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Motivation for Open Collaboration: Crowd and Community Models and the Case of OpenStreetMap

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Abstract

This article presents an examination of motivational factors relating to contribution to the wiki OpenStreetMap, a site for voluntary geographic information. Based on a wide literature review of motivation, open source, volunteerism, and serious leisure, a questionnaire was created and completed by 444 OpenStreetMap contributors. Results of judgments of the motivational importance of 39 reasons for contribution are presented and considered in relation to models of contributory behavior for crowd- and community-based online collaborations. Positive and important motivators were found that accorded with ideas of the "personal but shared need" associated with contribution to open-source projects, co-orientation to open-source and geographic knowledge, and attention to participation in and by the community. Differences in motivation between serious and casual mappers showed that serious mappers were more oriented to community, learning, local knowledge, and career motivations (although the latter motivation is low in general), and casual mappers were more oriented to general principles of free availability of mapping data.

Keywords

OpenStreetMap, crowdsourcing, community

The Internet has and continues to make major changes in how, where, and with whom people collaborate. The continuum of participation stretches from anonymous

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contribution of instrumental resources to persistent presence and identity in social-networking sites and the exchange of personal and intimate details. Whereas much work on the Internet, particularly in its first decade, grappled with how to authenticate online relationships and to increase the richness of online interaction, that is, how to create online communities, current attention is turning to how to encourage contribution and commitment to online ventures that aggregate knowledge across large numbers of people, that is, how to manage crowdsourcing. The quintessential example of the latter is Wikipedia, but as this special issue addresses, the crowdsourcing potential of the wiki goes beyond a single application. Wiki use and success for crowdsourcing is also more nuanced than a jointly editable web page, requiring a purpose that appeals widely and sustains contribution as well as mechanisms that support participants while providing trust in the value of continued participation. As these new models of online production emerge, questions arise as to the best way to organize online productions and how to motivate many independent, distributed, online participants to contribute information, updates, and commentary to a central site.

This article presents results of an empirical study of motivations to contribute to the geographic information wiki OpenStreetMap (OSM). This wiki project fits in the genre of online collaboration known as *volunteered geographic information* (VGI; Goodchild, 2007), an area expanding with the increase in affordable global positioning system (GPS)–enabled devices. OSM is an open-source and open-access project founded in 2004 by Steve Coast, a student at University College London. The goal of the project was, and is, to collect geographic data that are free to edit and use. The study builds on work by the authors in understanding and exploring models of online collaboration and the potential motivators for contribution to such voluntary, knowledge-based collaborations. The first section provides a theoretical positioning of motivations that distinguish between motivation for crowd versus community aspects of wikis and other online collaborative projects. This is followed by a short review specifically addressing motivation to contribute to VGI projects and then the presentation of the study and results of a survey on motivations completed by 444 OpenStreetMap contributors.

Motivation to Contribute Online

A wide range of literature that addresses motivations to contribute to online enterprises was examined as a foundation for the research and discussion presented here. In previous publications, Haythornthwaite (2009, 2011a, 2011b) has drawn on the literature on peer production, participatory culture, open source, and open access (Benkler, 2006; Bruns, 2008; Jenkins, Clinton, Purushotma, Robinson, & Weigel, 2006; Raymond, 1998; Willinksy, 2005) and on her studies of online community, group behavior, collaboration, and social networks to articulate a model of motivation to contribute to open collaborations that integrates across crowd- and community-based online forums. The model suggests that online crowds and communities can be

seen as two ends of a lightweight-to-heavyweight continuum of online participation; this position is presented in more depth in the next section. Separately, Budhathoki and colleagues (Budhathoki, 2010; Budhathoki, Bruce, & Nedović-Budić, 2008; Budhathoki, Nedovic-Budic, & Bruce, 2010) reviewed the literature on volunteerism (e.g., Clary et al., 1998), leisure studies (e.g., Stebbins, 2006), and social production of knowledge in open source and open wikis (e.g., Benkler, 2006) to address the theoretical foundations for motivation to participate in online geographic information systems. This background laid the foundation for the design of the survey reported here, as discussed later. Together, the background literature, theoretical model, and the motivational survey provide the underpinning for this study of motivation to contribute to the open collaboration wiki OSM.

Motivations to Contribute to Crowds and Communities

Wikis, such as OSM, must attract two different kinds of contributors and contributions. On one hand, large numbers of contributions are needed to fill the data set with information, such as geographic information from around the world; thus, crowds of contributors are needed to provide data through a mechanism that supports independent contribution. On the other hand, core and repeat contributors are needed who contribute for the long term and who also negotiate directions of the open-source project and receive recognition and reward for sustained and substantial contribution. Reward is often in the form of social contact with those who are equally interested in the topic, for example, in geographic matters. Communities of contributors can encourage continued participation, making a home and recognition structure for those with similar interests. Wikis provide this dual way of organizing: an easy contribution structure for widespread input of information and interaction sites (such as "talk" pages) where community members can debate and set standards, recognize each other, and discuss knowledge matters beyond instrumental information upload.

This dual aspect of wikis suggests that different motivations may hold for those who contribute as a member of the crowd versus as a member of a community, and thus different forms of organizing and reward structures may pertain and need to be created for each of these two forms of organizing. Although contrasting these two forms helps tease out the motivations of contributors to each, we suggest that crowds and communities are not distinct forms but instead reside at two ends of a continuum of organizing for collective action online (Haythornthwaite, 2009). This view helps in articulating what purpose each type of collective serves and what motivates participation in crowd- and community-based initiatives and has implications for the kinds of structures that support wikis with their dual crowd and community aspects. The following outlines this idea of a continuum of contributory behavior.

Starting with the crowdsourced end of the continuum, we take it as an integral part of this type of organizing that participants—at least at the beginning—have no association with each other. Because the contributors do not know each other, a necessary condition is that some authority must exist that is organizing the project.

Thus, a minimum requirement is for an authority to exist beyond the potential crowd of contributors who organizes and operates the system that provides a way for individuals to contribute to the common effort. In this way, the crowdsourcing application acts as a *latent tie structure* (Haythornthwaite, 2002, 2005b), that is, a common ground on which ties may develop. But although associations may arise among individuals, a key to crowdsourced participation is that the enterprise as a whole requires no such interaction among participants. By contrast, although a community-based initiative may also start with the latent tie structure (and indeed is most likely to), it succeeds only when interpersonal ties develop, as in online support groups, knowledge communities, and so on. Community forms of organizing need to turn latent ties into weak and stronger ties and need at least a critical mass of persistent, internal strong ties (Bruckman & Jensen, 2002).

