Beyond End User Content to Collaborative Knowledge Mapping: Interrelations Among Community Social Tools

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ABSTRACT
Most studies of social tools examine usage of each tool in isolation. Instead, we explore how online communities combine multiple social tools, and use social tools together with external tools. Based on interviews with community leaders and quantitative analysis of 128 online community spaces, we explored the combined use of six social software tools—wikis, blogs, forums, social bookmarks, social file repositories, and task-management tools. We contribute a detailed characterization of how enterprise online communities combine multiple social tools, adding to our understanding of community behaviors: Communities combine social tools to curate and organize complex information spaces. When combined, each tool is used for limited “core” functions; thus “social” features are not always leveraged for every tool. Leaders and members divide labor by tool boundaries. Our results suggest that an important overlooked aspect of social media concerns how different tools can be effectively combined. While most prior work on communities emphasizes end user content, we identify additional important design activities where community participants curate and organize pre-existing content from multiple tools to serve their community needs.

Author Keywords
Online communities; social software; interrelationships; user study; workplace; office.

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
Online communities have long used online forums and email to interact [8]. With the explosion of social software and Web 2.0 applications, there is a host of new tools available, including wikis, social file repositories, forums, blogs and microblogs. This rapid emergence of new social tools and new tool features, means that online communities often do not know which tools to deploy or how to use them effectively [2,17,21,27]. If communities were limited to a single social tool for all their needs, choices might be easier, but communities can now combine multiple tools for interaction, archiving, and other needs. The problem is exacerbated in mature communities, who may have multiple older tools to manage as well [17]. In this new context, how are enterprise online communities composing multi-tool technology environments, and can we provide guidance to leaders about effective tool combination practices? Our study focuses on enterprise online communities, but the same questions are relevant for internet communities who have the same complex portfolio of tools to choose from.

Researchers have documented how individuals and groups in organizations appropriate social tools [23]. However, such studies generally explore use in a single tool situation, where appropriation is really common. For example, wikis afford publishing information, collaborative editing, and team coordination [21]. Blogs enable workers to access and share information, solve problems, give and get feedback, build their network and collaborate [7]. Social file sharing supports discovery of, and discussion about content [20]. Social bookmarks enable people to organize, share, and find resources [18]. Across these studies, “social” features—such as tags, comments, “like” options, identification of authors and commenters, and the ability for multiple people to edit—enhance these tools, enabling content sharing and discovery, collaboration, and contributor visibility. However, it is unclear if these benefits will accrue when communities combine multiple tools. Also, the results of single-tool studies may have unknowingly been influenced by users’ use of other tools.

In this paper, we study how enterprise online communities combine social tools in a multi-tool environment. In theory, a multi-tool context should enable communities to evaluate the strengths of each tool and avoid sub-optimal tool appropriations. Multi-tool environments can be incredibly complex, involving many tools and resources. We therefore selected a sub-set of multi-tool use cases we could study for a broad set of communities, triangulating both qualitative and quantitative methods. In particular, we examined cases where multiple social tools are combined to support a single activity. We call these tool interrelations. We address the following questions about interrelations between social tools used by enterprise online communities:
• When a community has access to multiple software tools, do they combine tools to exploit their different functions?

• If tool combination does occur, what interrelations do we see between different social tools? How are the tools used together and in support of what activities?

• Why do certain types of interrelations occur? What social and technology design features encourage these interrelations?

To tackle these questions we studied how six different social tools—wikis, blogs, forums, social file repositories, social bookmarks, and task-oriented spaces (called “Activities” [2])—were used together by communities in an enterprise. We examine long-term communities, managing complex, diverse sets of information. Such communities also often exploited external overlapping tools, i.e., tools outside their community space that duplicate internal tools, such as basic file repositories. Thus we wanted to know:

• How do communities combine external overlapping tools with social tools inside their community space?

The six social tools we studied are integrated in a web application, Connections Communities (www.ibm.com/software/lotus/products/connections/communities.html). A “Community” is a single shared space that gives members options to activate any of the six tools, providing one UI to access them. The Communities application provides a unique opportunity to evaluate how communities combine the six generic social tools. We can therefore determine: (a) how frequently communities combine tools, and (b) how different tools are combined. These questions are important because several tools support overlapping functions, e.g. both wikis and activities can coordinate tasks [2,21]; blogs and forums can be used to share group news and gather feedback [7,27]; wikis, activities, and shared repositories can be used to attach files [2,20,21]; and so on. And certain external tools’ capabilities directly overlap with social tool functions (e.g., basic vs. social file tools [20]).

Combination supported three major tasks: organization, i.e., making internal resources findable; curation, i.e., drawing in external resources; and notification, i.e., alerting others to new content, to provide feedback or simply for awareness. Communities had a tool-delineated division of labor between leaders and members for these tasks. We describe how tools were combined and labor divided to accomplish these tasks. We offer implications for community and technology design. Our data also quantifies the huge efforts dedicated to organization and curation, revealing a new understanding of community dynamics.

RELATED WORK
Prior research provides guidelines for how communities can collaborate using multiple tools [10,22,26,27]. Wenger et al. motivate our study, highlighting critical challenges communities have in selecting, setting up, and managing technology [27]. They provide guidelines for community technology stewards to handle these tasks, describing how different communities emphasize different “orientations.” Orientations affect the tools groups select, but there are still many possible multi-tool configurations per orientation.

