

Improvising Harmony: Opportunities for Technologies to Support Crowd Orchestration

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ABSTRACT

This paper details the work of a seldom studied but growing population of members of grassroots, offline-project based groups. We aim to understand how these groups self-organize to enable a large number of volunteers to gather and “get things done,” and identify design opportunities for technologies to support such work. By studying the work structure, we identified two types of members, *regular* and *episodic* participants, who differ in structural role, motivation, and type of work they do. We studied two key tasks: 1) project management, which is mostly done collaboratively by the regular participants; and 2) organization of work events—the project implementation, which involve many episodic participants. For both tasks, we report on common practices and tools that are currently used. We then discuss design implications and user requirements for developing specialized tools to support these tasks.

Keywords

Crowd orchestration; volunteer; project collaboration; social computing; peer production.

1. INTRODUCTION

Modern technologies are making it ever easier for groups to self-organize in an ad hoc manner, bootstrapping from chaos into productive, coordinated work [44]. Scholars [3][49] contend that such effort offers an alternative to, and competes with the “traditional institutional forms of getting things done.” While the HCI and CSCW communities have a long history of studying technologies to support group work [20][41], and have given ample attention to online peer production groups [31][44][50], we know far less about opportunities for technologies to support grassroots, self-organizing groups that gather many people to “work on the ground” (e.g., organizing events, building community gardens, putting on art performance, and so forth).

We call this growing form of tangible, ad-hoc, and near-term goal-oriented (i.e., small project-based) group endeavor *crowd orchestration* (CO). It poses a number of unique challenges: first,

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even though they are not traditional volunteer organizations, CO groups depend entirely on *volunteers*. This means they cannot financially reward participants, but must inspire other types of motivation and tailor their practices to cater for the diverse needs of the crowd. Second, grassroots groups usually lack established organizational structures and full-time staff that most formal organizations, like The Red Cross, have. Little is known about how work is divided among large numbers of unpaid participants. Third, as they work on tangible outcomes in the physical world, they often require many people to work at the same time, in the same location, where significant challenges can emerge in collaboration and coordination.

To understand how these groups operate and to identify design opportunities for technologies to support them, we conducted an interview study with 26 individuals in the USA and UK who have participated in CO-like groups. A key finding of our work is the co-existence of *regular participants*, who dedicate a significant amount of time and effort to the group, and *episodic participants*, who only participate occasionally and may not be committed to continuity. Regular and episodic participants tend to take different roles and engage in different types of work.

We started by studying what motivates people to participate in CO groups, and how it varies for the regular and episodic participants, and further, how the varied motivations may inform designs of technologies that support the different types of work that regular and episodic participants do. Specifically, we focused on studying two common tasks of CO groups: 1) *project management*, which is mainly handled by regular participants, and 2) organization of *work events* (i.e., the implementation of project), which often involves large proportion of episodic participants. We examined the common practices and tools that are currently used by CO groups to identify key user requirements for new technologies to support these tasks.

2. RELATED WORK

We ground our study in two genres of scholarship: social science literature on volunteerism, and literature on technologies that support peer production, mainly from the HCI and CSCW communities.

Social science research on volunteerism has covered many topics [56]. Among them, a long lasting interest is what motivates volunteering. Early research mostly studied “traditional” charity-based volunteer organizations, focusing on benevolence and altruism [8][39]. Later, especially as the volunteering scene broadened, scholars recognized a diversity of motivations [9][22]. For example, some volunteer for self-serving reasons such as skills or career development. *Self-Determination Theory* (SDT) [13][46] has been usefully applied to volunteering motivations [18][21][22]. As an expansion of Herzberg’s two-factor theory

[25], which contrasts *intrinsic* (for its own sake) with *extrinsic* (from external rewards or punishments) motivation, SDT puts human motivations on a continuum of increasing internalization and proposes the following control mechanisms:

- *External regulation* is based on demands or pressure to attain contingent rewards or avoid punishments.
- *Introjected regulation* is a partly internalized motivation driven by norms or ego-involvement.
- *Identified regulation* comes from understanding the importance or effectiveness of an activity for achieving a desirable end.
- *Integrated regulation* means engaging in an activity because of its assimilation with personal value.
- *Intrinsic regulation* refers to engagement in an activity solely because it is enjoyable.

SDT has been used to explain the varying behaviors of volunteers (e.g., retention and turnover rate [22]) and their work preferences (e.g., task significance and required level of skill [37]). Consistent with this theory, autonomy orientation (i.e., more internalized motivation) and autonomy support (i.e., supporting the internalization of motivation) [17] were found to positively correlate with volunteer productivity and satisfaction [22].

Recent research has also focused on the evolution of volunteering, from the wholly *collective style* by emphasizing affiliation with institutions and long-term commitment, to the inclusion of a more *reflexive style* of volunteering that prioritizes individual interest and needs [24]. One outcome is a rise in episodic volunteering—individuals performing a one-time, or occasional service. Prior work [24] also suggests that ad hoc, project-based arrangements attract people seeking episodic volunteering opportunities, since assignments can be completed in a finite timespan and can be tailored to one’s workload preference. In fact, previous literature has linked the rising trend of episodic volunteering to the “expanding field of informal, self-organized initiatives with no center of authority and project-oriented objectives” [24]—a rather accurate description of CO groups.

In the HCI and CSCW community, there has been a growing interest in studying and developing ICTs to support volunteer work. While some believe that ICSSs can helpfully improve many aspects of volunteer groups’ work, from recruitment, public relation, to project management [36], studies that examine the current practices of ICT use in volunteer groups repeatedly reported underutilization of digital tools, often constrained by the limited financial resource and IT personnel [23][55]. Several recent studies attempted to introduce new technologies for volunteer activities. For example, [35] used participatory design to create database software for non-profit volunteer organizations. [27] developed a mobile tool that supports data collection for volunteer campaigns. [54] explored design opportunities for infrastructure to support everyday, ubiquitous forms of volunteering.

