ECL do for my organization? Or alternatively, what types of problems are best suited for ECL? Having addressed the necessary but more academic questions above, we can now pose questions of greater interest to organizations faced with challenging problems. Answering these questions provides an understanding of the strengths and limitations of ECL. While a full understanding of emergent collective systems is an ongoing research topic under the general topic of collective intelligence (Tovey 2008), various authors (Johnson 1998) (Surowiecki 2005) (Mauboussin 2007) have analyzed the types of problems amenable to collective intelligence, of which ECL is a subset. These studies did not directly address leadership, but rather problem solving in general and the utility of experts or collectives in particular. To extend the conclusions of these studies to leadership, we apply the understanding that modern leadership often provides decision making resources to problems that are not tractable at the individual or sub-group level, as captured by the trend in collective involvement discussed earlier. Within this context, studies of expert performance and failure are relevant. (We note that the focus here is on quality of leadership, and not how quickly a solution can be achieved – certainly a group can work faster than an individual, but without any difference in the quality of the solution).

Because different problem types require commensurate solution resources, part of the reason studies of ECL have not been addressed is the choice of model problems used to analyze decision or leadership resources in academic studies. Johnson (Johnson 1998) argued that a sequential problem domain (the type of problem where a sequence of decisions are made, as in solving a maze) is a broader class of model problems than the single decision problems that are commonly studied (particularly in game theory) and is closer to the type of problems commonly found in organizations. Because in the real world no problem or its solution is in isolation, there always is a problem that must be solved before and after. Johnson found that sequential problem domains can exhibit both emergent problem definition and emergent solutions, where isolated decisions are less likely to express these.

Emergent problem definition is when an individual solving the problem with their own rules and experiences can contribute to global problem definition that is not even defined or knowable by the individual, just as an ant helps the ant colony solve a shortest path problem without being able to comprehend or measure the shortest path.

An analysis of the type of sequential problems amenable to emergent solutions identified ones where the problem domain is sufficiently complex such that multiple "parallel" solution paths exist (where a path is a sequence of decision points) and where there are connections between these paths. A detailed graph theoretic analysis of the same problem domain (White and Harary 2001) arrived at the same conclusion and set up general rules for the types of decision path networks in which ECL can occur. Essentially the conditions are equivalent to stating that multiple paths to solving similar problems exist and there is overlap (connection) between these different paths. An example of the problem domain is the multiple but connected paths in an ant foraging problem or a supply chain management problem[1]. Qualities of the collective that enable ECL are addressed in the next question.

Another conclusion by Johnson (1998) was that emergent solutions could even occur when there is an absence of common starting and end points. Said another way, emergent collective solutions can even occur when individuals in an organization have different beginning points and different goals, as long as their solution paths are connected or overlap. A classic example of this is the so-called "water cooler effect" in organizations where individuals informally share information without incentives and without knowing that what they share is useful, but where occasionally major benefit is gained from these interactions. The above conclusions about the problem domain for ECL are significant, because the more challenging problem domains, exhibited by multiple solution paths and goals, are also the ones that are amenable to the unique problem-solving leadership of self-organizing collectives. The discussion for the next question will clarify the relationship between the problem and the problem solver (the leadership).

Another approach to analyzing the types of problems best suited for ECL is to identify the types of problems on which experts fail and then determine if these problems are addressable by collective intelligence, as was done specifically in the field of finance and investment (Mauboussin 2005). Mauboussin observed that the utility of experts is getting squeezed between the exploitation of computer processing – largely based on the ability to project actionable trends in large amounts of data – and self-organizing collective intelligence – the ability of groups of investors to outperform experts. He identified four types of problems that combined two extents, rule-based and probabilistic, each with either high or limited degrees of freedom (problems with higher degrees of freedom or options are considered more complex). Mauboussin argued that computers are best at rule-based problems with limited degrees of freedom such as credit scoring (the statistical evaluation of credit worthiness). Experts are best at rule-based problems with high degrees of freedom such as chess. Self-organizing collectives, and by inference ECL, are best at probabilistic problems with high degrees of freedom, such as the stock market or economic forecasting. Collectives tie with experts on probabilistic problems with limited degrees of freedom. We note that counterexamples to the above generalizations can be found in scientific computing, for example, where computers

[1] http://en.wikipedia.org/wiki/Supply_chain_management

are better than experts in highly probabilistic problems, as when Monte Carlo solutions implemented on computers are optimal.

