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What Matters to the End Users?**

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Abstract

Peer-to-peer systems have been received much attention recently. However, few studies have examined what makes them successful from the user point of view. For example, how important is the interface for the success of a peer-to-peer system? How serious is the free-loading problem for the end user? This article reports a study examining end user perception of the features in peer-to-peer file sharing systems. First, it discusses the motivation for the study. Section 2 then describes the details of the study including the data collection and the analysis methods used. In particular, it identifies twenty-six features of peer-to-peer file sharing systems and examines how these features are perceived by the end user in similarity and in importance. Section 3 presents the results, interpretations, and an overall picture relating the system features to the traditional software requirement categories. The final section explores potential implications.

1. INTRODUCTION

Peer-to-peer (p2p) computing is said to be the third generation of the Internet after the Internet itself and the World Wide Web. It is said to bring back the power to the ordinary user because its users can share their computers and other resources without any

What is a peer-to-peer system?

A peer-to-peer system is commonly characterized as an application that work with other such systems without a centralized server. However, as some pointed out, this definition would exclude many systems that we typically consider as peer-to-peer because they may use servers in one way or another, like the centralized file directories of Napster.

Now a consensus seems to be emerging that the best way to characterize peer-to-peer systems is not by a common technology but by what it does. One such definition is “p2p is a class of applications that takes advantages of resources—storage, cycles, content, human presence—available at the edge of network” [Shirky 2001b], where the nodes are not fixed parts of the network but may come in and out of it any time.

This definition nicely characterizes the common theme underlying diverse categories of p2p systems...For example, in p2p file sharing systems like Napster, the resources are the songs and other types of files that are found on individual users' computers, which do not have permanent IP address and can be turned off at any time. In p2p based distributed systems, the resource is the computing power that resides, again, at individual's personal computers. [Seti@home](#) for example distributes pieces of the signal data obtained from a telescope to individuals' home computers for processing and combines the result in its search for signs of extraterrestrial intelligence. The speed of [Seti@home](#) is said to be 14 TFLOP (trillions of floating-point operations per second) at the cost of \$500,000 while the fastest supercomputer is currently at 12.3 TFLOP at \$110 million dollars. The O'Reilly's p2p open directory (OpenP2P 2001) lists altogether 19 categories of applications that more or less fit this definition of p2p systems, including agents, development frameworks, distributed search engines, gaming, internet operating systems, the writable web, among others.

central authority. P2P systems can garner the computing power that exceeds the most powerful supercomputer at one two hundredth of the cost. It will enable your watch to communicate with other devices like VCR or microwave without any pre-arrangement. Peer-to-peer is a disruptive technology that will radically change the way of doing business as Napster has done for the music industry.

Many articles have been written about these systems from technical and legal perspectives. This article examines them from end user point of view.

Peer-to-peer file sharing systems are a class of applications that enable their users to share files directly among themselves without the need for a central file server (see the sidebar, 'What is a peer-to-peer system?'). Thanks largely to the Napster saga and also to its appeal to the large potential user base, it is one of the most well known categories of peer-to-peer systems. Napster at its peak boasted the registered user base of 70 million and 1.57 million simultaneous users. According to Webnoize, the top four file-sharing systems-- FastTrack, Audiogalaxy, iMesh, and Gnutella-- were used to download 3.05 billion files during August, 2001. An Internet research firm predicts that the FastTrack file-trading network should pass Napster in terms of volume and use by the time this article is published.

The P2P file sharing systems are interesting in several ways. They merge the distinction between server, client, and router and place them all on individual computers to enable them to communicate and share resources without dedicated servers (Oram 2001). They test existing laws and regulations by raising questions such as whether those making technologies that facilitates illegal distribution of copyrighted materials are infringing the existing laws and regulations. They form a backbone of other types of p2p applications such as groupware and content distributor. The files shared through these systems include not only music files but also videos, advice, tips, audio books, and pictures including pornographic materials.

Understanding what aspects of these systems really matter to the user is critical for the design of better future systems. Take the problem of freeloaders, for example. A network analysis shows that 70% of the system users only download files without

uploading any file(Adar & Huberman 1998). These freeloaders have been called by some “Net leeches” and viewed as a potential cause for the downfall of the p2p system. Should we then equip these systems with anti-freeloading mechanisms such as tying the number of downloads to the number of uploads or using a point system that rewards the contributors? Is it possible that most users do not consider freeloading to be a problem and that an anti-freeloading mechanism might introduce psychological cost which might actually work against the success of these systems (Shirky 2000)?

