

Exploring Knowledge Processing in a Social Complex Adaptive Organization : Wikipedia through the Lens of the LIFE Model

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Abstract

A deeper understanding of how organizations behave as social complex adaptive systems is needed. In this paper we demonstrate how the Leadership Invigorating Flows of Energies model can help with this understanding. The model highlights the role of emergent leadership as a force encouraging the creation, diffusion, and utilization of knowledge through self-organizing mechanisms. We illustrate our approach by examining Wikipedia and show how it can be described as a social CAS. Our analysis of Wikipedia describes how emerging intrapreneurship behaviors result in dynamic flows of knowledge and self-organizing feedback mechanisms across the organization. We provide implications for organization studies and present evidence to support claims made by advocates of complexity theory. We conclude by proposing that Wikipedia can be seen as a new form of organization, and finish with a brief note highlighting a possible way forward.

Keywords : Complexity Theory, Emergent Leadership, Wikipedia, LIFE Model, Self-Organization

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1. Introduction

The Read and Write Web, also called Web 2.0, offers powerful tools to create collaborative online strategic communities such as the one underlying Wikipedia. Applications such as wikis allow users who have little or no knowledge of programming languages to modify the content of a web page instantaneously. Based on the software Wikimedia, the Wikipedia project, also known as the Free Encyclopedia, has grown into a repository of more than 11,000,000 articles with more than 75,000 active contributors in more than 260 languages [Wikipedia, 2008c]. Wikipedia is an organic, loosely structured process to produce encyclopedia-type content [Achterman and Loertscher, 2006] and is now the eighth most visited website worldwide. The purpose of this paper is to analyze Wikipedia from the perspective of a social complex adaptive system (CAS).

Complexity theory provides insight into how simple patterns can emerge from complex relationships among a great number of individual elements comprising CAS. It advocates that creativity and innovation occur when systems operate far from equilibrium at the “edge of chaos”, where they show emergent behaviors that enhance their ability to adapt to a particular situation of their environment [Parker and Stacey, 1995; Bak, 1996]. Stacey [1995] claimed that rather than trying to yield predictors of or prescriptions for long-term innovative success, research into complexity theory and organization studies needed to focus on explaining whole systems and their dynamics, and link

this analysis to their innovative success. Following that claim, this case study illustrates why Wikipedia should be considered as a social CAS. To analyze Wikipedia as a CAS we present a new model of organizational knowledge processing. This model is termed the Leadership Invigorating Flows of Energies (LIFE) model in order to reflect the important dynamic systems aspect of energy, which can only be examined by considering its flows and sources.

In the context of this paper, complexity theory provides a framework to understand how knowledge forms at the level of individuals and then influences knowledge intrapreneurship at the collective level of the organization, such as in the case of Wikipedia. Complexity theory also gives insights into how each agent of the organization is self-evolving with its own rules through its own knowledge processing system (KPS), and how each agent influences the non-deterministic evolution of the whole organization through emergent entrepreneurial behaviors. We believe that the existing models of organizations, and in particular of knowledge processing systems, fail to address the non-linearity and self-evolving characteristics of organizational processes. Our examination of Wikipedia through the lens of the LIFE model is an attempt to remedy that situation. This model of the organizational knowledge processing system, based on insights derived from complexity theory, depicts the role of leadership as a force encouraging the creation, diffusion, and utilization of knowledge. It describes how knowledge flows dynamically through an organization.

First, we explain the importance of social energy in the analysis of social CAS, followed by a succinct description of the LIFE model to support the analysis of Wikipedia. A detailed analysis illustrates how the LIFE model can be used to understand the knowledge processing cycle that takes place within Wikipedia. Wikipedia's LIFE are identified and examined. Finally, several implications are discussed before suggesting areas for further research.

2. Social CAS and the Importance of Social Energy

In this article, we assume that because human organizations are social CAS, sufficient flows of social energy are necessary to sustain their self-organization processes (and hence their survival). Social CAS are systems comprising individuals and elements of their social environment that dynamically interact through non-linear feedback. Such feedback systems constitute a key to the self-organization, unpredictability, and learning capabilities within organizations. To understand the patterns of behavior that emerge from a complex system, a holistic approach that examines synergies among the parts of the system is appropriate. Complexity results from interactions among the components of a system, and is therefore not located in any specific or identifiable site within the system [Cilliers, 1998].

The boundaries of social CAS are both dynamic and contingent on the perspective of the observer. This leads to multiple potential interpretations of any open system. In essence, the

purpose of the boundary creator determines the nature and location of the system's perceived boundaries [Byrne, 1998]. Social CAS are open systems that demonstrate some operational closure. In order to protect themselves from potentially adverse environmental influences, social CAS frequently create boundary filters and barriers to impede flows of energy and information.

CAS evolve via self-organization towards a dynamic critical state in which small changes may generate large effects on the whole system [Bak, 1996; Byrne, 1998; Phelan, 1995; Stacey, 1992]. The attraction towards such a state is natural; hence, forcing a system away from its critical state results in wasted effort, as the system would naturally try to revert or shift to a similar critical state [Bak, 1996]. A critical implication of this behavior when examining social CAS is that managerial attempts to contravene self-organization will result in wasted time and resources for an organization.

Self-organization of CAS requires a constant flow of energy to ensure the system's survival, defined as ability to avoid a static state wherein it is unable to adapt to its environment. Energy flows are part of the interactions among the system's elements and between the elements and their environment—interactions governed by the information held locally by the elements [Byrne, 1998]. In social CAS, conventional inputs (factors of production such as labor, raw materials, and capital) may designate sources of energy, but they do not actually define or describe the energy itself.

