The motivational arc of massive virtual collaboration[1]

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Abstract

Massive virtual collaborations (MVC) involve large numbers of mostly unpaid contributors collectively creating new content. Wikipedia is the most dramatic example of MVC; smaller-scale examples include blogs and discussion groups and free/libre open source software (FLOSS) projects. In this paper, we propose a model of motivations for contribution to MVC that integrates various theoretical perspectives to extend prior work. Specifically, we distinguish three different levels of contribution to projects (initial, sustained and meta) and capture the dynamic and recursive effects of contributions on emergent individual and project states.

Keywords: Massive virtual collaboration; motivation; Wikipedia; free/libre open source software.

Introduction

The Internet has facilitated a new era of human collaboration. Novel information and communication technologies, supporting online community spaces and shared information resources, have made possible a new mode of coordinated effort among contributors, which we call "massive virtual collaboration" (MVC). The term massive virtual collaboration highlights the following signal features of these phenomena:

1. large numbers of distributed contributors, commensurate with the popularity of the activity but ranging from dozens to tens of thousands or more;
2. mostly unpaid contribution by contributors, for reasons subject to much speculation but less data; and
3. jointly focused activity, in which contributors collectively innovate new content, structure, presentation, and/or computer software with possible value to some larger audience.

Wikipedia is the most dramatic example of MVC. This online encyclopaedia has expanded rapidly (over seven million articles in more than 200 languages) due to the huge number of text contributions from voluntary contributors (more than 6 million account holders) who help to develop and edit content for the site. However, MVC also includes smaller-scale collaborations, such as blogs and discussion groups on a wide variety of topics, evaluations of products or posts on sites like Amazon or Slashdot, and the free/libre open source software (FLOSS) projects that bring together teams of programmers and users who contribute software and documentation.

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Because the success of MVC depends on contribution from voluntary participants, motives for voluntary contribution have been a consistent topic of research in these various settings. Researchers have identified a variety of factors that motivate contribution and thus lead to increased membership and quantity of output, as we review below. By contribution, we mean the effort that is given by individual volunteers to create the collective good produced by the MVC, such as articles or text for Wikis and blogs; software, documentation, bug reports or tests results for FLOSS; and even videos or other multimedia on sites such as YouTube. By motives, we mean factors that increase the probability that an individual will make a contribution. The purpose of this paper is to develop a model of motivation for MVC contribution that integrates various theoretical perspectives to make three advances over the current literature.

First, we note that understanding the motivations for MVC contributions is complicated by the great diversity in levels and nature of contribution. Researchers have noted that the distribution of contributions to MVC is typically quite skewed, with a few people doing the majority of work, and the majority doing little or none at all. For example, Mockus *et al.* (2000), in their study of the Apache community, observed that the top 15 contributors (out of 388 total) contributed over 83% of modification requests and 66% of problem reports. Similarly skewed distributions of contribution characterize other forms of MVC. On Wikipedia, only 25% of registered users have edited 10 times or more, and 2.4% of users have contributed 80% of the edits (Zachte, 2007). A similar pattern of unequally distributed contributions is found in most other kinds of voluntary organizations. For example, Reed and Selbee (2001) state that "in Canada in 2000, 18% of adults were responsible for 80% of all money donated to organized charities, 9% accounted for 80% of hours volunteered, and 21% accounted for 65% of civic participation."

Despite its ubiquity, this skewed pattern of contribution seems not to have been factored in to work on motivations in virtual collaborations, which generally tacitly assume that all contributors are alike, either in theorizing about motivations or in empirical study (one exception is Aigrain (2003), who does note the importance of recognizing different roles in an information community and providing each its suitable motivations). In response to this gap, our model distinguishes between three different levels of contribution, which we label initial, sustained and meta-contribution. The model addresses the evolution of contributors from one level to the next, in what we call the *motivational arc of contribution*, drawing on different theories to explain motivation to move to each level. Of course, the level of contribution varies continuously across members of a project, so any grouping into distinct categories is a theoretical abstraction. However, we argue that these groups do exhibit distinct patterns of involvement with different motivations, making the theoretical abstraction meaningful.

Second, we note that prior attempts to theorize motivation of contributors to MVC have generally considered the problem at an individual level, taking the project as a given context. This approach is an over-simplification because it is the contributions of developers that create the project context that motivates future contributions. Therefore, our model includes propositions concerning the effects of contributions on emergent states of the project as a whole and the effect of those states on motivations for contributions.

Finally, most prior models have been static, taking the state of the contributor and the project as fixed (an exception is Ye & Kishida, 2003). Again, this approach is problematic because contributors and projects evolve as the result of contributing, thus changing the context for future contributions. Therefore, our model includes propositions concerning the

dynamic and recursive effects of contributions on individual states and on project states, and the effects of these emergent states on motivations to further contribute.

The next section of the paper first briefly reviews a model of helping behaviour that we use to structure our theorizing about motives for contribution. We then introduce each level of contribution (initial, sustained and meta) and develop a model of motivation for each. We conclude our theorizing by describing feedback loops between the three levels. The paper then concludes by discussing some aspects of the model and suggesting its implications for research and practice.

Theory: MVC participation as a helping behaviour

In this section we present our theory of motivations for contribution to massive virtual collaborations, drawing on and integrating several streams of prior research. We are interested in phenomenon of voluntary participation in MVC and view MVCs as a form of voluntary organization, that is to say, "an activity that produces goods and services at below market rate" (Wilson, 2000, p. 216). More specifically, in the framework of Gordon and Babchuk (1959), MVCs are *instrumental associations* that create some output that transcends the membership, or possibly *instrumental-expressive associations* if they do so while at the same time possibly "carrying on activities… of direct interest to the participants or help to provide satisfactions of personal fellowship". Wilson (2000) describes volunteering as "part of a cluster of helping behaviors, entailing more commitment than spontaneous assistance but narrower in scope than the care provided to family and friends" (p. 215). We therefore use a model of helping behaviours to structure our analysis of motives for contribution. In broad overview, the literature suggests that helping behaviour results from the satisfaction of four precursor conditions (Schwartz & Howard, 1982):

1. First, an individual must recognize a need in others. This condition, called *attention*, focuses on recognizing situational cues that suggest the need for a helping response. These situational cues vary in salience and seriousness.
2. Next, an individual must have *motivation* to respond, often arising from a combination of feelings of social obligation and/or responsibility together with a self-perceived capability to respond. The capability to respond arises from the volunteer's resources (Uslaner, 2003) and skills and knowledge relevant to the voluntary role (Wilson, 2000, p. 221).
3. Individuals weigh the obligation and capability of helping against the social and tangible costs of doing so in a phase called *evaluation* (Schwartz & Howard, 1982). Of course, helping may also have benefits to the volunteer. Unlike much of the literature on helping behaviours that has examined crises situations requiring quick decisions, evaluation of volunteering can be done deliberately over time.
4. Finally, in cases where individuals opt not to help the person in need, a series of psychological *defence mechanisms* occur in which the individual self-justifies why a helping response was not needed (Schwartz & Howard, 1980). Given our focus on motives that distinguish those who do or do not volunteer, we will not examine this stage further in our theorizing.

