

COORDINATION AND LEARNING IN WIKIPEDIA: REVISITING THE DYNAMICS OF EXPLOITATION AND EXPLORATION

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ABSTRACT

The evolution of Wikipedia betrays an increasing reliance on policies and guidelines, signalling certain stabilisation in the knowledge making processes underlying the encyclopaedia. We interpret such a state of affairs as reflecting the need to provide a few principles and guidelines of coordination, in a context that has otherwise been marked by vast diversity, high membership turnover and the lack of traditional exploitative structures. Rather than reflecting bureaucratisation and a shift away from its constitutive principles, the consolidation of these coordinative mechanisms further embeds the distinctive profile of knowledge making processes characteristic of the online encyclopaedia. They reinforce the diversity of the collective (rather than individual capabilities and skills) as the primary source of knowledge and render the mechanisms of harvesting

Managing 'Human Resources' by Exploiting and Exploring People's Potentials
Research in the Sociology of Organizations, Volume 37, 161–192
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ISSN: 0733-558X/doi:10.1108/S0733-558X(2013)0000037010

that diversity and assembling it to a reasonable knowledge output key means of social learning.

Keywords: Commons-based production; collective learning; diversity; organisational form; technological affordance; Wikipedia

INTRODUCTION

In order to remain viable in a changing environment, organisations have to strike a balance between putting their resources into most efficient use while maintaining capacity to adapt and build new capabilities. [March \(1991\)](#) captured this tension in the conceptual coupling of *exploitation* and *exploration* type of learning and managerial action. The basic idea is simple yet powerful. Profitability usually stems from setting up organisational arrangements in a way that allows exploiting current resources more efficiently than competitors in the present environment. At the same time, the organisation should not sacrifice its capacity to adapt to environmental change. While the dilemma has been predominantly studied in the context of business organisations, it figures, in one form or another, across a much wider spectrum of collective pursuits. Indeed, studies drawing on March's seminal contributions have pointed out that maximising collective learning may occasionally require dismantling organisational structures ([Miller, Zhao, & Calantone, 2006](#); [Siggelkow & Rivkin, 2006](#)).

In this chapter, we take the question of exploitation and exploration beyond the domain of corporations or formal organisations more generally. We pursue the issues raised by this dilemma in the context of Wikipedia that, on many counts, represents one of the most interesting and successful organisational experiments of our time. Similar to any value-creating activity, Wikipedia confronts the necessity of governing resources, dealing with diversity and responding to uncertainty in ways that may be said to recount the dilemma of exploration and exploitation. However, these perennial issues manifest differently in collective pursuits like Wikipedia that are built on premises unlike those that are epitomised by standard formal organisations. The apparent success of Wikipedia challenges standard beliefs and canons with respect to how knowledge-intensive collective pursuits ought to be organised, and its growing consolidation offers an intriguing setting in which the trade-offs of exploitation versus exploration can be investigated. Wikipedia can certainly be understood as a

community (Faraj, Jarvenpaa, & Majchrzak, 2011; O'Mahony & Lakhani, 2011; Ransbotham & Kane, 2011) or approached as just a specific instance of commons-based production (Forte, Larco, & Bruckman, 2009; Hess & Ostrom, 2007; Ostrom, 1990, 2000). Both formulations underscore the contrast Wikipedia offers to standard organisational arrangements and offer useful insights. Yet, left on their own, they fail to fully capture Wikipedia's evolutionary dynamics and the issues of learning and governance it incorporates. Exactly how does the dilemma of exploitation and exploration play out in the context of what we call *online social production*, of which Wikipedia is a prominent but certainly not the only example, remains an open question and one that has seldom been pursued.

Following Benkler (2006), we understand online social or commons-based production as a mode of producing goods, utilities or services that does not conform to the standard market and firm-based arrangements. Key to social production is the recurrent generation of value by means of voluntary, non-pecuniary contributions of time and resources by participants, and the free distribution of whatever output is thus produced. For this to happen, certain important requirements have to be satisfied. Key among them, as Wikipedia and numerous open source software development projects attest, is the free availability, non-rivalry and scalability of resources (e.g. information and information-based goods) used by the participants. These conditions render the imperative of fixed capital (amassing and building up resources) no longer a prerequisite for setting up collective value-creating pursuits (Benkler, 2006). They also enable individual participation in projects of this sort in scalable terms that suit individual talent, mood or inclination, time availability, skill or capacity. In this respect, online social production dispenses with the institutional foundations of formal organisations (property rights and employment contract) and the framework of duties and obligations that regulate the dealings of owners, managers and employees (Kallinikos, 2011).

The chapter is structured as follows. In the first section, we briefly recapitulate March's conceptualisation of the problematic of exploitation and exploration and place its understanding within the context of the standard organisational arrangements that Wikipedia challenges in a number of ways. In so doing, we are led to reframe some of the issues raised by the trade-offs between exploration and exploitation. In the second section, we describe Wikipedia as a distinctive, value-creating arrangement that derives from principles associated with commons-based resource regimes and is made possible by a specific production technology. The combination of these two aspects allows bringing together individual and

collective learning in novel ways. In the third section, we present and analyse the consolidation of Wikipedia as a platform for knowledge integration and learning, as this is expressed by widespread concerns among participants for setting up and eventually enforcing policies and guidelines governing content production. In this context, we present a few descriptive statistics that support the evolutionary patterns we describe. In the last section, we discuss the implications of our ideas for the issues of exploration and exploitation and collective learning. The distinctive nature of Wikipedia and its evolution suggest that the trade-offs of exploration and exploitation play out rather differently, indicating a few and interesting contrasts to the ways the dilemma is addressed in formal organisations. Our findings further suggest a set of implications with respect to how the processes of knowledge making and learning are conceived, framed and addressed.

WIKIPEDIA AND STANDARD ORGANISATIONAL ARRANGEMENTS

The thrust of [March's \(1991\)](#) argument is that the benefits stemming from learning to exploit current resources are typically more obvious and imminent than the often elusive and temporally more distant returns from exploratory activities. Ignoring long-term environmental uncertainty simplifies the context in which decisions are made, and, indeed, powerful stakeholders may only possess a short-term interest in an organisation. Exploitation tends therefore to weed out exploration, potentially locking the organisation into short-term solutions that nevertheless risk becoming gradually obsolete or inefficient in a changing business environment. The imbalance between exploitation and exploration may ultimately result in a competency trap; that is, a situation in which the initial success of the organisation leads to its demise later on ([Liu, 2006](#)).

In his seminal article, March approaches the question of exploitation and exploration from the perspective of individual and organisational learning. Others have associated the dilemma with incremental and discontinuous product innovation ([Tushman, Smith, Chapmam Wood, Westerman, & O'Reilly, 2010](#)), competency and failure traps ([Liu, 2006](#)) or even framed it, more widely, in terms of adaptation and adaptability ([Weick, 1979, 1993](#)). March theorised that individual members of a collective arrangement become gradually more productive by learning best practices through socialisation, while the organisation learns by adapting its practices,

structures and rules (organisational code) as a reaction to individual knowing and knowledge making (March, Schulz, & Zhou, 2000). The original, agent-based simulation model has been since then extended to include direct interpersonal learning and tacit knowledge (Miller et al., 2006), and to assess the effectiveness of decentralised exploration in multilevel organisation (Siggelkow & Rivkin, 2006).