The presence of continuous flows of social

energies is a distinguishing characteristic of social CAS. The term “social energy” is rarely employed in the social science and business literatures, although the idea underlies the work of sociologists such as Durkheim [1912] and Pareto [1916/1935]. The term “human energy” was utilized by Argyris [1964] to represent one kind of organizational input. Similar concepts have recently surfaced in the field of organization studies, as exemplified by Dougherty [2008]. Drawing on work in psychology by Lazarus [1991a, 1991b] and Markus and Kitayama [1991], we define mental energy as the motivations, emotions, and cognition that arouse an individual to act toward a desired goal. Social energy is the collective manifestation of mental energy hence, we define social energy as the ability or capacity to engender, sustain, diminish, redirect, or terminate an effect within a human organization.

Social energy flows occur as a consequence of social interactions. Examples of such interactions include conversations, meetings, emails, protests, sports events, and classes. Social energy can even be stored in forms such as documents, as suggested by the work of Greenblatt [1988] and Hawes [2005], and retained in organizational databases. Social energy exists in every organization, in varying forms and quantities. More importantly, it can be channeled, i.e., managed effectively and efficiently for organizational benefit. Social energy is simultaneously an individual and an organizational resource it simultaneously arises from and also facilitates emergence of unique properties of the organizational system. Understanding the sys-

tem’s emergent properties (such as creativity and enthusiasm) allows management to avoid countermanding the natural processes that arise in social CAS.

3. The LIFE Model : A Lens to Examine Complex Adaptive Organizations

The LIFE model <Figure 1> provides an overview of the Knowledge Processing System (KPS) from a complexity theory perspective (Anonymized1). It illustrates the dynamism inherent in organizational KPS, depicting how social processes and interactions among individuals create and influence feedback systems. The model indicates how flows of energies guided by emergent leadership and centered on the Organizational Knowledge Base (OKB), underlie the interactions among the processes of the Knowledge Processing Cycle. Positive and negative feedback loops focus on the OKB, enabling the emergence of complex adaptive behavior within the organization.

3.1 The Organizational Knowledge Base

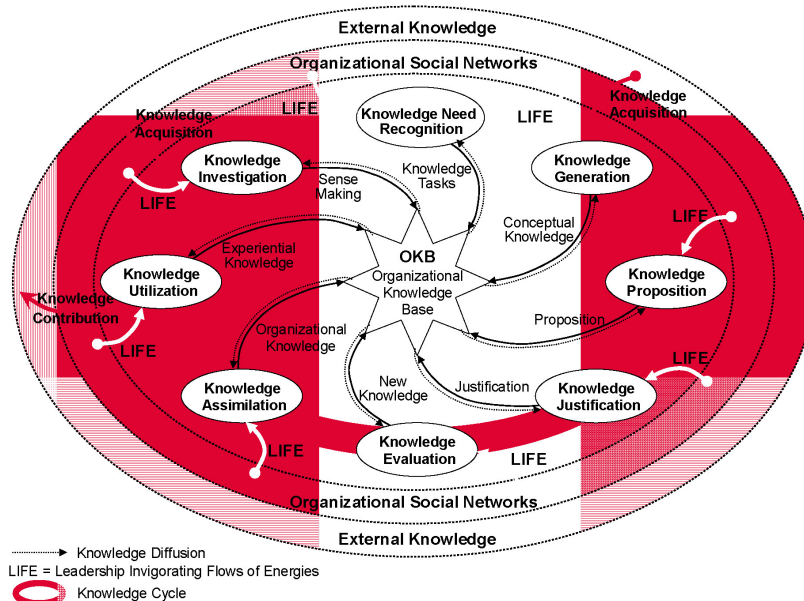
A social CAS with its own emergent properties, the OKB serves as both the foundation of the KPS and the repository of all its outcomes, aggregating all knowledge in the organization. We define knowledge broadly, as portrayed in the E2E (existence to enlightenment) model [Faucher et al., 2008], encompassing the concepts of data, information, knowledge, and wisdom, in both tacit and explicit forms. It forms

part of a scale-free representation of the Knowledge Processing System that is present in every individual and organization. The OKB, as the center of a social feedback system, interacts with the Knowledge Processing Cycle through flows of knowledge and energies, enabling it to accumulate and adjust its knowledge content.

3.2 The Knowledge Processing Cycle

The Knowledge Processing Cycle is a self-organizing social process demonstrating emergent patterns of knowledge flows. It is embedded in the Organizational Social Network, the knowledge processing environment sustaining the self-organization of the KPS. <Figure 1> illustrates the eight concurrent and inter-dependent activities of the Knowledge Processing Cycle, and shows their interactivity with the

OKB, external knowledge, and the Organizational Social Network. The function of these eight processes is described in <Table 1>. This set of knowledge activities synthesizes knowledge processes of the most common models established in the literature, integrating them into a new framework based on complexity theory. The order of the activities in the diagram of the LIFE model matches the sequence typically described in published models [e.g. Argyris 1993; Nonaka and Takeuchi, 1995; Luo, 2000; McElroy, 2000; Trott, 2002; Zollo and Winter, 2002; Awad and Ghaziri, 2004; Wiig, 2004]. However, this is not the only possible sequence, as in different circumstances and organizations; knowledge will follow its own path through the processes of the model. A fixed cyclicity is not essential and the activities can occur concurrently or after one another, in any sequence, indicating that this