As another example, the new fee-based applications like MusicNet are expected to charge about \$10 per month with a fixed number of allowed downloads while reducing the download speed to 10 seconds for a typical song down from four or five minutes with the current no fee systems. Understanding whether enough end users exist for whom this tradeoff is reasonable would be critical for the success of such applications. Examination of p2p-related Usenet groups reveals strong opinions about the importance of being able to share files without fees. Are these opinions stemming from ideology (“the importance of preserving freedom to exchange”) or pragmatism? Is there enough percentage of the user base that is willing to pay to make this emerging business model successful?

Furthermore, the existing systems now competing for the dominance that Napster has enjoyed in this niche of p2p based file sharing differ in the features they offer. Some systems like LimeWire supports multiple searches in parallel so that the user can easily select another location to download from when a file fails to download instead of having to clear out the current search. Morpheus can locate another peer sharing the same file and resume the download if the original file fails to download. Different systems offer different combinations of community building features such as chat, direct messaging, voice connection, and buddy list (which enables the user to know who among his or her buddies are online and communicate with them). Do they promote a community spirit that is perhaps essential in getting the system going –for example, by encouraging people to contribute rather than merely receiving resources? What about the features controlling for advertisements, scams, or obscene materials? How much do these features matter to the end users and what kind of tradeoffs are they willing to make?

This report presents an overall picture of the end user perception of the p2p file sharing system features based on multiple studies including a survey, qualitative analysis of p2p Usenet messages, and individual interviews. This picture is designed to answer the following questions: What are the features that these systems offer to the end user? What is the relative importance that users attach to the various features of p2p systems? What are the major concerns underlying these features? Are there group-specific patterns—between men and women or between experienced and non-experienced? Examining these questions and identifying the factors important to the user of p2p systems should help us better understand what makes such systems successful. It should also help developers and entrepreneurs of P2P systems in designing their systems.

2. STUDY

In order to answer the above questions, we first identified the features currently being offered by the existing p2p systems, categorized them, collected data about users' perception of these features, and analyzed the data to identify usage patterns and user segments.

2.1 Identifying and Categorizing the Features of a Peer-to-Peer File Sharing System

The features of the existing p2p file sharing systems were identified through multiple sources. First we have compiled the list of fifty-nine qualified systems through a course project and web resources (OpenP2P 2001). We visited the web site for each of these systems if existed, looked for the features list, and merged them into a big list. Secondly, the students in a course project compiled the list of the features that they have found in the course of installing and using these systems. The trade magazine articles about these systems provided the third source of these features. After these features were compiled, two coders independently categorized these features and the results compared. Through an iterative process, they arrived at the twenty-six generic features that seem to represent all the features found. In order to test the completeness of this list, they examined the

messages from the two usenet groups on p2p systems (alt.gnutella and free.napster) since February 2000, identified all the system features mentioned in these messages. They were able to categorize these features into one of the features on the list. These features are shown in Table 1. Most of the features should be self-explanatory or explained above except the following: *Provide passive search* refers to the feature of displaying the search terms used by other users but only collectively without revealing who used these terms.

2.2 Collecting Data

Users' perception data were gathered from multiple sources as well, including a survey, a course project, interviews, and content analysis of usenet messages. For the survey, a questionnaire was designed to explore the relative importance of the twenty-six features, as well as the effects of gender, P2P experience, and self-efficacy on the features. The importance was measured using the 7 point scale with 1 being Irrelevant and 7 being Very Critical. Self-efficacy is a measure of an individual's beliefs about own abilities to understand and effectively use new systems, and was based on work by Compeau and Higgins (1995). P2P experience was measured based on self-assessments of whether the respondents had ever used a P2P system, and for those that had used such systems, how much they currently use it. After minor revision of the questionnaire based on a pre-test, it was administered to students in a large Mid-Western Research University and industry practitioners to minimize possible sample bias in the data. After examining the responses, 242 of them that provided all the responses were used for the analysis.

Qualitative data on user perception were also obtained from the course project report where students reported on their experience of using the different systems, from the p2p usenet group messages either complaining or praising system features, and from interviews with individual users.

3 RESULTS AND INTERPRETATION

The survey shows our average user—mid-20 with 2.6 years of job experience-and with self-efficacy of 8 pt. out of 10--spending about 14 hours a week using a p2p system, downloading 17 files per week and uploading 3 files per week.