To inform the design of technologies that support large group of volunteer to work together, we can also draw a parallel between research into online peer production and our study of CO groups. The most widely studied peer production systems are Wikipedia [5][28][32][42] and open source software (OSS) development [16]. Recently, researchers have studied digital volunteerism as a new type of peer-production. Examples include social media users self-organizing to assist in disaster response [10][50], and participants of online citizen science projects [27][44].

A main focus of research on peer production has been to understand the work structure of this new form of collaboration. Quantitative analysis of Wikipedia edits revealed a power law distribution of contribution with a small portion of “experts” doing the majority of the work [28]. Drawn from legitimate peripheral participation theory [33], Bryant et al. [5] suggest that some Wikipedia editors progress from peripheral activities to ones that are more and more central to the functioning of the community (e.g., meta-level tasks such as mediating disputes, establishing policies). A similar pattern was reported for open source software development [16]. Studies of disaster relief volunteers on social media also found that the work is organized around a core group of “trusted volunteers,” with “occasional and spontaneous” volunteers at the periphery, who mostly join during the intensive post-disaster work period, and contribute mainly in simple unskilled tasks. Some of them may move towards the center of the community [10][50].

Drawing inspiration from social science theories, researchers have studied ways to motivate contribution to peer production. Among others, Karau and William’s collective effort model [26] is often cited. It predicts that contributions can be increased by two ways—reducing the contribution costs, and increasing the perceived value of outcomes. Based on it, prior work illustrated that contributions can be effectively increased by technologies that ease the participation (e.g., an automatic task-routing system [12]), and designs that highlight the uniqueness and value of contributions [33][42], provide positive feedback and appreciation [32], and accomplishment of goals [59].

Informed by the above literature, we see design opportunities for technologies that support CO group work in similar ways to support online peer production groups, as they are both project-based, self-organized effort. But they may also differ. For example, CO groups are obviously more constrained by time and location, and involve more face-to-face interactions. To understand how CO groups “get things done,” we follow the literature on peer production by studying their work structure and identifying effective strategies that motivate members to contribute to projects. We describe our interview-based research methods in the next section.

3. METHOD

3.1 Recruitment Criteria

We used the following criteria to identify groups we wanted to recruit interviewees from: 1) “self-organizing,” i.e., not managed by paid, professional staff. 2) grassroots organizing for tangible objectives. Therefore, “club” types of groups focused on socializing only, or groups targeting social movements such as activism, are not included; 3) work is mainly done in the physical world instead of online. In the interview, in addition to self-reported motivation and experience, we also attempted to inquire general descriptions of the group, if possible, to obtain a rich picture of participating practices.

3.2 Participants

We recruited 26 participants (11 male) from 21 diverse CO groups by posting on social media and mailing lists, directly contacting members via group websites, and snowball recruiting. During analysis, we classified 16 of them to be regular members and 10 to be episodic members. We list brief descriptions of the groups in Table 1.

3.3 Data Collection and Analysis

We conducted semi-structured interviews using a protocol designed to focus on the following areas of interest:

- *Motivation for participation*, including what attracted members to join and to continue contributing, if they do; otherwise, what deterred them.
- *Coordination of work*, where we start by inquiring about work routines and procedures, and focus on understanding how members divide the work, what roles they adopt, and how they work together.
- *Tools used by participants*, including both information and communication technology (ICT) and non-ICT types, their usage, benefits and limitations.

Interviews lasted around 50 minutes and were conducted remotely, via telephone or video conferencing software, and were recorded and then transcribed. Analysis was informed by the grounded theory approach following an iterative open coding process [52]. For each transcript, relevant quotes were selected and copied to a spreadsheet to be analyzed both individually and collectively across transcripts. We first open-coded each quote and used the codes to identify categories based on clustered concepts. Categories were then grouped into broader themes.

During analysis, a prominent theme we identified was the existence of two types of participant – *regular* participants who contribute on a regular basis, and *episodic* participants who perform only occasional or one-time service (details discussed in the next section). We therefore performed a secondary coding to identify descriptions that specifically applied to regular or episodic members. Such descriptions can be either self-referential (e.g., when an interviewee identified to be regular/episodic talked about him or herself), or other-referential with explicit indication of category (e.g., when referring someone else as “core member,” or “who only showed up for a couple of hours at the show”).

4. RESULTS

4.1 Work Structure of CO Groups

To situate discussion of the work structure of CO groups, we note that while groups that we sampled from work on different projects (see Table 1), two common elements of their work are *work events* and *project management*. For example, G13 is a group working on urban farming project. It has a “planting day” every few weeks when participants will gather to work in the farm. G10 is a group building community housing, and it organizes many “construction days” that people can sign up for to participate in the construction work. G1 is a group working on annual event, and the event itself is the work event for the volunteer members. Outside these work events, work is continuously required for project management, which often involves planning, organizing and coordinating the work events, as well as managing the personnel, finance and other resources. In most groups, this is accomplished through holding regular *planning meetings*. Aside from the meetings individuals coordinate via ICTs such as email, phone, social media, etc.

4.1.1 Regular and Episodic Participants

Consistent with literature on volunteerism and peer production [6][16][24][27][50], we identified regular and episodic participants in all the CO groups we sampled. We should mention that this distinction is not dichotomous. Rather, consistent with [24], there is a continuum of regularity of participation. Further, a small portion of episodic participants may become regulars as their engagement deepens [5][50]. We distinguish *regular* and *episodic* participants to highlight a disparity of involvement and

Table 1: Description of interviewees’ groups. Episodic members are labeled with letter E. Project description is on tasks that the volunteer crowds do, not including administrative work.