<Figure 1> The LIFE Model

〈Table 1〉 The Knowledge Processing Cycle

(Adapted from Anonymized⁹)

Process	Function
Knowledge Investigation	interpretation of knowledge being used inside and outside the organization; involves comparing objectives and results, as well as checking the alignment between the organization and its environment.
Knowledge Need Recognition	formulation of knowledge needs and related tasks
Knowledge Generation	creation of new knowledge by individual and group learning processes
Knowledge Proposition	formulation of knowledge claims in response to a recognized knowledge need
Knowledge Justification	discussion and argumentation of knowledge claims, including maintenance of existing knowledge as well as verification of proposed new knowledge
Knowledge Evaluation	testing and evaluating the value of the knowledge proposed, generated or in use in the organization; includes authorizing or denying knowledge propositions
Knowledge Assimilation	adoption and incorporation of knowledge
Knowledge Utilization	application and external dissemination of knowledge

model is not as linear as traditional models. Due to the non-linearity of the KPS and its mechanisms, activities at all levels of the organization can have system-wide repercussions reinforcing or depressing its operation.

The knowledge activities represented in the LIFE model are natural processes existing on their own they do not need to be created by managerial effort. However, this does not imply that they can not be formalized and supervised in order to improve their effectiveness and efficiency.

3.3 The Leadership Invigorating Flows of Energies

The Leadership Invigorating Flows of Energies model portrays the synergies among leadership, knowledge processes, and flows of social energies within the context of organizational knowledge management. In the context of this model, following the work of Zaleznik

[1977], Kotter [1985], and Alvesson [1992], we distinguish “leaders” from “managers.” Leaders are emergent and arise from within the KPS, to initiate, enable, and/or enhance its functioning. Expanding on the work of Burgelman [1983], we propose that emergent leaders display many of the qualities associated with the concepts of entrepreneurship and intrapreneurship. Effective leadership in our model can be equated with the idea of an intrapreneur who stimulates and supplies energy to a social system, allowing efficient and rapid emergence to occur. Emergent leaders are defined by the relationships that they embrace within the organization and the activities of the Knowledge Processing Cycle, not according to their position. They can be any member of the Organizational Social Network—an individual, a team, or a group.

The knowledge processes invigorated by emergent leaders require the transformation and redirection of flows of energies, both phys-

ical and social, toward accomplishing organizational goals. As noted above, energy manifests itself in multiple forms in a social system, including mental energy (knowledge, motivation, ambition), affected by filters and catalysts such as policies, meetings, and enlightening social interactions. Relationships among organizational members can release tremendous amounts of social energy. As part of the system, potential emergent leaders can influence and are influenced by all activities of the Knowledge Processing Cycle, as well as by other organizational members. One critical role of managers is to recognize what type of energy is needed to favor the emergence of intrapreneurial behaviors. Although managers can foster a supportive environment, they cannot supply all the requisite flows of energies, nor can they control them. Managers may, however, serve as emergent leaders for some of the processes taking place in the Knowledge Processing Cycle. The idea of emergent leaders and their influence over the stages of the knowledge processing cycle without many traditional management controls is clearly evident in the Wikipedia example that we describe below.

4. Wikipedia : The Free Encyclopedia

Wikipedia is a registered trademark of the non-profit Wikimedia Foundation, which is the initiator of many free content projects on the Internet. All these projects are subject to self-editing conducted in collaborative ways [Wikipedia,

2008c]. With little financial support since its creation in 2001, Wikipedia has grown rapidly into one of the largest and most utilized reference Web sites on the Internet. Wikipedia's internationalization has been extremely rapid, overcoming many different national policies and creating a global virtual community without precedent. According to Alexa.com [2008], Wikipedia attracts about 9% of all Internet users, and is the eighth most visited website worldwide [Internetworldstats.com, 2008].

According to its own definition, Wikipedia is a multilingual, web-based, free content encyclopedia project [Wikipedia, 2008c]. Wikipedia is written by self-volunteered editors who collaborate with each other from all over the world in an open way by using a wiki-based platform. Many wiki applications feature a back page used for discussion, reflection, and feedback [Achterman and Loertscher, 2006]. Users employ this space to explain their contributions, to evaluate the current content, or to disagree with other contributors. Nearly all of the content of Wikipedia can be edited without permission by anyone with access to the Internet, as long as their contribution abides by Wikipedia's editing policies [Wikipedia, 2008h]. Wikipedia uses software known as MediaWiki which allows easy reversal of editorial changes, whether they are mistakes or deliberate vandalism [Wikipedia, 2008b, 2008i].

4.1 Wikipedia Policies and Guidelines

While Wikipedia has a clear overall strategic purpose, it has few clear managerial directives.

The small number of overall policies and guidelines are intended to define its purpose and maintain the open and voluntary nature of the project. They can be summarized as the five 'pillars' that define its character [Wikipedia, 2008i] : It is a *free content encyclopedia using a neutral point of view* and following a *code of conduct, but with no firm rules*. Nonetheless, Wikipedia was founded on five 'rules' : a free license, the wiki process, the ability of anyone to edit, a neutral point of view, and the ultimate authority of Jimmy Wales ('Jimbo') and the Wikipedia board on process matters [Wales, 2008].

