

Stigmergic Collaboration: The Evolution of Group Work

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Introduction

¹ The steady rise of *Wikipedia.org* and the Open Source software movement has been one of the big surprises of the 21st century, threatening stalwarts such as Microsoft and *Britannica*, while simultaneously offering insights into the emergence of large-scale peer production and the growth of gift economies.

² Many questions arise when confronted with the streamlined efficacy and apparent lack of organisation and motivation of these new global enterprises, not least “how does this work?” Stigmergic collaboration provides a hypothesis as to how the collaborative process could jump from being untenable with numbers above 25 people, towards becoming a new driver in global society with numbers well over 25,000.

Stigmergic Collaboration

³ Pierre-Paul Grasse first coined the term stigmergy in the 1950s in conjunction with his research on termites. Grasse showed that a particular configuration of a termite’s environment (as in the case of building and maintaining a nest) triggered a response in a termite to modify its environment, with the resulting modification in turn stimulating the response of the original or a second worker to further transform its environment. Thus the regulation and coordination of the building and maintaining of a nest was dependent upon stimulation provided by the nest, as opposed to an inherent knowledge of nest building on the individual termite’s part. A highly complex nest simply self-organises due to the collective input of large numbers of individual termites performing extraordinarily simple actions in response to their local environment. Since Grasse’s research, stigmergy has been applied to the self-organisation of ants, artificial life, [swarm intelligence](#) and more recently, [the Internet itself](#).

⁴ As stigmergy is a method of communication in which individuals communicate with one another by modifying their local environment, it is a logical extension to apply the term to many types (if not all) of Web-based communication, especially media such as the [wiki](#). The concept of stigmergy therefore provides an intuitive and easy-to-grasp theory for helping understand how disparate, distributed, *ad hoc* contributions could lead to the emergence of the largest collaborative enterprises the world has seen. However, is it correct to call these enterprises “collaboration”?

⁵ References to collaboration can be found in a staggering number of topics including, but not limited to, art, science, industry, business, education, technology, software design, medicine, and civil society. The research being conducted in these diverse areas, however, is still confined to institutional silos. This makes it challenging to develop a cross-disciplinary theoretical framework that goes beyond a dictionary definition and provides insight into the collaborative process in application-oriented contexts.

⁶ The following represents some of the current findings of the author’s PhD research on and around collaboration and stigmergic collaboration, and comprises the core components of the theoretical framework guiding this article:

1. Collaboration is dependent upon communication, and communication is a network phenomenon.
2. Collaboration is inherently composed of two primary components, without either of which

collaboration cannot take place: social negotiation and creative output.

3. Collaboration in small groups (roughly 2-25) relies upon social negotiation to evolve and guide its process and creative output.
4. Collaboration in large groups (roughly 25-n) is enabled by stigmergy.

1. Collaboration is dependent upon communication, and communication is a network phenomenon.

7 Collaboration being dependent upon communication (in some form or another) is self-evident and requires no explanation (collaboration cannot be a solo venture), and the notion that communication is a network phenomenon is also reasonably intuitive. However it should be stressed that communication not only makes use of networks as channels, but also generates networks through its very being—entities communicating using any medium become connected nodes. Both these factors—collaboration requiring communication, and communication being a network phenomenon—make collaboration especially well suited to the Internet's hyperlinked network structure.

2. Collaboration is inherently composed of two primary components, without either of which collaboration cannot take place: social negotiation and creative output.

8 That collaboration is inherently composed of two primary components—social negotiation and creative output—is not to say that there aren't other important components, but rather that these two are fundamental to the process as it is generally regarded. In formulating a theory of stigmergic collaboration, it is important to note that the social negotiation that takes place during collaboration may be implicit and unknown to the participants. As collaboration is a fundamental biological behaviour which takes place anywhere humans work together, it is not necessary to 'know' that one must negotiate one's identity, values and ideas prior to and during collaboration. By simply being in the presence of other humans one can collaborate without having any regard for or knowledge of the process's existence. However, even if it is unconscious, social negotiation (the delineation and identification of personal boundaries, interests, stakes, objectives, etc.) must take place as the result of the communication required by collaboration.

9 Another caveat to the second primary component, creative output, is that the output may take the form of an ongoing process instead of a final conclusion. An example would be an intimate relationship—the parties involved may collaborate very closely towards the successful continuance of the collaborative process.

3. Collaboration in small groups (roughly 2-25) relies upon social negotiation to evolve and guide its process and creative output.

10 Research has shown that the ideal size for collaborating groups (where technology is not being used in any way) is 2-8, with an upper limit of around 25 (Lipnack & Stamps 180-1). In these smaller groups, successful collaboration is generally reliant upon social negotiation to evolve and guide the development of the group's creative output. In such scenarios, discussion plays a key role in the negotiation of emergent, shared understandings—this is, perhaps, the essence of face-to-face collaboration. Discussion acts as a point of mediation between the individual collaborators and the creative outcome which may or may not eventuate. It is in this shared space, the space 'between' the participants, where the traditional collaborative process develops its third member—that is, the member who is the sum of the whole and who seems to guide the process while developing ideas that are beyond the individual contributors' capacities.

4. Collaboration in large groups (roughly 25-n) is dependent upon stigmergy.

11 Although social mediation is an inherent part of collaboration, when applied in traditional face-to-face collaboration social mediation can provide a barrier to the rapid and seamless integration of contributions that characterises projects such as *Wikipedia.org* and

the Open Source software movement. It may be that there is simply so much complex information to be negotiated when people communicate directly that the negotiations of the many collapse under their own weight without the mediation of an administrative/stigmergic system.