Contemporary online productions tend to show characteristics of both crowd-like and community-like forms of organizing. A wiki may include contributors who treat the site as a place to visit, make a contribution, and leave. Others may see the site as a place to contribute, discuss, and find people with common interest with whom they begin a continuing relationship. Since people tend to enjoy connecting with others, community aspects often emerge around even the most strictly crowdsourced activity. One example is the way a site such as DC Vault (http://www.dc-vault.com/) provides a place to tally and "brag" about contributions of computer time to distributed computing initiatives, thus making a way for humans to connect even around applications that require only the most instrumental and independent of contributions.

Because, on one hand, aspects of community so often emerge around crowdsourced activity and, on the other, individuals can drop into an online community as if they were a member of a crowd, it is at this point that we want to move away from the terminology of *crowd* and *community*. Here the terms *lightweight* and *heavyweight* are used to refer to the two overlapping forms of organizing and participation, where *weight* refers to the demand on participant commitment and engagement (i.e., *weight* is not used to signify the importance of the product or enterprise itself, which may vary from entertainment to critical societal impact). The change in terminology is important for disassociating particular applications, technologies, and connotations from the underlying principles that structure the continuum of participatory behavior. For example, to talk about Wikipedia as a crowdsourced initiative made up of contributions from disconnected individuals immediately brings up the issue of the engagement that happens on the talk pages as well as the internal hierarchy that monitors conformance to contribution standards. But it is still important to be able to discuss the structures of Wikipedia that facilitate crowdsourced operation so that motivations for contribution to both the lightweight and heavyweight collaboration can be defined and supported.

Lightweight. A few examples of the range of forms of organizing help situate an articulation of dimensions that distinguish light- from heavyweight collaborations. At what one might call the more extreme end of the lightweight-to-heavyweight continuum are applications of a highly impersonal nature, such as the well-known SETI@

home project (Search for Extraterrestrial Intelligence; http://setiathome.berkeley.edu/) or other applications using this kind of infrastructure (SETI operates on BOINC, the Berkeley Open Infrastructure for Network Computing). Key here is that any individual on his or her own can download the software and set his or her computer to participate; no interaction among participants is needed. More human-oriented applications include those soliciting contributions for tasks people perform better than computers. An early example is found in NASA Clickworkers initiatives. In various active and inactive programs, participants have been invited to identify craters on lunar surfaces, craters on Mars, hominid fossils in Africa (Alexander, 2008; http://planetary.org), and galaxy formations (http://www.galaxyzoo.org/). Other such human sense-making applications address verifying text. Distributed Proofreaders (http://www.pgdp.net/c), for example, asks for human input in correcting text from digitized public domain books, and implementations of CAPTCHA (Completely Automated Public Turing Test to Tell Computers and Humans Apart; used to verify a human versus machine accessing a site by having the human type in a word that is difficult for a machine to read) may also add a second word that is used to help identify a word in optical character recognition–captured data (Gugliotta, 2011; von Ahn, Maurer, McMillen, Abraham, & Blum, 2008). Lightweight collaborations are becoming increasingly popular for citizen science, for example, in projects including human biology (e.g., 23andMe and the companion 23andWe) and environmental monitoring (http://www.naturewatch.ca/). Although many new and ongoing applications can be cited as examples of lightweight organizing, more general activities also fit the model outlined here, for example, citizen journalism, blogging, online commentary (particularly, the use of the "Like" button), and even the relatively mundane task of populating the web with resumes, project pages, and websites. Where contributions are independent yet building to a larger whole, they conform to the lightweight way of organizing.

Lightweight enterprises are not designed just for independent contribution; they are also designed to be simple and easy enough for as many of the crowd as possible to contribute, with little to no advance knowledge or training needed and low commitment to the amount of contribution or duration of engagement. The lightweight side underpins the whole idea of wikis and open, collaborative information resources. Thus, Wikipedia encourages contribution:

> Be bold in editing, moving, and modifying articles. Although it should be the aim, perfection is not required. Do not worry about making mistakes. In most cases, all prior versions of articles are kept, so there is no way that you can accidentally damage Wikipedia or irretrievably destroy content. (http://en.wikipedia.org/wiki/Wikipedia:5P)

Participation is encouraged and requires no conversation with others, no apprenticeship, and no need to wait for others' contributions before beginning. Mistakes likely to affect the beginner are downplayed, with encouragement to "be bold" and begin editing.

> Similarly, the Distributed Proofreaders site encourages lightweight participation:
>
> Remember that there is no commitment expected on this site beyond the understanding that you do your best. Proofread as often or as seldom as you like, and as many or as few pages as you like. We encourage people to do 'a page a day', but it's entirely up to you! We hope you will join us in our mission of 'preserving the literary history of the world in a freely available form for everyone to use'. (http://www.pgdp.net/c)

Minimal commitment is required in learning ("do your best") and effort ("do 'a page a day'"); "it's entirely up to you!"

The Distributed Proofreader's encouragement also demonstrates another aspect of many online peer productions, that is, an appeal to the greater good. Here the appeal is to two goods: "preserving the literary history of the world" in "a freely available form." This appeal to a greater good fits with Raymond's (1998) recognition of the "personal but shared need" that drives open-source initiatives. Whereas open-source initiatives have internal recognition systems, e.g., of experts versus novices, and thus as a whole are more like heavyweight (community) models, the personal-but-shared orientation also holds for lightweight models. Indeed, the orientation to a wider societal good may be even more important for lightweight models because there are no social bonds acting to keep attention to its operation. Thus, a co-orientation to a wider societal goal may be the only motivator at the lightest end of the continuum. Hence, we suggest that a co-orientation to wider concerns—such as preserving the literary or physical world, exploring outer space, or promoting science, political activism, open access, and so on—is particularly important for lightweight collaborations. We return to this with evidence for this position in the results on motivations revealed in the study of OSM.