A similar study on the utility of collective problem solving (Johnson et al. 1998) concluded that computers worked well for problems with large amounts of homogenous data (limited degrees of freedom); obversely, experts work well on problems with small amounts of heterogeneous data (high degrees of freedom). Computers, experts and non-experts all work well on homogenous data of small extent. Self-organizing collectives are good at the types of problems that non-experts, experts and computers are not able to address: problems with large amounts of heterogeneous data.

Another approach to describe the types of problems best suited for ECL is based on the relative degree of structures and options (Johnson and Watkins 2007) within the system and identifying the sweet spot of emergent solutions. This analysis captures how synergistic emergent solutions, including ECL as a subset, arise in systems which have sufficient structure to create options (e.g., taller trees enable options like giraffes), but not excessive structure that reduces options (e.g., a board game becomes unplayable with more and more rules). This clarifies in the discussion above about the possible confusion that how rule-based systems (those systems with high structure) can also have high degrees of freedom (systems with many options): rule-based system in order to be functional must have just the "right" amount of rules. Too many rules will reduce the degrees of freedom, their utility, and the applicability of collective solutions and of ECL. Similarly, it clarifies how probabilistic problems (system with stochastic options) can also have few degrees of freedom (few options): typically problem domains with limited structure (low complexity) have consequently few options. This analysis also suggests that overly-constrained organizations (too much structure, too few options) that wish to enable ECL processes must reduce the structure in the organization to increase the possible options, thereby enabling ECL processes. Reducing structure and increasing options also has the additional advantage of often making the organization more robust and more adaptive to change (Johnson and Watkins 2007).

Two figures are presented that graphically summarize the above discussion. Figure 2 illustrates how the utility of the expert and self-organizing collective changes with increasing complexity, where complexity is taken to be a composite of concepts used above for the problem domain: heterogeneity, amount of data, degrees of freedom, etc. For low complexity problems, the expert (or leader) has little utility because anyone can solve the problem, including computers. At some level of complexity, defined as the *expert complexity barrier*, the utility of the expert declines because their performance declines. In certain kinds of problem domains – as discussed above, collective leadership resources can overcome this barrier, until the collective capability also reaches a collective complexity barrier. The *collective complexity barrier* was found (Johnson 1998) to be determined by the abilities of individuals relative to the global problem challenge and the diversity of the collective, because the collective solution is found to amplify the diverse contributions of the individuals. If the individuals have little understanding of their part of the problem domain, their contribution to the collective is random and the collective process has nothing to amplify. Similarly if the diversity of the collective does not span the problem domain, the collective process is missing required components for a global solution (we note that the utility of diversity is presented simplistically here and suggest reviewing the source material for a full presentation).

Page (2007) elegantly summarizes the above limitations of collective solutions with the "diversity prediction theorem" (a rearrangement of the variance theorem in statistics):

{Collective error} = {Average individual error} – {Prediction diversity}

For example, when the average individual error is high and/or the prediction diversity is low, then the collective error is high, and the collective complexity barrier is reached.