Cooperation is distinguished from other forms of helping behaviour by its focus on larger groups of individuals rather than dyads (one helper and one person receiving help). In research on cooperation, motivation is analyzed within the context of possible mutual benefits, instead of a one-way benefit from helper to receiver. The most recent research on cooperation, altruism, and unselfish behaviour has shown that helping springs from

motivations both deeper and more complex than simple self-interest. For example, Clary *et al.* (1998) suggested a combination of selfish and unselfish motives as the basis of sustained voluntarism. With respect to selfish motivations, they suggested that individuals volunteer as a method of self-education, as a social activity, and/or to assuage feelings of guilt concerning one's own entitlement or privilege. Individuals also volunteer on an unselfish basis springing from what Clary *et al.* (1998) identify a combination of altruistic and humanitarian values. Finally, they suggest that group-related motivations emerge when people volunteer in order to identify with or maintain their status as a member of a valued group.

A. Non-participant becomes initial contributor

We now consider motivations for different levels of contribution in turn. The first and largest group we consider is *initial contributors*. Contributors begin their involvement with a project with an initial contribution and potentially evolve to further levels depending on personal and project factors, as we review below. It is important to consider motives for initial contributions for two reasons, first because all contributors must pass through this stage, and second because in most MVC, only a small fraction of users of a system actually contribute. For example, as of January 2007, Wikipedia was reportedly the 6th most popular site on the Web, visited regularly by an estimated 189 million users ("Awareness", 2008), but had roughly 6 million registered accounts ("Statistics", 2008). (An account is not required to edit, but anonymous edits are only a fraction of the total.) Comparable ratios are reported for other MVC. Tancer (2007) reports that fewer than 1% of visits to most user contributed sites are contributions, with the exception of Wikipedia, where the rate is reported to be 4.6%. Dahlander and McKelvey (2005) found that only 7 of 50 users of Linux surveyed had ever sent comments to the author of an application, with even lower ratios for operating system itself and for more substantive contributions; the rest were passive users. As Aigrain (2003) points out, free riders are not really a problem in information commons where the cost of reproduction is close to zero and where there may even be positive externalities of usage (as we discuss below), but projects do need visitors to become contributors to sustain and grow the collaboration, making it important to understand the motives behind this initial step.

1. Attention

According to the literature reviewed above, the first stage in volunteering is becoming aware of the project's need for help. In other words, a basic factor for an initial contribution is simply having heard of the project at all. For example, Bryant *et al.* (2005) note that many initial users find Wikipedia from a Google search. Specifically, we propose:

Prop A.1.1. The more visible the project, the more likely users are to initially contribute.

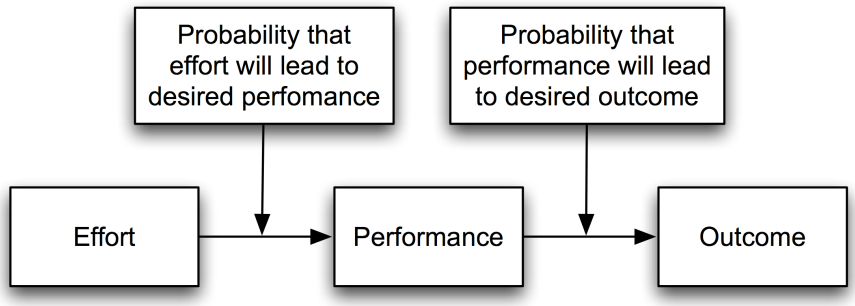

Figure 1. Major elements of expectancy theory.

2. Motivation to respond

Once the prospective contributors become aware of the possibility of contribution, the helping behaviour model suggests that there must be some impetus for the response based on a perceived capacity to contribute, coupled perhaps with a perceived obligation. For new contributors, we suggest that only the first factor is likely to be salient as it seems unlikely that they feel an obligation to a project they barely know. To explain factors affecting the perceived capacity to respond, we draw on expectancy theory (Vroom, 1964), which hypothesizes an effect on motivation from the perceived link between expected effort and performance, and between performance and outcomes, as shown in Figure 1. We consider each linkage in turn. First, this theory suggests that factors that increase the perceived likelihood of the initial effort achieving a positive performance will increase motivations. Factors that would increase this perception include particular knowledge about either the domain of the MVC or about online contribution in general (a construct known as media self-efficacy, that is, one's belief in one's own capabilities to use the technology). For example, Bryant *et al.* (2005) suggest that new Wikipedia users start by correcting mistakes on topics they know or adding topics that are not covered rather than by making big additions or corrections. Specifically, we propose:

Prop A.2.1. The more domain expertise someone has, the more likely s/he is to initially contribute to an MVC project.
Prop A.2.2. The more media self-efficacy someone has, the more likely s/he is to initially contribute to an MVC project.

Furthermore, drawing again on expectancy theory, we suggest that projects that reduce the needed effort or increase the likelihood of effort leading to a desired performance will increase motivation to contribution. For example, Bryant *et al.* (2005) note that the ease of editing a Wikipedia page is important in facilitating a reader's transition to being an editor. No login or registration is required and additional features are available but do not get in the way of that first step. Similarly, many blogs and other sites that aggregate user contributions make it easy for individuals to post comments. Specifically, we propose:

Prop A.2.3. The easier it is to contribute to a project, the more likely users are to initially contribute to an MVC project.

3. Positive evaluation of contributing

Finally, the helping model suggests that potential contributors make an evaluation of the costs and benefits of contributing. For participation in an MVC, costs include at least a computer and Internet access. Therefore, we propose:

Prop A.3.1. The lower someone's perceived cost of a computer and Internet access, the more likely s/he is to initially contribute to an MVC project.

The major cost to participation is the opportunity cost of the time spent doing so. Dahlander and McKelvey (2005) found that the most reason non-contributors cited was a lack of time. Hertel (2003) found that people more willing to tolerate the time cost of contributing made greater contributions. Therefore, we propose:

Prop A.3.2. The more available time someone has, the more likely s/he is to initially contribute to an MVC project.

We now consider possible benefits to participation. In the case of MVC, outcomes rarely include direct monetary or material benefit, but prior research has suggested a number of non-monetary benefits. We review these below when we discuss sustained contribution, but note that few of these seem likely to apply to an initial contributor who is not familiar with the project or with other contributors. Bryant *et al.* (2005) note that initial users were often curious about claim that they could just edit a page, so we suggest instead that the benefit is simply satisfaction of curiosity about the project. Therefore, we propose:

Prop A.3.3. The more curious someone is about a project, the more likely s/he is to initially contribute to an MVC project.

In summary, we view the decision to make an initial contribution as largely curiosity-driven ("testing the waters") driven by project visibility and facilitated by the contributor's having available time and some level of expertise and self-efficacy, and the project's being easy to use with low barriers to entry. These factors are shown in Figure 2. Note that we have shown each stage of helping behaviour as an intermediate variable in the model.