The particular examples mentioned are meant to show applications that, in principle, require no person-to-person interaction among contributors. Individuals are encouraged to add information, observations, and so on to sites but are not promised and are not led to expect feedback or summaries of contribution. Although we note that community aspects do emerge from lightweight designs, for example, in the bragging rights associated with gaining "credits" for contributions to BOINC projects and the conversations that appear on the talk pages that accompany wikis, these activities are not needed or essential to the crowdsourced design. In each case, unconnected individuals can turn independently to the technology and the online sphere to donate time or add information in support of a collectively recognized purpose.

The terms *lightweight* and *heavyweight* are used to refer to a *way of organizing*, a structure on which individual contributions are aggregated into a whole and not to one particular application or to a particular type of technology; for example, what is addressed is not the place of Twitter on the lightweight-to-heavyweight continuum but is instead the place of particular forms of purposeful organizing along a continuum of participant relationships.

So far, we see the following attributes as evident in lightweight forms of organizing:

- Contributors who do not know and do not need to know each other and have no expectation of a continuing relationship with others
- Contributions of a similar kind, easy to submit, requiring little learning, and independent of every other contribution
- Control by a central authority that determines how contributions will be made, what is required for a contribution, what rewards (if any) are available to contributors, and how contributions will be used
- Contributions that lend themselves to statistical aggregation of results, and recognition systems (if any) can be based on quantity of contribution
- Motivation predicated on personal interest or need but with attachment to a wider societal concern.

Heavyweight. Continuing on from the lightweight model to examples of heavyweight collaborations diversifies the discussion to consider open-source projects, such as Linux, Wikipedia, Apache; online communities, such as the Well (Rheingold, 2000) and Livejournal; online support groups and patient communities (e.g., PatientsLikeMe; http://www.patientslikeme.com); e-learning communities; gaming communities, such as *World of Warcraft* or the *Age of Mythology* (Gee, 2005); and the conduct of academic disciplines, particularly in publication and review practices (Haythornthwaite, 2009). To describe the features of heavyweight organizing in full requires a review of concepts from a variety of areas, including community and online community (e.g., Haythornthwaite, 2007; Matzat, 2004; Preece & Maloney-Krichmar, 2005; Sassenberg, 2002; Wellman, 1999), collective action (Van Zomeren & Iyer, 2009), group behavior (e.g., Poole & Hollingshead, 2005), collaboration (Haythornthwaite, 2005a, 2006), and communities of practice (Wenger, 1998). Although a review of such scope is beyond this article, some consideration of online communities can help show differences between lightweight and heavyweight forms of organizing.

Core to communities is attention to what is done by others within the community. What others do, and what others think of what the contributor does, is of high importance. Some key elements of heavyweight forms of organizing, both online and offline, include the internal establishment of norms and rules of behavior, development of roles, and the enactment of reward structures and rituals. Contrast this with the intent of a lightweight enterprise, where the goal is for input without evaluation by others and without a need to watch and monitor what others are doing. Heavyweight enterprises follow patterns of interaction associated with communities, including known membership, persistent identity, and hierarchies of expertise; behaviors conform to social norms that are set and monitored by community members; ways of gaining status are known and awarded from within. Success of such enterprises requires commitment and adherence to group norms as well as to the goals of the overall enterprise.

Communities—aka heavyweight enterprises—fail when norms are seriously violated (e.g., trolls; Dibbell, 1996) and/or when the community fails to build internal relationships (Bruckman & Jensen, 2002).

As described elsewhere (Haythornthwaite, 2009, 2011b), the academic world is a prime example of a heavyweight enterprise. Members of the community are known and visible to each other, recognized by name through their research and publications; the promotion and tenure system rewards community-sanctioned activity and establishes a hierarchy of titles and positions. Academics also demonstrate strong association with wider societal concerns, which has been particularly evident recently in a concern for open science and open access to research findings and publications (e.g., as evidenced by the growth of open-access journals and institutional repositories and organizations such as the Scholarly Publishing and Academic Resources Coalition [http://www.arl.org/sparc/] and the Public Knowledge Project [http://pkp.sfu.ca/]).

Design for collaboration in a heavyweight manner received a lot of attention when online communities first appeared. The question was how there could be a sense of community among individuals who were communicating only online, through media that did not replicate the full nuance of face-to-face cues. Much work has gone into finding both technical and social ways to enhance the richness, engagement, and sense of being there experienced in online environments and to creating the attention to others necessary for a heavyweight operation. Only more recently has there been consideration of multiple and partial memberships in these communities, suggesting that some participants are using the heavyweight enterprises in a lightweight fashion, for example, reading postings, or making infrequent minor contributions to content, rather than being concerned with the ongoing norms and practices of the enterprise. Thus, again, the distinction between lightweight and heavyweight is made to refer to different modes of design and engagement, not to particular instances of online communities.

The following attributes are evident in heavyweight forms of organizing:

- Contributors who know and need to know each other, have a strong expectation of a continuing relationship with others, and are differentiated by expertise, role, and so on
- Contributions of different kinds, requiring apprenticeship and learning, building on, and fitting with others' contributions
- Control by group consensus that determines how contributions will be made, judged, and rewarded as well as how individuals will be recognized for contributions
- Contributions that do not lend themselves to statistical aggregation of results but instead require discussion and consensus; recognition systems that are based on judged quality of contribution and where the recognized status of the evaluator matters in judgments of quality
- Motivation predicated on personal interest or need, with attachment to a wider societal concern but also by orientation to the group and its norms, members, and network of affiliations

Lightweight and heavyweight. In summary, the theoretical underpinning derived from research and literature suggests two ways of organizing are in operation for online collaborations: (a) an independent, crowdsourced way of organizing that functions through centralized authority control and contributions from unconnected participants and (b) an interrelated, community-sourced way of organizing that functions through consensual control and contribution from participants who are visible and known to each other. The background review also suggests that regardless of design, individuals may engage with online collaborations in a lightweight or heavyweight manner. Overall, this suggests that differences will be found, and/or need to be harnessed, when considering motivations to contribute to open collaborations.

Wikis provide probably the clearest case where both models of organizing coexist: lightweight features, such as simple, similar contributions, favor quick and easy participation; heavyweight features, such as discussion pages and a critical mass of others for discussion, favor longer-lasting engagement with the enterprise and the community of participants. As open-source/open-access operations, wikis are expected to conform well to motivations around public interest, and participants can be expected to exhibit a personal-but-shared co-orientation to the overall purpose of the project at its wider societal level, with concerns with the local instance and community becoming important as a project develops more community-like features. To examine how these ideas hold among users of an open-source wiki, we turn to motivational factors for contribution in the case of the voluntary geographic information application OpenStreetMap (OSM).