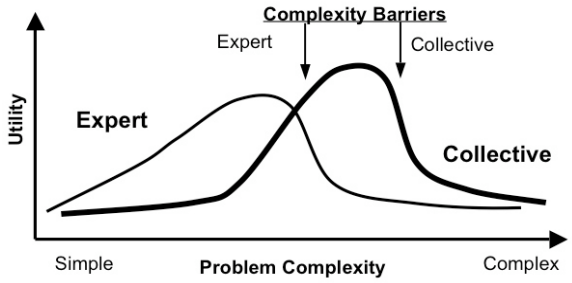

Figure 2: The utility of the expert and collective with increasing complexity (Johnson 2008). Increased complexity could be higher degrees of freedom (increased interdependency, greater extent, greater number of rules) and more probabilistic. Each decision making system experiences a complexity barrier, above which the expert or collective cannot reliably make useful decisions.

Figure 3 is constructed to provide the corresponding problem domain landscape for the WHOLE landscape in Fig. 1, based on the above discussions. In Fig. 3 the changing utility from the individual leader to the collective leadership is captured by progressing from the left to right. Similarly, the changing utility of structure-based solutions to emergent solutions is captured by progressing from bottom to top. The designation of the abscissa, the diversity of the problem domain, is chosen based on the argument that, of all of the aspects of complexity listed above, the need for increased participation of the collective is driven primarily by the increased diversity or heterogeneity of the subsystems of the problem domain or, mapping to Mauboussin's description, by the increased degrees of freedom. The designation of the ordinate of Fig. 3, "the degree of emergence required in the problem solution", captures the transition of the problem domain from being rule based to domains that enable emergent solutions. The recursive definition of the ordinate (meaning that we use the same designation of leadership to define where it is needed) is partially due to the lack of a general understanding of types of systems in which emergent solutions arise. Certainly, distributed problem domains with random or stochastic aspects are necessary for emergent processes, but these are probably not sufficient. A better understanding of the types of problem domains where emergent leadership resources arise, both for individuals and the collective, is an important area of research.

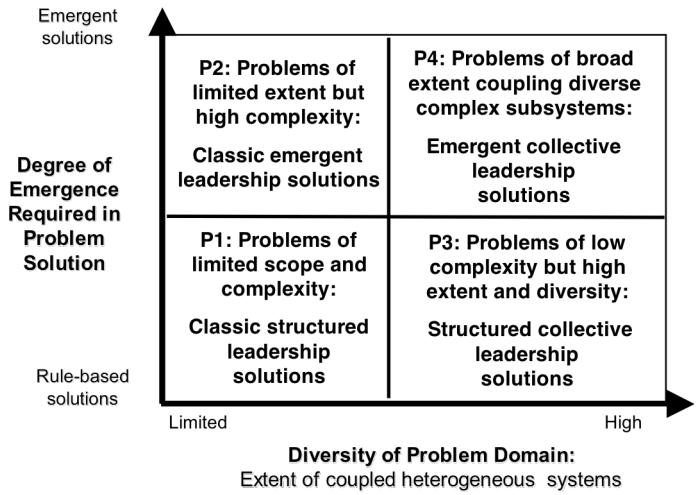

Figure 3: The problem domains corresponding to the WHOLE landscape (Fig. 1). Because this is a problem domain for leadership and assumes a level of need for leadership, the problem domains amenable to individuals (those located in the left of Fig. 2) are not included.

What are the requirements for ECL to exist and to be effective? To make use of prior studies to answer this question, we make the same correspondence as for the last question: studies of the requirements for self-organizing collective intelligence to exist and be effective are relevant to ECL, because modern leadership often requires enabling collective intelligence processes. As observed for the last question, this area is also an ongoing area of research, with different conclusions being made by different researchers that are not always in alignment.

General requirements for collective emergent performance were proposed (Johnson 1998), which parallel those observed for optimal decision making in groups (Scharmer, Arthur et al. 2002). The performance of emergent collectives requires:

1) Sufficient diversity of problem solving approaches or experiences,
2) An agreement on the possible options where or when individuals interact, but where agreement is *not* required on preferences or prioritization of the options, and
3) Some overlap of activities, as would normally be true in a larger organization, including informal activities, such as in the water-cooler effect.