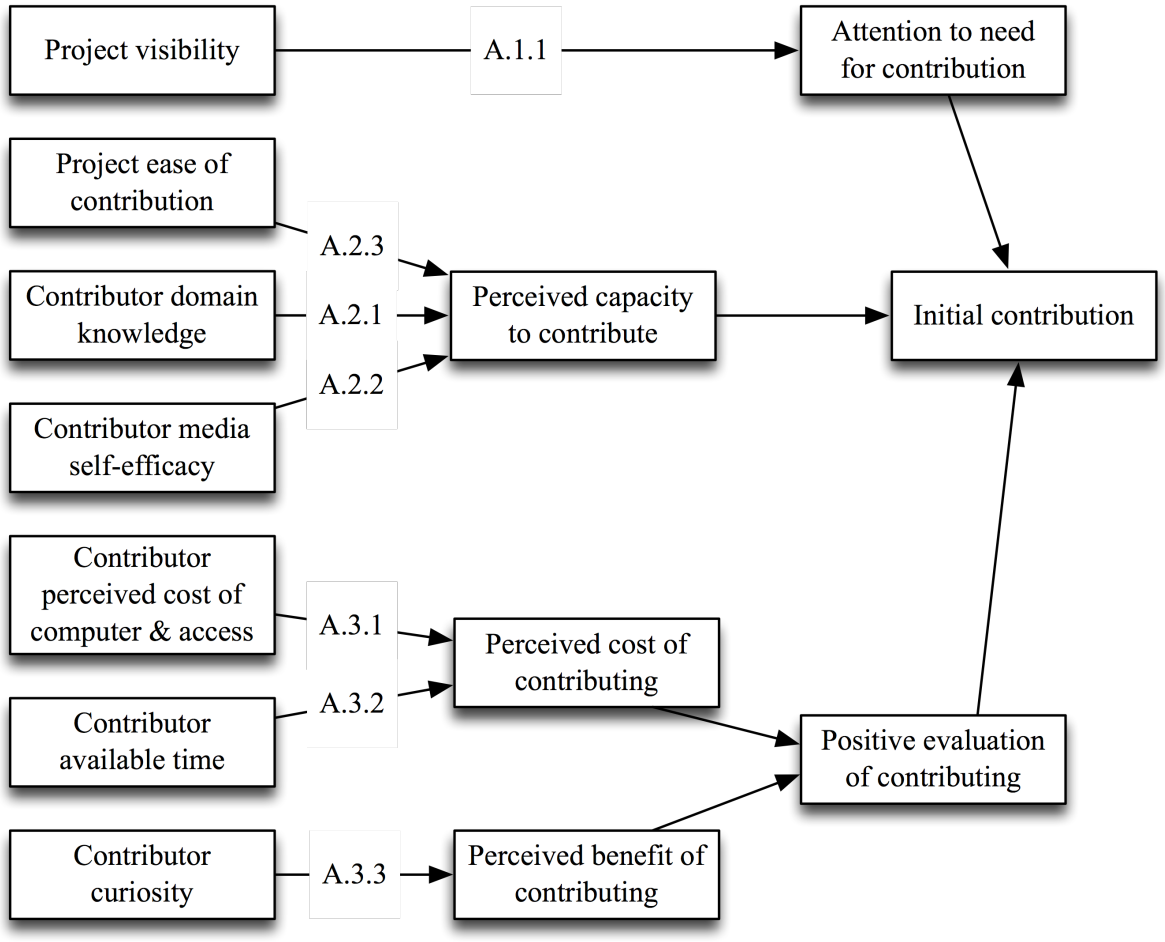

Figure 2. Motives for initial contribution.

B. Initial contributor continues contributing

We next consider factors that might cause an initial contributor to sustain their contribution, thus becoming *sustained contributors*, the second group in our overall model of motives for MVC contribution. It is striking that the majority of contributors to MVC do not

participate past an initial trial. For example, numerous studies of FLOSS teams have found large numbers of contributors but most provide only a single contribution, such as a single bug report or modification request (Howison *et al.*, 2006). Similarly, there are currently more than 6 million Wikipedia accounts, but the median number of edits is only 1, meaning that most members drop out of contributing the day they join. As a result, the initial stage includes the bulk of contributors, but since each makes at most a few contributions, the overall volume of their contributions is low. Instead, sustained contributors, despite being a small proportion of the total number of contributors, account for the bulk of contributions. Of course, there are differing levels of sustained contribution. For example, Wikipedia authors range from occasional contributors to "high end" authors who explicitly try to improve "their" articles with the goal of having them appear as a featured article (Riehle, 2006) or those who take on responsibility for multiple articles.

1. Attention

Again, the first stage is attention. We can assume that sustained contributors are aware of the project (Prop A.1.1 above) from their initial encounters. However, we suggest that to continue contributing, a second factor is whether the contributor perceives that a contribution is needed by the project. Dahlander and McKelvey (2005) note that the second most cited reason for not contributing to a FLOSS project is that there did not seem to be a need, e.g., the software worked well enough or was so specialized that there did not seem to be an opportunity to contribute. Therefore, we propose:

Prop B.1.1. The more visible the project's needs, the more likely a contributor is to continue to contribute.

2. Motivation to respond

The second stage in the model is the motivation to respond, based on a perceived capacity to respond and a feeling of obligation. Considering the first, we suggest that feelings of domain knowledge and media self-efficacy remain important (Prop A.2.1 and Prop A.2.2 above). However, as the contributor learns more about the particular MVC technology, this factor may shift from generalized self-efficacy to self-efficacy with the particular technology. For example, Riehle (2006) notes that Wikipedia provides features such as templates to support more sophisticated editors.

On the other hand, in contrast to initial contributions, we argue that feelings of social obligation are likely key in decisions to be a sustained contributor. A key characteristic of MVC is that they are group activities. To understand the group nature of this work, we draw first from research on communities of practice (CoPs), which has identified shared ideology as a motivating factor. For example, Hodkinson and Hodkinson (2004) found that groups of teachers coalesced around shared ideologies of their CoPs (cf., Barab *et al.*, 2002; Hodkinson, 2004). Kavanagh (2004) notes that part of the motivation for some to contribute to FLOSS was identification with a narrative of resistance to proprietary software, which may explain the finding that license choice, a reflection of ideology, seems to affect amount of output per developer (Fershtman & Gandal, 2007). In Wikipedia, sustained contributors express feelings of contributing to the greater good (Bryant *et al.*, 2005). Therefore, we propose:

Prop B.2.1. The more strongly a contributor identifies with the ideology of the community, the more likely s/he is to become a sustained contributor.

Finally, because only a small percentage of individuals do go on to become sustained contributors, it seems plausible that there may be personality factors that differ between contributors and others. For example, Clary *et al.* (1998) suggested that individuals contribute on an unselfish basis, springing from what they identify as a combination of altruistic and humanitarian values. Therefore, we propose:

Prop B.2.2. The higher in altruism or volunteerism someone is, the more likely s/he is to continue to contribute to an MVC project.