Applying Wenger et al.’s framework, most studies of actual technology deployment focus on communities with a single orientation using a single configuration of tools, e.g. technology use by communities within Wikipedia [11], Encyclopedia of Life [24], MovieLens [11], Facebook [25], QuitNet [14], Slashdot [12], and Stack Overflow [15]. Early studies of technology use by communities described similar case studies [8]. There is little empirical work presenting quantitative and qualitative data, describing multi-tool use by a range of enterprise communities who can select from and configure a generic set of social tools.

We are aware of one study by Muller et al. of multi-social-tool appropriation by a range of communities [19]. Muller et al. described how the types of enterprise communities included in our study—Communities of Practice (CoP), Teams, and Technical Support Communities (Tech)—used different tools. They found some differences in how different community types initiated and used different social tools. However, their study was purely quantitative, and did not describe rationale or practices for using the different tools, as we do in this paper. Nor did they study combination of tools, which is our focus.

We examined technology use by both community leaders and members, who enact different activity types [3,4,9]. To foster successful communities, prior work advocates that leaders should: encourage contributions and discussion [9,10,22], contribute and read content [4], organize and curate content [22,27], deal with disruptive behavior [4,9,10], create a positive environment [4,9], foster connections [10,26], manage new members [10], advertise [4,9], and maintain infrastructure [4,9,22,27]. Members’ should: contribute and read content, and interact with other members (asking/answering questions, providing/receiving social support, etc.) [4,8,9,10]. However, prior work does not directly observe patterns of how leaders and members combine a variety of tools to accomplish these activities.

STUDY CONTEXT
We examine communities in a global enterprise offering technology products and services to businesses. The commercial tool, Connections Communities (“Communities”) was available to all employees, and the company encouraged employee leadership of, and participation in, internal online communities. As a result, there were 166,000+ communities and 580,000+ distinct members. Communities was used by a variety of community types: including CoPs, organizational teams, and technical support communities [19]. These groups used Communities primarily to connect and build relationships among employees who could share information and resources with each other, and sometimes collaborate on a shared deliverable. CoPs did these activities in the context
of a shared interest or practice; teams in the context of producing a shared deliverable; and technical support communities in the context of a mutually used technology. Relating these community types to the “orientations” described by Wenger et al., there was a strong emphasis on content, projects, and access to expertise [27].

The default Community homepage includes three columns (see Figure 1): left column, top to bottom, includes the community’s logo, links to tools, and a tag cloud; middle column starts with an community description, then one box per tool (Blog, Forum, Files, etc.) listing latest updates (Figure 1 only shows the first tool for this community, Blog); right column includes “Important Bookmarks” (communities choose these), Members, and an optional list of Related Communities (manually configured by leaders).

Communities is an example of highly configurable end-user software [23], meaning that it includes a set of general-purpose tools that can be appropriated in multiple ways. The Blog, Wiki, Forum, Files, and Bookmarks tools have the standard functionality of similar tools widely available on the internet, plus typical “social” features: author profiles, comments, tagging, sorting, and “liking.” The Activities tool provides task-oriented spaces with structured fields for to-dos, text content, file uploads, and the ability to organize content into “sections” [2].

STUDY METHOD
We wanted to understand which tools were combined and how they were used together. Thus we collected detailed qualitative data by interviewing expert community leaders about how and why they combined tools, and by directly examining community spaces. We also gathered broad quantitative data characterizing communities’ multi-tool environments and tool inter-linking. We describe interviews with 8 leaders, observations of 67 community spaces, and a quantitative linkage analysis of 128 community spaces.

Interviews With Community Leaders
To collect descriptions of how and reasons why communities combined tools, we interviewed 8 community architects. Architects were expert community leaders who worked with multiple communities in their business division (e.g., Software, Hardware, Services, Sales, HR, etc.). Their jobs were to determine best practices for community tool usage, set up technology, and train and consult with community managers [5]. Generally they were responsible for the success of all the communities in a particular division or sub-division within the company. Because they worked with multiple communities, this enabled us to collect data about a range of practices across the company. The other leader role at the company was community managers, who were responsible for the day-to-day activities of a single community through its life cycle. All our participants were community managers for at least one community, in addition to their architect roles.

Our participants represented a broad set of divisions, including Hardware, Sales, and multiple sub-divisions of Software, Services, and Corporate Development. Each led

Figure 1. Communities default landing page for an example community (only top third of page is shown). (A) Community description, configured to link to top community content. (B) Important bookmarks, configured to link to more top community content. (C) Preview of each tool’s contents, configured to start with the Blog. (D) Related Communities list.
both CoPs and Teams with experience leading and consulting with many communities. To recruit such a diverse set of people, we identified an initial 4 community architects representing different divisions through our working relationships with them, developed from our work designing tools for community leaders [16]. We identified an additional 3 architects who worked in different business divisions. We identified 1 participant in a new division based on a recommendation from another participant.