Importantly, individuals and organisational code are able to integrate knowledge at relatively different speeds, which has significant implications for the kind of overall capability the organisation can achieve (see also Holmqvist, 2004). If the individuals are socialised quickly to the organisation, this may lead to increased productivity. At the same time, the organisation as a whole ends up curtailing its opportunity to accommodate diversity and to learn from whatever new knowledge and skills are commanded by newcomers. These issues are of crucial importance for Wikipedia in a double sense: as a knowledge product (an encyclopaedia) and as a consolidation of specific knowledge practices on how to produce a peer-based encyclopaedia (a collective arrangement).

According to March, having a mixture of slow and fast learners or a turnover of members can help maintain the balance between exploitative and exploratory learning in an organisation. Others have suggested designing the organisation as a loosely coupled system of both exploratory and exploitative units (ambidexterity) and shifting periodically between exploitative and exploratory modes (punctuated equilibria) (Gupta, Smith, & Shalley, 2006; Raisch, Birkinshaw, Probst, & Tushman, 2009). In most organisations, these concerns are the responsibility of top management and often mediated by a human resource function that assumes the responsibility for recruitment and training of personnel and the design of jobs and positions. Such operations are thus embedded into standard management thinking that assumes a degree of organisational stability and managerial capacity as the basis of directing resources and boosting learning. Under such circumstances, 'management controls the allocation of decision rights to exploit or explore' (Gupta et al., 2006, p. 696). Furthermore, industries incorporate different levels of environmental uncertainty at different times, and thus the optimal balance between exploitation and exploration varies from one organisation and time to another (Holmqvist, 2004).

The rather different premises on which online social production is built calls for the somewhat closer consideration of the standard institutional framework into which human resource practices are embedded and the appreciation of the terms by which people enter and exit organisations, and commit themselves to one or another course of action. A crucial element of

that framework is reflected in the employment contract. While just an element, the employment contract epitomises crucial social and behaviour premises of that framework. In the context of modern formal organisations, an individual is admitted to the organisation *qua* role and it is the role that becomes the object of managerial control and coordination rather than the person understood as a psychological entity with wider concerns and engagements (family, community) that transcend work and the bounds of the organisation (du Gay, 2011). To the extent that the role is decoupled from the rest of individual's social and psychological commitments (Gellner, 1994; Luhmann, 1982, 1995), it offers a model of human involvement in the organisation that Weber conceived as behaviour free from heavy emotional attachments (*sine ira et studio*), and therefore an object amenable to individual and also organisational control, adaptation and reshaping (Weber, 1947, p. 340). The partial inclusion of individuals in the organisation therefore facilitates flexibility and substantially raises an organisation's ability to renew its human resources and reshuffle the profile of jobs and positions within the organisation (Kallinikos, 2003, 2004; Maravelias, 2003). This can be understood to underpin, for instance, attempts to accommodate both exploratory and exploitative learning by designing ambidextrous organisational structures (Raisch et al., 2009), and is of fundamental importance generally, as March notes, for maintaining a viable balance between exploration and exploitation. However, such flexibility comes at the cost of imposing a solid regulative framework (employment law and relations) that organisations have to accommodate, in one way or another.

In other words, the renewal of human resources and the profile of fast and slow learners are the outcomes of managerial decisions in which the pursuit of efficiency is constrained by the regulative framework into which the employment contract is embedded. Wikipedia is different. In Wikipedia, there are no obvious owners and employees, no managerial relationships in the standard sense, while members or, perhaps more correctly, contributors flow relatively freely in and out of the system (Ransbotham & Kane, 2011). The system itself has few formal roles that are generally loose and to a considerable degree self-assigned (Aaltonen & Lanzara, 2011; Burke & Kraut, 2008). What regulates contributors' behaviour is not a formal contract and a system of strictly prescribed roles. The terms by which people participate in Wikipedia are largely informal and underspecified, as compared to employment relationships. Crucially, participation acquires highly flexible and piecemeal forms, made possible by voluntarism and the ideology of commons as well as the scalability of the technological platform on which member interactions and contributions take place.

Even under these drastically different conditions, it would seem reasonable to assume the need to balance between efficiency and flexibility. As a collective arrangement bound up with delivering consistent performance, Wikipedia cannot but confront, in one form or another, the dilemma of exploiting human resources while exploring new capabilities. Doing away with the regulative framework of formal organisations inevitably implies depriving oneself from the received wisdom of governing collective pursuits manifested in managerial hierarchies and roles governing individual participation in the organisation, and organisational design in general. Indeed, the short history of Wikipedia attests to growing number of policies and guidelines that have sought to accommodate the terms of knowledge production, as the outcome of the inevitable complexity brought about the unprecedented popularity and success of the project (e.g. [Beschastnikh, Kriplean, & McDonald, 2008](#); [Burke & Kraut, 2008](#); [Butler, Joyce, & Pike, 2008](#); [Matei & Dobrescu, 2011](#)). The balance between individual and organisational learning may, however, play out rather differently when organisational membership is rendered unstable or even superfluous and financial incentives do not control individual behaviour ([Kallinikos, 2011](#)). Before turning to these basic questions, we need to describe the distinctive profile of Wikipedia in some more detail.

WIKIPEDIA AS AN EXAMPLE OF SOCIAL PRODUCTION

Since its inception in 2001, Wikipedia has grown into one of the most popular websites and reference tools, eclipsing products based on more traditional and time persisting editorial processes. The relationship between individual and collective learning in Wikipedia is shaped by inventive ways (commons-based principles of organisation) of realising the promise of a technological platform and the online collaboration it offers. In the following, we seek to provide an account of the distinctive nature of Wikipedia and analyse the technological platform upon which it has been established as a successful organisational experiment.

Placed in a broader historical purview, Wikipedia would seem to recount some of the design principles found in long-surviving, self-organised resource regimes ([Ostrom, 2000](#)). At the same time, Wikipedia is a contemporary phenomenon, closely tied to information and communication technologies and the ways by means of which computational encoding and

mediation would seem to redefine the premises of commons-based production (Benkler, 2006). The non-rival, publicly available and often non-depletable nature of information resources is of paramount importance here, as it sets online social production apart from other sorts of resource regimes. Under such conditions, free riding or excess individual benefits may not result in what has, since Hardin's (1968) seminal *Science* piece, been known as the tragedy of commons. What might look like free riding in other standard economic settings may in the case of Wikipedia become a resource, since those that benefit from its knowledge output without contributing anything tend to raise the attraction of the encyclopaedia by providing their attention for the articles. Attention creates an audience base that may encourage others to contribute their effort in writing the articles. Though different, this dynamics shares common elements with the attention economy characteristic of many contemporary Internet-mediated business models (Anderson, 2009; Baldwin, 2007; Evans, 2009).

In terms of production technology, Wikipedia is currently made of over 25 million¹ web pages that are produced and maintained on a software platform called MediaWiki. Each page belongs to one of the twenty namespaces that classify the page according to its function within the overall collective arrangement. Encyclopaedia entries reside in the main namespace, while pages in other namespaces represent users' personal profiles, policies and guidelines, content categories and so on – each combined with an opportunity to discuss the page content on a respective talk page. This has an important effect in terms of how Wikipedia is structured: linking pages across different namespaces brings different kinds of outputs and activities to bear upon each other, thus creating an elaborate morphology of organisational artefacts, functions and their relationships. While in standard organisational settings the structure is given top down, in Wikipedia it has evolved bottom up. Wikipedia page offers a locus of mediated activity and as such incorporates four technological affordances that have heavily influenced the encyclopaedia task structure and its evolution.