VGI

Geographic information forms a basic infrastructure underpinning a wide range of decision making in society (Executive Office of the President, 1994; Groot & McLaughlin, 2000). Yet, until recently, the creation of maps has required expensive equipment and specialized expertise, and control has resided with government mapping agencies and commercial mapping companies. Declining cost and wider prevalence of portable digital devices with GPS capabilities has expedited the move to Internet-based contribution to VGI applications. Motivation to contribute stems from an interest in geography and/or mapping but also an awareness of the limitations of existing map data. The belief that the world is well mapped and that maps are constantly updated for better accuracy is a *mapping myth* (Estes & Mooneyhan, 1994). Government and commercial interests have taken priority, and consequently, certain areas are mapped whereas others are not, and certain features are represented on the maps whereas others are ignored (Wood & Fels, 1992). Recent disasters have also highlighted how the landscape may change quickly, requiring almost real-time information to understand and monitor the geographic situation, as in the Haiti earthquake in 2010 (Richmond, 2010) and the Japanese tsunami in 2011.

To assess potential motivators for participation and contribution relating to VGI, Budhathoki and colleagues (Budhathoki et al., 2008, 2010) reviewed literature in three areas of voluntary participation in knowledge production environments: *volunteerism*,

a foundational concept in VGI (Elwood, 2008; Goodchild, 2007), which provided psychological concepts and models for motivations to volunteer (Clary et al., 1998; Clary & Synder, 1999; Finkelstein, Penner, & Brannick, 2005; Houle, Sagarin, & Kaplan, 2005); *leisure studies*, which is relevant since participation in VGI is commonly a leisure rather than work activity (Brown, 2008; Jones & Symon, 2001; Stebbins, 2006); and *social production of knowledge*, which addresses projects based on open source and open access that parallel the knowledge production and resource sharing of VGIs (Benkler, 2006; Hertel, Konradt, & Orlikowski, 2004; Hertel, Niedner, & Herrmann, 2003; Sproull & Kiesler, 2005; Wasko & Faraj, 2005). This review yielded a comprehensive list of potential intrinsic and extrinsic motivators (Table 1) and a theoretical basis for understanding motivations that was used to design the survey instrument on motivation.

OSM

> OpenStreetMap is a free editable map of the whole world. It is made by people like you. OpenStreetMap allows you to view, edit and use geographical data in a collaborative way from anywhere on Earth. (http://www.openstreetmap.org/)

OSM was chosen as the research site as it is frequently cited as one of the most successful VGI projects within the geographic information system (GIS) community (Budhathoki et al., 2010; Goodchild, 2007; Haklay, 2010). The project was founded in 2004 with the goal of collecting geographic data that can be freely edited and used and aims to meet the geographic information needs of small businesses, nonprofits, and individual users who cannot access traditional sources because of cost or other restrictions (Haklay & Weber, 2008). OSM first started in London, England, but now involves people from around the globe. At the start of this study, there were 120,000 registered OSM users; as of March 2012, there are just more than 573,000 users. We chose to study a geographic wiki as it expands both our understanding of more diverse wiki systems (e.g., beyond encyclopedias) and of geographic wiki systems.

The OSM community of volunteers contributes to different aspects of the project. Contributors may contribute geographic information by using GPS-enabled handheld devices to measure the locations of the earth's features and to upload that information; digitize on-screen features using satellite imagery; upload freely available information, such as street networks in the United States; and label features created by other users. Many volunteers build the geographic database and online maps, and others help develop and maintain the underlying technical infrastructure, such as software code for tools for uploading data, editing and rendering maps, maintaining transaction history, and implementing tagging schemas. Yet others participate in talk-page discussions that contribute to crucial decisions related to community norms.

Participants choose the task to volunteer for; that is, there is no central individual or group determining and delegating tasks. Even a complex task, such as the

Table 1. Potential Motivators for Contribution to Volunteered Geographic Information Projects.

Intrinsic	Extrinsic
Unique ethos: Distinguishing ideals, values, sentiments, or guiding beliefs shared by volunteers	Career: Opportunity to demonstrate skills for future jobs, commercial activities, financial capital
Learning: Opportunity to learn from own and others' experiences	Social relations: Opportunity to strengthen social relations
Personal enrichment: Opportunity to increase intellectual or spiritual resources	Project goal: Engagement depends on perceived likelihood of project success
Self-actualization: Development and application of talents, capacities, potential	Community: Engagement in support of community maintenance, development, coherence
Self-expression: Opportunity to express skills, abilities, individuality	Identity: Engagement supports identity formation
Self-image: Enhanced through the expression of unique skills, abilities, knowledge	Reputation: Engagement depends on enhancement of reputation
Fun: Hedonic gains derived from the pleasure of creation; profound and fulfilling satisfaction of desires	Monetary return: Engagement depends on direct monetary benefit
Recreation: Gaining a sense of renewal, regeneration, or reinvigoration	Reciprocity: Engagement depends on reciprocal benefit or expectation of reciprocity
Instrumentality: Belief that contribution is crucial to the goal of the project	System trust: Engagement depends on trust in technical infrastructure.
Self-efficacy: Belief that contributor has knowledge and skills to meet the expectation of others in the team	Networking: Engagement depends on ability to make connections with others
Meeting own need: Collective development of product/service to meet personal need	Sociopolitical: Opportunity to engage with, advance sociopolitical motives
Freedom to express: Opportunity to have freedom to choose tasks and exercise personal creativity	
Altruism: Opportunity to add to the common good	

Source: Paraphrased from Budhathoki, Nedović-Budić, and Bruce (2010).

development of a taxonomy of real-world objects and feature classes, is driven by the community: Anyone is free to propose a new tag to describe a real-world feature or update an existing tag (Haklay & Weber, 2008). Unlike professional GIS development, there are no a priori defined standards. As need arises, a community member makes a proposal and the community discusses and decides on it.

OSM participants are not always only online; many users meet face-to-face for an OSM "mapping party." These are announced and coordinated using the OSM wiki, which is provided as a part of the OSM interface. Users meet at a certain location in the community, get to know each other, share experiences, and spend some time exploring and mapping the community; such meetings help in satisfying social and learning needs of many users, for example, in how to use GPS technology and how to contribute to OSM.