Group	Subject ID	Group Project Description
G1	P2	Annual neighborhood event with market, performance, etc. Volunteers work on the event day for various tasks
G2	P22 (E)	Donation events to help children in the Middle East. Volunteers take shifts to work at the donation site.
G3	P24 (E)	Accept donated books and giving out to children in the neighborhood. Volunteers take shifts to work at the donation site.
G4	P25 (E)	Organize neighborhood art performance. Volunteers work on the event day.
G5	P3	Breast cancer walk for public awareness. Volunteers work on the event day.
G6	P4, P6	Neighborhood gaming events. Volunteers work on the event day to set things up.
G7	P18 (E)	Yoga practicing events. Volunteers participate at the event day and also work together to set things up.
G8	P20	Group outdoor adventure. Volunteers get together for the scheduled day, both as participants and set up the events.
G9	P1	Building community solar power system. Volunteers sign up for multiple “building days” to build the power system.
G10	P8	Building community shared housing. Volunteers sign up for multiple “building days” to work on the housing construction.
G11	P12 (E), P13, P14	Building community housing for low-income families. Volunteers sign up for multiple “building days”.
G12	P5, P11 (E)	Urban farming project for shared food. Volunteers sign up for multiple “planting days” during the farming circle.
G13	P10	Urban farming project for shared food. Volunteers sign up for “planting days”.
G14	P19 (E)	Community gardening. Volunteers are assigned individual garden and participate in “work days” for various maintenance tasks.
G15	P23 (E)	Community gardening. Volunteers sign up for gardens and participate in “work days”.
G16	P7, P21	Burning Man project. Volunteers build artwork and participate in the event.
G17	P15	Community theater performance. Volunteers take various roles in performance, practice and set up for the performance.
G18	P26 (E)	Performance art show. Volunteers sign up for art show events, work on the stage and various set-up tasks.
G19	P16	Helping local older adults. Volunteers sign up for volunteering slots.
G20	P17	Helping local older adults. Volunteers sign up for volunteering slots.
G21	P9 (E)	Organizing mycological education trip. Volunteers help out during the trip.

contribution levels among members and elucidate differences in roles, motivation and practices.

We found that episodic participants prefer to participate in events where they can show up for a day of work without long-term commitment. They rarely engage in project management, planning or other organizational activities—even if they are open to them. This echoes previous research [7][24] suggesting that episodic volunteers prefer, and also are most suited for project-based assignments.

Project management work mainly falls to the regular participants, often the most devoted, who contribute significant time and take greater responsibility. Size of the group of regular members range from 3 to about a dozen in the sample of groups we studied. In many ways, their roles resemble those of paid professional staff in formal NPOs. For example, they may adopt the role of *human resources staffer* to recruit new members, *marketing staffer* to promote the group and seek funding, *coordinator* to manage group members, *site manager* to lead work on the ground, *accountant* to handle financial tasks, and so on.

4.1.2 Emergent Hierarchical Structure

Prior work suggests that grassroots groups may not build a hierarchical structure as formal organizations do, due to a lack of clear authority [58]. But almost all the groups we encountered reported a hierarchy—not maintained by power and authority, but *emerging* from different levels of involvement and different roles people adopt. By taking part in organizational work, regular members are seen as the group’s “core” and episodic members as the “periphery”—a structure that is reflected in many studies of peer production groups [5][16][27][50]. For example, P2 is in a group organizing annual neighborhood social events. It has a “*planning committee*” of 8 members who meet monthly, and recruit and lead a large number of members who only work on the event days. P10 described the structure of a community farming group as having an “*inner core*” of “*7 or 8 people who are acting to get things done,*” an “*outer core*” of “*about 20 people who help lead work parties,*” and episodic volunteers, “*anywhere from 60 to a 120 people show up for 4 or 5 hour work parties.*” (P10)

CO group hierarchies tend to have “distributed leadership,” with regular members encouraged to take “local leader” roles for work events or subparts of a project, often leading a group of episodic participants. Local leadership is commonly attained through either repeatedly doing a task—so developing the ability to train and lead others—or through actively volunteering oneself for a role—often to suggest new additions to the project. Local leaders may have complete autonomy in terms of planning and execution, and this allows CO groups to keep administrative costs low.

While hierarchy is often explicitly acknowledged in some way (e.g., by talking about a “core group” or “planning committee”), it is emergent in that there is often no formal admittance to the “core group” but rather it is earned through increasing participation and voluntary accountability. For example, in several groups we studied, planning meetings scaffold such a structure via self-selection: these meetings are open to all, but attendees tend to be those interested in more involvement. Only those who show up on a regular basis are seen as core members, taking on more responsibilities and accountability to the group.

Interviewer: How did you decide they are the core group?
Interviewee: They just kept showing up... kept coming to meetings and then stepping up more and more. Do we decide on it? No, and I don't... it's not even spoken too much, but I realize we can count on each other.” (P10)

Table 2. Relevant frequency of code occurrence for each of the motivations from Self Determination Theory

Regulatory styles		Example	Regulars	Episodics
External regulation	Instrumental	Share outcomes; get discounts or other perks	3%	30%
	Social	Enjoy socializing and/or ongoing relationship	25%	16%
Introjected Regulation		Self-improvement; fulfill obligations; follow norms	0%	28%
Identified Regulation		Support the group goals and value the the results	13%	14%
Integrated Regulation		Consist with personal values and beliefs	25%	2%
Intrinsic Regulation		Enjoyment of work	34%	9%

4.2 Motivations of CO Group Members

We were interested in what motivates people to participate in CO groups. Following previous research [21][22][37], we coded CO participants’ motivation under the framework of self-determination theory (SDT) [13][18]. By using participant category (Regular or Episodic) as a code we were able to map participant motivations along the SDT spectrum, as shown in Table 2. It shows a different distribution of motivation type between the two categories. Here we discuss each type of motivation and the key findings.