3. Positive evaluation of contributing

The third stage of the model is the comparison of costs and benefits of contributing. We considered costs of contributing above, and those propositions hold for sustained contributors as well (Prop A.3.1 and Prop A.3.2 above), though the time cost of contribution may be higher for a sustained contributor, as additional work is expected to meet the standards of the MVC, and these standards are likely higher for larger or more organized MVCs. On the other hand, sustained contributors are likely aware of system features that facilitate deeper involvement, such as talk pages or watch lists in Wikipedia (Bryant *et al.*, 2005).

Turning to benefits, we expect that sustained contributors derive benefits beyond mere satisfaction of curiosity. Curiosity can be satisfied quickly, perhaps explaining why many participants drop out so quickly. To develop a specific set of propositions, we now consider in what ways the project might be rewarding. We start by considering individual rewards for contribution. An initial explanation for contributions to FLOSS projects was that performance signalled competence that would lead to better employment prospects (Lerner & Tirole, 2002), thus rewarding contribution. To achieve this benefit, it is more useful to signal in a prominent project, again emphasizing the importance of project visibility. However, the empirical support for this suggestion has been weak (Hann *et al.*, 2002). As well, this motivation would not generalize to MVC such as Wikipedia, in which contributions are not signed and not as clearly employment related.

For FLOSS development, a significant personal reward for contribution is the result of the contribution, namely a better functioning system (Hann *et al.*, 2004). However, such a motivation does not itself explain the decision to share improvements. To explain contribution, many researchers have pointed to the importance of reciprocal giving in MVC, where a contribution is made with the expectation of benefiting from others' contributions (Raymond, 1999; Sauer, 2007). Therefore, we propose:

Prop B.3.1. The more someone expects to benefit from the project as a whole, the more likely s/he is to continue to contribute to an MVC project.

A sometimes-overlooked motivation is the personal satisfaction of contribution. For example, researchers studying FLOSS projects have noted factor such as personal interest (Freeman, 2007) and the enjoyment of programming. To better understand why making MVC contributions could be intrinsically rewarding for sustained contributors, we draw on Hackman and Oldham's (1980) model of work motivations (this model has also been applied to MVC by Chin & Cooke, 2004; Hertel, 2007). Hackman and Oldham identify five job dimensions—skill variety, task identity, task significance, autonomy and feedback—that they suggest create positive psychological states about the work and thus lead to work motivation, as shown in Figure 3. The first three factors lead to experienced meaningfulness of work.

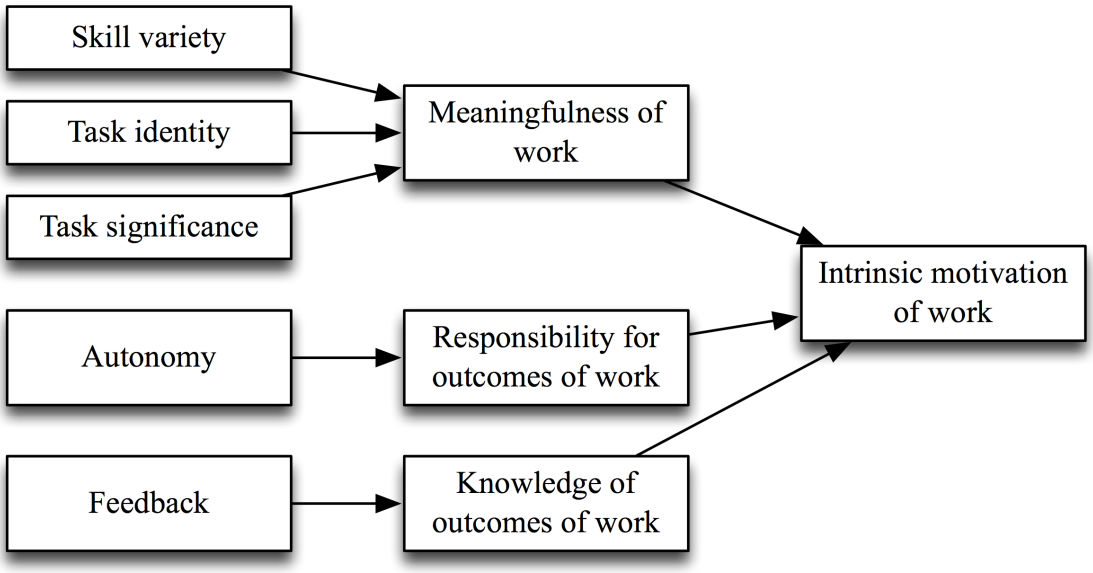

Figure 3. Hackman and Oldham's work design model (from Hackman & Oldham, 1980).

Autonomy leads to perceived responsibility for work. Feedback leads to knowledge of work outcomes. Together, those three factors lead to making the work motivating.

There is some evidence that the variety of skills involved in MVC contribution motivates contributors. For example, a commonly cited personal benefit of contribution is learning (Ghosh, 2002). Working on an MVC project provides an opportunity for contributors to learn new skills (Ye & Kishida, 2003). As well, Lakhani & Wolf (2005) identified as a motive for contribution to FLOSS projects the chance to feel creative, i.e., using a set of skills that may not otherwise be regularly exercised. Therefore, we propose:

Prop B.3.2. The greater the skill variety of available MVC tasks, the more likely a contributor is to become a sustained contributor.

Above we noted that new Wikipedia users start by correcting mistakes on topics they know or contributing on areas that are not covered rather than by making big additions or corrections (Bryant et al., 2005). Similarly, initial contributors to FLOSS projects often start by contributing small bug fixes or taking part in technical discussions. However, we expect that sustained contributors will be more motivated by tasks with greater task identity, that is, those that include a complete work process with a clear beginning and end, such as overseeing an article or taking responsibility for a particular program module. Therefore, we propose:

Prop B.3.3. The greater the task identity of available MVC tasks, the more likely a contributor is to become a sustained contributor.

Finally, the visibility of the project seems important in making the contributions to the project seem significant (Prop A.1.1 above). It is difficult to motivate people to spend time programming for a system no one uses or writing for a site that has few readers. In this respect the free rider problem identified by economists can be mitigated: free riders provide the audience for the work thus providing a positive benefit for the project as a whole.

The second factor in Hackman and Oldham's (1980) model is autonomy leading to perceived responsibility for the task. A frequently cited benefit of working on FLOSS projects is chance to work on something entirely of one's own choosing (Kuznetsov, 2006). Because MVC relies on voluntary contributions, we believe that they are generally high in autonomy (Chin & Cooke, 2004), but projects may adopt different practices. Therefore, we propose:

Prop B.3.4. The greater the autonomy of available MVC tasks, the more likely a contributor is to become a sustained contributor.