Researching Motivational Factors

Development of the Survey

The potential motivational factors identified by Budhathoki et al. (2010) were used as a theoretical guide in the survey development. In addition, prior to the development of the survey instrument, approximately 3,000 text messages of users' conversations as archived in OSM talk pages were analyzed to gain insight into users' motivations to contextualize for OSM the literature-suggested motivational factors in VGI. Results from the qualitative analysis were used to determine the relative importance of the motivating factors derived from the literature review. (For details on the qualitative analysis, see Budhathoki, 2010).

A total of 44 items were used to measure 22 of 24 motivational factors identified by Budhathoki et al. (2010). The focus here is on results of 39 questions from the 44 items used in the survey (4 items were dropped because they were completed by only a small subset of users, and 1 was not addressing motivation). All items were measured using a 7-point Likert-type scale with 1 as *strongly disagree* and 7 as *strongly agree*. Thus, a high score indicates that individuals considered the item to be highly important as a motivator for their perception of and contribution behavior in OSM.

Identification of contributors and recruitment for survey. When this research began in April 2009, there were approximately 120,000 registered users in OSM but a smaller number of contributors. To identify contributors from the pool of the registered users, data on contributions were downloaded from OSM (http://downloads.cloudmade.com/). The data consisted of user-contributed geographic data (latitude/longitude values), contributor user name, and time of contribution. Data on 33,440 contributors were extracted, along with the total number of nodes each contributed, the contributor's first and last date of contributions, and the number of distinct days of contribution between these dates. This number was further reduced to the 31,015 contributors who could be reached using the OSM messaging system. With permission of OSM, in December 2009, the survey was distributed with a message sent to all 31,015 contributors of the OSM directing them to a URL for the online survey implemented in Survey Monkey. A reminder notice was sent 2 weeks later. The survey was open for about a month, with responses stored on the survey site.

A total of 459 responses were received, of which 444 were valid after removing duplicate responses as identified by a personal identification number given to each

respondent. To estimate nonresponse bias, the number of survey respondents contributing was compared to the total number contributing by region. Results showed that the proportion of respondents resembled the proportion of contributors by region for all areas except South America, an area with no survey respondents: Africa (1.4% of contributors vs. 6.5% of the sample), Asia (5.8% vs. 3.6%), North America (10.6% vs. 9.2%), South America (2.1% vs. 0%), and Europe (74.5% vs. 71.2%).

Respondents were mainly young (64.6% between 20 and 40), male (96.2%), with some college education or more (95%), employed full-time (61.2%) primarily in the commercial sector (72.0%), and living in Europe (80.2%); respondents contributed most often from home (72.0%) rather than work (Table 2). Supporting ideas posited by Budhathoki et al. (2008) and Haythornthwaite (2009) that contributors would have a strong co-orientation to open source and open access, OSM contributors show widespread involvement in open source, with the majority of contributors having participated in open-source software projects (60.3%) and/or contributed to Wikipedia (71.5%).

As is often the case in participation patterns, a majority of contributors add a small number of contributions, whereas only a few provide a large number of contributions (Ortega, Gonzalez-Barahona, & Robles, 2008). Log data showed that in OSM, respondents had contributed from 1 to 1 million nodes, with 20% providing fewer than 10 nodes, 60% providing 10 to 4,000 nodes, and 20% contributing 4,000 nodes or more. These data were taken as a starting point for examining differences in motivations between those who contribute little—and thus are expected to exhibit motivations associated with lightweight engagement with OSM—and those who contribute a lot—and are expected to exhibit motivations associated with a heavyweight engagement.

Serious versus casual mappers. To pursue differences in motivation by participation, OSM contributors were classified into two broad groups: serious and casual mappers. Serious mappers were identified on the basis of being at least two standard deviations from the mean or higher in (a) number of nodes contributed and/or (b) longevity of contribution (i.e., the difference in date between the last and first contribution) and/or (c) number of days of contribution during the period of longevity (i.e., frequency of contribution). To create the sets, we excluded as outliers those who had contributed millions of nodes, for example, through uploading from freely available GIS data. Of the remaining 406 respondents, 63 (15.5%) fit this definition of *serious mapper* (compared to 11.3% across all contributors), and 343 fit the definition of *casual mapper*. By using more than contribution rate, this classification aims to provide insight into different kinds of motivations for contributing on the basis of commitment to OSM and to see how these conform to ideas suggested by the lightweight and heavyweight models of organizing.

Motivations to Contribute Geographic Information

Results for the Likert-type scale judgments of the motivation to contribute for 39 questions as reported by all 444 participants, and by the 63 serious and 343 casual

Table 2. Respondent Demographics.

Variable	%
Age	
Younger than 20 years	3.8
20-30 years	32.2
31-40 years	32.4
41-50 years	21.3
Older than 50 years	10.4
Gender	
Male	92.6
Female	2.7
Not reported	1.1
Education	
High school or less	5
Some college	17
College/university degree	49
Postgraduate/doctorate	29
Location by continent	
Europe	80.2
North America	10.9
Africa	5.2
Asia	2.4
Australia	0.5
South America	0.0
Employment	
Full-time employee	61.2
Part-time employee	9.1
Freelance	11.8
Student	12.4
Retired	2.2
Other	3.3
Sector	
Commercial	71.6
Government	12.2
Academia	10.8
Nonprofit	2.3
Other	3.2
Location when contributing	
Home	72.0
Office	2.7
Professional GIS experience	
None	50.5
Some	25.1
1-5 years	14.8
6-10 years	6.6
More than 10 years	3.0
Open-source contribution	
Software	60.3
Wikipedia	71.5
OSM contribution[a]	
Fewer than 10 nodes	20
10-4,000 nodes	60
More than 4,000 nodes	20

Note: N = 444 respondents. GIS = geographic information system.
[a]Derived from log data rather than the questionnaire.

mappers, are presented in Table 3. To consider the overlap among questions, we performed a factor analysis on the 444 responses that resulted in the identification of seven motivational constructs relating to monetary reward, learning, self-efficacy regarding local knowledge, personal promotion, altruism, project goal, and personal need. Of the 39 items, 23 were retained through the factor loading and reliability checking; the remaining 16 items did not load on any factors (Table 4; see also Budhathoki, 2010).