Table 1 shows the features ordered by their perceived importance (means). A principal component analysis of these features reveals eight factors, explaining 63.5% of the variation. Table 2 shows these results together with the average perceived importance for each of the factors. Table 3 shows the group differences that were found significant. These findings are discussed in groups as suggested by the factor analysis, in the order ranked by the most important feature in the group.

	Features	Average Importance Score (1-7 increasing scale)
1	Charges no fee	6.50
2	Is fast	6.38
3	Is stable	6.34
4	Is reliable	6.33
5	Can resume loading	6.05
6	Has large file selection	5.78
7	Can exit nicely	5.75
8	Has large user base	5.56
9	Has good search features	5.53
10	Gives error message	5.32
11	Can organize file as library	5.28
12	Can control spam	5.16
13	Provides server inf.	5.04
14	Can turn off ad	5.01
15	Has good security feature	4.93
16	Supports passive search	4.36
17	Supports direct messaging	4.14
18	Can filter content	4.10
19	Supports buddy list	3.99
20	Is open source	3.83
21	Can credit contributors	3.82
22	Has colorful interface	3.57
23	Supports chat	3.46
24	Has points for uploading	3.44
25	Supports only legal files	3.14
26	Has voice connection	2.93

Table 1. Representative features of peer-to-peer file sharing systems in the order of perceived importance

By far the most important feature for the end user is that *No Fee* is charged for downloading the files (mean of 6.5). Hereafter, the average perceived importance score (on the scale of 1-7) of the feature discussed will be indicated by the number in a parenthesis following the feature name. A source of its perceived importance partly seems ideological as indicated by strong comments found on the survey and the usenet such as: “free music, all the time. “ or “Must be free.” But also found, though definitely a minority, are strong opinions on the other side: “Call me old fashion, but I believe in paying the creator for their creation. Napster, and other similar programs, is nothing but electronic shoplifting!”

Another source of this perceived importance for the *No Fee* feature is pragmatic, as indicated by the factor analysis. This feature is grouped with three other features: *Large file selection* (5.78), *Large user base* (5.55), and *Supports only legal files* (3.14).

Together these features capture the main functional features of the p2p file sharing system—namely being able to get as many desired files as possible. *Large file selection* and a large user base should be positively related as they both contribute to the choice aspect while *Supports only legal files* would be and is negatively related to the first two features, as it would limit the choice. *Charges no fee*, on the other hand, contributes to the goal of downloading the maximum number of desired files from the cost perspective. Thus, together they seem to be about the core product value.

The features ranked the second through the fourth in importance reflect concerns about the basic properties of the process infrastructure —*Is fast* (6.38), *Is stable* (6.33), and *Is reliable* (6.33). The factor analysis groups them together along with *Gives error message* (5.3). It is interesting that these basic features applicable to any other applications rank the second as a factor group and individually rank higher than any of the other features except the *Charge no fee* feature. The importance of *Is fast* and *Is stable* is significantly higher for experienced group of users than non-experienced presumably because they are the basic requirements that experienced users need for their functioning while the basic requirements for non-experienced would include many others.

Table 2. Factor Loading

	Component								
	Mean Score	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00
Is stable	6.34	0.82							
Is fast	6.38	0.67							
Is reliable	6.33	0.65							
Gives error message	5.32	0.52							
Factor Average	6.09								
Can exit nicely	5.75		0.82						
Can organize file as library	5.28		0.41						
Factor Average	5.51			0.78					
Can resume loading	6.05			0.38					
Has good security feature	4.93								
Factor Average	5.49								
Has good search features	5.53				0.73				
Provides server inf.	5.04				0.62				
Factor Average	5.29								
Has large user base	5.56					-0.69			
Supports only legal files	3.14					0.65			
Has large file selection	5.78					-0.46			
Charges no fee	6.50					-0.40			
Factor Average	5.24								
Can control spam	5.16						0.72		
Can turn off ad	5.01						0.71		
Can filter content	4.10						0.42		
Factor Average	4.75							0.83	
Supports direct messaging	4.14							0.81	
Supports chat	3.46							0.80	
Supports buddy list	3.99							0.69	
Has voice connection	2.93							0.38	
Has colorful interface	3.57							0.36	
Supports passive search	4.36								
Factor Average	3.74								
Can credit contributors	3.82								0.71
Is open source	3.83								0.69
Has points for uploading						0.60			3.44
Factor Average	3.70								

Table 3. Group Differences: The features listed for each group are the ones that members of that group found more important at the significance level of .01 or less.