Regarding operational directives, Wikipedia provides a set of 'rules of thumb', but common sense is always called upon to interpret them [Wikipedia, 2008s]. The following is a synthesized list for contributors :

- Be bold in updating;
- Be civil, gracious and tolerant to other users;
- Discuss changes thoroughly;
- Edit summaries with decency and clarity;
- Assume good faith of authors;
- Sign-in for traceability and readability;
- Use the preview function;
- Do not infringe copyright;
- Agree with the five rules of the foundation of Wikipedia
- Ignore all rules if necessary for improvement.

Wikipedia organizes its current policies under the following five categories to address 'Wikipedia standards' [Wikipedia, 2008L, 2008o] :

Behavioral policies emphasize the need for users to stay respectful of others. They stress discussion of the content rather than the authors, and encourage honesty to prevent faked consensus and learning to prevent repeats of problematic behavior.

Content policies refer to three main topics : No original research (NOR), Neutral point of view (NPOV), and Verifiability (V). While in the context of organizational knowledge processing, new knowledge is certainly generated in Wikipedia, it is not a publisher of original thought. Articles are required to contain only verifiable content from reliable sources without further analysis. Wikipedia users are also requested not to synthesize content in order to advance a position.

Deletion policies are based on consensus even where particular articles require the authority of an Administrator in order to be deleted or un-deleted. Controversial articles require a three-step process and a waiting period of a week before being deleted or un-deleted in order to give time to users to discuss the issue at hand. In cases of exceptional controversy the Wikimedia Foundation office reserves the right to temporarily delete an article without this process [Wikipedia, 2008b].

Enforcing policies deal with bans, arbitration, and protection issues. They are designed to safeguard the consensus process and ensure that users violating the welfare of Wikipedia by exhibiting disruptive behavior, such as vandalism, can be banned [Wikipedia, 2008t].

Legal and copyright policies emphasize the fact that Wikipedia has no tolerance for copy-

right violation and that Wikipedia content can be used under the GNU Free Documentation License.

Altering any policy is also achieved through a consensus process. It is interesting to note that voting is not considered useful in this process. Indeed, a vote on Wikipedia can never create consensus, but rather only indicate whether or not one may already exist [Wikipedia, 2008g].

4.2 Wikipedia Structure and Management [all data in this Section is from Wikipedia, 2008m].

Wikipedia possesses a shallow organizational structure. Anyone can join Wikipedia at the lowest level as an *editor*. As of the 5th of October 2008, there were 7,978,268 registered Wikipedians (editors) of whom 1,598 were graded as *Administrators*, also called *Sysops*, with duties, responsibilities, and authority relative to the creation and maintenance of both Wikipedia content and user accounts [Wikipedia, 2008d, 2008h]. There are also 1,958 *Rollbackers* who have access to a method of rapidly undoing non-productive edits (usually vandalism).

As Administrators are often perceived as the “official face” of Wikipedia, they are held to high standards of conduct. The community grants Administrator status only to trusted users who show a deep understanding of policies [Wikipedia, 2008h]. A candidate for Administrator status is assessed by a thorough seven-day community consensus-based process which is then reviewed by two groups of Administrators with special rights, called *Bureaucrats* (31) and *Stewards* (36). Candidate Bureaucrats are eval-

uated in a similar fashion and promoted by the Stewards, who themselves are elected from and by the global community of the Wikimedia Foundation’s projects.

Small groups of Administrators also hold special rights for particular tasks. *Oversight* (29) permits hiding revisions of pages from all users, while *Check User* (28) status allows retrieval of any contributor’s real identity.

Wikipedia is guided by the *Board of Trustees* of the Wikimedia Foundation, composed of 7 members [Wikipedia, 2008b]. The board is assisted by the *Arbitration Committee*, currently consisting of 13 members, and at least 4 known *Developers*. The Arbitration Committee is a last-resort process for editing disputes among users [Wikipedia, 2008e], while the Developers have the highest technical level of access and can make direct changes to the MediaWiki software and Wikipedia databases.

5. Wikipedia through the Lens of the LIFE Model’s Knowledge Processing Cycle

In the case of Wikipedia, the Organizational Knowledge Base is at the same time the publicly-accessible Wikipedia repository and the sum of all the energy flows contributing to the Knowledge Processing Cycle, linking all contributors (editors and Administrators alike) through the Organizational Social Networks. As such, it is also the main enabler of feedback within the Wikipedia organization. Editors and Administrators contribute according to their own views, with ongoing interactions creating a dynamic

consensus, which emphasizes that knowledge in Wikipedia is socially constructed.

The following analysis describes the organizational knowledge processing cycle of Wikipedia, highlighting the flows of knowledge and energies within the operations of Wikipedia. Due to the openness of Wikipedia, the management of the organization and its editorial operations are structured in a very similar fashion. It has been proposed on Wikipedia [2008q] that *product, processes, and policies* partly explain the dynamics of the project. The editors (who follow the policies and use the processes to create the product) and Administrators (who create the policies to guide the processes used to develop the product) provide the basis for the relationships among these three elements. The processes are the principal focus of this article. Each of the following sections briefly summarizes the processes occurring at the administrative and editorial levels in light of our organizational management analysis. This systemic approach illustrates the scale-free aspect of the LIFE model, while providing a deeper analysis of Wikipedia.

To help manage Wikipedia, five different types of pages are used at the administrative level [Wikipedia, 2008p]: process pages (to outline organized ways of operating), wiki project pages (for specific project related discussions), community pages (for centralized discussion), help pages (to explain how to do things), and essay pages (to propose personal or group views to gather consensus). At the editorial level, every entry in Wikipedia receives four pages: one for the actual article, one to edit it (with a preview

function), one for discussion, and one to display its history (to follow changes). Different tags are given to articles to indicate their editing status [Wikipedia, 2008a]. Wikipedia keeps track of any changes made to the actual entries and it is always possible to revert (or *rollback*) to any previous version.