External regulation, means being motivated by extrinsic rewards (or the avoidance of punishments) and following Nov et al. [37], we further divide this into “instrumental rewards” and “social interaction” for volunteering context.

Instrumental rewards: the possibility of sharing the co-produced outcome is often used as an instrumental motivator for participants. Many CO groups also offer rewards such as “*attend the event for free*” (P22). Instrumental rewards were primarily described as motivators by episodic participants. So, given the limited tangible rewards CO groups can afford, people who are primarily motivated by instrumental value may not want to contribute continuously.

Social interaction: the nature of CO work—that it happens in the local community and involves physically gathering—provides ample opportunities for socializing. We found that this motivates both regular and episodic members. Regulars, especially, value social relationships formed through interactions, seeing the “core group” as a “*relationship-based group.*” (P08)

Introjected regulation refers to pursuing ego-enhancement or filling obligations. We saw it primarily in episodic or early-stage participation, where people are attracted because, for example, they are able to “*learn about operating machines*” (P26), or “*it gives me a sense of function*” (P24). Filling social obligations was also reported. For example, a group of company employees might sign up for a work event. However, they were found to be “*not as easy to recruit again as those sign up on their own.*” (P14)

Identified regulation, in the context of CO groups, may result from perceiving the value or effectiveness of the group’s work, be it creating useful or influential products, helping others in need, etc. This motivation was frequently reported by both episodic and regular participants.

Integrated regulation is primarily seen in regular

participants, who are often motivated by idealistic belief in the group mission. For instance, “I think that we are definitely strong supporters of the mission, as opposed to just anybody who signs up for a one-time thing” (P14). Participants are especially likely to join the core when group values match their own. For example, P05 is an active member of a community gardening project because “I teach this stuff, you know, if I teach sustainability...it’s putting into practice what I preach.” (P05)

Intrinsic motivation is characterized as enjoying the activity purely for its own sake. Many regular participants reported this. For example, “A lot of people who are involved [in the board] love to do theater.” (P15). Meanwhile, not feeling intrinsically motivated (e.g. “did not like the construction work” (P13)) was mentioned as a de-motivator that led episodic participants to drop out.

Table 2 highlights differences between regular and episodic members. It suggests that those with more autonomous motivation—*intrinsically motivated* by enjoyment of the work and its idealistic value—are more likely to be regular members taking core responsibilities. In contrast, those drawn to more extrinsic rewards tend to remain episodic members.

In the rest of the paper, we focus on two key tasks of CO groups: collaborative project management and organization of work events. Given the divergence of participants involved in them—the former mainly done by regular members and the latter by crowds with a large portion of episodic participants—we recognize different needs reflected in the work practices that align with their motivational differences. Specifically, we identify *autonomy support* in regular participants’ project management work, and *motivation support* in mobilizing and coordinating crowds.

4.3 Collaborative Project Management

As discussed earlier, we regard the organizational work to put on work events as collaborative project management. This is often divided among core group members, each taking specific *roles*, and collaborating closely, typically by having regular planning meetings to divide work, discuss issues, and report on progress.

4.3.1 Autonomy Support

According to SDT, supporting autonomy fosters more internalized motivation, increasing work satisfaction and productivity [17][18]. For core members, a primary way to support autonomy is to encourage *self-initiative*—choice over what one wants to do. This is reflected in the largely bottom-up process for role assignment: a common tactic is to leave it up to the members to identify what needs doing, decide what they are capable of and interested in doing, and volunteer for the roles. It is viewed as *empowering* for regular members, and many groups explicitly avoid top-down assignment that could undermine autonomous motivations. This is illustrated in the following quote, describing how a new member of a “planning committee” self-assigned his role: “He just came into the group and you know we do not really define what he is going to be doing... after being at a couple of meetings, he is going to find things that he thinks he would be best at doing within the group.” (P02)

Regular meetings, especially the practice of “reporting and discussing together,” seem to support self-initiative by creating *transparency*—through shared awareness of different parts of a project and promptly communicated needs [15]. Regular members reflected on the importance of “*visibility*” and “*asking for help*” to show accountability and facilitate work redistribution: “The more visible you can make what you are doing the better because

for two reasons. People can see that you’re trustworthy... they can also see that you need help. They can think to themselves, oh I really know about email systems, or my friend knows, I should connect them.” (P04)

Autonomy support also extends to *competence* and *relatedness*. Competence support is achieved through positive reinforcement and feedback. It means expressing support and trust for regular members, while minimizing intervention and overhead. It is reflected by the “distributed leadership” work structure we discussed earlier, which affords the regulars autonomy to accomplish their goals. Relatedness support is seen in the idea of “*shared ownership*.” CO groups as co-production groups cultivate a sense of ownership in their essential value. It is especially important for regular members who invest heavily in group products, and “*have their specific roles and they take ownership over it.*” (P03). In particular, co-ownership is reflected in the democratic decision-making among the core members that frequently involves voting, debate and conflict resolution.

4.3.2 Fluidity, Adaptability and the Challenges

In contrast with formal organizations, the bottom-up role assignment of CO groups leads to more fluid, ill-defined roles, where core members may frequently vary responsibilities or switch roles altogether. This is also partly due to the fact that many CO groups are newly emergent grassroots efforts, lacking experience or precedents to copy. As P07, who is a core member for an art project group, pointed out, “*nobody really knows exactly how to do this...so we have to try and figure out like whose idea is the best, who is best at doing what.*” P04 also described it as a “*trial and error process*” to redistribute and optimize assignments.