Each of these requirements has significant implications for the operation of an organization that wishes to enable ECL processes.

The need for diversity (#1 above) is a growing appreciation in organizations, not based on moral reasons, but on performance arguments and are summarized extensively by Page (2007). Note that diversity is taken to be different approaches or experiences in solving a problem, which may or may not correspond to more traditional definitions of diversity, such as ethnicity.

The second requirement establishes the need for the compatibility of the diversity. This addresses contrary observations to those above that diversity can be disruptive to better problem solving, and provides the reason why diversity alone (#1) is not sufficient for collective performance, either in intentional groups or ECL. This requirement resulted from an analysis (Johnson 1998) which concluded that the potentially disruptive differences of diversity can often be traced to a disagreement on acceptable alternatives or options, and not necessarily the differences in the preferences of the accepted options – the latter being our common perception. Another way to state this requirement is that for self-organizing collective intelligence to occur, contributions of different individuals must be compatible: if two individuals do not agree on the existence of an option, then it is impossible to find synergy in this option. The qualification of requirement #2 that agreement on preferences is not required is equally important for organizations. Often the approach by organizations to mobilize the collective processes is to establish common

organizational goals, often under the guise of strategic planning. This additional structure, which often aligns individuals' goals as well as organizational goals, can impede the development and expression of diverse problem solutions required by ECL (as noted above the reduction of structure can enable ECL; similarly increasing structure can inhibit ECL provided it reduces options). This observation is particularly true in the modern business climate of rapid change where organizational goals can become quickly outdated. A better alternative is for an organization to develop adaptive processes, rather than organizational goals.

The final requirement (#3) parallels the earlier discussions on the connectivity in the paths of problem domain, because the overlap of different paths corresponds to common potential activities of individuals making up the emergent solution. The interactions of these three requirements can be summarized: the source of an emergent collective solution is diversity, made compatible by an agreement on options where members of the collective have some common activities. Interestingly, these requirements, taken together, also state that diversity is not required to be compatible where individuals do not have common activities. This last observation is a direct result of the sequential problem domain.

Mauboussin's (2007) three requirements for collective performance were established without distinction between emergent and non-emergent collective processes, and partially align and partially contradict the above requirements for ECL:

1) Sufficient cognitive diversity,
2) A mechanism for aggregation of the diversity and
3) An incentive for individual performance.

The first requirement is partially equivalent to #1 above by Johnson, in that diverse problem solutions can reflect different cognitive diversity. But it was demonstrated (Johnson 1998) that even individuals with identical cognitive rules could contribute different experiential diversity due to the random learning experiences of most problem domains. While this may seem a subtle point (cognitive diversity could include random experience, too), organizations invest significantly in developing cognitive diversity through training. This strategy appears to be contradicted by studies (Bischoff 1998) that show the required information for job completion across companies of all sizes relies more often (up to 80%) on informal sources of information (e.g., casual interactions with colleagues) rather than formal sources (e.g., training, bosses, manuals, best practices, or leadership from management). This observation is a significant indication of the importance of individual experiences rather than formal processes that establish cognitive diversity. This study also establishes the importance of informal collective processes and may be a guide to the development of ECL.

The second requirement, an aggregation method of the diverse contributions, in some problem domains is explicit and knowable, and in other domains is tacit and currently not known. For example, the aggregation mechanisms for structured-based collective leadership in Q3 (Rodriguez and Watkins 2007) and in the application areas examined by Mauboussin (2007) are explicit. A similar understanding has not been established for ECL and might be argued to be comprised of the wide array of social mechanisms for information exchange and synergy. Until we achieve a greater understanding of the processes in ECL, the best stating point for an ECL aggregation methods are the requirements of compatibility and opportunity for exchange established listed in the prior set of requirements (Johnson 1998).