5.1 Knowledge Investigation

At the administrative level, knowledge investigation is normally performed by Wikipedia's Administrators according to either their own interest, or according to lists of recognized needs. As Wikipedia is fully open, every contributor can investigate anything or propose new investigations. This exemplifies the absence of management in the traditional sense, replaced by intrapreneurship and emergent leadership. Thanks to the breadth and diversity of users, and the openness of Wikipedia (all characteristics of CAS), it is only a matter of time before feedback (from the knowledge evaluation process in particular) identifies missing or deficient practices in the community [Wikipedia, 2008t]. Knowledge acquisition is therefore done by the contributors through sense-making processes and integrated into Wikipedia's OKB as needed. This permits proposals for future developments, typically indicated in specialized discussion pages or by creation of a new page-constituting feedback from other processes in the Knowledge Processing Cycle, specifically knowledge need recognition.

At the editorial level, knowledge investigation is performed by editors. Missing or deficient en-

tries are rapidly identified and edited by contributors, often organized in patrols sharing specific tasks [Wikipedia, 2008o]. Knowledge acquisition performed by editors provides content for current or future entries. Different editors will hold different assumptions and epistemic stances, consequently leading to further discussion, investigation, and interactions, which primarily occur on discussion pages of the relevant entries or activities.

5.2 Knowledge Need Recognition

At both the administrative and editorial levels, knowledge need recognition is accomplished by any contributor, individually or in a group, who identifies an area that needs to be improved or created. Each contributor will proceed according to his or her own knowledge, interests, and experiences, or following lists of recognized needs created to promote this process. Contributors voluntarily emerge to take on any task that interests them; consequently, only motivated contributors are working on tasks that they have chosen. Communication with other users working on the same task occurs through web forums dedicated to Wikipedia, as well as discussion pages. The great diversity of web users makes it possible to have people from all levels and backgrounds interacting and developing the organizational, operational, and technical aspects of Wikipedia. Because contributors may identify potential duties they are not eager to undertake or with which they lack familiarity, they can tag a task that they believe requires attention. Interested Administrators or editors

will then volunteer to perform the relevant actions.

5.3 Knowledge Generation

At the administrative level, knowledge generation is both formal and informal. Informal knowledge generation occurs through social interactions among contributors through forums and discussion pages, with the variety of contributors providing many opportunities for creative feedback. Formal knowledge generation takes place within special task groups that employ specific forums and communication means to direct their effort on particular tasks [Wikipedia, 2008u].

At the editorial level, Wikipedia serves as a repository of knowledge; its intended purpose is not to generate new knowledge, but to store and make available established knowledge. Hence, knowledge generation in Wikipedia does not rely on original research, which is avoided as part of their editorial policy ('No original research' policy). Rather, knowledge is generated through the addition of secondary material and its integration into the OKB. In this sense, knowledge is generated not by formal hypothesis testing and application of the scientific method to original experiments, but through a process transforming data and information into higher levels of understanding. Knowledge generation equates with the knowledge contribution made by editors.

5.4 Knowledge Proposition

In Wikipedia, the knowledge proposition activity follows an identical process at both ad-

ministrative and editorial levels. Propositions are made by contributors in special discussion pages or forums [Wikipedia, 2008p]. The knowledge proposition process is ongoing, exhibiting active feedback systems between the Knowledge Processing Cycle and the OKB. Every contributor can make knowledge propositions at both administrative and editorial levels. These correspond to the strong feedback loops in Wikipedia between knowledge assimilation, knowledge need recognition, and knowledge proposition, as deficiencies noticed during knowledge assimilation lead to direct adoptions or suggestions for new (or needed) knowledge. Tension among different users and groups with alternative perspectives and opinions lead to debate, which constitute ongoing interaction through feedback loops linking knowledge proposition and knowledge justification. However, at the editorial level, this process of proposition and peer review through knowledge justification (described next) is not followed by every editor, and some make changes without asking or notifying the community.

5.5 Knowledge Justification

Wikipedia emphasizes constructive justification at both administrative and editorial levels, which is accomplished through discussion pages available for each article, proposition, or official process within Wikipedia. Contributors defend their ideas and try to convince the majority that the proposed changes are appropriate. Propositions are then reviewed by interested editors and Administrators and subject to a consensus-

based decision. As these discussions are open to everyone, the critique of any proposition is democratic and based on peer review. Justification also occurs when contributors challenge existing content or processes. The history of the justification process is kept in the discussion page of each article or in special archives for future reference. However, many contributions at the editorial level are made without justifications [Goldspink, 2008].

At the editorial level, the use of references and reviewers is intended to help maintain the neutrality and robustness of entries, but the choice of supports is left to the contributors, thereby allowing personal bias to enter the frame [Goldspink, 2008]. Although the process is not precisely anonymous (given that every edit or contribution is associated with a screen name or IP address), politics and self-promotion are minimized due to the inherent multitude of editors and the structure of the organization.