Considering answers from all participants, we found the highest motivations for questions about (a) the importance of the community to success of the OSM project, (b) the goals of the project (three items loading on the project goal factors), and (c) the general ethos of altruism (three items loading on the altruism factor). All but one item among these is equally important to serious and casual mappers. The exception is one of only two items that casual mappers report as significantly more important to them than do the serious mappers. The item is "It is important to help others by providing digital maps that are available for free." As a first example of the difference between serious and casual mappers, this appears to support the ideas regarding lightweight models and motivators, that is, that a lightweight or casual user will find overall orientation to wider societal impacts highly and possibly more important than serious mappers, as this is one of a smaller set of motivators for such contributors. More on this appears later.

Also high on the list are items associated with (d) confidence in local knowledge and contribution in relation to OSM (one independent item not loading on any factor and three items loading on the knowledge factor). Perhaps not surprisingly, serious mappers find these items significantly more important than do casual mappers, in keeping with ideas of self-efficacy. Those who know what they are doing, and are confident in it, either are or become the serious contributors. Serious mappers' greater confidence may also be what makes their experience more fun, accounting for why answers to "I enjoy contributing to OSM" load with items relating to self-efficacy regarding local knowledge. Although these answers do not reveal whether prior knowledge or knowledge acquired while using the system help promote confidence and contribution, from a design perspective, it suggests that it may be desirable to address self-efficacy in helping casual contributors become confident serious contributors.

A series of individual questions follow in the list with high motivation scores. First is contributing because mappers have the freedom to select the areas to map. This might be related to self-efficacy if the knowledge they hold is not local to where they live. Trust that the system will keep contributions safe technically is next. This is an interesting aspect for systems where effort may be wasted if the code fails. Third is the fun aspect of the visual nature of mapping. Motivational aspects thought to relate to fun appear both separately and with other factors. This shows that "fun" by itself is not a single motivator. Fun fits here with local knowledge, with learning ("I find maps fascinating"), and separately as enjoyment of visual display and computer use ("Entering data on the computer . . .").

Table 3. Motivational Items and Results for All Respondents and for Serious and Casual Mappers.

Item Number	Measurement Item	Motivation as Derived From the Literature	Factor Analysis	Factor *M* or All *M*	All		Serious		Casual		*p*
					M	*SD*	*M*	*SD*	*M*	*SD*	
37	OSM will not succeed in developing a world map without the community.	Community		6.16	6.16	1.108	6.30	0.87	6.12	1.14	.248
27	Digital map data should be available for free.	Unique ethos	P	6.14	6.45	0.897	6.36	1.02	6.46	0.90	.432
29	I believe that "Free Wiki World Map," which is the goal of OSM, is achievable.	Project goal	P	6.14	5.97	0.93	5.98	0.78	5.96	0.94	.857
30	I believe in "Free Wiki World Map", which is the goal of the OSM project.	Project goal	P	6.14	5.95	1.053	5.85	1.05	6.00	1.02	.281
38	I contribute to OSM because I can provide accurate information from my local knowledge.	Instrumentality of local knowledge		6.01	6.01	0.964	5.93	0.84	6.02	0.98	.509
24	It is important to help others by providing digital maps that are available for free.	Altruism	A	5.73	6.13	0.864	5.91	0.89	6.17	0.85	.033*
25	I contribute to OSM because those who are in need of digital map data will use my contribution.	Altruism	A	5.73	5.87	1.039	5.92	1.00	5.85	1.06	.646
26	I expect OSM users to actively contribute geographic data to the project.	Reciprocity	A	5.73	5.24	1.324	5.07	1.11	5.28	1.35	.247
13	I enjoy contributing to OSM.	Fun	K	5.58	6.00	0.938	6.25	0.74	5.88	1.00	<.005**
11	When I see information about the places I know missing from OSM, I map them.	Instrumentality of local knowledge	K	5.58	5.41	1.088	5.83	0.91	5.30	1.10	<.000**

(continued)

Table 3. (continued)

Item Number	Measurement Item	Motivation as Derived From the Literature	Factor Analysis	Factor *M* or All *M*	All		Serious		Casual		
					M	*SD*	*M*	*SD*	*M*	*SD*	*p*
14	I think that my contributions are as good as those of others.	Self-efficacy	K	5.58	5.09	1.305	5.83	1.12	4.92	1.28	<.000**
12	When I see errors on the map for the area in which I live, I correct them.	Instrumentality of local knowledge	K	5.58	5.94	0.919	6.18	0.80	5.86	0.93	.014**
33	I contribute to OSM because I have the freedom to select the areas to map.	Freedom to express		5.50	5.50	1.121	5.47	1.11	5.51	1.12	.820
39	I trust that my contributions are safe with OSM, as its technical system is reliable.	System trust		5.47	5.47	1.022	5.39	1.14	5.48	0.99	.509
15	Seeing my contribution appear visually on OSM map provides me with a profound sense of satisfaction.	Fun		5.38	5.38	1.243	5.68	1.21	5.32	1.24	.041*
3	I find maps fascinating.	Fun	L	5.29	6.05	1.042	6.24	0.93	5.98	1.06	.073
4	OSM allows me to gain a new perspective about the area I live in.	Learning	L	5.29	5.28	1.348	5.65	1.29	5.17	1.36	.012**
2	Contributing to OSM lets me develop my mapping skills.	Learning	L	5.29	4.97	1.218	5.30	1.01	4.88	1.28	.020*
1	Contributing to OSM helps to develop a new perspective about the geography of the world.	Learning	L	5.29	4.80	1.272	5.16	1.26	4.69	1.28	<.009**
32	I contribute to OSM to create maps that can meet my needs.	Meeting personal needs	N	5.20	5.57	1.143	5.57	1.07	5.55	1.16	.908

(continued)

Table 3. (continued)