Technological Underpinnings

First, a page in a wiki system is a paradigmatic example of *editability* that often describes digital cultural records and artefacts (Kallinikos, Aaltonen, & Marton, 2010). As distinct from paper documents, digital artefacts or records are perpetually in the making and can steadily be modified, elaborated, restructured or deleted. Wikipedia pages can be edited in-place

by activating the editor function embedded into the page itself; a single click turns a Wikipedia reader into an encyclopaedia contributor. The contrast with a traditional encyclopaedia can hardly be overstated.

Second, the pages are stored under a robust version control system, which makes it possible to revert any content output (such as an article or a policy document) into any of its earlier versions. This makes it not only relatively easy to deal with outright vandalism but also, more importantly, to dramatically loosen the editorial controls, as it is difficult to cause permanent harm to the product. *Retractability* allows dispensing with editing that takes place prior to the publication of article and putting all the effort into gradually perfecting always published entries. Instead of painstakingly working to finish an article prior to its initial publication, the workflow starts from the immediate release of a first draft version (known as a stub) and proceeds thereof with numerable revisions.

Third, *hyperlinking* between items and records in different namespaces allows for a functionally differentiated system to emerge out of the writing of structurally undifferentiated pages. Hyperlinks are, after all, relationships between different items within and across the functional domains (namespaces) of the collective arrangement. Different kinds of output such as policies, templates and discussions and, indirectly, their contributors are through hyperlinks brought to bear upon each other and, ultimately, to make social production process governable.

Fourth, in contrast to paper-based encyclopaedia production, the online environment into which the page is embedded breaks down the traditional production process of procuring comprehensive and completed articles from reliable and institutionally certified authors. The completed article is not any longer the undivided input unit around which the system and the human contributions underlying it are structured. Instead, the technology allows interventions at a much more detailed level (Kallinikos et al., 2010). The production process can accommodate just as easily the correction of a single typographic error as the contribution of an entire new article.

Socio-Economic Conditions

Taken together, the attributes of editability, retractability, hyperlinking and modularity/granularity describe the technological affordances of Wikipedia platform. Combined with the *non-rival* nature of digital resources (Benkler, 2006; Faulkner & Runde, 2010) and *the ideology of commons*, these affordances provide the ground upon which Wikipedia is established as a

collective pursuit. The technological underpinnings and the nature of information as non-depletable and non-rival, and therefore publicly available resource, make it possible for individuals to join Wikipedia under extremely variable conditions that suit their own talent, skill, time availability, capacity, interest or inclination. A potentially massive contributor base is thus established in which standard membership rules (employment contract or other admission rules) no longer apply. The commons-based nature of the system and its egalitarian ideology further constrain hierarchy and concentration and make its governance a collective, self-designing and *reflexive* process (Kallinikos, 2011; Lee & Cole, 2003; Zittrain, 2008). Fig. 1 summarises our analysis of the specific technological underpinnings and socio-economic principles on the basis of which Wikipedia emerges as a distinctive social production system.

Given these conditions, content production, editorial work and the governance of the collective arrangement take place largely as writing and editing pages that are then hyperlinked to enhance, connect, frame and regulate each other and the behaviour of contributors. In doing so, technology allows an organisational code governing the domain of production to grow gradually out of content production, relying on the very same medium of writing. Governance and coordination take place and are accordingly shaped by means of writing about writing, which makes whatever learning that occurs in one domain of the collective arrangement potentially applicable

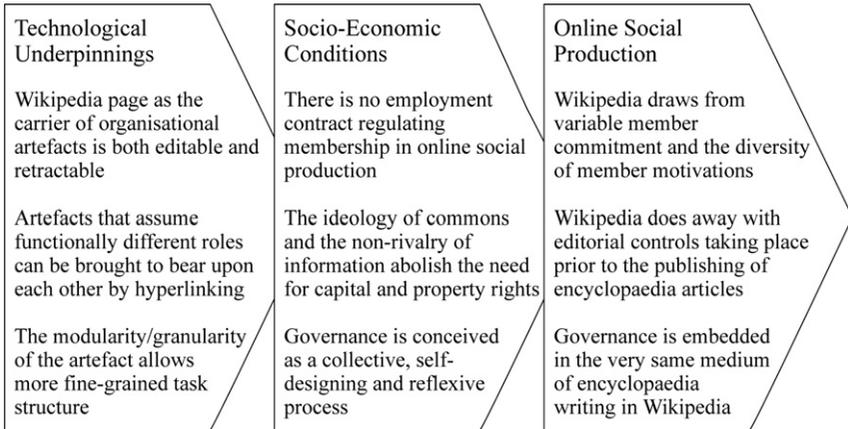


Fig. 1. Technological Underpinnings and Socioeconomic Conditions that Support the Production of Wikipedia.

to the other domains. The lack of face-to-face interaction entails that the organisational code in Wikipedia is developed mainly in writing, a condition that makes it largely explicit rather than tacit and, in principle, editable by anyone.

A solitary expert working on a single entry for a traditional encyclopaedia is unlikely to create much new knowledge about encyclopaedia production itself, and even if s/he would, the publishing company would hardly be able to capture such learning. In contrast, a Wikipedia contributor may have to engage in dialogue about the application of a particular editorial policy as part of the ongoing work and thus learn more about the policy and even trigger its revision. In the former case, the technological underpinnings and practical conditions of content production, editorial work, and governance are fundamentally different and require different skills to master, whereas in Wikipedia the activities take place as writing, writing about writing, and even writing about writing about writing (i.e. discussion about policies). Wikipedia allows both collective learning by doing and capturing the lessons learned into its organisational code in a manner that is, we suggest, central to the entire experiment. Let us now turn to reconstructing the evolution of Wikipedia through the lens of individual and collective learning.

THE EVOLUTION OF WIKIPEDIA

In the preceding section, we have suggested that the mode of operation of Wikipedia is inherently bound with the new technology of encyclopaedia production. The website originated as a spin-off from an ultimately failed experiment to apply a traditional peer-review process to create a free online encyclopaedia called Nupedia (Niederer & van Dick, 2010). The founders deployed a wiki publishing platform to support a subproject called Wikipedia that was intended to feed languishing Nupedia. The subproject was not originally intended as the locus of encyclopaedia production. Its collaborative makeup allowed, however, interactive patterns and structures to grow endogenously as the contributors explored various options made possible by the combination of specific socio-technical conditions and technological underpinnings described above (see Fig. 1). Over its 11 years existence, English Wikipedia has undergone considerable transformation (e.g. Butler et al., 2008; Forte et al., 2009), and the assessment of its profile of exploitation and exploration of resources needs therefore be placed against this evolution.

During the initial stage, attracting as many contributions on as many topics as possible was crucial to help bootstrap the venture. The coupling of activities that initially revolved on individual articles was loose, which allowed the system to directly benefit from massively decentralised exploratory activities (Siggelkow & Rivkin, 2006). However, as the encyclopaedia grew, concerns gradually shifted from the coverage to the reliability and coherence of entries that span today over a considerable range of matters (Anthony, Smith, & Williamson, 2009; Halavais & Lackaff, 2008; Spinellis & Louridas, 2008). Editorial processes and practices were needed to consolidate a coherent encyclopaedia product out of disparate contributions, and innovative governance mechanisms differentiated from content production to cope with the increasing complexity of the collective arrangement itself (Aaltonen & Lanzara, 2011). Despite the strong alternative roots and the libertarian ethos of Wikipedia (Shirky, 2008), more and more effort had to be oriented beyond content production to the preservation of the value that has become embedded into the collective arrangement. This is consistent with previous studies that have found that the benefits of decentralised exploration become contingent on integrated organisational systems (Siggelkow & Rivkin, 2006), and suggests a changing role of exploratory learning in the rise of Wikipedia (Ransbotham & Kane, 2011).