The fluidity also springs from the need to be *adaptive* given the high turnover rate, which is a fundamental characteristic of volunteer groups [37]. One’s availability may often be constrained by other life commitments, such as work or travel, so members often temporarily take over others’ roles or delegate their own. Interviewees valued accommodating and flexible team mates that they could rely on—“*having people to pick up the slack is very important...where you’re not getting paid, and it’s all volunteer time, it really helps to have access to that... It’s that we have kind of a circulating group of people that someone else could step in and fill the void when someone wants a break.*” (P11)

Bottom-up, fluid role self-assignment leads to a few challenges for collaborative project management: 1) uneven, non-optimized work distribution. 5 interviewees who have been in the selected leader position reported high workload, having to take multiple roles, often the unclaimed roles that no one else selected to do. We recognize that relying on discussions at monthly or less frequent meetings may not provide enough transparency and facilitation of work distribution. 2) A lack of clear definition of roles. It leads to overlaps, neglect, or even conflicts between members. This is exacerbated by the fact that the job assigning is often spontaneous and sometimes implicit. For example, one may start “helping out” in a different role when it seems necessary, which is likely to happen when CO group members work in the same physical space.

4.3.3 Tools Supporting Collaborative Project Management

Collaborative project management work spans from co-located physical meetings to remote communications. In particular, we identified a range of tools for *collaborative task management*. 4 interviewees reported having a shared to-do list, either “*a piece of*

paper passing around” or bulletin board at the meeting site, updated regularly. A quote from P10 details a common scene at planning meetings and the use of such a shared list in supporting collaborative task identification, assignment, and coordination: *“We have a meeting once a week, and we’ll say what needs to get done and how are we going to do it then we make a list on the chalkboard. Sometimes we break into groups and brainstorm... So then, as you have all these tasks up on the list and we start prioritizing it, and we say, ‘Okay, who wants to be the leader of that?’ then we’ve got these leaders and we write down, ‘what materials do you need and how many people do you think?’”* (P10) As this quote illustrates, the use of these tools aligns closely with the self-initiated role assigning process of the core group, fostering transparency and shared awareness.

4 groups maintain an electronic “shared chalkboard.” Two reported using Google Docs and two others created a wiki page for everyone to contribute ideas and action items, track assignments and schedule, etc. These tools provide additional benefits - not only allowing remote and asynchronous project management, but also serving as a repository of reusable information for the future: *“We have Google Docs which helps coordinating like, who is arriving when and what are they bringing... we had one page on there to go—for current schedule to make sure that it is in need of attention...then we have a lot of that are sort of the repository of information that’s been accumulated* (P07)”

Other groups simply rely on personal communication applications to do task management work. Consistent with prior research, project management heavily depends on email [1][57]. Most groups reported having a mailing list dedicated to discussion about coordination and logistics, which is indispensable to project management between meetings. While it is a natural extension of group communication, there are well-documented challenges in using email for task management [1][57]. We heard similar problems including overloaded and cluttered messages, lack of timely responses, and disruption of collaboration, for example, *“I try to do zero inbox, that’s how I manage it... that’s a disaster, hectic,”* (P06) and *“people don’t check their emails and you don’t get a response for days and you just wait.”* (P02)

In addition to email, 4 groups reported using forum style discussion tools such as Yahoo or Facebook Groups, often to discuss specific issues in a short timeframe. We heard of groups switching between multiple communication tools for project management. A reason for this is the varying needs for backchannel communications. For example, P07’s art project group use Google Docs for structured task management, and a mailing list for group wide communication (e.g., meeting minutes and information requests). When a specific issue comes up, they may switch to a Facebook Group to engage in discussion threads—one benefit she mentioned is that it gives individuals a choice to opt in or out of a particular discussion.

4.4 Design Implications for Supporting Collaborative Project Management

Based on the above analysis, a collaborative project management (PM) tool such as Basecamp or Asana may offer one place for CO groups to do all their work without breakdowns, including task management, one-to-one and group communication, decision-making and archiving. However, no group in our study used such a tool. While we believe technical and financial constraints may play a role, we note that existing tools are developed primarily for managing for-profit projects enacted by paid participants with defined roles and responsibilities (such as regular reporting) that

cannot be shirked. So they may fail to anticipate certain needs of CO groups. Here we highlight two points to consider when designing PM tools for CO groups, which are expected to be used both synchronously (i.e., during group meetings) and asynchronously (i.e., outside group meetings) by a group ranging from a couple to a dozen of members.

4.4.1 Supporting Bottom-up Work Assignment

Our analysis revealed that assignment of CO organization work is highly bottom-up, relying on regulars to collectively identify—sometimes to “pool”—tasks that need doing, and to self-assign from the pool. Currently these activities are often supported by rudimentary tool such as chalkboard or shared document. For a specialized PM tool, we recommend a key feature to be an intuitive, fully shared view of a collaboratively created and maintained to-do list, perhaps using the chalkboard metaphor, which allows everyone to add, edit, delete, annotate and self-assign items, as easily as drag-and-drop. Actions should be transparent and easy to track. While some PM tools already provide a shared “project view” for team activities, we emphasize the need for support of collaborative work distribution and redistribution for CO groups—this is often not explicitly supported (e.g., in Basecamp and Asana, one is expected to create one’s own task, or assign tasks to someone else, not put tasks up for anyone to commandeer). A CO tool should enable a collaborative process that fosters autonomous motivation. For example, everyone could tag tasks in common pool as time-sensitive, requiring certain skills, etc. to assist the self-selective process. To initiate redistribution, one could “request help” by flagging challenging tasks they are currently taking. “Social reference,” by enabling members to recommend tasks to others, could also help optimize the process.