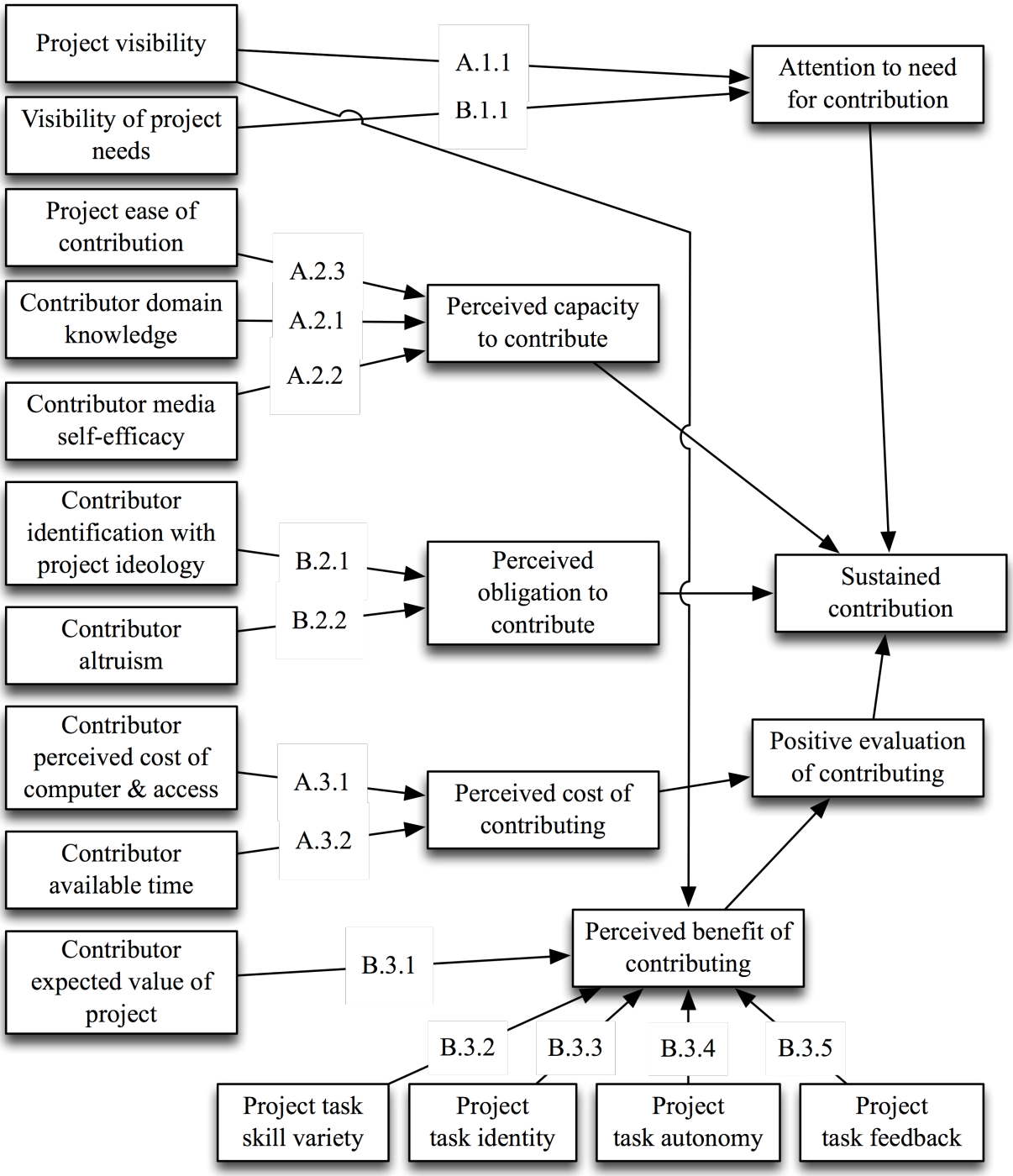

Figure 4. Motives for sustained contribution.

The final factor in Hackman and Oldham's (1980) model is feedback leading to knowledge of actual work outcomes, a factor that has been consistently echoed in prior research. For instance, Bandura & Schunk (1981) claim that "consistent positive feedback should encourage high collective efficacy". FLOSS researchers often suggest that contributions to FLOSS projects are rewarded by recognition by peers within the project or the FLOSS community more generally (Bezroukov, 1999; Markus *et al.*, 2000). Forte & Bruckman (Forte & Bruckman, 2005) suggest that Wikipedia authors are also rewarded by recognition in the group for their work, in informal responses or through explicit mechanisms such as a featured article or "barnstars" and other awards for contribution. Feedback can also come from the task itself, such as the positive feedback of seeing a modified program run (Chin & Cooke, 2004). We note the possibility of a virtuous cycle here: as an individual contributes, they become more visible, which increases the likelihood of feedback and thus further contributions. Therefore, we propose:

Prop B.3.5. The more task feedback someone receives directly or from other contributors, the more likely s/he is to become a sustained contributor.

In summary, we view the decision to continue contributing as driven by the contributor's feelings of obligation to the project, the intrinsic motivation of the task and feedback from the task and other participants. These factors are shown in Figure 4.

C. Sustained contributor becomes meta-contributor

Finally, we turn to consideration of motivations for meta-contributors (though some aspects of motivations for this group likely overlaps the motives of active sustained contributors). We note that in successful MVC, a very few contributors, perhaps only 1% of sustained contributors, shift their focus from substantive contributions to what we label "*meta-contributions*," those contributions that structure and enable further contributions (Bryant *et al.*, 2005). For example, on Wikipedia, a few meta-contributors structure large sections of the encyclopedia, check that the style of articles is consistent or administer the Wikipedia rules. Indeed, the presence of such structuring and the resulting coordination amongst contributors is what makes MVCs collaborations. Comparable roles in FLOSS are members of a consortium that houses and oversees multiple projects, such as the Apache Software Foundation.

1. Attention

As with sustained contributors, we note that becoming a meta-contributor starts with awareness of the project's need for this kind of work. The distinguishing characteristic of meta-contributors is that they are concerned with structure of the whole project, not just a few pieces, and with the community, not just its output (Bryant *et al.*, 2005). Knowledge of this level of issues likely emerges through the process of contribution though projects can also make these needs more visible to potential meta-contributors (Prop B.1.1 above), e.g., by making these roles explicit and having those in them providing role models to others.

2. Motivation to respond

Regarding the second stage in the helping process, we suggest that meta-contributors go through much the same evaluation as sustained contributors in determining their capacity to respond. However, rather than domain knowledge and media self-efficacy (Prop A.2.1 and