Fig. 2 provides a visual display of the growth of the total and monthly number of contributors to the articles in English Wikipedia. The figure shows that the scale of collective activity grew slowly during the two years after the first surviving contribution was recorded in 16 January 2001. Indeed, the eventual success of Wikipedia has often obscured the fact that the website did not immediately attract a large number of contributors. It took more than two years before the project took off and the venture started to attract members at an increasing pace sometime in the late 2003. After three years of almost exponential growth, the number of monthly contributors (thin line in Fig. 2) levelled off while the all time contributor base (thick line in Fig. 2) continued to grow steadily, reaching two million in late 2009. The rapidly growing gap between the all time and monthly contributors points to a very high turnover of contributors from one month to another.

The fluidity of membership in online communities is not uncommon and is usually assumed to be detrimental to community-based knowledge; it is also likely to conjecture that it may run counter to the ability to integrate tacit interpersonal learning (Miller et al., 2006) and individual knowledge fast enough into organisational code characteristic of standard organisational settings (March, 1991). By contrast, organisational code in Wikipedia is

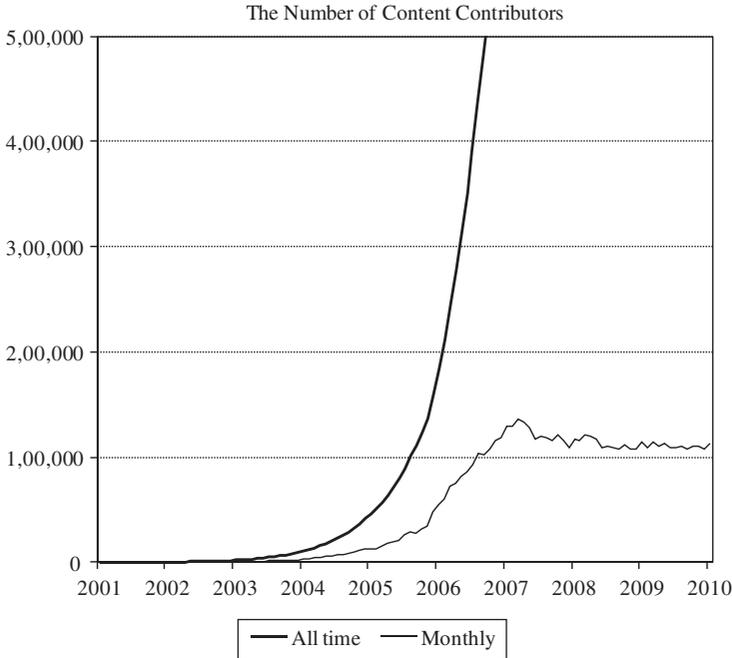


Fig. 2. The Growing Gap between the Number of Monthly Content Contributors and Total Contributors Reveals a High Turnover of Members in English Wikipedia. The Vertical Axis in the Figure is Scaled so that the Pattern of Monthly Contributors Is Clearly Visible. The Thick Line that Represents All Time Contributors Grows Roughly Linearly Beyond the Visible Area.

mostly explicit and, in principle, editable by any individual contributor. It has been argued and, to some degree, demonstrated that in the online environment, the diversity brought about by extreme contributor turnover can be an asset in itself (Faraj et al., 2011; Ransbotham & Kane, 2011). In the following, we present a three-stage model that shows how Wikipedia has dealt with the diversity of its fluid contributor base, turning, in this process, knowledge diversity to an exceptional resource base. Drawing on Fig. 2, few other indicators and prior research (Aaltonen & Lanzara, 2011), we distinguish three stages or periods in the evolution of Wikipedia, namely those of (i) establishment/take-off which coincides with the 2001–2002 period, (ii) growth and consolidation covering the years from 2003 to 2006 and (iii) maturation or sustainability period from 2007 onwards.

2001–2002

The production technology, a wiki publishing platform, was in place early 2001, but there was no obvious way to put it into use for exploiting knowledge distributed across the social fabric. There was neither managerial capability to mobilise relevant human resources – due to all those distinctive characteristics of Wikipedia analysed in the preceding two sections – nor obvious incentives for individuals to contribute to a rather rudimentary and unknown website. Only few people knew at that stage about the existence of Wikipedia. It took almost two and half years before Wikipedia reached one thousand monthly content contributors in May 2003. The issue of motivation was at this stage probably a key concern for a project aiming at exploiting what Shirky (2010) calls cognitive surplus in the society. It has been suggested that the basic human desire to share and, in this process, be assisted and given form by the right tools, would be the primary motivator behind the initial growth (Benkler, 2006; Shirky, 2008). Be that as it may, it is clear that the complex collective arrangement Wikipedia embodies grew stepwise. By the same token, the battery of policies, procedures and practices governing it took shape endogenously. Both outcomes suggest exploratory learning and the need to tap a diversity of intellectual resources as driving forces behind Wikipedia evolution.

Joining Wikipedia and spotting potential improvements was at this stage very easy. In addition to a tiny bit of goodwill to click on the editor function as needed, all an aspiring contributor had to learn to become part of the human resource were few simple wiki markup codes. The overall collective arrangement was weak and most of the activity took place between peers who learned to contribute into the system on an individual basis by trial and error, and by discussing each other's contributions on individual articles. The failing Nupedia kept perhaps reminding these pioneers that received models for drawing on socially distributed knowledge might not work in the new context, lacking the support characteristic of either market and firm-based governance of transactions or a strong community.

Accommodating the diversity of contributors and their contributions seems to have been paramount during those early years as a means of attracting contributors and letting their knowledge and capabilities build up the collective arrangement endogenously. By the end of 2002, less than 2,000 people had contributed to the encyclopaedia articles and the number of monthly contributors was just above 500 suggesting that it was still largely possible to monitor and manage the activity directly through discussion on talk pages. However, the initial freewheeling approach could not ensure

that the proliferating miscellany of contributions would fall into a coherent encyclopaedia product or the contributors would be able to agree over the content of individual entries.

2003–2006

Wikipedia became gradually more popular. This resulted in an accelerating growth of size and complexity that brought upon inevitable problems, some of which were directly related to the characteristics of online social production. For instance, so-called edit wars emerged when people started repeatedly reverting each other's contributions on the same article, ending up in a vicious cycle (Viégas, Wattenberg, & Dave, 2004). Lacking the support of standard authority and role structures, Wikipedia was pushed under the new conditions to explore novel ways of managing the heterogeneous and loosely coupled ensemble of people, resources and operations that made up the encyclopaedia at that point in time. At the outset nobody could exactly know how to achieve a systemic governance of a collective arrangement that had no obvious predecessor. The original solution had been to harness peer discussion, taking place on talk pages, to negotiate and envision how to cope with emerging issues. This has had two important implications for exploratory learning.

First, discussion between article contributors can easily turn into an exploration of collaborative solutions and arrangements and thus create new knowledge on how to manage Wikipedia itself. Given the right tools, the development of article content offers a natural platform for exploratory dialogue of this sort, drawing potentially from a vastly broader range of views than a traditional peer-review process (Kittur & Kraut, 2008). The issues and contradictions that emerged when individuals work under conditions that are relatively unstructured and fuzzy were thus turned into an opportunity for learning and participating in communicative action. This, in itself, may motivate further contributions (Hansen, Berente, & Lyytinen, 2009) as well as lay the ground for consolidating managerial knowledge specific to Wikipedia.