Item Number	Measurement Item	Motivation as Derived From the Literature	Factor Analysis	Factor *M* or All *M*	All		Serious		Casual		*p*
					M	*SD*	*M*	*SD*	*M*	*SD*	
31	I contribute to OSM because the map data I am looking for does not exist elsewhere.	Meeting personal needs	N	5.20	4.88	1.695	4.88	1.80	4.85	1.66	.912
36	Corporate control of digital maps is a concern to me.	Unique ethos		5.06	5.06	1.664	4.93	1.52	5.09	1.68	.487
6	Entering map data on the computer is an enjoyable part of my OSM experience.	Fun		4.98	4.98	1.301	5.16	1.19	4.94	1.32	.227
5	OSM has enabled me to use my mapping skills.	Self-actualization		4.43	4.43	1.539	5.03	1.40	4.30	1.54	<.001**
10	OSM community is important to me.	Community		4.25	4.25	1.420	4.90	1.20	4.10	1.42	<.000**
28	Contributing to OSM allows me to highlight social issues (these can be environmental, political or other social issues) that are important to me.	Socio-political		4.18	4.18	1.497	4.36	1.56	4.15	1.48	.331
23	Contributing to OSM lets me develop my technical skills through direct, hands-on experience.	Learning	I	4.04	4.58	1.304	4.85	1.35	4.53	1.29	.079
22	OSM experience will look good on my resume.	Career	I	4.04	3.86	1.327	4.09	1.01	3.82	1.42	.157
21	My friends and family value my contribution to OSM.	Social relation	I	4.04	3.71	1.263	3.78	1.06	3.67	1.29	.535

(continued)

Table 3. (continued)

Item Number	Measurement Item	Motivation as Derived From the Literature	Factor Analysis	Factor *M* or All *M*	All		Serious		Casual		
					M	*SD*	*M*	*SD*	*M*	*SD*	*p*
8	OSM has added richness to my life.	Personal enrichment		3.84	3.84	1.512	4.54	1.29	3.70	1.51	<.000**
16	I want to be recognized as an active OSM contributor.	Reputation		3.77	3.77	1.370	4.65	1.20	3.58	1.32	<.000**
35	Digital map data should be available for free only for noncommercial applications.	Unique ethos		3.55	3.55	1.942	2.51	1.58	3.74	1.94	<.000**
7	OSM has improved how I think about myself since I joined it.	Self-image		3.19	3.19	1.496	3.98	1.40	3.03	1.46	<.000**
9	OSM has given me a sense of identity.	Identity		2.96	2.96	1.500	3.46	1.38	2.86	1.50	<.004**
20	I use OSM to display my skills to potential employers.	Career	M	2.14	2.48	1.362	3.11	1.39	2.35	1.31	<.000**
19	I am planning a commercial business in the future using OSM data.	Monetary return	M	2.14	2.28	1.442	3.13	1.66	2.16	1.38	<.000**
17	I use OSM data in making profit in my business.	Monetary return	M	2.14	1.93	1.216	2.43	1.39	1.86	1.20	<.001**
18	I have benefited financially from my involvement in OSM.	Monetary return	M	2.14	1.78	1.205	2.24	1.48	1.68	1.13	<.001**
34	The right to use OSM data should be based on how much one has contributed to OSM.	Reciprocity		1.93	1.93	1.264	1.90	1.26	1.93	1.26	.874

Note: OSM = OpenStreetMap. Factors: P = project goal; I = personal promotion; N = personal need; K = self-efficacy regarding local knowledge; M = monetary reward; L = learning.
*$p < .05$. **$p < .01$.

Table 4. Factor Loadings and Reliability Test for Motivations.

Motivation Construct, Ordered by Eigenvalue (*M* and *SD*)	Factor Loading	Eigenvalue	% of Variance	Cumulative % of Variance	Cronbach's Alpha
Monetary reward (*M* = 2.14, *SD* = 1.06)		4.76	20.68	20.68	.79
I use OSM data in making profit in my business.	.87				
I have benefited financially from my involvement in OSM.	.78				
I am planning a commercial business in future using OSM data.	.77				
I use OSM to display my skills to potential employers.	.60				
Learning (*M* = 5.29, *SD* = 0.95)		2.70	11.77	32.45	.75
Contributing to OSM helps me to develop a new perspective about the geography of the world.	.80				
Contributing to OSM lets me develop my mapping skills.	.79				
OSM allows me to gain a new perspective about the area I live in.	.67				
I find maps fascinating.	.59				
Self-efficacy regarding local knowledge (*M* = 5.58, *SD* = 0.81)		1.94	8.43	40.88	.71
When I see information about the places I know missing from OSM, I map them.	.79				
When I see errors on the map for the area in which I live, I correct them.	.78				
I enjoy contributing to OSM.	.63				
I think that my contributions are as good as that of other users.	.59				
Project goal (*M* = 6.14, *SD* = 0.77)		1.54	6.68	47.57	.64
I believe that "Free Wiki World Map," which is the goal of OSM, is achievable.	.84				
I believe in "Free Wiki World Map," which is the goal of the OSM project.	.76				
Digital map data should be available for free.	.49				
Altruism (*M* = 5.73, *SD* = 0.83)		1.27	5.54	53.10	.59
I contribute to OSM because those who are in need of digital map data will use my contribution.	.74				
It is important to help others by providing digital maps that are available for free.	.72				

(continued)

Table 4. (continued)

Motivation Construct, Ordered by Eigenvalue (*M* and *SD*)	Factor Loading	Eigenvalue	% of Variance	Cumulative % of Variance	Cronbach's Alpha
I expect OSM users to actively contribute geographic data to the project.	.64				
Personal promotion (*M* = 4.04, *SD* = 1.00)		1.14	4.95	58.05	.59
OSM experience will look good in my resume.	.72				
My friends and family value my contribution to OSM.	.71				
Contributing to OSM lets me develop my technical skills through direct, hands-on experience.	.53				
Personal need (*M* = 5.20, *SD* = 1.19)		.97	4.26	62.28	.50
I contribute to OSM because the map data I am looking for does not exist elsewhere.	.82				
I contribute to OSM to create map data that meet my need.	.73				

Note: OSM = OpenStreetMap. Extraction method was principle component analysis; rotation method was varimax with Kaiser normalization. Although the alpha for personal need is slightly lower than the 0.6 recommended threshold (Nunnally, 1967), the motivational construct is considered, as the literature suggests that personal need is one of the motivators for knowledge contribution in an online community. Thus, whereas the first six factors emerged from factor analysis, the seventh factor can be said to be suggested. (For the correlation matrix of the 23 motivational items, and more on this analysis, see Budhathoki, 2010.)

A set of items relating to learning (four items loading on the learning factor) appear next in the ordering of motivations, with serious mappers reporting significantly greater motivation derived from learning new perspectives about the world and about the area in which they live. That serious mappers find this more motivating than casual mappers suggests a tie-in to the ideas of self-efficacy and knowledge. Together, these build a profile of serious mappers as more keen to learn and develop knowledge that leads them to be informed and confident contributors.