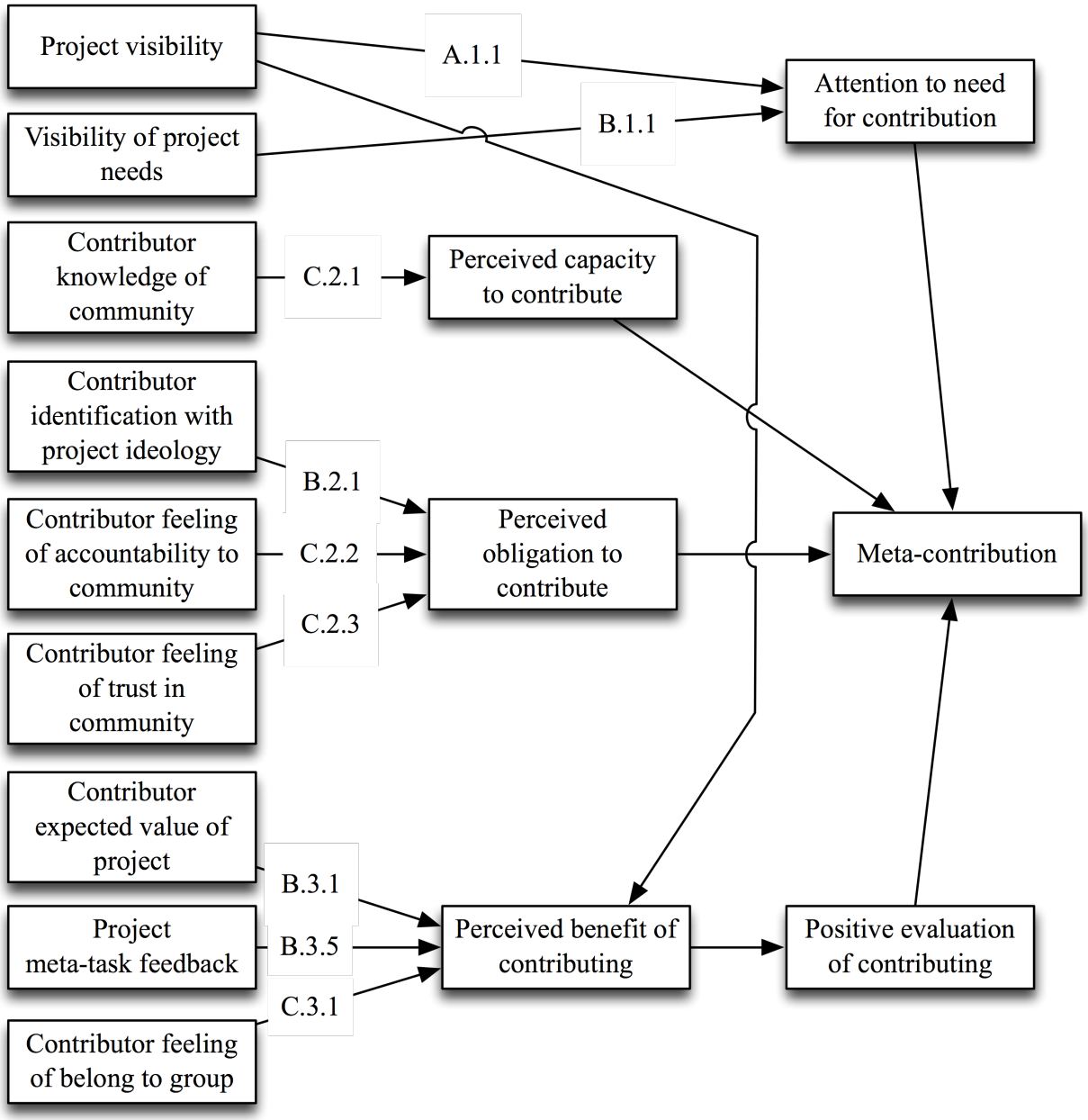

Figure 5. Motives for meta-contribution.

Prop A.2.2 above), meta-contributors must have a good knowledge of the community and its norms and rules. Therefore, we propose:

Prop C.2.1. The greater someone's knowledge of the MVC community, the more likely s/he is to become a meta-contributor.

As with sustained contributors, we believe that meta-contributors feel a social obligation to respond based on their adoption of the project's shared ideology Prop B.2.1 above), though in their role of meta-contributor, they also help shape this ideology. We suggest that for a contributor to be motivated to provide this level of contribution, they must have feeling of accountability and trust towards the other community members that leads to a sense of obligation. Because of the nature of meta-contributor's work, they have the implicit

or explicit expectation that they may be called upon to justify their beliefs, feelings, and actions to others (Lerner & Tetlock, 1994). Therefore, we propose:

Prop C.2.2. The more accountable someone feels for the community, the more likely s/he is to become a meta-contributor.
Prop C.2.3. The greater someone's trust in other contributors, the more likely s/he is to become a meta-contributor.

3. Positive evaluation of contributing

The third stage of the model is the comparison of costs and benefits of contributing. We expect the same low evaluation of costs for meta-contributors as for sustained contributors (Prop A.3.1 and Prop A.3.2 above). Considering benefits, above we hypothesized a set of individual benefits that motivate sustained contribution. While meta-contribution may still be intrinsically motivating (Prop B.3.3 to Prop B.3.5 above), we suggest that individuals receive little direct personal benefit from meta-contribution. Therefore, we draw on the literature on Social Movements to explore benefits beyond individual motivations. Marshall (1998) defined a social movement as an organized effort by a group of people to effect societal change. Because many or most social movements coalesce around a shared ideology, some of the literature in this area may apply to massive virtual collaboration projects, to the extent that some of these projects also amalgamate on the basis of the shared values or goals of the contributors (e.g., Elliot & Scacchi, 2003) (Prop B.2.1 above). Klandermans' (1997) model of motivations (as augmented by Simon *et al.*, 1998) suggests four distinct areas of motivation for participation in a social movement: reward motives, collective motives, social motives, and the identification with the group or a subgroup. These motives overlap previously discussed motivations. Reward motivations are the personal gains realized by individual contributors (Prop B.3.1 above). Collective motivations come from the individual's evaluation of the group's goals or ideology (Prop B.2.1 above). Social motives are based on the direct social reinforcement provided others (e.g., praise, cf. our discussion above of the importance of feedback, Prop B.3.5 above).

Finally, group or community identification means that individuals join a movement because of their feelings of being part of or wanting to contribute to a valued group. Group identification differs from social motives in that the latter arise directly from interactions with other people—whether group members or not—while the former is a preferred state of mind based on a sense of belongingness. This sense is part of the explanation for the feeling of obligation to the group noted above (Prop C.2.2 and Prop C.2.3). Kavanagh (2004) suggests that social group is important in motivating contributions to FLOSS teams and Bryant *et al.* note that active Wikipedia contributors develop an identity in the project, e.g., by having a Wikipedia home page and use a talk page to interact with others (2005). Therefore, we propose:

Prop C.3.1. The greater someone's feeling of being part of a group, the more likely someone is to become a meta-contributor.

In summary then, we view the decision to continue contributing as driven by a sense of group membership, leading to feelings of obligation to the group, as well as by the intrinsic motivation of the task. These factors are shown in Figure 5.

D. Feedback

Finally, we consider how the contributions discussed above change the state of the project, and thus the motivations for future contributions. Note that in discussing motives for contribution, we included both project and individual factors. The project factors are changed by contributions, thus affecting motives for further contributions. These linkages are important because they provide a dynamic aspect to the model. Specifically, we propose linkages between levels of contribution at each of the stages identified above, as follows:

Prop D.1.1.	A higher level of initial contributions leads to more sustained contributions by increasing the flow of new members.
Prop D.1.2.	A higher level of sustained contribution leads to more initial contributions by increasing project visibility.
Prop D.1.3.	A higher level of meta-contribution increases initial and sustained contribution by making contribution easier.

The interaction of these feedback loops, summarized in Figure 6, is what drives the exponential growth experienced by successful MVC: as they attract contributors and contributions, their ability to attract further contributions is multiplied.