In 30-60 min phone interviews, we asked architects about the types of communities they led, how these communities used each of the six social tools in Communities, and what other tools (like external file repositories, wikis, forums, or communication tools like email) they used and how. We made it clear to participants that we wanted to understand how their communities actually used the tools, rather than how architects intended people to use the tools. Indeed we will provide multiple instances of where members did not do what architects wanted or expected. Interviews were audio recorded and detailed notes were taken to create a list of usage goals and practices for each individual tool and interrelation between tools mentioned by participants. We used this list to determine common interrelations between social tools. We did multiple passes through interview notes to identify themes related to these interrelations.

**Exploratory Examination of Community Spaces**

Our interviews did not allow us to observe actual tool usage by community participants. Thus to supplement our qualitative data, we conducted a small-scale, exploratory examination of community spaces, observing and interpreting how communities used the six social tools. We sampled 67 public communities with the highest overall posting in and viewing of their community space (54 CoPs and 13 Teams). Our goal was to understand if the themes from our interviews occurred in communities other than those led by our interviewees, and to observe concrete examples of how leaders and members enacted the themes, but not to quantitatively assess how frequently they occurred in a large population of communities. Thus we did not conduct a content analysis with a formal coding scheme, but instead examined community spaces, observing the ways tools were used and interpreting the purposes of posts in those tools.

For each of the 67 communities, we viewed the pages that summarized every post. The summary pages for all the tools except the Wiki included, for each post, the title, author, date updated, and number of comments. The summary page for Blogs also included the entire article. For the Wiki, we viewed the top-level parent page and a tree-structure listing the titles of all the Wiki pages. On each of these summary pages, we used the available information to assess the purpose of each post. The post titles were informative because members also used these pages to determine when to click on a post, so authors made the titles descriptive of the purpose and contents. We clicked on posts when their purpose was not apparent, to view all of their content. We took notes about the variety of purposes the posts in each tool served. We also noted the practices used to accomplish these goals, such as linking to other tools. This analysis, importantly, confirmed that linking was the primary way in which people enacted the interrelations described in our results.

**Quantitative Linkage Analysis**

The exploratory examination of community spaces showed that communities combined tools by linking from one to another. We performed a linkage analysis to quantitatively characterize how inter-linked the tools were, as well as the patterns of different links, i.e., which tools commonly linked to each other, and whether links were formed within the community or across communities. Tools that interview participants said were important to the community had many links to them in the linkage analysis, even non-social tools (e.g., email linked by “mailto” links, meetings indicated by links to web-conferencing and scheduling tools). Also during our interviews, the community description on the homepage emerged as an important place for the activities observed in our study. Even though the homepage description is not a “tool,” we added it to our linkage analysis and present it in the results.

To analyze interrelationships, we crawled all leader- or member-posted text in 128 Communities (excluding text inside Files) to identify links (URLs). For each link, we captured the source Community (where it was posted), the source tool (Wiki, Blog, Forum, Bookmark, Activity, Community description), whether its target was internal (inside the Community) or external (outside the Community), and the target tool (see Table 2 for a list of external target tools and Table 1 for a list of internal target tools). When an Activity was the target tool, we could not determine if it was part of the same or some other community, so we exclude Activities from internal target tool analyses (Table 1 columns). We analyzed the data to understand: How many tools does each community typically use? How inter-connected are tools in the community space both internally and externally? What tools do communities commonly combine? Our criteria for inclusion in the linkage analysis were:

- **Active management**: Leaders had to sign up for Community Insights [16], a tool to help leaders enhance their community. A research goal is to make community design recommendations, so we wanted active leaders.

- **Mature**: Greater than one year old, allowing time to develop norms for using the tools, and materials describing these norms to new members.

- **Active**: Updated in the last month. We wanted relatively successful communities since our aim was to describe effective tool usage practices.

- **Type**: We chose 3 of the 5 community types described in [19]: CoPs, Teams, and Tech. IdeaLabs and Recreational communities were excluded because there were not enough of them that met the other criteria.)
end user content creation) in enterprise communities. Reveals a new emphasis on content curation (in contrast to, e.g., demonstrating and O

RESULTS
between specific tools informed by the qualitative findings described and provided showed rich descriptions and ratings of the phenomena of tool interrelationships. This suggested we explore links between specific tools inside and outside the community.

RESULTS
Our results show that combining social tools is common and the reasons and ways communities did so. The results demonstrate new use cases introduced by tool combination, e.g., layering social functionality of one tool onto another and dividing work for a single activity into multiple tools. The practice of linking tools and resources together also reveals a new emphasis on content curation (in contrast to end user content creation) in enterprise communities.

Combining Tools is Common
Our quantitative analysis showed that communities commonly use multiple tools: 88% of communities used (i.e., posted at least once to) 4 or more social tools in their Community. Tools were used with the following overall frequency per community: Wiki (89%), Files (88%), Forum (88%), Bookmarks (88%), Blog (71%), and Activities (19%). However, communities did not use tools independently; rather, we found considerable linkage between tools. Each type of tool had links, with the vast majority pointing to tools other than themselves, inside and outside the community. As shown in Table 2, Wikis contained the most links (average of 588 for 114 communities with Wikis), then Blogs, Forums, Bookmarks, and Activities.