The third requirement of incentives is motivated by establishing the conditions necessary for achievement of an accurate individual contribution. This is supportive of the prior discussion on the need for a sufficient ability of the individual. An observation that may detract from a simplistic application of this requirement to the ECL process is a study (Johnson 1998) that examined the correlation of performance of ECL on individual performance. The surprising result was that collectives comprised of broader diversity in *individual performance* performed better than collectives comprised of the highest individual performers. This would appear to contradict the diversity prediction theorem presented earlier, which states that the increased individual performance would result in a lower collective error. But a more careful analysis shows that the individual performance and diversity are not uncorrelated, and a collection of high performers can have a low diversity and hence result in a high collective error if average diversity decreases faster than average individual performance increases. This observation has profound implications on the common organizational incentives of hiring the best applicants and rewarding the best performers. While these individual performance incentives are important for the classic types of leadership, they may not be optimal for Q3-Q4 and particularly ECL.

For completeness we note that (Surowiecki, 2004) identified four requirements for the existence of wise crowds, again without distinction between emergent or non-emergent processes:

1. Sufficient diversity of opinion,
2. Sufficient independence of opinion,
3. Sufficient decentralization (or draw on local knowledge), and
4. An aggregation mechanism.

Because the Mauboussin (2007) study begins with and updates Surowiecki's work, the above list is a comparable perspective on the requirements of collective processes.

A final consideration for the choice of the type of leadership resources is simply individual versus collective efficiency: given that all leadership approaches in the WHOLE landscape are equally applicable to a problem (e.g., have equal utility), what approach is the most efficient, e.g., requires the fewest resources for the shortest amount of time? A simple answer to this question is that leadership solutions that are more automated (either as a normal function of an organization or truly automated within information systems as in many prediction markets) will be most efficient (assuming human costs are generally highest). A more complex consideration is that emergent processes (Q3-Q4), particularly collective processes due to their distributed nature, require more time and possibly more resources to function and therefore would be a less desirable choice if classic localized leadership resources (Q1-Q2) are applicable. Of course, consideration must also be made, in addition to efficiency, about the different qualities and robustness of solutions.

A final observation on this question is similar to the observation that was made by Wildavsky on leadership in general, how the leadership and the type of organization are coupled by the culture of the organization. The equivalent here is that the last two topical questions (ECL problem domains and the requirements for ECL) are coupled by the culture of the organization – and must be addressed as such. Said another way, the culture of the organization determines the problem domains addressable by ECL and the requirements for ECL to function. For example, problem domains which focus primarily on financial and investment cultures may have different ECL requirements (such as incentives) than organizations solving more socially or politically dominated problems.

Once an ECL solution is found, how can an organization exploit the solution? A leadership solution by ECL is by definition emergent and may be challenging to perceive and understand, as addressed in the main text and in earlier questions in this

section. How these emergent leadership solutions are discovered and understood is an important area of research and beyond the scope of this paper. Here we assume that the ECL solution is recognized (possibly by an increased global performance or as a collective solutions to a global problem), and the question is then how to capture and reproduce or exploit the emergent solution in the organization. A preliminary question is why not just "rely" on the emergent type of the leadership, since it already exists. One difficulty is that because of the nature of an emergent solution, its reliability may be unknown until significant experience is accumulated (as in Adam Smith's Invisible Hand regulating a capitalistic economy). Another consideration is the relative efficiency of emergent versus non-emergent types of leadership as discussed earlier. For these efficiency reasons, it may be optimal to shift solutions from Q4 to Q1 or to Q3, and is called the *embodiment of ECL* as the emergent solution is captured in the structure or is "embodied" in the collective or individual leaders. This process for the collective embodiment is equivalent to individual leadership embodiment, for example, by establishing the hero (Q2) within the structure of an organization (Q1), figuratively making the hero a king. As with other aspects of ECL, the embodiment of ECL into an organization is an ongoing research topic, but some studies are relevant. Aspects of embodiment of innovative collective organizational leadership have been studied under the name of generative leadership (Surie and Hazy 2007). The study concludes that to facilitate generative leadership, organizations must focus on managing connections and interactions between people, rather than on individuals' traits, supporting some of the prior observations concerning the potential detrimental effect of incentives for individual performance, at the expense of informal connections.