Conclusions

The purpose of this paper was to develop a model of motives for contribution to MVC projects that distinguished different motives for different levels of contribution. By merging different theoretical perspectives, including work satisfaction and social movements, we can understand the phenomenon of Massive Virtual Collaboration at multiple levels. Specifically, we suggest that MVC contributors may initially get involved to satisfy curiosity about the project, but that sustained contribution is driven by agreement with the project ideology and the intrinsic motivation of the task, and meta-contribution by feelings of group membership that lead to a sense of social obligation. Furthermore, contributions at each level change the project and thus the motives for further contributions.

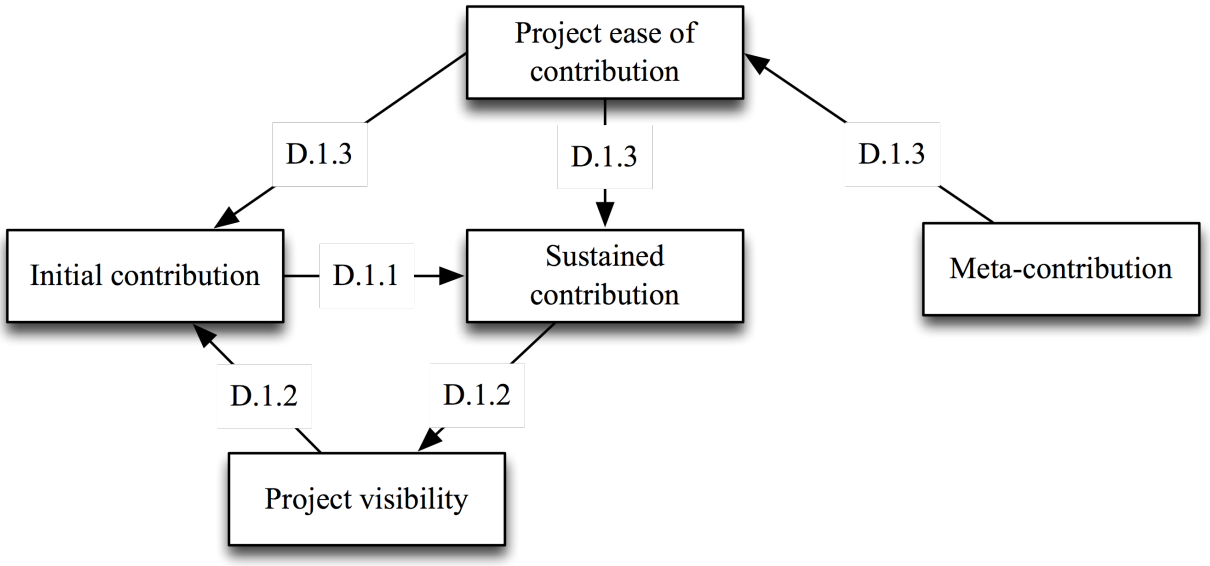

Figure 6. Feedback loops between contribution and project states.

Our model has implications for both the academic and the practitioner communities. To the academic community, the proposed framework of research could guide future studies of motivations. First, such studies ought to consider different kinds of contribution separately rather than treating them all the same. For example, surveys of motives for contribution should be careful to include the level of participation and to separate motives for different levels of contribution. Similarly, studies of the process of contribution should likely develop samples that focus on sustained contributors, as a random sample of contributors will likely include many initial contributors who have not continued their participation, thus biasing the results.

We also note that only a small fraction of MVC users ever become even initial contributors and an even smaller fraction goes on to contribute regularly. Therefore, the process may be less a case of projects motivating contribution and more a case of self-selection of contributors who are already motivated. For example, if members self-select and remain contributors in the MVC project based on the similarity of their personal ideologies to those represented by the project, this may ensure a cascade effect on membership similar to what would be predicted by Schneider's attraction-selection-attrition framework (e.g., Schneider *et al.*, 1995; Schneider *et al.*, 2000). According to Schneider, individuals join and leave organizations based on the degree of perceived alignment between their own personal value systems and those apparently espoused by the organization. The attraction-selection-attrition framework provides a multi-level explanation of why large groups often become more homogenous over time with respect to the values or ideologies embodied in the group's mission and operations. Looking at teams in varying stages of progression can help us understand the phases of development, growth and maturity of a MVC effort and help us refine the model.

To the practitioner community, the framework provides an explanation of the motivations behind those who join MVC projects and their existing efforts. By looking at these efforts in a broader context and at two levels—personal and project levels—we can understand how to make these efforts more fruitful which then can assist organizations as they work through development and implementation of virtual teams in their work practices. For example, our model suggests the importance of project visibility, ease of use, visibility of work that needs to be done and feedback to participants about their work. Increasing these factors is predicted to result in more satisfied contributors with a sustained ability to work together and enhance the work product.

Increasingly, many organizations with multiple locations use the Internet to facilitate communication and coordinate business operations. The potential appears to exist for MVC projects to uproot a variety of existing business models in the information sector (Carnevale, 1995; Castells, 1996; Pink, 2005). As organizations become more dependent on technology to facilitate collaborative efforts, it becomes important to understand the lifecycle of such collaborations. This paper provides a framework for understanding the motivations behind those who join such efforts, the use of technology and how efforts become a part of the fabric of society. By looking at these efforts in a broader context, we can understand how to make these efforts more fruitful for contributors and for those who benefit from their voluntary efforts.

References

"Awareness". (2008). Wikipedia: Awareness statistics. Retrieved 6 Feb, 2008, from http://en.wikipedia.org/wiki/Wikipedia:Awareness_statistics

"Statistics". (2008). Statistics. Retrieved 6 Feb, 2008, from http://en.wikipedia.org/wiki/Special:Statistics

Aigrain, P. (2003). The Individual and the Collective in Open Information Communities, *16th Bled Electronic Commerce Conference*. Bled, Slovenia.

Bandura, A., & Schunk, D. (1981). Cultivating competence, self-efficacy, and intrinsic interest through proximal self-motivation. *Journal of Personality and Social Psychology, 41*, 586-598.

Barab, S. A., Barnett, M., & Squire, K. (2002). Developing an empirical account of a community of practice: characterizing the essential tensions. *Journal of the Learning Sciences, 11*(489–542).

Bezroukov, N. (1999). Open source software development as a special type of academic research (critique of vulgar raymondism). *First Monday, 4*(10).

Bryant, S. L., Forte, A., & Bruckman, A. (2005, 6–9 November). Becoming Wikipedian: Transformation of participation in a collaborative online encyclopedia In *Proceedings of GROUP'05*, Sanibel Island, FL.

Carnevale, A. P. (1995). Enhancing skills in the new economy. In A. Howard (Ed.), *The Changing Nature of Work* (pp. 238–251). San Francisco: Jossey-Bass.

Castells, M. (1996). *The Rise of the Network Society*. Oxford, UK: Blackwell.

Chin, P. O., & Cooke, D. (2004). Satisfaction and Coordination in Virtual Communities. In *Proceedings of the Tenth Americas Conference on Information Systems*, New York, New York.