For internal links, Communities had an average of 154 links pointing to their own community (out of an average total of 812 links). As shown in Table 1, the most referenced internal tools were Wikis (55% of internal links), Files (22%), and Blog (13%). Surprisingly very few links pointed to the community’s homepage (7%) or Forum (3%). While each tool contained within-tool references (especially the Wiki and Blogs), many links were to other tools (see Table 1). Some frequently linked tools included Wiki to Files (4015 links, 26% of internal Wiki links), Blog to Wiki (436 links, 13% of internal Blog links), Forum to Wiki (313 links, 37% of internal Forum links), and Bookmark to Wiki (107, 66% of internal Bookmark links).

Our linkage analysis also showed which tools were used in isolation. Activities had very few links: 400 total (0.38% of all links), and only 49 pointed to other tools in the same community (see in Table 1). Activities seemed to be used in a fairly isolated way, even within a multi-tool environment.

Our link analysis showed that communities also relied on external tools: i.e., resources outside the community space. Communities signaled which external tools were relevant by linking to them. Table 2 lists the categories of tools linked to by our dataset of 128 communities. For external links, the biggest category was links to other communities.

<table>
<thead>
<tr>
<th>Internal Source Tool (linked from)</th>
<th>Wiki</th>
<th>File</th>
<th>Blog</th>
<th>Cmty Home</th>
<th>Forum</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wiki</td>
<td>9885</td>
<td>4015</td>
<td>289</td>
<td>912</td>
<td>370</td>
<td>15471 (77%)</td>
</tr>
<tr>
<td>Blog</td>
<td>436</td>
<td>194</td>
<td>2303</td>
<td>270</td>
<td>84</td>
<td>3287 (16%)</td>
</tr>
<tr>
<td>Forum</td>
<td>313</td>
<td>120</td>
<td>77</td>
<td>161</td>
<td>171</td>
<td>842 (4%)</td>
</tr>
<tr>
<td>Cmty description</td>
<td>251</td>
<td>6</td>
<td>25</td>
<td>21</td>
<td>9</td>
<td>312 (2%)</td>
</tr>
<tr>
<td>Bookmark</td>
<td>107</td>
<td>13</td>
<td>18</td>
<td>11</td>
<td>12</td>
<td>161 (1%)</td>
</tr>
<tr>
<td>Activities</td>
<td>25</td>
<td>4</td>
<td>0</td>
<td>6</td>
<td>14</td>
<td>49 (0.2%)</td>
</tr>
<tr>
<td>Total</td>
<td>11017 (55%)</td>
<td>4352 (22%)</td>
<td>2712 (13%)</td>
<td>1381 (7%)</td>
<td>660 (3%)</td>
<td>20122</td>
</tr>
</tbody>
</table>

Table 1. Internal Tool Linkages: For each source tool inside a community, the number of its links that point internally to each target tool within the community, aggregated across the 128 communities in our dataset. The “total” column and row include the total number and percent. Results: As a center of curation and organization, wikis are the source and target of most links. As common “attachments,” files are a target of many links.

508 communities met these criteria. We selected all 17 Tech communities and randomly sampled 57 each of CoPs and Teams, totaling 131 communities. We were unable to collect full-text data from 3 communities, leaving us with a dataset of 103,900 links from 128 communities.

Use of Multiple Methods
Our use of multiple methods enabled us to compare the results of each method to ensure they were consistent. Below, we describe only those results that aligned across all three methods. This approach is known as methodological triangulation [5]. Characterizing tool interrelationships based on results that were consistent across multiple, complementary methods, adds credibility to our findings (e.g., interviews elucidated in depth perspectives of a limited set of people, but linkage data quantified practices for a broad set of communities and people). Note that the data from our three methods were not analyzed together, but rather the final results were compared for consistency.

The methods were designed to complement each other. Together the qualitative methods provided an understanding of the phenomenon of tool interrelationships: the interviews provided rich descriptions and rationale for the interrelations. The examination of community spaces showed whether the interrelations occurred in the spaces and provided concrete instances of what interviewees described. The quantitative linkage analysis design was informed by the qualitative findings that communities purposefully used tools together and that links were used to mark interrelationships. This suggested we explore links between specific tools inside and outside the community.

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(22.5%), indicating significant interrelationships between communities (also noted in [17]). The next biggest category was internal links to the same community (19.4%). A large number of links were to external overlapping tools (13.7%) (i.e., external tools with similar functions to an internal tool, such as external file repositories or wikis). People are key to communities, so many links pointed to individuals’ intranet profiles or email addresses (10.6%). These links referenced experts, people in particular roles, and so on.

Which community space tools were linked to primarily internal vs. external targets? Virtually all Bookmarks (98%) and Forum links (93%) pointed outside the community space. Though the majority of Wiki and Blog links also pointed outside the community, a substantial proportion pointed inside (23% and 19% respectively). See Table 2.

These data show that tool combination is common, but do not tell us how and why different tools are combined. Why do communities link different tools so often? What activities do the interrelations serve? Why are some tools more externally focused than others? Why are different communities so interlinked? How do communities use content in external overlapping tools as compared to internal tools? What social and technology design features encourage these interrelations? We address these questions by presenting results from our leader interviews. We identified three main categories of interrelationships among the six tools in Communities and overlapping external tools. These interrelationships do not cover all use cases for the six social tools, but rather uses where tools were combined.