Given the low admission requirements and the minimal technical demands for joining the writing of the encyclopaedia, the opportunity to explore a novel setting could itself be perceived as a reason to jump on the wagon. However, peer communication becomes quickly unwieldy as a coordination mechanism as the number of participants grows (Thompson, 1967). The second point is that while the talk pages provide an opportunity

for local resolution and individual learning, they alone do not offer systemic governance. It would neither be efficient to keep reinventing local solutions for nearly identical problems that crop up on pages edited by different contributors nor provide by these means the perception of consistency throughout the encyclopaedia from the perspective of the users. While Wikipedia is founded on a massively decentralised exploratory learning, its phenomenal success required curbing excessive exploration to allow for the efficient exploitation of diverse knowledge held by the contributor base.

The peer-based approach and the ideal to solve issues through reflexive dialogue probably encouraged people to make contributions and initiated the process in which system-wide governance mechanisms grew from within, and also helped to unleash the exponential growth seen in Fig. 2 that quickly undermined peer interaction as the primary governance mechanism (Kittur, Lee, & Kraut, 2009). Many ideas concerning the management of the collective arrangement were perhaps originally discussed in the context of individual articles from which they were gradually consolidated into universally applicable policies and guidelines. Hence, the organisational code came into being as pages in a separate namespace on the same technological platform. Using Wikipedia recursively for its own management emerged thus as a means by which individual explorations into the art of encyclopaedia writing could be quickly converted into collective learning. The extreme turnover of contributors generated knowledge variety that was successfully incorporated into the social production system in a manner not possible in traditional organisational arrangements.

It may be ultimately difficult to verify what exactly unleashed the exponential growth of Wikipedia. The escalating numbers of contributors established new conditions that gradually shifted the locus of governance from discussions revolving on individual articles to the separate domain of emerging policies and guidelines and, indeed, discussion about them. Fig. 3 shows that from late 2002 to late 2004, contributions to encyclopaedia policies and guidelines were accompanied by much more dense and intensive discussion than the work on actual encyclopaedia entries. At the peak period during the first half of 2003, there was one discussion post for every two contributions into policies and guidelines, suggesting an active period of policy-making and consolidation. In contrast, the ratio for encyclopaedia articles remains roughly one discussion post to ten content contributions throughout the period.

The high turnover of contributors was beneficial both for the purpose of harvesting knowledge distributed in society and in creating diversity that supported individual and organisational learning. As the regular

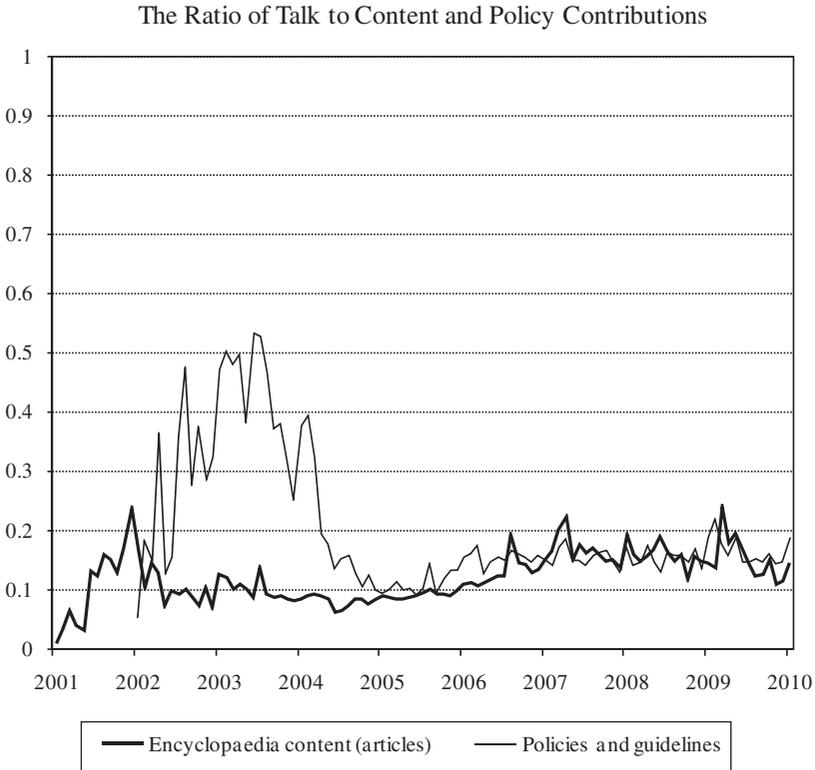


Fig. 3. The Ratio of Talk Page Activity to Encyclopaedia Article and to Policy/Guideline Contributions. The Ratio for Policy Discussion Starts from January 2002 due to Very Low Absolute Number of Edits in Wikipedia Talk Namespace in 2001. Until September 2001, There Were Less Than 10 Monthly Edits in the Namespace.

contributors became more aware of the complex nature of encyclopaedia and its rapidly growing contributor base, they were able to establish a distinct policy-making domain within Wikipedia to support the management of the collective arrangement.

The increasing popularity of Wikipedia started to also attract various sorts of vandalism, but, most importantly, the complex nature of encyclopaedia output and tens of thousands of monthly contributors with uneven skills and motivations had to be somehow managed. For instance, the retractability of content not only made possible to attract contributions

by dramatically loosening editorial controls as compared to traditional publishing processes but also led to situations in which contributors kept reverting each other's edits. The phenomenon that was labelled edit warring was eventually solved by collectively devising *Three-Revert Rule* (3RR) that caps the maximum number of allowed reverts per day on a single page and requires the opposing parties to solve their differences by accepted dispute resolution mechanisms. Such a rule stems from searching for and, perhaps, experimenting with solutions to a behavioural pattern that emerges by virtue of the novel technological platform. It embodies new knowledge about online social production as a result of exploratory learning; yet, at the same time, the rule somewhat limits the scope for further exploration in the context of individual articles.

2007 Onwards

Wikipedia's capability to manage knowledge resources and activities distributed throughout society has emerged out of interactions between individual contributors in a manner that was made possible and conditioned by the technological underpinnings of the wiki platform, the specific nature of information as resource and the commons-based principles characteristic of the entire venture. The collective arrangement reacted to the unfolding complexity of encyclopaedia product by endogenously generating explicit policies, guidelines and editorial procedures, that is an organisational code, that apply across a large spectrum of activities associated with the making of coherent body of knowledge. These solutions started then to regulate the very interactions from which they originally arose, and the immediate need to explore new editorial rules became less pressing as the basic mechanisms for maintaining the product were in place. Also, at some point, the content of the encyclopaedia articles began to resemble a good-enough reference tool for most purposes making it less trivial to add value to the product by haphazard contributions. These two factors have most likely significantly contributed to the levelling of monthly contributor base seen in [Fig. 2](#).

These observations suggest a progressive shift towards socialising and exploiting the contributors in the context of an increasingly intelligent collective arrangement. The need to add more articles became less prominent and a core set of concerns developed that indicate a clear shift from innovating to maintaining the existing product. The original task of harvesting the knowledge distributed across the social fabric is counter-balanced by concerns for finding ways to put the existing arrangements into

most efficient use, a condition that could be seen as an instance of learning to exploit the current resources. The growing proportion of reverted edits and the declining trend of new article creation in Figs. 4 and 5 would seem to be consistent with this. Fig. 4 shows that an increasing number of submitted contributions are rejected by Wikipedia. This can be partly a reaction to vandalism, but combined with the declining trend in new article creation (Fig. 5) may be taken to indicate the possible maturation of the processes by which encyclopaedia's output is currently coming to being.