12 This is not to say that social negotiation does not take place in stigmergic collaborative contexts—it may even be essential to developing the collaborative community—but rather that negotiation takes a back seat in terms of the creative drafting process. Most (if not all) stigmergic wiki collaborations have discussions associated with the content being developed, but it is possible to contribute (to *Wikipedia.org*, for instance) without discussing what you are contributing to or creating. Conversely, it is also possible to take part in discussion without editing an article. Although such discussions are most certainly an important and perhaps crucial form of contribution, they are typically secondary to the objectives of the overall project. For an example of a discussion accompanying mass collaboration, see the [Israel talk page](#) at *Wikipedia.org*. In addition to such points of discussion, bulletin boards, IRC (chat) and e-mail lists often support and augment the negotiation.

Stigmergic Wiki Collaboration as Distinct from Co-Authoring

13 From the perspective of individual sites of work within a stigmergic collaboration (effectively Web pages in the context of a wiki), the activity may appear to be identical to that of co-authoring—with the exception that the process is augmented by a few key elements. The most prominent of these elements is the aforementioned lack of discourse required to initiate and partake in collaboration. The use of stigmergic communication to sidestep social negotiation effectively fast-tracks the creative gestation period, removes social boundaries and as a consequence lowers the ‘costs’ of contribution by eliminating the need to become acquainted with and maintain relationships with fellow contributors. This is not to say that developing and maintaining relationships with co-authors isn’t a valuable thing to do, or that it isn’t possible during a stigmergic collaboration, but rather that it isn’t a fundamental part of this collaborative process, whereas it is in traditional co-authorship.

14 Backing away from the perspective of individual collaborative loci and taking a wider view, multiple contributions to stigmergic collaborations naturally form clusters representing the contributors’ interests. One’s contributions might also overlap with those of others, thereby generating sets of collaborators linked via their contributions, personal interests and shared discourse. These “contributor groups” form networks that may operate either implicitly or explicitly, with groups actively working together or (and perhaps more frequently) remaining largely unknown to each other. Networks that allow such user groups to self-organise, known as [‘group forming networks’](#), have been identified in research as being one of the more powerful drivers of network value which may have contributed significantly to the growth of giants such as *Ebay*, *Wikipedia.org*, the Open Source software movement and even the Internet itself.

15 The interdependence of collaborative loci, drafted by a large number of people and mediated by the encoding of a local environment, is what gives stigmergic collaboration one of its most distinguishing features and sets it apart from traditional co-authorship: a coherent collaborative domain emerging from the interrelated, implicitly coordinated efforts of many individuals and groups of contributors.

Non-Textual Mass Collaboration

16 It is important to note that although the examples of stigmergic collaboration given in this article are of wiki collaborations, the process is not limited to the use of the wiki, or for that matter, the textual medium. The Open Source software movement may provide examples outside of the use of wikis, although the code collaboratively created still exists as a language utilizing a textual (ASCII) medium. SourceForge.net provides many examples of such code-based stigmergic collaborations with its source code repositories.

17 An example for stigmergic collaboration that transcends and includes the textual medium is the [IHMC CMapTools](#) server network. CMapTools is essentially open source concept mapping software with the additional functionality of allowing for maps to be [accessed](#) via the Internet". Once accessed (if permissions are granted by the map owner), additional collaborators can add/edit/delete the contents of a map or link to another map in a similar way that an editor might in a wiki collaboration, linking from page to page. The CMap software also allows for [synchronous collaboration](#), functionality which goes beyond the current asynchronous editing of wikis, providing the participant with a more connected sense of their collaborator's engagement. However, it might be that such connection may disrupt a sense of distance that enables a wiki editor to contribute with less self-consciousness about their work than they would have if they knew someone was watching their drafting process. The value of a real-time wiki has yet to be extensively evaluated, although [the functionality is emerging](#). It might be that such features will change the dynamics of stigmergic collaboration, returning them to a more traditional collaborative process by stimulating direct social engagement between contributors, however it is equally if not more likely that the ability to edit synchronously while maintaining stigmergic mediation, will only produce more novel collaborative dynamics.

18 Beyond these examples, there is no immediate reason why the stigmergic collaborative process couldn't work in non-textual media such as sound or image—imagine a 'wiki style' documentary or concerto. It is likely, given the wide range of experimentation taking place on the Internet today, that such projects are already being developed. In these directions the strongest innovations could be made, as this would provide for the availability of all media for expression. This would not only open up collaborative opportunities to new media, but also to new user groups. Providing the systems were intuitive and easy to use, having the ability to collaborate in non-textual media could significantly reduce literacy hurdles to and provide incentive for those currently less inclined to seek access to the Internet's wealth of information and opportunities. With the ability to upload, share and edit common media, it may be that [Flickr](#), [YouTube](#) and especially [JumpCut](#) having the ability to 'remix' a shared video work using an online editor, may already be developing in this direction.

Conclusion

19 The phenomenon of stigmergic collaboration as described in this paper (collective, distributed action in which social negotiation is stigmergically mediated by Internet-based technologies) is most surely still in its infancy and will continue to evolve with technology and its social/cultural applications. Further, it seems likely that this process will expand to include the pantheon of core media—text, audio, still and moving image—and will play an increasing part in the creation and dissemination of the entertainment, news, and policy of the future. Considering this, future research into the dynamics of stigmergy might focus on the cross-disciplinary transfer of knowledge from work carried out in the insect, robotics and artificial intelligence worlds in order to learn how to better apply and extend this new collaborative process.

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