**1) Leaders Organize and Curate Content**

The first three interrelationships involved activities performed by community leaders. For all the communities led by our participants, the Wiki, homepage, and links to other communities were owned and edited by leaders.

**Wiki as knowledge map to internal and external tool content**

Our linkage analysis showed communities used multiple tools, inside and outside Communities. Interviews revealed that before adopting new social media tools, long-term communities had already built up considerable resources in external tools. Such established communities thus had to manage this pre-existing external content, along with new social tools after adopting Communities. To organize their complex information landscape, a very common practice was to use social tools within Communities, particularly the Wiki, to create a knowledge map for the complex resources the community managed. Wiki maps helped members locate content distributed across many tools.

Such Wikis acted as static reference pages enabling new members to get acquainted with community resources. It also highlighted key content and helped members navigate to specific content spread across other tools. The Wiki therefore included many links to individual items in other tools (e.g., “more information about product release in the Blog post”) and/or the tools themselves (e.g., “post product questions in this Forum”). See Figure 2 for an example.

“We tend to use Wikis more as index pages, or content curation pages... So we’ll have a page in the Wiki that has the details about [product] client references, so it’ll have some information about what the client references are... and it’ll link to the place in the Community Files where you can actually download the presentations.” –MI

Wiki knowledge maps were not usually community-wide collaborative efforts. Leaders stated that in all their communities, a small set of people on the leadership team created and maintained the Wiki. This is consistent with prior research [4] indicating that leaders take responsibility for organizing community content. For example, notice how at the bottom of Figure 2, two Wiki owners ask “Do you have a suggestion for new content or an update? Please send your suggestions to [name] and [name].”

Our linkage analysis supports this interrelation: Wikis held the majority of community links. Table 2 shows 65% of all links posted were in Wiki pages. This is especially striking given the small number of Wiki pages per community (an average of 15 pages), adding support to leaders’ claim that the knowledge map was the primary use of Wikis. Also, aside from community descriptions, Wikis were the main

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Table 2. In our dataset of 128 communities, for each source tool (column 1), # communities using the tool (column 2), the average # of posts in the tool per community that uses the tool (forums includes topics + replies, the rest only include top-level posts) (column 3), the average # of links in the tool per community that uses the tool (column 4), and the percentage of links pointing inside and outside the community space (columns 5-6).

<table>
<thead>
<tr>
<th>Source Tool</th>
<th>#cmty use</th>
<th>avg #post</th>
<th>avg #link</th>
<th>%link inside</th>
<th>%link outside</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cmty descr</td>
<td>128</td>
<td>1</td>
<td>5</td>
<td>49.9%</td>
<td>50.1%</td>
</tr>
<tr>
<td>Wiki</td>
<td>114</td>
<td>15</td>
<td>588</td>
<td>23.1%</td>
<td>76.9%</td>
</tr>
<tr>
<td>Blog</td>
<td>93</td>
<td>61</td>
<td>186</td>
<td>19.0%</td>
<td>81.0%</td>
</tr>
<tr>
<td>Activities</td>
<td>27</td>
<td>188</td>
<td>15</td>
<td>12.3%</td>
<td>87.8%</td>
</tr>
<tr>
<td>Forum</td>
<td>113</td>
<td>341</td>
<td>102</td>
<td>7.3%</td>
<td>92.7%</td>
</tr>
<tr>
<td>Bookmark</td>
<td>113</td>
<td>63</td>
<td>63</td>
<td>2.3%</td>
<td>97.7%</td>
</tr>
</tbody>
</table>
they added to the Bookmark tool as “important,” moving it to this prominent area. This posed a problem for leaders, who wanted to control homepage links, since these were key navigation guides to the content owners managed and where they believed they were the experts.

“We specifically tell [members] not to post Important Bookmarks, because it does mess up our right sidebar, and I actually go in and delete them as I see someone has done something, even if they read the warning or they just ignored it... [The Important Bookmarks] are just the ones we put there. I have to clean it out like every week.” –M2

Other Communities generate relevant content
Other related communities were major sources of relevant content. Communities drew in that content by linking to it, leading to significant interlinking between communities. On average 23% of links in a community were to other communities (Table 2). Relationships usually resulted from a collaboration or shared topic of interest. Several communities embedded feeds in their Wiki pages to automatically collect and display related content posted in any other community. One leader described this:

“We have something like 40 of these communities that we call 'smart communities.' All of these... rely on the same tagging taxonomy. What we use the Wikis for is, to embed these feed windows so that instead of having your community manager go out and find all the assets that they want to put links to on the Wiki... we set up feeds to look for specific tags based on that community and the interest... You can post it anywhere... and we'll populate those Wiki pages.” –D1

In addition to the Wiki, communities frequently linked to a small set of related communities in their homepage links (described next) and in a widget called “Related Communities” (Figure 1D). The sole function of the Related Communities widget was to link to other communities. All of these tools—the Wiki, homepage links, and related communities widget—were primarily maintained by community leaders.

(2) Members Curate Content
All leaders reported explicitly encouraging members to contribute to Bookmarks and Forums. One of the activities members did in these tools was to curate external content.