To enhance social transparency and provide a clearer definition of roles, we also recommend a “people view” visualizing each individual’s responsibilities and status, etc., as well as ongoing collaboration with and dependency on other group members. This view could also allow users to start backchannel communication for clarification and negotiation of boundaries (e.g., by pointing to specific tasks). P02 mentioned that, as echoed in previous work [42], people often feel uncomfortable doing so in a collaborative context. Lightweight social interaction such as a “help” button to express willingness to support or takeover a task could be used to facilitate the negotiation.

4.4.2 Lightweight, Flexible and Supporting Fluidity

One interviewee mentioned considering Basecamp but concluded that it is too *“heavy weight”* (P06) for a volunteer group, requiring substantial investment from everyone to maintain. This highlights a key shortcoming of existing PM tools: lack of flexibility to accommodate groups with varied levels of involvement and dynamic usage patterns. Current tools often impose procedural controls, such as check-in/check-out, reporting, and tracking individual progress. However, for CO groups, regular members’ high autonomy would render these control mechanisms as redundant functional clutter, and their use could be detrimental to intrinsic motivation. Our analysis suggests that tools for regular members should favor unobtrusive visibility, and thus accountability, over supervision and control. So CO support solutions should avoid mandatory actions, rather offering choices, and encouraging members to be visible to others, for example, with a “group news feed,” where members can announce their progress and comment on that of others’.

A more critical challenge, as suggested by our analysis, is to support the high fluidity of member responsibilities and dynamic

patterns of use. For example, it should allow users to easily indicate temporary leave, role switching or delegation and avoid complex user authorization for such changes. Beyond that, technology should consider how to support knowledge transition for frequent role switching. For example, each task node could be linked to an archiving page that lists all the activities of people who previously worked on a task, as well as resources used and learning materials.

4.5 Organizing Work Events

While the activities of work events vary widely among CO groups, we sought commonalities in procedures that enable a large crowd to perform collective action at a focused time and location. We solicited descriptions from both episodic members who are participants of work events and core members who have acted as *event coordinators*. Unlike role assignment among core members, we identified significantly more centralized *planning* and top-down *assignment* in coordinating work events involving episodic members.

Planning: before work events, the coordinator or a group of regulars plans the goals, procedures and resources required. An important part of this step is the task *breakdown*—to divide work into smaller parts. Consistent with Benkler’s suggestion on enabling peer production [4], the parts should be highly modular—independently doable to reduce complexity and coordination costs, and low in granularity—the time and effort required should be minimal in order to draw enough participants, especially those with low motivation.

Assignment: this is often a top-down process to allocate tasks to the working crowd. In some groups, a coordinator makes an announcement about available tasks so participants can choose. In other groups, the coordinator assigns tasks by *profile matching*, based on pre-collected information such as preferences, skills, and availability. We found that groups that are larger, more mature, or engage in more routine activities (as compared to more creative activities such as art project) are more likely to perform top-down assignment.

4.5.1 Motivating Episodic Participants

Since CO groups depend on a large portion of episodic participants—who cannot be held accountable for commitments and may have limited motivation, efforts are made to entice contribution and to nurture potential long-term engagement. Drawn from economic and social science theories, contribution to collective effort could be encouraged by adopting two strategies: reducing costs of participation, and increasing perceived value of outcomes [26][31].

We found coordinators invested significant effort in lowering participation cost, to *“make it really easy for people”* (P06). This means reducing the perceived difficulty and complexity of the work. For instance, by having a coordinator perform all the task breakdown and matching work, one *“only needs to sign up for an event and fill out a short form”* (P13). In our interviews with episodic members, we noted a *non-transparency* of work planning. Episodic members were mostly unaware of the planning and articulation work (i.e., work division and re-integration) [51], but focused only on the small chunks that were available or assigned to them. They seemed to welcome the simplicity of this approach. They also welcomed explicit coordination [29], where clear instructions were communicated (e.g., overview, procedure and expected time commitment). This helps with *expectation setting*, which minimizes aversion to unknown costs: *“the biggest barriers are fear from the people about whether it’s going to work*

and [how much] time needed...In the email we say the only time that we actually need you to volunteer is like those three or four hours.” (P04)

To emphasize the value of contributions [32][33], some groups publicly acknowledge each individual, or reward those who made substantial contributions. Some coordinators send out personalized thank-you notes. Participants valued the acknowledgement and gratitude they received and recognized the positive effect of an appreciative group leader or coordinator—*“enough for me to think, I am valued”* (P22). Some coordinators expressed frustration that they could not accurately identify people that should be acknowledged, which is a challenge with large crowds. To be consistent with the norm of “welcoming any level of contribution,” and to avoid additional work, most CO groups do not ask participants to log or self-report contributions. Of course this makes it even harder to target individuals for acknowledgement and further engagement.

4.5.2 Challenges for Work Event Coordinators

Our analysis revealed the unique position of and significant challenges for coordinators of CO work events. On the one hand, they act as group leaders at the top of the hierarchy, directing others. On the other hand, they lack authority and must often prioritize serving the satisfaction of others. P03 described her coordinator job as *“customer service”*—attending to individual needs to ensure a positive participation experience. Several other interviewees also mentioned that they would frequently *“check in with everybody”* (P06) and *“make sure people are having fun, not burning out”* (P08), and sometimes they had to compromise work outcomes for the sake of participants’ enjoyment. Some also reported a tension between maintaining formal structures (e.g., standard procedures that reduce individual input) and ensuring individual needs, which piles on extra work for the coordinators.