5.6 Knowledge Evaluation

Every user can participate in knowledge evaluation as the process in Wikipedia is transparent. However, Administrators have special rights and duties regarding that process. Wikipedians are encouraged to treat anyone's complaint with the utmost respect, as long as complaints are presented in a constructive way. A fairly recent evaluation tool is the 'Wikipedia Scanner' (also called 'Wikiscanner'). This publicly searchable database links Wikipedia edits to the organizations where the edits originated. Since its release on 14 August 2007, it has pro-

voked a number of scandals by showing that some organizations were editing criticisms about themselves. Although the Wikiscanner is the work of an independent Wikipedian, the Wikimedia foundation and Jimmy Wales have endorsed it [Wikipedia, 2008v]; a Wikipedia spokesperson stated that “Wikipedia Scanner may prevent an organisation or individuals from editing articles that they’re really not supposed to” [Fildes, 2007].

At the editorial level, a status indicator at the top of every entry in Wikipedia informs readers of the quality and nature of the entry. One of the tasks of editors is to check for changes involving poor editing or vandalism (as not all knowledge generated goes through either a proposition or justification phase). Bots are used for making repetitive edits that would be extremely tedious to undertake manually, such as cleaning and control activities related to vandalism [Wikipedia, 2008f]. A history of all evaluations is kept either in the discussion pages or in the history pages. As a last resort, arbitration is available through the Administrators, or if no solution can be found, by the Arbitration Committee.

5.7 Knowledge Assimilation

At the administrative level, knowledge assimilation occurs as contributors learn about and familiarize themselves with Wikipedia’s mechanisms and policies, impacting on both individual awareness and the way people use and modify the content and organization. This is accomplished through formal and informal feedback

among Wikipedians at the individual level, connecting knowledge generation with the other processes in the Knowledge Processing Cycle and reflecting the openness of the organization. This is not imposed on any contributor; it is just assumed they will familiarize themselves in order to fit in. Different guidelines and tools are available to them such as ‘the New Admin School’ where they can learn how to become a more efficient Administrator [Wikipedia, 2008n].

At the editorial level, assimilation commences when a user edits a page. As the change is instantaneous, it is immediately incorporated in the Wikipedia OKB (providing a form of immediate positive feedback) and other users can see the change right away. Of course, because some changes may not have gone through a justification process, this process is in a close feedback system with the evaluation process. The evolution of every article through a succession of iterations and changes demonstrates self-organization at work.

5.8 Knowledge Utilization

At the editorial level, the intention behind Wikipedia is to make knowledge accessible to everyone. This is accomplished by exposing the physical part of the organizational knowledge base to the public via the Internet. Wikipedia’s actual contribution is difficult to assess, but statistics can help to understand the scale of its importance. Wikipedia is the eighth most visited site worldwide, attracting more than 9% of the total number of users of the Internet [Alexa.com, 2008]. The 11,410,179 articles available (in all

languages combined, as of⁵ [October, 2008] provide one of the biggest repositories of human knowledge today. [See Wikipedia, 2008k and 2008r for a discussion, statistics, and summary Table].

Analyzing the extent of the knowledge utilization at the administrative level is almost impossible in the context of this case study. However, the success and rapid expansion of Wikipedia allows us to believe that knowledge utilization has occurred among administrators in efficient ways, exemplified by the rapid implementation of tools such as rollback and Wikiscanner [Wikipedia, 2008m, 2008v].

The preceding analysis shows how the Wikipedia OKB is a social knowledge base which has interactions demonstrating all elements of the Knowledge Processing Cycle. Clear feedback loops have been identified, and it can be said that the competitive advantage of Wikipedia resides in its policies to improve its content. However, one of the most interesting features of Wikipedia is its leadership.

5.9 LIFE of Wikipedia

One of the main types of leadership invigorating flows of energies in Wikipedia corresponds to 'recruitment' in a corporate organization. Wikipedia is an open community into which anyone can enter. In Wikipedia, emergent leaders are the ones becoming editors or Administrators. As anyone can become a contributor, the possible sources of LIFE and their amounts are endless. Similar to a meritocracy, it is up to the editors to show their abilities to

serve well the community in order to access the role of Administrator [Wikipedia, 2008d]. Therefore, the principal source of LIFE is the energy contributed by users, consisting of their motivation, spare time, and donations that help to pay for the maintenance of Wikimedia databases and their five employees. It is clear that these contributions stimulate each other and constitute a far greater force together than the sum of the individual inputs. This point emphasizes the need to further develop the concept of social energy in the context of describing organizations as social CAS.

Policies in Wikipedia are a strong catalyst of LIFE. As stated by Jimmy Wales in October 2001, the Wikipedia community will continue to grow and survive only as long as contributors carry on doing the right things. By 'doing the right thing', he mostly meant the preservation of Wikipedia's shared vision for the NPOV and for a culture of thoughtful, diplomatic honesty [Wales, 2008]. Wikipedia's content policies create an energizing feedback system that affects all contributions and demonstrate how leaders can help the system towards achieving its goals without trying to exercise strong control. As suggested by Nonaka et al., "leadership is about enabling knowledge creation, -not controlling and directing it" [2006 : 1192].

6. Implications and Discussion

The most striking aspect of Wikipedia is that it changes continuously. Change is an inherent constituent of the free encyclopedia's organization and content. The organization of Wikipedia

emerges from social interaction among Wikipedians in order to channel the intrinsic flux of human action towards a common goal, through the generalization and institutionalization of specific meanings and rules within the community, matching the criteria described by Tsoukas and Chua [2002]. Wikipedia embeds the notion of change in its organizational mechanisms.