Bookmarks to curate external content
The vast majority of bookmarks (97.7%, see Table 2) catalogued a wide variety of external content. Unlike the Important Bookmarks, leaders actively encouraged members to add to the collection of general bookmarks, soliciting members’ knowledge of external resources. For example, one community of practice leader wrote in their community charter (published in the Wiki):

“We aim to become the "home base" or "one stop shop" for all of your [Community Name] collaboration needs. In order to do so, it’s important that we provide links to the other valuable communities in [our company], as well as any other content relevant to the [Community Name] Community. Please feel free to add to our collection of Bookmarks...”
**Forum and Blog engage people who curate external content**

Forums pointed primarily to resources outside the community (92.7% of Forum links, Table 2). Leaders noted that members congregated in the Forums to share their knowledge in support of other members. By answering questions, discussing topics, or brainstorming, members drew external resources into the community space via links. A few leaders told us the Blog was also used by members to draw in external resources (81% of Blog links pointed externally). Whereas leaders pre-planned and mapped relevant external content in the Wiki, members dynamically created a map of relevant external content in ad hoc Forum and Blog posts. A leader discussed layering these social software “conversations” over external content:

“It used to be ‘content is king,’ you know everybody used to say that. To me, content without a conversation around it, everybody’s ever going to find the asset. And I think that’s been hard for a lot of people, because I think most of us grew up when there was a manageable number of assets, even though we thought it was a lot. And today, there’s just tons more. And we’ve got [employees] who go, ‘well I posted it out on iRAM, why didn’t everybody find it?’ And you’re like, ‘cuz there’s about a billion places.’” —D1

**(3) Notifications of New Content: Blog announces new content in Files or Wiki; Forum used to discuss Files**

In addition to organization and curation, another function of linking social tools was to draw attention to new content and to solicit and organize feedback to that content. Leaders and members used the Forum and Blog for notifications.

Blog posts often announced new Files or Wiki content in the Community or externally (e.g., see Figure 1C). A similar interrelation involved using the Forum to discuss files posted to the Community or externally. The Files tool supported commenting on files, so feedback could be gathered and organized in that tool. However, these interrelationships existed because people expected others to check the Blog and Forum for new information. Conversely, they did not expect people to check the File or Wiki tools themselves for new content.

Our linkage analysis shows that the Blog points to the internal Wiki, and internal and external Files fairly commonly, an average of 3.4 times and 18 times per community, respectively. Forums point to internal and external Files an average of 13.7 times per community. Of course, not all of these references were notifications and content analysis would be needed to determine exactly how many of these links to Files and Wikis were notifications.

While leaders advocated using Blogs for announcements, we observed other instances where members instead used Forums. When asked about this, leaders saw it as a misuse of tools caused by member confusion between the two tools because of their similar functionality and affordances.

“We try to make it so that you use the Blog for... a one-to-many announcement... And then try to use Forums for when it truly is a many-to-many conversation. But we still have people get them confused.” —D1

For notification activities, the Forum and Blog competed with email. When we asked leaders about other tools they used besides those in the community space and external file repositories, the only other tool discussed by all of them was email. Most leaders said their communities were trying to replace email use by the community, with the Forum and Blog. However, email continued to be used since adoption of newer social tools was an ongoing change in most communities’ interaction practices.

**(4) Organizing Files**

Both leaders and members helped organize community Files, which were often spread across multiple repositories.

**Blogs, Forums, and Wiki index information stored in Files**

Leaders and members organized Files, linking to them in the Wiki, Blogs, and Forums. After the Wiki, Files were the most commonly linked to internal tool (see Table 1). We extended this analysis to examine how often different tools linked to any internal or external file repository. File repositories got many pointers from the Wiki (10659 links across 128 communities, an average 83 links/community, or 10% of all links), the Blog (2366, or an average 18 links), and the Forum (1757 links, or an average 14 links).

Leaders noted how members would describe a file in another social tool and include a link to the file. The link served to supplement information being shared in a Blog post, help answer a Forum question, and so on. In all cases, the source tool provided the mechanism to help members discover the target file to determine if they wanted to download it. Thus, people were not relying on Files’ intrinsic “social” features—such as tags, recommendations and notifications—to help others become aware of, describe, and find them. Instead the primary interrelation in which Files participated was as a reference “attachment” to another type of post in the Community.

“What we’ve done is a very simple practice of, when you find an asset, wherever it is, it could be in Files, Cattail [an external file repository], Twitter, you just post a note with the URL in the content of that Blog.” —D1

**External overlapping vs. Community file repositories**

Many communities used multiple file repositories. Communities had an average of 68 links to files in external overlapping file repositories (8.5% of all links in our dataset). Mature communities needed to incorporate legacy file repositories. File repository technologies have changed over time, sometimes leaving mature communities with multiple instances. One leader showed us a diagram with ten file repositories used by her communities, saying:

“The community leaders are curating content... [Members] still come to the Community as their first stop. The whole point is, don’t send them out to the 10 repositories. Send them to the community and then they can access that content... ‘Business Value Accelerators’ go in the BVA repository. That’s where they should go. Practitioner Portal is used for ‘work product,’ and it has to be harvested and scrubbed and tagged, but that’s where it should go... And we’ll help you
build Wikis and links and stuff to that content, but that’s easy to find for people in your community.” –R1

The quote above also illustrates how communities sometimes had very specific repositories for certain file types (e.g., assets, work products, etc.). We saw a clear partitioning between external overlapping and social tools. The external overlapping file tools tended to be for storing “assets” or “work products”, which was a specific designation given to high-value, reusable materials that usually went through a review process. The Community Files tool was for anything else.