Another prominent challenge is *dealing with unpredictability*. To retain volunteers and lower participating barriers, CO groups often allow any level of contribution and flexibility to join and leave at any time. Also, many groups adopt a radically inclusive recruiting strategy and the outcome is a large number of loosely associated, potentially “lurking,” episodic members. On the one hand, it makes it hard to predict how many people will attend, and what kind of skillset will be available for each event. For example, P10 mentioned there are around 1000 people in the mailing list they use for work event announcement, but there would be only 60-120 attending. On the other hand, lack of accountability (e.g., non-response, absence, dropout) is almost inevitable with crowds, but is amiably tolerated as group norms. Interviewees described various strategies to cope with unpredictability. Some emphasize timely communication. Some rely on having flexible and resilient plans, such as by identifying and prioritizing critical tasks, or substituting with paid workers. Some study attrition rate and its predictors (e.g., weather, volunteering experience) in order to adjust recruitment effort.

4.5.3 Tools Supporting Organizing Work Events

As seen in peer production literature [10][50], over time, organizing procedures get more formalized, which helps to reduce participation cost. We learned that the formalization of coordination procedures is supported by a variety of standard artifacts (e.g., standard lists, forms and brochures), which streamline and reduce variation in procedures. For example, the goal of planning and work breakdown is to create a *job list*. Given that work events are often repetitive in nature, such a list then can be reused, maintained and formalized overtime. In 3 groups, this list was expanded into a brochure with job descriptions sent out to

members before work events to facilitate work assignment and *expectation setting*. P09, an episodic participant described such a brochure: *“I received a list of things like cleaning up, bringing wood... we also receive a package, all the documentation about things that we need to bring, like flashlight, and useful information about the agenda.”* (P09)

In groups where coordinators perform top-down assignment, a commonly used tool is a form to collect individual information such as work preferences, skillsets and availability. In some groups this is paper-based, handed out when participants sign up, while others use a web-based form such as Google Forms. The forms must be simple and require minimum effort for participants to fill: *“I added a Google form which streamlined the process tremendously... I try to be really specific. So there is like five different things they can volunteer for and I also try to think through like before the event, during the event, little chunks. So they would feel it's really easy to participate.”* (P06)

The content of these forms may be entered into a database. Similar as in [53], coordinators often use Microsoft Office™ tools like Excel or Outlook, or create a paper-based “database.” The coordinator can then go through the database to match individuals to different tasks. But challenges may arise from trying to satisfy both individual preference and project optimization. For instance, *“part of the challenge is matching people based on not just what they love, but matching them based on skill level”* (P20).

Communication with crowds takes a major portion of a coordinator’s work routines and is supported by various ICT tools. We heard a mix of, and frequent switching between one-to-many mass communication and one-to-one personal communication. Periodically, or prior to work events, coordinators send mass emails to *mobilize* the crowd. These are typically announcements about events, polling for interest and availability. Most use a group-wide mailing list, often on a monthly basis so *“people don’t feel overwhelmed”* (P10). Some groups also cross-post announcements on social media accounts like Facebook, Twitter, Nextdoor, etc. to reach a wider audience. After that, mass communication at a smaller scale happens by gathering contact information of those who responded to a call. More detailed information about the event is sent out, often including job descriptions and other logistics. Some groups also send task assignments at this point. To cope with dropouts, as the event approaches, many coordinators send out a reminder email to confirm availability. In response to mass emails, some participants initiate individual communication threads with the coordinator. These exchanges are usually to communicate availability, to ask specific questions, or to negotiate about tasks.

The communication described above can be highly taxing for coordinators, and is constrained by the event timeline. Several groups thus develop or appropriate existing tools for event-related communication. One example is the use of event organizing websites like Meetup.com, reported by 2 interviewees. Such tools can accommodate the basic event-related communication well, including announcement making, RSVP, group and personal messaging, etc. An additional benefit is the social aspect. Several interviewees sought awareness of other event participants (e.g. *“you can see each other’s profiles, and mutual friends you have in common.”*(P20)), and communicate with other participants. For example, the commenting section can be appropriated for social Q&A to help collaboratively address individual—especially new—participants’ questions.

Existing event organizing tools, however, are mostly developed for social, instead of work events and may fail to support work-

related needs, especially for task assignment, like providing task descriptions, requesting specific skills, collecting preferences, sending targeted instructions, taking ownership, etc. Two groups reported developing their own specialized *“event portal,”* both featuring a calendar view where members can sign up for different days, indicate preferred tasks and review logistics and instructions. They also allow participants to communicate with coordinators and give timely notice for plan changes (e.g., by cancelling registration). P14 also valued such a tool as a database for keeping records of individuals’ contact, profile, work records and also feedback collected.

4.6 Design Implications for Supporting Work Events Organization

Our analysis suggests that a specialized CO work event organization tool that integrates coordination (i.e., task planning and assignment) and communication could facilitate organization of work events. We note that task assignment could seamlessly fit into the communication process—for example, task matching could be performed immediately after an RSVP, and participants could then be grouped for task-specific information and communicate within their group. An integrated tool could also accommodate individual flexibility by enabling self-selection and changes—for example, choosing from a task list, or making changes to an assignment, and the coordinators might only need to be notified or asked for approval, greatly reducing their workload. We emphasize that the tool should aim to improve the experience of both sides: the coordinator, and the participating crowd. Next, we will discuss three key points that we believe can add value to such a tool.

4.6.1 Computation Supported Coordination

At the present time, task assignment is onerous but particularly tractable to computation. A system could easily replace much of the coordinator’s work by performing automatic task-matching based on multiple criteria such as self-reported preference, profile and participation history, and the result is likely to be more optimal. A similar idea has already been explored in developing automatic task routing technologies for peer production systems (e.g., Wikipedia) [12]. To satisfy individual preference, the result could be a task recommender system for participants, with default “best match” and other options ranked by selected criteria. Hearing that interviewees repeatedly mentioned that the success of work events is defined in terms of two factors: attainment of project goal, and providing an enjoyable experience, we recommend the matching system to also include individual enjoyment as a key criterion. For example, post-event surveys could be administered to collected individual experiences with different tasks for future reference.