6.1 Wikipedia : An Example of a Social Complex Adaptive System Embracing Change

As illustrated in the preceding analysis, Wikipedia exhibits the key characteristics of social CAS. There are continuous flows of positive and negative feedback among users and the processes of the Knowledge Processing Cycle, which leads to the emergence of a complex feedback system that nurtures the self-organization of the Wikipedia community and its outputs. Aligning with Bak [1996], this self-organization process is supported by the memory of the system. Wikipedia has many processes to store the history of the system and make it available to all users.

Wikipedia is rooted in the concept of flows, as depicted by the notion of *becoming* as opposed to *being*. This is consistent with the claims made by many scholars throughout history from Heraclitus(500 BC) through to scholars such as Bergson [1913], Whitehead [1929], Prigogine [1980] and more recently in the management literature by Chia [1997]. In essence, Wikipedia embraces change as a core value, which leads to the support and fostering of in-

tra-and entrepreneurial behaviors within the community. Policies calling for contributors to edit as much as they wish, while being 'bold' in editing, are just one example. However, as suggested by Bouchikhi [1993], although individuals may be fully competent and purposeful actors making a difference, they hardly ever make it alone.

This case study confirms three claims underlying complexity theory. First, managers should stop thinking about control and rigid structures, which are illusions of power and stability (Anonymized⁵). If one acknowledges the complexity of an organization, its growth and survival in a changing environment lie in flexibility and adaptation [Levy, 1994; Lindgren and Bandhold, 2003; Stacey, 1992]. Second, organizations require structures that allow self organization [Anonymized⁶, McElroy, 2000; Stacey, 1992]. Self-organization implies allowing the structure of the whole organization to evolve continuously. In Wikipedia, this is achieved through a flat, flexible organizational structure in which different units are interlinked via a knowledge network subject to constant visibility and change. While control is impossible, it is possible to create guidelines and decision rules to help cope with complexity in order to achieve organizational goals indirectly [Levy 1994]. In Wikipedia, a simple set of principles provides a unifying philosophy and specifies the overall goal of the system.

A third common claim regarding self-organization in human organizations is that enough variety of people and ideas must be present in the organization [Anonymized⁸, Byrne, 1998;

Firest one and McElroy, 2003]. Hence, managers need to introduce mechanisms to maintain sufficient instability and variety, as well as a system of selection to stimulate novelty and emergent adaptation [Stacey, 1992]. They need to trust and support organizational members, permitting the rise of change champions [McWilliam and Ward-Griffin, 2006], i.e., the emergent leaders. In Wikipedia, this is done by allowing everyone to edit content and propose change, guided by strong and clear policies that lead the Knowledge Processing Cycle processes.

6.2 Who and what are the Managers of Wikipedia?

It is difficult to say whether there are ‘managers’ in Wikipedia. The open structure of Wikipedia does not emphasize the traditional aspect of ‘command and control’ found in many organizations. Administrators appear to be managers since they have special rights over other Wikipedians and they are entitled to provide administrative support and foster a flourishing environment for the project. However, it appears that in the case of Wikipedia, these ‘managers’ share a lot of the characteristics of the emergent leaders featured in the LIFE model. In fact, unless they are able to demonstrate the aptitudes required as an emergent leader they are unlikely to be promoted through the meritocratic mechanisms that underpin Wikipedia processes.

Nonaka et al. [2001], suggest that, in order for an organization to create knowledge, top managers need to ensure that there exists an ap-

propriate atmosphere inside the organization. They suggest that love, care, trust, and commitment among members of the organization are the basis for knowledge creation and knowledge sharing processes. It is uncertain whether Wikipedia managers provide love to their users; however, they do provide a supportive environment for Wikipedia to grow harmoniously. Jimmy Wales provided a vision, and then allowed the community to self-organize [Wales, 2008]. As emphasized by Rutherford and Holt [2007], how a manager chooses to foster organization-wide corporate entrepreneurship is a key factor in its success. In the case of Wikipedia, this applies to knowledge intrapreneurs—those who edit the encyclopedia. Managers can have a devastating influence if they don’t understand the dynamism underlying their organization as suggested by the work of Thiétart and Forgues [1997], power struggles can push an organization into counterproductive dynamics.

Regine and Lewin [2000] suggested that managers need to overcome three main paradoxes. First, their power lies not so much in *controlling* others but in their ability to *allow* others to achieve their goals. This follows the claim that managers are inclined to the ‘illusion of control’ [Stacey, 1992]. In the case of Wikipedia, there are many examples. One is that no one can choose or predict what page will be edited or created. Wikipedians are free to act as they wish. Another involves the past actions of one of the cofounders, as many Wikipedians spotted that Jimmy Wales was editing his own Wikipedia page, trying to minimize part of its content [Wikipedia, 2008j]. Although considered the

head of the organization, he was forced to acknowledge his inappropriate behavior and change. The second paradox is that managers don't have to be omniscient but accessible. In Wikipedia, every user can communicate with every Administrator. In order to foster that kind of communication, the current status of the Administrators is available to let the user know who is active. The high number of Administrators makes it easier to obtain an answer quickly. Finally, the third paradox that managers have to deal with is that they are not autonomous but rather interdependent with all the other agents of the organization. This is clearly shown in Wikipedia by the fact that all major changes are governed by consensus-based processes.

The flexibility of this managerial structure raises the question of whether it is sufficient to facilitate the continued rapid growth of Wikipedia. As pointed out by Espedal [2007, p. 105], "emotions and impulsive behaviour' and 'conflict and opportunistic behaviour' can be detrimental to executive decision making; therefore, it is important to provide constraints or guidelines on executive actions." His advice is that such constraints should be enacted as rules, which are more effective in achieving transformation through leadership than managerial discretion would be.