These developments may, on the one hand, have discouraged contributors interested in being involved in creating a new kind of encyclopaedia, as it is suggested by the gradual decline in the number of monthly contributors in Fig. 2 (see also Ortega, 2009). On the other hand, Wikipedia has developed into a sort of knowledge platform in itself. The collective arrangement

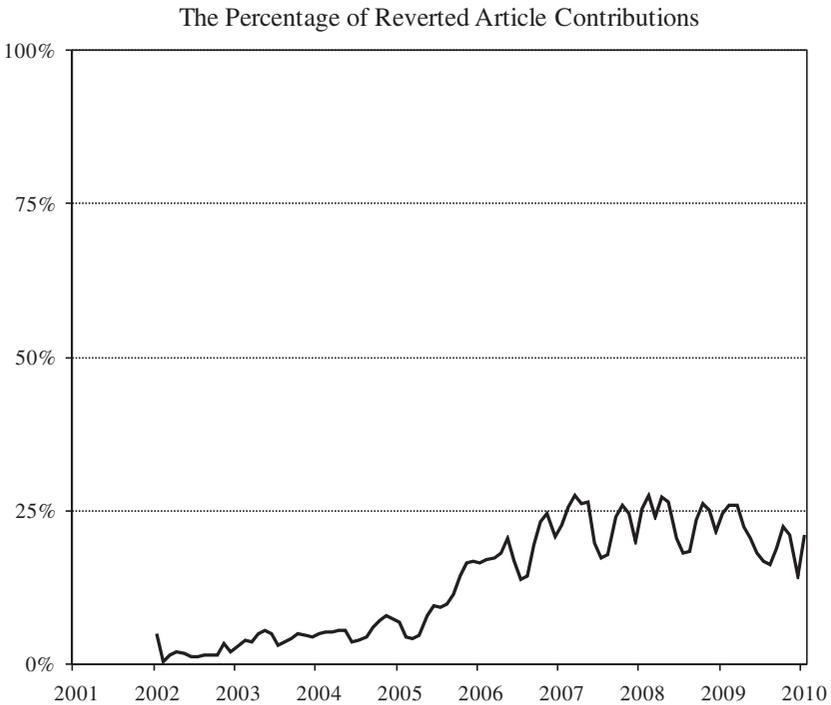


Fig. 4. The Percentage of Reverted Article Contributions. The Figure Starts from January 2002 due to Suspected Inaccuracies in 2001 Data.

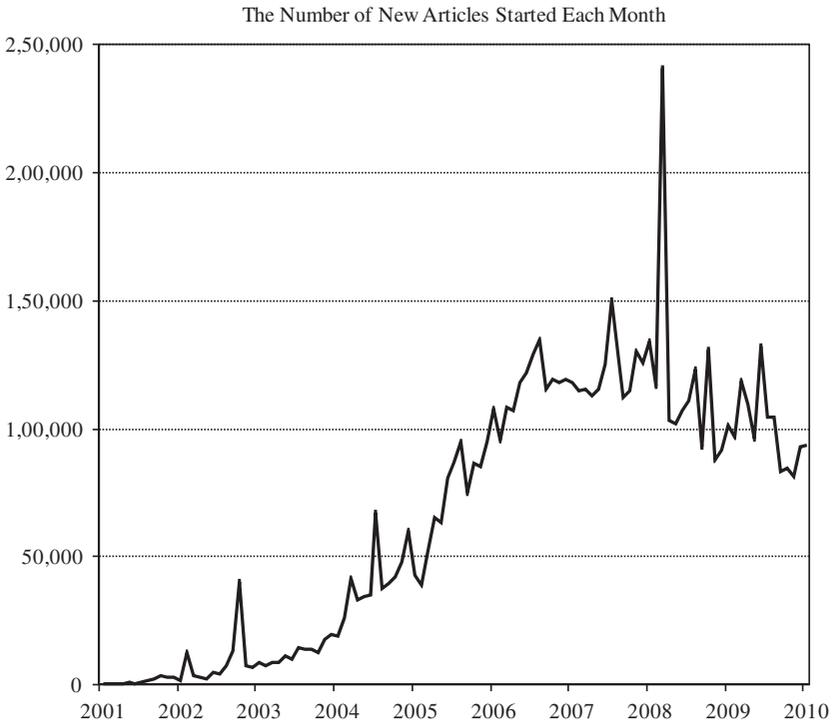


Fig. 5. The Number of New Article Pages Started Each Month.

exploits and provides value for three key groups of actors: contributors, readers and the members of Wikipedia community. The contributors of article content can be understood to benefit from the attention Wikipedia articles attract while the readers get a free reference tool. Today, there is a perceivable value to making sure your hobby or political party is appropriately presented in one of the world's most popular reference tools, which can be understood to resemble a two-sided platform that generates value by coordinating inputs (knowledge and attention) between two different parties (Evans, 2009). Finally, those who help to maintain the system can derive value from being a part of a respected and widely recognised collective accomplishment (Burke & Kraut, 2008).

Table 1 summarises the three phases in the evolution of Wikipedia with reference to individual contributors and the collective arrangement. These ideas suggest that the questions of exploration and exploration are

Table 1. Three Phases in Wikipedia Evolution from the Perspective of Individual and Collective Learning.

	Individual Contributor	Collective Arrangement
2001–2002 – A weak system with low member entry requirements	Individuals start to make contributions into an encyclopaedia-to-be and by discussing their actions on talk pages create new knowledge on how to produce a peer-based encyclopaedia.	An initially weak collective arrangement tries to harvest knowledge on whatever topics distributed across the social fabric.
2003–2006 – Exploration drives growth and governance	The overall user base and activity grow at an increasing speed, while some regular contributors shift their attention from content production to tasks related to governing the increasingly complex arrangement.	Individual knowledge on how to produce a peer-based encyclopaedia online is integrated into the organisational code, giving rise to a distinct governance domain.
2007 onwards – Fragile sustainability as a knowledge platform	Content contributors exploit the attention of the audience, readers get a free reference tool and the active members of community enjoy their recognised positions in Wikipedia.	Wikipedia socialises individual contributors into its sophisticated rules and practices, for instance by rejecting an increasing portion of contributions.

differently expressed over the three stages of bootstrapping/take-off, consolidation and maturation that mark Wikipedia’s evolution. This probably applies to every organisation. One could go as far as to claim that the trade-off of exploration and exploitation is an interesting way of describing the transition from birth to consolidation characteristic of many collective pursuits (e.g. [Kimberly & Miles, 1980](#)) – the evolution of Wikipedia could be understood as a succession of punctuated equilibria. In the first two stages, we observe growth driven by exploratory learning and the quick integration of individual knowledge into the organisational codes that are positively supported by the high turnover of members. The activities revolve on loosely coupled articles, which allows for the benefits of decentralised individual exploration to accumulate at the level of the entire system ([Sigelkow & Rivkin, 2006](#)). In the last phase, the emphasis shifts from decentralised exploration to the exploitation of existing resources, but

the sustainability of the platform dynamics seems somewhat fragile as suggested by the declining monthly contributors population (Ortega, 2009). On what follows we reflect on what seems to us to be the distinctive qualities of Wikipedia and some of the lessons that can be learned from its study.