Despite these programmatic efforts, the abundance of file repositories led to liberal attitudes about where files were stored. Leaders described encouraging members to post files anywhere and link to them in the Community, e.g.:

“I personally think we ought to keep [the Community] separated from the file repositories, and you just use links, you know just URLs... So more of a people-centric approach than telling people which file repository to use... Let’s all blog about it and tag it, so we don’t all have to know where and how people are storing stuff” –D1

Technology Features, Social Norms Affect Interrelations

These interrelations occurred because of a combination of technology features and community social norms. For example, knowledge maps and homepage links were carefully crafted by community leaders. Not only did leaders want to control these critical navigation resources (social), they also felt members were unable to contribute (technology design). Leaders described the Wiki as too flexible to lay out and simultaneously difficult to format. One leader described how enabling community members to use it was virtually impossible:

“In terms of posting content, I find myself explaining what a Wiki is... When people explain to me what they are trying to do... I say to do that in an Activity because you have features designed specifically for that. Whereas a Wiki page... is more complicated.” –S1

Similarly members linked to external resources in Forums partly because they tended to do most of their posting there. Forum design encouraged this by focusing on conversations that resembled Internet Forums with which workers were already familiar. Similarly, members frequently posted to Bookmarks because they were easy to use. These interrelationships was enforced by norms fostered by community leaders, who posted guidelines encouraging members to post in the Forums and Bookmarks.

Files were frequently referenced in other tools because it was difficult to find files. Despite Files including tags, sorting features and folders, leaders still described Files as “one big bucket” where individual files were “hard to find.” The summary page listing a community’s Files showed only meta-data, without the textual descriptions, making it hard for people to evaluate a file. Leaders favored the Wiki to organize file navigation and the Blog to announce them, since these tools allowed customizable ways of describing the relevance of a file to members.

DISCUSSION

Our major result is a characterization of how the six social tools in Communities are combined with each other and with external tools. We now discuss high-level themes and implications for social and collaboration software design.

Combining Social Tools is a Common Practice to Support Organization, Curation, and Notification

Combination of tools was a common and important practice that is not well documented in prior work. Communities combined tools to support three major uses: organization, or making the community’s internal resources findable (done with the Wiki, homepage); curation, or drawing in external resources (Wiki, homepage, Bookmarks, Forum); and notification, or asking others to look at new content, for awareness or to provide feedback (Forum, Blog). These activities as performed by leaders and members, were clearly partitioned into different tools—partly as a social practice to make it clear where and how members should participate, and partly because of tool affordances. The sheer quantity of links between tools, plus confirmation from interviews, shows that much effort was put into these activities. Our results point to the importance of understanding how communities combine multiple tools.

Limited Use of Individual Tools in a Multi-Tool Context

One important unexpected implication of tool combination was that individual social tools were not themselves used for multiple purposes. Thus a community tended to use an individual tool for a single function (e.g., storing Files), but combined it with other tools if multiple functions were required (e.g., Forums or Blogs for discussing Files). Some tools might be appropriated for a couple of functions, but leaders noted communities were careful to limit this to avoid confusing members.

Limited appropriation is clearly demonstrated for Files. The primary function of Files was to serve as a reference “attachment” to other types of posts in the Community. Thus, people did not rely on Files’ “social” features—such as tags, recommendations, and notifications—to help others become aware of them, describe them, and find them later. Instead, other tools such as Forums and Blogs were used for these purposes. Our findings are contrary to previous studies that looked at social file tools [20], which found that social features within Files were used to announce, rate, and solicit feedback. However this discrepancy between our results and prior studies may arise because prior work explored tool use in isolation rather than in relation to other tools used by the same community.

In the same way we saw Wikis being used for a limited set of purposes when combined with other tools. The Wiki’s primary use for communities was as a knowledge map or static reference document. However, leaders did not commonly talk about Wikis as a collaboration or coordination tool, as is often cited in literature studying
Wiki use in isolation [21], because collaboration usually happened in Activities [2]. Again this difference may arise from the multi-tool context of our study.

**Social Tools Are Not Always Used Socially**
The uses of Files and Wikis imply that social tools are not always used “socially” when combined with other social tools. For example, announcing files in the Blog reduces the number of places a community has to look for new information. But this suggests that people do not expect others to discover their file using just the Files tool, despite its social features such as tags, feeds, recommendations, and listing the author along with the file. The usage of Files in combination with the Blog is practical: communities do not want too many places to check for new information, so they consolidate announcements in the Blog. This finding emphasizes the need for communities to develop common practices for where to discuss, monitor, curate, and so on, an issue discussed next.

**Managing Complex Info Spaces with Tool Usage Rules**
Overlapping functionality among a community’s tools can cause confusion. For example, leaders reported that members were confused about when to use the Blog versus Forum. Similarly, we observed different communities appropriating the same use cases differently across the two tools; e.g., some groups allocated announcements to the Forum, others to the Blog. To mitigate confusion, community leaders defined practices for using each tool for a specific purpose that did not overlap with the other tools. The fact that we were able to find so many communities with thriving online spaces indicates that such efforts can lead to effective utilization of complex resources.