6.3 Does Self-organization Result in a Lack of Quality Control?

The primary control in Wikipedia is that all editors, good or bad, can edit its content. Indeed, with so much openness, bad editing or

even vandalism will be spotted in a very short period of time, and then reversed. This is of course different from traditional knowledge storage and publishing, which limit the number of approved editors, imposing a strong hierarchical control over any proposed content. A 2002 study by IBM [Viégas et al., 2004] found that as a result of this process, most vandalism on the English-language Wikipedia was reverted within five minutes. Recent examples such as the collapse of Barings Bank, Enron's bankruptcy, and massive trading fraud at Société Générale illustrate the importance of openness and transparency within organizations.

McElroy [2003] suggested that organizations should be structured as open enterprises, implying that their knowledge processing systems should stay politically open to allow qualified agents to access and criticize knowledge produced by other agents. Organizational knowledge would then be subject to constant visibility and improvement. This is clearly the kind of structure possessed by Wikipedia, with flexible rules, openness for editing by members, and open scrutiny processes that are tailored to members' needs instead of being driven by an attempt to 'control'. As suggested by McElroy [2003] and the LIFE model (Anonymized⁴), openness in the Knowledge Processing Cycle processes does not mean undermining the authority of any management team of the organization; rather, it implies more transparency of the organization's decisions and activities for the agents of the organization.

The quality of the content of Wikipedia also

needs to be considered. It is growing much faster than any traditional knowledge and publishing repository. Indeed, as of 5 October 2008, Wikipedia featured 2,201,515 articles in its English edition. In contrast, the largest traditional English-language encyclopedia, Encyclopædia Britannica (online version), only contains an estimated 120,000 articles [Wikipedia, 2008k]. An investigation published in the journal *Nature* [Giles, 2005] indicated that quality in Wikipedia is generally comparable to that in other, more established reputable sources. This research project, which involved experts comparing Wikipedia and Britannica articles, found that the average science article in Wikipedia had only one inaccuracy more than Britannica's average of three per article.

The self-organization mechanisms in Wikipedia do not appear to negatively affect its overall quality. We suggest that Wikipedia represents a new type of organizational model that fits Spender's [1996] call for a diffuse, non-bureaucratic management style in which employees at every level become independent agents. Hence, they would take responsibilities, experiment, make mistakes, and learn as they aim for continuous improvement. Spender proposed a shift from the resource-based to the knowledge-based view of the firm. Instead of treating managers as rule-makers, employees as rule-followers, and firms as a collection of tangible resources, he suggested that what is needed is a knowledge-based theory in which organizations are a venue for alliances among independent knowledge creating entities. According to him, entities can be individuals, teams,

or organizations. In terms of the LIFE model, achieving Spender's proposition requires emergent leaders who foster the intrapreneurial spirit of the whole company. In the case of Wikipedia, contributors to the organization are volunteers assisted by extremely few employees. It is striking that Wikipedia, successful as an organization, seems to empirically follow Spender's framework. This leads to the question of whether a new model of employment is needed, or if the Wikipedia structure is somehow applicable to other organizations.

7. The way forward

In order to advance ecological understanding in organization studies, and provide an enlightening example of a social complex adaptive organization, this paper presented one case study supporting the usefulness of the LIFE model. More case analyses are required to further justify the model. Other forms of research are also necessary to complement this case study. Interviews of Wikipedians and historical analysis of Wikipedia pages would provide further insights into the dynamics of Wikipedia's self-organization and intrapreneurial behaviors. The case study presented in this paper focuses on the English application of Wikipedia although we assume that our results can be generalized to most language applications of Wikipedia, it is possible that different Wikipedia applications could exhibit cultural differences. Further research is needed to assess this possibility as it could be a fruitful source of cross- and inter-cultural studies. As shown by Lam [1997],

and echoed by Collinson and Wilson [2006], societal and cultural factors linked to knowledge embeddedness influence its transference. Hence, the understanding of Wikipedia itself and transfer of organizational knowledge among different language applications of the 'free encyclopedia' may be hindered.

The nature of Wikipedia questions many academic assumptions. Editors of Wikipedia write articles for free, with almost no recognition (official or otherwise) for their work, while still being loyal and coordinating and leading the whole project. This leads to questions about the concepts of entrepreneurship and intrapreneurship, the first as Wikipedia is not technically an enterprise but still the outcome of entrepreneurial behaviors, and the latter because the motivations of the members of the organization (intrapreneurs in this case) seem quite different than in most business organizations. Wikipedia therefore raises interesting questions about organizational agency and the forms of social interactions required by an organization to innovate or simply operate. This relates to the role and source of flows of social energies, some of which have been illustrated by the LIFE model and the preceding analysis of Wikipedia. More research is needed to show the repercussions of this systemic and ecological concept, and illustrate how it underlies many aspects of organizational dynamics.

Complexity theory leads to the understanding that all organizational members should possess the capacity to live with and tolerate ambiguity and paradox, the willingness to accept change, and the ability to learn and allow one's mind to

be changed by others [French, 2001]. Because change is inherent to self-organization, as illustrated within the Wikipedia context, managers need to understand, accept, and adapt to the flows of energies that take place. As suggested by Tsoukas and Chua [2002], organization is a pattern that is constituted, shaped, and emerging from change.

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