Next are two items relating to contributing because of a personal need for map data (loading on the personal-needs factor). This is equally motivating for all mappers, suggesting personal need as a common entry point for contributing and supporting ideas from Raymond (1998) and Benkler (2006) about a personal-but-shared need driving open-source contribution.

Anticorporate sentiment is a further relatively high motivator (above 5 on the 7-point Likert-type scale) and resonates with ideas that the information provided should be freely available for use. A similar item, "Digital map data should be available for free only for non-commercial applications," appears as a stronger motivator for casual than for serious mappers. Overall, serious mappers are less commercially averse than casual

mappers. Although all respondents rate monetary outcomes as low or non-motivators (scores of 1.78 to 2.48 on the 7-point Likert-type scale), for all four items that load on the factor associated with monetary and career outcomes (monetary reward), scores for serious mappers are significantly higher than for casual mappers. This factor also relates to personal need, including aspects of benefiting financially, making a profit in business, planning a commercial business, and displaying skills to potential employers.

Of the remaining items, three seemingly different motivators load on a factor relating to individual outcomes (loading on the personal promotion factor): being acknowledged by friends and family, improving one's résumé, and gaining hands-on technical experience. Scores on these are relatively neutral (4 on the 7-point Likert-type scale), with no difference between serious and casual mappers.

Discussion

It was conjectured that differences in motivations exhibited by these two classes of contributors would reflect motivations relating to lightweight versus heavyweight models of organizing and contributing, that is, that lightweight contributors would show more concern with wider societal factors, whereas heavyweight contributors would maintain this concern but also be oriented to the internal working of the community. Overall, differences are evident across these two classifications of contributors: 21 of the 39 motivation items were found to be significantly different for serious versus casual mappers. More differences were found for items on the lower end of the motivation scale (e.g., scores of 4 and lower), and only in two cases were items more significant for casual than for serious mappers.

The results show that, in keeping with ideas associated with the lightweight model, casual mappers are more co-oriented to overall goals of open-source projects. Although in most cases serious mappers report significantly higher motivation for items, it is casual mappers who find these two items more highly motivating:

- "It is important to help others by providing digital maps that are available for free" (serious mappers, mean = 5.91; casual, mean = 6.17).
- "Digital map data should be available for free only for noncommercial applications" (serious mappers, mean = 2.51; casual, mean = 3.74).

As argued earlier, on the lightweight side, where individuals do not have knowledge of or interact with others in the community, the primary motivation is going to be toward some general idea rather than interpersonal contact. Thus, for a lightweight contributor, the importance of the general social or information ideal is greater because there is less interpersonal and varied engagement to generate other motivations.

Serious mappers appear to temper their high motivations to open access and the project with attention to career. Although career consideration is a low motivator for all users, as noted earlier, serious mappers report career outcomes loading on the monetary-reward factor as more motivating to them than do casual mappers. When

these results are considered together with their motivation on the item "Digital map data should be available for free only for noncommercial applications" (which serious mappers report as less motivating than do casual mappers), their career-related motivation becomes even more clear. This is not unexpected. Serious mappers spend considerable time and effort on OSM contribution and, thus, require some way of translating that effort to make a living. Indeed, a few active mappers have started their own business company that uses OSM data, and the founder of OSM, Steve Coast, has joined Microsoft to work with Bing Maps.

In keeping with ideas of the heavyweight model, serious mappers are more co-oriented to the community than are casual mappers, answering with significantly higher motivation scores than casual mappers for questions of the importance of community ("OSM community is important to me") and of recognition by the community ("I want to be recognized as an active OSM contributor"). These questions capture the importance of the community to the individual but also the importance of visibility and making a place within the community—work that requires attention to and adherence to social norms and awareness of recognition and reward systems operating within OSM. Thus, in considering design for the serious mapper, it would appear to be important to provide means for both knowing what is happening in the community and making oneself recognizable in the community.

Geography is, of course, a communitywide motivator, and both casual and serious mappers are well motivated by an overall orientation and concern with mapping and geography and particularly by contributing to local geography. However, serious mappers are more highly motivated by this than are casual mappers, with higher scores relating to gaining new perspectives, filling gaps, and correcting errors. What seems to be appearing here is a co-orientation by serious mappers to community-specific goals, such as completeness and accuracy, as might be expected as community goals become more relevant to community-oriented participants. It may also mean that as individuals, serious mappers more strongly identify with the project, including both its outcome as a successful and respected project and their contributory status in such a project. After all, as they have concurred, "OSM will not succeed in developing a world map without the community" (the highest ranked motivation; see Table 3). Identification with such goals can be expected to come more strongly into play for those who are themselves more seriously engaged with the community, as is demonstrated here.

The differences between casual and serious mappers seem to reflect interest and self-efficacy in the global versus the local. Ways of tapping into casual mappers' interest and knowledge may be effected through building confidence by capitalizing on local knowledge. Seeing errors on a map of their local area is a particularly highly motivating factor for both kinds of mappers (means of 6.18 and 5.86 for serious and casual mappers). This may be related to self-efficacy: Serious mappers report more that "I think that my contributions are as good as that of other users," and casual mappers with knowledge of an area may overcome their inhibitions when confident in the information they can contribute. Structured ways of building confidence may be an

important design consideration, as would be attention to what information can be provided confidently by a new contributor, such as local and personal knowledge. Confidence might also be built socially through positive feedback by experienced mappers or through systems that provide feedback and/or allow a novice contributor to follow his or her progress in a private, individual manner rather than in public listings.

One important aspect of feedback highlighted in the OSM VGI case is the visual appeal of maps and visualizations. Contributors can see errors and missing places in a way that immediately attracts attention, and filling those gaps provides satisfaction. Although usual for geography and VGI applications, visualization of information patterns and omissions may serve as equally motivating factors in other domains, suggesting design for wikis that incorporates more visual input and display.

Capitalizing on the potential of local knowledge as a motivator, and as an area of participation with confidence, has a variety of implications for development, local governance, and citizen engagement. Since most problems are local, when citizens are willing to contribute their local knowledge, government and other development interventions have great opportunity to capitalize on citizens' knowledge in addressing problems that government cannot solve alone or are too costly to solve (e.g., gaining local knowledge during disasters). Thus, tapping into local knowledge is an important goal for wikis and VGI systems.

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