DISCUSSION AND CONCLUSIONS

The evolutionary pattern of Wikipedia depicted in the preceding pages may seem to conform with a widespread depiction of organisations as moving along several stages of development over their lifetime: namely from establishment through consolidation to maturation and eventual decline. This thesis has several old and venerable variants. Some of these are based on biological analogies such as the organisational life cycle model (Kimberly & Miles, 1980; Lester, Parnell, & Carraher, 2003; Quinn & Cameron, 1983), while others assume a trajectory of organisational growth or transition marked by several progressive stages (Child & Kieser, 1981; Miller & Friesen, 1980). Others depict the process of organisational consolidation and maturation as a predominantly social practice of increasing division of labour, rule-based governance and management professionalisation (Chandler, 1977), bureaucratisation (Meyer & Brown, 1978) and, more generally, institutionalisation (Powell & DiMaggio, 1991).

However, none of these theories captures the distinctive ways by which the dynamic of individual and organisational learning is played out in contexts such as that Wikipedia and, eventually, most online social production systems epitomise. Two things clearly stand out. First, the Wikipedia consolidation process is not attributable to external constituents (particular groups of stakeholders or other economic or institutional conditions) or logics of action imposed by a managerial elite. Second, regular and very high rates of membership turnover set Wikipedia strongly apart from those standard organisational arrangements from which these growth and transition theories derive. The appreciation of the evolutionary trajectory of Wikipedia needs to be placed against those fundamental attributes of the online encyclopaedia that stem from (i) commons-based principles of organising human contributions, (ii) the specific nature of information as resource and (iii) the technological underpinnings of knowledge and information editing sustaining Wikipedia. In what follows, we outline some of the key issues that emerge from our depiction of the distinctive nature of Wikipedia and its evolutionary trajectory.

Constitutive Diversity and Coordination

The primary challenge Wikipedia confronted after its take-off has been one of assembling a reasonable knowledge output out of a sizeable, shifting and globally distributed population of contributors with diverse interests, varying degrees of commitment, highly variable skill profiles and motivations. This is a different problem from that of balancing the obvious gains of exploitation against the less conspicuous or less immediate benefits of exploration. Indeed, exploration appears intrinsic to the way Wikipedia is constituted as a collective arrangement, and diversity as one of its milestones. Under these conditions, the critical issue becomes one of being able to distil a relevant and useful knowledge output out of constitutive diversity that would seem to match the nature of encyclopaedic knowledge. This delicate task has to be accomplished while maintaining and encouraging diversity and without violating the consensual, commons-based principles on which the encyclopaedia is built.

Seen from this point of view, Wikipedia reframes and, to a certain degree, inverts the problematic of exploration and exploitation and the ways it is related to individual and organisational learning. Exploration tends to be abundant, while exploitation remains lacking, due to the constitutive practical reasons and moral principles on which the encyclopaedia is founded. It is the very scarcity of exploitation that needs to be addressed as a means of turning the huge opportunities exploration provides to a reasonable knowledge output. The evolutionary trajectory of the encyclopaedia reported in the preceding section, the proliferation of policies and guidelines and even some elementary role differentiation (bureaucrats, administrators, editors, contributors) reflect attempts to address this problem. These developments represent a soft rule-based regime of governance by means of which Wikipedia has sought to maintain a few principles and conflict resolution mechanisms whose lack became apparent as the number of contributors grew substantially. It is important to remind the collective, self-reflexively produced nature of these solutions. The processes of governance, taking place on the same wiki publishing platform, make evident that Wikipedia's consolidation pattern differs rather drastically from models of organisational transition in which governance emerges as the imposition of a steering regime mediated by the institutions of hierarchy, property rights and the employment contract (Benkler, 2006; Kallinikos & Hasselbladh, 2009).

The inversion of the direction, which the benefits of exploration and exploitation run in the case of Wikipedia, is concordant to Zitttrain's depiction of how innovation relates to his, now widely acclaimed, notion of

system generativity. Zittrain (2008, p. 70) defines generativity as ‘a system’s capacity to produce unanticipated change through unfiltered contributions from broad and varied audiences’, a definition that fits and, to some respect, derives from the study of Wikipedia, among others (Zittrain, 2008, chapter 6; see also Benkler, 2006). The terms of broad audience participation are ensured by the technological and social conditions depicted in Fig. 1, representing the joint outcome of pioneering technological affordances (editability, retractability, hyperlinking and modularity/granularity) with new and innovative forms of social interaction, work and communication (commons-based principles of cooperation).

These observations further suggest that a certain personnel turnover as a solution that ensures the steady flow of new ideas in an organisation (March, 1991) may seem less relevant in the case of online social production. Such a solution is predicated on the assumption of a relatively bounded and regulated membership base. This is fully warranted in the case of standard organisational arrangements in which exploitation, as March has sensibly perceived, needs to be often explicitly counterbalanced through the instigation of exploration by, among, other means, the renewal of the organisations’ membership base. However, the problem that Wikipedia confronts is of a different nature and is played out under conditions in which the largely unfiltered participation of broad audiences ensures a constant flow of exploration (Ransbotham & Kane, 2011). The unfiltered participation of broad audiences reflects both ideological and practical reasons and can ultimately be traced back to the belief that in a great deal of circumstances, the many can outperform the considerably fewer experts. That belief, occasionally referred to as the ‘wisdom of crowds’ (Surowiecki, 2004), goes against deeply entrenched assumptions in the expert-dominated culture of the West and may well have driven Plato to rethink the key role he reserved for experts in the running of City affairs in his *Republic* (see Plato, 1993).

The lenses through which we perceive exploration and exploitation in the case of Wikipedia allow us to further differentiate it from online systems, often of proprietary nature, that source a composite task from a distributed and shifting labour force (hence crowdsourcing) by dividing it into subroutines that can be performed with no regard to the overall product (Doan, Ramakrishnan, & Halevy, 2011). In contrast to simple crowdsourcing, the coherence, quality and governance of Wikipedia encode other principles. Far from being based on a prior design imposed from the outside by proprietary concerns, they result from self-reflexive processes growing out of the commons-based principles of coordination and the interaction patterns they enable (Aaltonen & Lanzara, 2011).

Collective versus Individual Learning

The thesis of the ‘wisdom of crowds’ carries far-reaching implications with respect to how we conceive key issues in the social production of knowledge. It certainly reframes the understanding of social learning away from individuals as the primary bearers of knowledge and skills. Wikipedia as collective knowledge output is not made of the aggregation of discrete individual capabilities, knowledge and skills. There are undeniably various forms of learning on the part of individual contributors or smaller groups that the short history of Wikipedia exemplifies. Yet, the basic idea that a knowledge output of high quality can be assembled out of lay publics rather than experts radically reframes the role individual capabilities and learning plays in collective outcomes. At the very least, the participation of individuals in the accomplishment of collective objectives suggests that the latter are no longer linearly dependent on the former. Better collective outcomes may emerge without notable changes in individual capabilities and skills or even with less able individuals on average (Benkler, 2011).

The nonlinear connection of individual capabilities and collective outcomes may be said to apply to any organisation (Holmqvist, 2004; Sigelkow & Rivkin, 2006; Tsoukas, 1996). After all, organisations are not assemblages of individuals. They are made of complex processes, designs and task and role structures that ensure the recurrent accomplishment of sought outcomes. However, Wikipedia (and social production more generally) unbundles the connection of individual capabilities and collective outcomes in interesting ways that still await analysis and understanding (see, e.g. Benkler, 2011). Such unbundling suggests that the key issues Wikipedia confronts cannot be adequately framed in terms of adaptation to and accommodation of local realities (i.e. exploiting current resources in the existing environment), which distributed forms of action enable and promote (see, e.g. Tsoukas, 1996). Such a framing is itself predicated on a stark difference between a centre and periphery. Wikipedia is different. The centre (control structures) is weak and the diversity huge and inherent. The small groups that tend to cluster around the writing of particular entries exhibit transient and permanently shifting composition.