Computational technology could also assist coordinators in coping with unpredictability. To support recruitment planning, it would be valuable to provide suggestions about the number of participants needed, based on the workload and predicted dropout rate, which could be learned from previous records. It could also continuously monitor the RSVP and automatically decide to send additional mobilizing email targeting certain participant groups. Another promising technology for coordinator is one that supports work partitioning, possibly similar to that used for crowdsourcing complex tasks [30]. This would be especially useful for newly formed groups where no job list has yet been created. Given that work event is often constrained by the available skillset, an advanced version of such technology could create customized job lists based on the skills and preferences of those who sign up for a particular working event.

Lastly, specific to the work nature of CO groups, we note a high demand for continuous coordination on the work site, where the coordinators have to keep going around to check in with everyone and deliver necessary resources and instructions. We see opportunities for mobile technology to tremendously ease the on-site coordination, and it could be a natural extension of a work event organization tool. For example, a user could easily report the completion of a task he or she signed up for, thus the tool could monitor the progress of the work event and recommend action items to the coordinator. By creating a full awareness of the work site, it could also help the coordinator identify exceptional individuals and deliver acknowledgement right on time.

4.6.2 Supporting Episodic Use

“One challenge we have is some people are emailed, some people are phoned, some people don't have a phone, some people do Facebook, some people do texts. A really cool tool would be... preset a preference, and that one portal could communicate to your preferred method...” (P08)

The above quote illustrates that one challenge coordinators face is the variety of communication and other tools used by the crowd. We attribute this to lack of motivation for episodic participants to adopt and learn new tools for infrequent use, a problem reported in previous research into episodic volunteering [27]. A work-event organizing tool should thus minimize entry cost (e.g., by providing integration with applications that people already use). For example, an event page could be embedded in email or a Facebook post, and one could opt in to a preferred communication channel. Ideally, a coordinator could make one single announcement and the system would “translate” it into messages sent to each participant’s preferred channel.

4.6.3 Supporting Diverse Motivations

“Volunteers usually come for a reason and you have to figure out what the reasons are... some may want to learn skills. Usually it's for people who first come, so I try and take time to teach those people. People also come for the glory, part of this awesome thing. So for them it's very nice there'll be a list on the website and their name next to the work they did. Some think it's rewarding for the community of the group... And just make sure they feel included in that, for example, we usually do toast show barbecue.” (P14)

From our analysis, we identified large variation in the CO group members’ participating motivation. The above quote illustrates the importance of understanding different motivations and tailoring engaging strategies accordingly, as previous research suggests that a mismatch between motivation and type of reward one receives could reduce satisfaction and productivity [14]. Future work should explore tailoring reward mechanism for individual’s motivation, which requires studying how to assess a user’s position on the SDT spectrum, hopefully from early on. One potential approach is to explore computational methods for user profiling, for example, by mining behavioral data or texts, which we may learn from previous work on profiling users based on personal value system [11].

5. General Discussion

We present a study of proliferating grassroots, self-organizing volunteer groups that engage in project based work in the physical world. Our work contributes to the volunteerism literature by providing a nuanced analysis of the work practices of this distinct type of group, one of the so-called “modern” volunteering efforts . In particular, we focused on identifying areas of relevance to the HCI community, where computation and communication

technologies can be brought to help these groups better collaborate and accomplish their goals. While admittedly there is still a long way to go for developing specialized technologies, we want to draw attention to this growing form of peer production. It is especially pertinent timing given the fast growing trend of “peer economy” and “collaborative consumption” [2][48], which embraces grassroots effort, collaborative ownership and sustainability. Crowd orchestration may be a distinct wave in the tide of collaborative consumption that brings contribution and exchange from the individual to the group level.

By adopting the stance of considering CO groups as a form of “peer production in the physical world,” we are able to draw many similarities between them and online peer production groups. In particular, we found they share the disparity of contribution and involvement among individuals, and the evolved job division between regular and episodic participants [5][10][16][27][50]. We also found that they share common strategies to motivate participation and facilitate long-term engagement [10], [32][33][43][59]. Therefore, when developing technologies to support CO groups, we can possibly borrow design guidelines from the current practices of, as well as a rich body of literature on online peer production systems [5][10][16][27][29][32][59].

Despite commonalities, CO groups do certainly have their own characteristic and distinct needs and constraints. While online peer production such as Wikipedia and OOS is often characterized as a distributed model in contrast with the centralized model with managerial hierarchies as in the enterprise, we consider the CO group as a more in-between model. While there are many distributed bottom-up, self-organizing processes to push forward a project, its implementation—i.e., the time-sensitive work event— involves concerted, centralized planning and top-down coordination, which are driven by the specific time, duration and location, against a more distributed model. Meanwhile, we note that episodic participants of CO groups, while on the lower levels of the hierarchy of the work structure, may play a more critical role for the CO group than those in an online peer production group. Previous research into the latter often reports that “occasional contributors” work on peripheral tasks, such as proofreading Wikipedia articles [5], reporting software bug [16]. In contrast, episodic participants often act as the major labor force for the CO group work. This leads to more critical needs for CO group to strive to recruit, motivate and retain episodic members, and to some extent, placing regular members in an accommodating or even ‘crowd-pleasing’ position.

Moreover, unlike online peer production groups, CO groups do not use information and communication technologies as an integral part of their work, but rather, ICTs are often haphazard exigencies, chosen to satisfy many idiosyncratic and possibly temporary needs. Integrated tools are lacking, and to develop one will require careful consideration of varied work processes and divergent user requirements. So we offer this work as an initial guide to what is currently required to support this growing prospective user base.

6. ACKNOWLEDGMENTS

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