**Prominence of Content Curation and Organization**
Our data also quantifies the huge efforts put into organization and curation activities, representing a new understanding of enterprise community behaviors. Communities strongly emphasized content curation and organization as key activities, i.e., architecting information spaces. This is markedly different from the emphasis in prior literature on member content creation as the main community activity [6,9,10,13]. That literature emphasizes the leader’s role as a facilitator of peer interaction, not as an information source or curator [8]. Community design guidebooks have chapters dedicated to helping leaders encourage contributions among members [9,10]. Researchers offer study after study that look for ways to increase participation [10,13] or use contributions as a primary community success metric [6]. However, the community leaders in our study described a shift in their own focus from content creation to curation: “It used to be content is king. Now you’re never going to find it without people.” Several expressed the opinion: ‘the information is already out there somewhere so why duplicate it.’ Curation seemed to be a coping mechanism for information overload, enabling communities to create a place to collect and find relevant information. Leaders described members as providing access to external information via the Forum and Bookmarks. They described their own role as information architects creating Wiki knowledge maps and carefully selecting community homepage links. They wanted their members to post information in predictable ways that would allow others to access it. Our quantitative data supports these qualitative findings, showing considerable linking between community tools and to resources inside and outside the community.

This study contributes to an emerging literature describing curation processes in communities [11,24]. As the amount of information on the intranet and internet increases to levels no one person could consume, it may become less important for communities to create content, and more important for them to curate content. On the web, bloggers [1], content strategists for aggregator sites (like The Daily Beast and Huffington Post), and users who rate on Slashdot [12], curate content of interest to their audience. In a similar way, we contribute a detailed view of how enterprise communities divide labor and appropriate social tools in their curation and organization processes.

An emphasis on curation and organization has implications for community design, technology design, and success metrics. The prevalence of Wiki knowledge maps indicates that an index of the community’s information space offers an important way to orient members. Technology might automatically create these maps to ease the burden on community leaders and ensure up-to-date information. This might be achieved by analyzing frequently accessed links and resources. Also, technology might surface resources buried in a Forum discussion, making them easier to find and browse. We also observed that labor was divided along tool boundaries, indicating that technology should support the different curation roles of leaders and members, and provide restricted access to centrally curated content. Regarding success metrics, number of views may be more important than contributions in communities that emphasize information curation. This is supported by recent work studying metrics needs among enterprise community leaders [16]. Our work also suggests new success metrics: the diversity of links posted might be considered important indicators of the community’s progress in curating content.

**Communities Divided Labor by Tool**
While both leaders and members curated content, they did so in different tools. Leaders curated in the Wiki and homepage, while members curated in Bookmarks and Forums. This division of labor by tool is a useful way for communities to help members learn how to contribute. Leaders described selecting the tools where members could participate based on which were easiest to use and most likely familiar. For example, Bookmarks were easier to use than Wikis, so leaders encouraged members to curate via Bookmarks and maintained the Wiki themselves.

**Implication for Design: Goal-based Abstractions**
Both the existence of interrelationships between tools and member’s confusion over when to use certain tools argues for a new way of designing complex community collaboration spaces. These need to be organized around
activity- or goal-based abstractions rather than tool-based distinctions. For example, tool designers should enable leaders to organize the Community into areas for key community needs—like knowledge map, announcements and discussion, and contributing new assets. Communities should then use the appropriate tool—or tools, in the case of an interrelationship—to support these. Our study indicates that the above needs would be useful abstractions for enterprise communities. The interrelationships we observed show how social tools might be combined to support these abstractions, providing concrete implications for system integration. For example, announcements could be supported by a tool people monitor (Forum, Blog) that could easily link to reference materials (Files, Wiki pages).

Generalizing to Internet Communities

While this is an investigation of intranet communities, some lessons are also relevant to internet communities. First, our study points to the importance of understanding how communities combine social tools. Internet communities commonly use multiple tools and our results suggest that social tool use may be different in multi-tool versus single-tool environments. Second, our study emphasizes the importance of curation in online communities, as a coping mechanism for information overload. Curation is directly relevant to internet communities, and it deserves more study as emerging research have also indicated [11,23]. Third, some of the specific interrelationships identified in this paper may hold in an internet environment, serving to guide future research. The tools studied here were generic and widely available to internet communities (wikis, forums, blogs, etc.). Fourth, our observation that curation duties were different for leaders and members and relied on different tools may also be general. Finally, our study showed that links and curated content provide a way to identify related communities.

CONCLUSION

This paper represents a first step toward understanding of how communities combine multiple social tools. This points to avenues for future research. We studied interrelationships from the perspective of community leaders and more could be understood about this topic by studying the perspective of community members, though the linkage analysis documents behaviors of members. Different types of communities have different collaboration needs and might combine tools differently, something future studies could elucidate. We studied a particular set of six tools, but a different set of tools might yield different interrelationships. Because there are so many possible combinations used by many types of communities, studying interrelationships is complex. This complexity encourages researchers to study tools in isolation, because it is simpler. However, we have demonstrated that interrelationships are a real phenomenon, one that seems to be increasingly common. We call for future work to study other combinations of tools and types of communities.

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