The nonlinear connection of individual capabilities and collective outcomes can furthermore be drawn upon to distinguish the social structure of Wikipedia from the social form of community that has attracted a lot of interest recently (Faraj et al., 2011; O’Mahony & Lakhani, 2011). A community entails an identity, the distinction between insiders and outsiders, whereas Wikipedia is in principle borderless, the invitation to

participate is addressed to anyone and the terms of participation in the collective pursuit are minimal, flexible and marked by extraordinary degrees of membership turnover (Kallinikos, 2011). There is a community of Wikipedians, but Wikipedia as collective knowledge output cannot obviously be explained by reference to that community (Aaltonen & Lanzara, 2011; Forte et al., 2009).

These observations perhaps suggest that learning inheres in diversity and diversity is not made out of the aggregation of individual bits and pieces. But are not we blowing up and ultimately mystifying the construct of diversity? How could we really conceive of and eventually assess it? The answer is similar to pluralism, meaning negotiation and ultimately democracy²: as a ramified and shifting web of differences that have to be supported, cultivated and possibly expanded. Under these conditions, the critical factors, Wikipedia indicates, turn out to be (i) how to institute the principles that let a collective pursuit to orderly harvest knowledge that inheres in society without curtailing its diversity and violating its commons-based principles and (ii) how to find or construct the technical architecture that allows the large variety of tasks and contributions to be fashioned into a reasonably coherent output (computationally driven collaborative technologies). The successful experience of Wikipedia suggests that social learning and renewal are structurally entangled processes in which a viable balance is struck between the principle of broad and unfiltered audience participation (including individual motivations) and the arrangements, policies, guidelines and procedures through which collective outcomes are pursued and assembled.

The significance of these observations for learning and the processes of knowledge making are hard to overstate (Wenger, 1998). Despite the massive criticism directed against the naiveties of positivism and methodological individualism, the view of social learning as the aggregation of individual skills and capabilities still prevails.³ Certainly, most human resource management (HRM) strategies are predicated on such a view and the individual is by and large the main target of HRM-inspired organisational reforms and learning strategies. Wikipedia, however, suggests something different. The sheer reality of the encyclopaedia as a tangible reference tool and the modes by which its content is produced and used carry the pivotal role of collective knowledge and its relationship to distribution and structure away from ideology to empirical science. Wikipedia is here; it is a social fact providing tangible evidence in support of the claim that social knowledge and learning are evidently more than piling up discrete capabilities and skills lodged within separate, standalone individual interiorities or subjectivities.

We may be accused of idealisation and oversimplification. Wikipedia is after all not just produced by everyone; it is not exactly the product of all. The logic of power law distribution is widely known (Almeida, Mozafari, & Cho, 2007; Voß, 2005). Under the conditions power law applies, a minority (say 20 percent) accounts for the bulk (say 80 percent) of a collective's output, a condition that cascades itself across the stratified layers of the system (the second layer accounting for the 80 percent of the rest and so forth). Wikipedia and commons-based systems in general are known to provide a good approximation of the logic of power law distribution (Shirky, 2008). If this is the case, then our claims may well look as overstatements and the collective outcome Wikipedia can be explained by falling back to knowledge, abilities and skills of limited minorities and ultimately to the individual expert.

Not quite so, we think. Extracting a balance sheet of active and non-active contributors cannot really capture the essential logic of knowledge creation and misrepresents the workings of power law. For, what is inactive is not useless. What is immediately inactive may well shape both what becomes active and its quality. The apparent success of Wikipedia makes sense against the backdrop of an attention economy in which minor contributors and idle, from the point of view of knowledge making as concrete output, users provide the attention without which the collective pursuit could not exist. Furthermore, in the case of Wikipedia, 20 percent is anyway a sizeable number of heterogeneous and dispersed and, crucially, shifting contributors, as the monthly contributor base shows considerable fluidity. More generally, power law operates on large numbers and the distinctive profile of the distribution tends to more clearly emerge under collective outcomes in which a sufficient large number of people participate. In other words, the long tail, as it has recently been called (Anderson, 2006), is necessary for the upper minority to emerge. In all these respects, Wikipedia compels an understanding of collective action, knowledge making and learning that transcends methodological individualism and the metaphor of the social as a scaffold made of individual units, stacked one upon another.

POSTSCRIPT

In this chapter, we have discussed the issues of exploration and exploitation, collective action and learning beyond the standard settings in which these issues have commonly been investigated. We have assumed that the trade-offs of exploration and exploitation may apply to alternative forms of

organising collective pursuits and analysed Wikipedia with the view of investigating how the relationship between individual and collective learning accounts for its evolution.

Drawing on aggregate descriptive statistics and previous studies, we have shown that the problematic of exploration and exploitation is differently manifested in collective pursuits predicated on the massive participation of fluid audiences. Exploration tends to be abundant and exploitation tends to be scarce, and the problem therefore seems to run in the opposite direction to that premised on the logic of adaptation that is commonly associated with traditional organisational settings. Furthermore, Wikipedia discloses an interesting association between individual and collective learning. Massive audience participation and high contributor turnover attest to that collective outcomes cannot be understood as piles of individual capabilities and skills and they (collective outcomes) are only loosely related to individuals. Individual learning in Wikipedia is predicated on the distinctiveness of its collective setting, a condition that makes the understanding of learning as simple accumulation of individual contributions inadequate.

Over hundred thousand different people work every month for the collective arrangement; yet, there is neither employment contracts nor formal managerial authority steering the development and use of this massive intellectual resource. Wikipedia has been a phenomenal success so far, and the collective arrangement seems to have reached a degree of stability. At the moment, Wikipedia provides reasonable value for the shifting contributor population, encyclopaedia readers and the members of Wikipedia community with respect to their inputs. However, should any of these groups diminish their support for one reason or another, the collective arrangement would have to cope with a new situation. It is difficult to envisage how Wikipedia would evolve in the future and predict how it might or could react to such a challenge. In more traditional organisational settings, it is not uncommon to react to diminishing resources by tightening control over them (March et al., 2000). Whether this would be feasible or indeed merely accelerate the drift away from key constitutive commons-based principles of organization underlying Wikipedia, leading to the radical transformation and eventual decline of this refreshing social experiment, is difficult to say.

NOTES

1. Statistic page at <http://en.wikipedia.org/wiki/Special:Statistics> (accessed 21 October 2011).

2. The consensus characteristic of decision and policy making in Wikipedia may contrast it to democracy, if the latter is primarily tied to voting as distinct from meaning negotiation underlying consensus (Zittrain, 2008). However, voting without meaning negotiation, debate and dialogue degenerates democracy to a technical task of vote counting.

3. Benkler (2011, chapter 2) discusses the issue of individual behaviours/motivations and collective outcomes by reviewing some of the findings of evolutionary psychology and biology. As interpreted by Benkler, these findings suggest that indirect (or impersonal) reciprocity cannot, in some cases, account for evolutionary processes (so-called multilevel selection theory) that demand the recurrent, systematic (rather than occasional) sacrifice of individual members for the well-being of the group, community or species. Though only indirectly tied to our claims, multilevel selection theory is another powerful example of the complex trade-offs between individual contributions and collective outcomes.

ACKNOWLEDGEMENTS

The chapter draws on our collaboration with Giovan-Francesco Lanzara to analyse the freely available English Wikipedia database (Aaltonen & Lanzara, 2011). The empirical relationships depicted in this chapter are based on a dataset that covers nine years of contributions, from January 2001 to January 2010.

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