How does an organization utilize the WHOLE landscape? In a previous question (Fig. 3) we addressed what types of problems facing an organization would be the best match for the different leadership resources in the WHOLE landscape. This discussion provides one answer to this question: once an organization identifies the problem type, they can choose the appropriate type of leadership from the WHOLE landscape. Another use of the WHOLE landscape is to consider a change of leadership type to accommodate additional considerations than just problem type. For example, if an ECL solution already is observed, the earlier efficiency and robustness discussion suggests an advantage in capturing the emergent solution in Q1 or Q3. . A practical consideration for not shifting leadership types to emergent solutions (moving upward in Fig 1) is the conflict addressed at length by Goldstein (1998): the clash between hierarchy and emergent processes when emergent processes evolve or are enabled. Wildavsky (1989) discusses this conflict as a difference in underlying cultural processes, as a conflict of group processes versus rule-based or grid processes. Another perspective on conflicts in change of leadership types is proposed by (Komives, Longerbeam et al. 2006): some conflicts are transitional states between different stages in the development of leadership. While Komives focused on the development of individual leadership identity, many of the observations equally apply to an organization undergoing change: there is a natural leadership type that corresponds to the degree of maturity of the organization and to its rate of change. A detailed study on the relative efficacy and efficiency of the individual and collective resources was studied in a model problem of emergent collective problem solving (Johnson 2002), similar to ECL, for differing rates of environmental change. The study (mapping the results to the leadership viewpoint here) concluded that collective and individual leadership have associated with them different time constants for their

function, and if the rate of environmental change is faster than these time constants, the slower processes can be degraded and in the case of the collective process (the slowest process) can even be detrimental by tying up individual resources that could be used for more innovative approaches to address the rapid change. One interpretation of this study in the present context is that the WHOLE landscape can be used to optimally allocate resources in a large organization where multiple leadership resources can coexist and can be adjusted to address the current rates of change and problem types.

5 Conclusion

Traditional descriptions of leadership clearly distinguish between leaders and followers, but new societal challenges and emerging resources, particularly by new social/informational technologies, have blurred the leader-follower distinction. The proposed Where-How of Leadership Emergence (WHOLE) landscape clarifies when and for what types of challenges followers will become leaders and how solutions can emerge at global levels, possibly without the conscious intent of the collective. The WHOLE landscape charts *where* leadership can be located (from localized to distributed) and *how* leadership can arise (from being determined by rules/structures to being opportunistic/emergent). The WHOLE landscape was constructed to include prior leadership literature and observed leadership trends – providing an understanding of the development of academic and organizational leadership resources. By extending observed trends, the WHOLE landscape also identifies new leadership frontiers that may address the increasingly challenging problems facing organizations and society. These frontiers are identified in two areas: the use of information technology for structure-based collective leadership (Q3 in Fig. 1) and the discovery and exploitation of emergent collective leadership - ECL (Q4 in Fig. 1). Because ECL is identified as a new type of leadership resource, we discuss types of organizational problems that are appropriate for ECL and what enables ECL to function within organizations. Because ECL is a type of emergent leadership, we also discuss the mechanism for capturing or embodying the emergent leadership within the organizational structure.

The introduction of this new landscape for leadership results in many additional research questions, particularly for ECL. The WHOLE landscape strains our notion of leadership as something traditional embodied and explicitly exercised. In addition, ECL presents a research and investigation challenge in a deeper understanding of its non-embodied, distributed, and emergent qualities. Not only will harnessing the problem-solving potential of ECL be a boon to organizations, but the resulting insights will open new understandings of the working of human systems at all levels.

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