Clary, E. G., Snyder, M., Ridge, R. D., Copeland, J., Stukas, A. A., Haugen, J., et al. (1998). Understanding and assessing the motivations of volunteers: A functional approach. *Journal of Personality and Social Psychology, 74*, 1516–1530.

Dahlander, L., & Mckelvey, M. (2005). Who is not developing open source software? non-users, users, and developers. *Economics of Innovation and New Technology*.

Elliot, M. S., & Scacchi, W. (2003, 9-12 November). Free Software developers as an occupational community: Resolving conflicts and fostering collaboration. In *Proceedings of Group'03*, Sanibel Island, FL, USA.

Fershtman, C., & Gandal, N. (2007). Open source software: Motivation and restrictive licensing. *International Economics and Economic Policy, 4*(2), 209–225.

Forte, A., & Bruckman, A. (2005). Why do people write for Wikipedia? Incentives to contribute to open-content publishing, *GROUP 05 workshop: Sustaining community: The role and design of incentive mechanisms in online systems*. Sanibel Island, FL.

Freeman, S. (2007). The material and social dynamics of motivation: Contributions to Open Source language technology development. *Science Studies, 20*(2), 55–77.

Ghosh, R. A. (2002, 14 October). Free/Libre and Open Source Software: Survey and Study. Report of the FLOSS Workshop on Advancing the Research Agenda on Free / Open Source Software. Retrieved 16 March, 2006, from http://www.infonomics.nl/FLOSS/report/workshopreport.htm

Gordon, C. W., & Babchuk, N. (1959). A typology of voluntary associations. *American Sociological Review, 24*(1), 22–29.

Hackman, J. R., & Oldham, G. R. (1980). *Work Redesign*. Reading, MA: Addison-Wesley.

Hann, I.-H., Roberts, J., Slaughter, S., & Fielding, R. (2002). Economic incentives for participating in open source software projects. In *Proceedings of the Twenty-Third International Conference on Information Systems*.

Hann, I.-H., Roberts, J., & Slaughter, S. A. (2004). Why developers participate in open source software projects: An empirical investigation, *Twenty-Fifth International Conference on Information Systems* (pp. 821–830). Washington, DC.

Hertel, G. (2007). Motivating job design as a factor in open source governance. *Journal of Management & Governance, 11*, 129–137.

Hertel, G., Niedner, S., & Herrmann, S. (2003). Motivation of software developers in Open Source projects: an Internet-based survey of contributors to the Linux kernel. *Research Policy, 32*, 1159–1177.

Hodkinson, H., & Hodkinson, P. (2004). Rethinking the concept of community of practice in relation to schoolteachers' workplace learning. *International Journal of Training and Development, 8*(21–31).

Hodkinson, P. (2004). Research as a form of work: expertise, community and methodological objectivity. *British Educational Research Journal, 30*(9–26).

Howison, J., Inoue, K., & Crowston, K. (2006). Social dynamics of FLOSS team communications. In *Proceedings of The Second International Conference on Open Source Systems*, Como, Italy.

Kavanagh, J. F. (2004). Resistance as motivation for innovation: Open source software. *Communications of the Association for Information Systems, 13*, 615–628.

Klandermans, B. (1997). *The Social Psychology of Protest*. Oxford: Basil Blackwell.

Kuznetsov, S. (2006). Motivations of contributors to Wikipedia. *ACM SIGCAS Computers and Society, 36*(2), 1.

Lakhani, K. R., & Wolf, R. G. (2005). Why Hackers Do What They Do: Understanding Motivation and Effort in Free/Open Source Software Projects. In J. Feller, B. Fitzgerald, S. Hissam & K. R. Lakhani (Eds.), *Perspectives on Free and Open Source Software*. Cambridge, MA: MIT Press.

Lerner, J., & Tirole, J. (2002). Some simple economics of Open Source. *The Journal of Industrial Economics, 2*(1), 197–234.

Lerner, J. S., & Tetlock, P. E. (1994). Accountability and Social Cognition. In *Encyclopedia of Human Behavior*.

Markus, M. L., Manville, B., & Agres, E. C. (2000). What makes a virtual organization work? *Sloan Management Review, 42*(1), 13–26.

Marshall, G. (Ed.). (1998). *A Dictionary of Sociology*. Oxford: Oxford.

Mockus, A., Fielding, R. T., & Herbsleb, J. D. (2000). A case study of Open Source Software development: The Apache server. In *Proceedings of Proceedings of the International Conference on Software Engineering (ICSE'2000)*.

Pink, D. H. (2005, March). The book stops here. *Wired, 13,* 125–135.

Raymond, E. S. (1999). The magic cauldron.

Reed, P. B., & Selbee, L. K. (2001). The civic core in Canada: Disproportionality in charitable giving, volunteering, and civic participation. *Nonprofit and voluntary sector quarterly, 30*(4), 761–780.

Riehle, D. (2006). How and Why Wikipedia Works: An Interview with Angela Beesley, Elisabeth Bauer, and Kizu Naoko. In *Proceedings of the 2006 International Symposium on Wikis (WikiSym '06)*.

Sauer, R. M. (2007). Why develop open-source software? The role of non-pecuniary benefits, monetary rewards, and open-source licence type. *Oxford Review of Economic Policy, 23*(4), 605–619.

Schneider, B., Goldstein, H. W., & Smith, D. B. (1995). The attraction-selection-attrition framework: An update. *Personnel Psychology, 48*, 747–773.

Schneider, B., Smith, D. B., & Goldstein, H. W. (2000). Attraction-selection-attrition: Toward a person–environment psychology of organizations. In B. Walsh (Ed.), *New Directions in Person-Environment Psychology*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Schwartz, S. H., & Howard, J. A. (1980). Explanations of the Moderating Effect of Responsibility Denial on the Personal Norm-Behavior Relationship. *Social Psychology Quarterly, 43*(4), 441–446.

Schwartz, S. H., & Howard, J. A. (1982). Helping and cooperation: A self-based motivational model. In V. J. Derlega & J. Grzelak (Eds.), *Cooperation and Helping Behavior: Theories and Research* (pp. 327–353). New York: Academic.

Simon, B., Loewy, M., Stürmer, S., Weber, U., Freytag, P., Habig, C., et al. (1998). Collective identification and social movement participation. *Journal of Personality and Social Psychology, 74*, 646–658.

Tancer, B. (2007, 25 April). Who's Really Participating in Web 2.0? *Time*.

Uslaner, E. M. (2003). *Civic Engagement in America: Why People Participate in Political and Social Life.* College Park, MD: Department of Government and Politics, University of Maryland.

Vroom, V. H. (1964). Work and Motivation. New York: Wiley.

Wilson, J. (2000). Volunteering. *Annual Review of Sociology, 26*, 215–240.

Ye, Y., & Kishida, K. (2003). Toward an understanding of the motivation of Open Source Software developers. In *Proceedings of 2003 International Conference on Software Engineering (ICSE2003)*, Portland, OR.

Zachte, E. (2007). Wikipedia Statistics—Tables—English. Retrieved 6 Feb, 2007, from http://stats.wikimedia.org/EN/TablesWikipediaEN.htm