GROUP	PROFILE (features perceived as more important by the respective group)
Male	More experience, More job experiences, More download, More upload; Higher Self-Efficacy; <i>Has large user base</i>
Female	<i>Supports voice connection, Supports passive search, Has colorful interface, Has security features, Can filter content, Supports only legal files, Points for uploading</i>
Experienced	More male, Higher Self-Efficacy; <i>Has large file selection, Has large user base, Is fast, Is stable, Can resume downloading, Charges no fee</i>
Non-Experienced	<i>Supports voice connection, Supports buddy list, Supports chat, Supports direct messaging, Supports passive search, Has colorful interface, Can control spam, Can filter content, Can organize files as library, Supports only legal files, Has security feature, Can credit contributor, Has points for uploading</i>
High Self-Efficacy (those with Self-Efficacy Score of 9.5 or above on 1-10 scale. N=80)	Older, More male; More job years. Experienced. More frequent and regular user; <i>Charge no fee, Has Large file selection, Has large user base</i>
Low Self-Efficacy (those with Self-Efficacy Score of 6 or lower on 1-10 scale. N=82)	<i>Supports voice connection, Supports buddy list, Supports direct messaging, Supports passive search, Can filter content, Has colorful interface, Supports only legal files, Can credit contributor, Has points for uploading</i>
Uploader (those who upload one or more files a week)	<i>Can credit contributor, Has points for uploading</i>
Non-Uploader (those who upload less than one files a week)	

The next three factors all rank closely after the above two discussed and seem to capture the enhanced value of the product, i.e. those features of the product that are not absolutely essential but make its use easier. *Can exit nicely* (5.75) and *Can organize files as library* (5.28) are grouped into a factor. *Has good search feature* (5.53) and *Provides server information* (5.04) are factored into another. *Can resume loading* (6.05) and *Has good security feature* (4.93) are factored into the third. The three factors rank closely together in average (5.51, 5.49, 5.29). Individually, however, *Can resume loading* ranks the highest, reflecting the major part that downloading plays in the overall process, the frequency that the downloading process gets interrupted with, and perhaps the frustration one feels when that happens (“it is annoying when something only downloads halfway, i hate when it causes errors on my computer”). *Has good security feature* ranks the lowest but not by much (4.93). The rationale underlying the grouping of these features into the three different factors is not yet clear.

Can resume loading is perceived more important by experienced users than non-experienced because presumably the frustration from interrupted downloading correlates with the amount of time they spend using the system. Non-experienced users, on the other hand, perceive *Organize files as library* and *Has good security feature* more importantly.

The next three factors group the different aspects of the social concerns--privacy, community, and equity--in that order.

The privacy factor includes *Can control spam* (5.16), *Can turn off ad* (5.01), and *Can filter content* (4.10), all reflecting the importance of not being intruded by unwanted materials. It is interesting to note that the user perceives the ability to turn off ad more important than the ability to filter content possibly obscene materials. This finding might be due to the fact that potentially offensive materials can be ignored by not opening the files with suggestive titles or filenames while ads cannot be so avoided.

The community factor consists of *Supports direct messaging*, *Supports chat*, *Supports buddy list*, *Has voice connection*, *Supports passive search* and *Has colorful interface*. All except *Has colorful interface* are about the ways in which users can communicate with one another. The low rank of this factor is somewhat surprising given the role it can play in learning, debugging, sharing information, and/or fostering

community spirit.

There is, however, a significant difference between more experienced and less experienced on the importance of this factor, suggesting that users do find these features useful in the beginning when they learn to use the system but its importance diminishes as they become more comfortable with the system. There is also a slight but significant gender difference: female perceive voice connection more importantly than men. However, there is a significant correlation between women and inexperience. The regression result shows that the effect of gender over and above the experience effect on voice connection is small but significant. Users with low self-efficacy also perceive the following features as more important: *Supports voice connection*, *Supports buddy list*, *Supports direct messaging*, and *Supports passive search*.

The two features, *Supports passive search* and *Has colorful interface*, also belong to this community factor although with low factor loadings. We might speculate that *Supports passive search* is grouped with the other features in this factor because they all, except the interface feature, provide a way to find out what to search for or that those who value the community aspects more highly tend to also prefer colorful interface (as seem partially supported by the fact that females perceive these features significantly more important than men). However, with the low factor score, further studies are needed to confirm these conjectures.

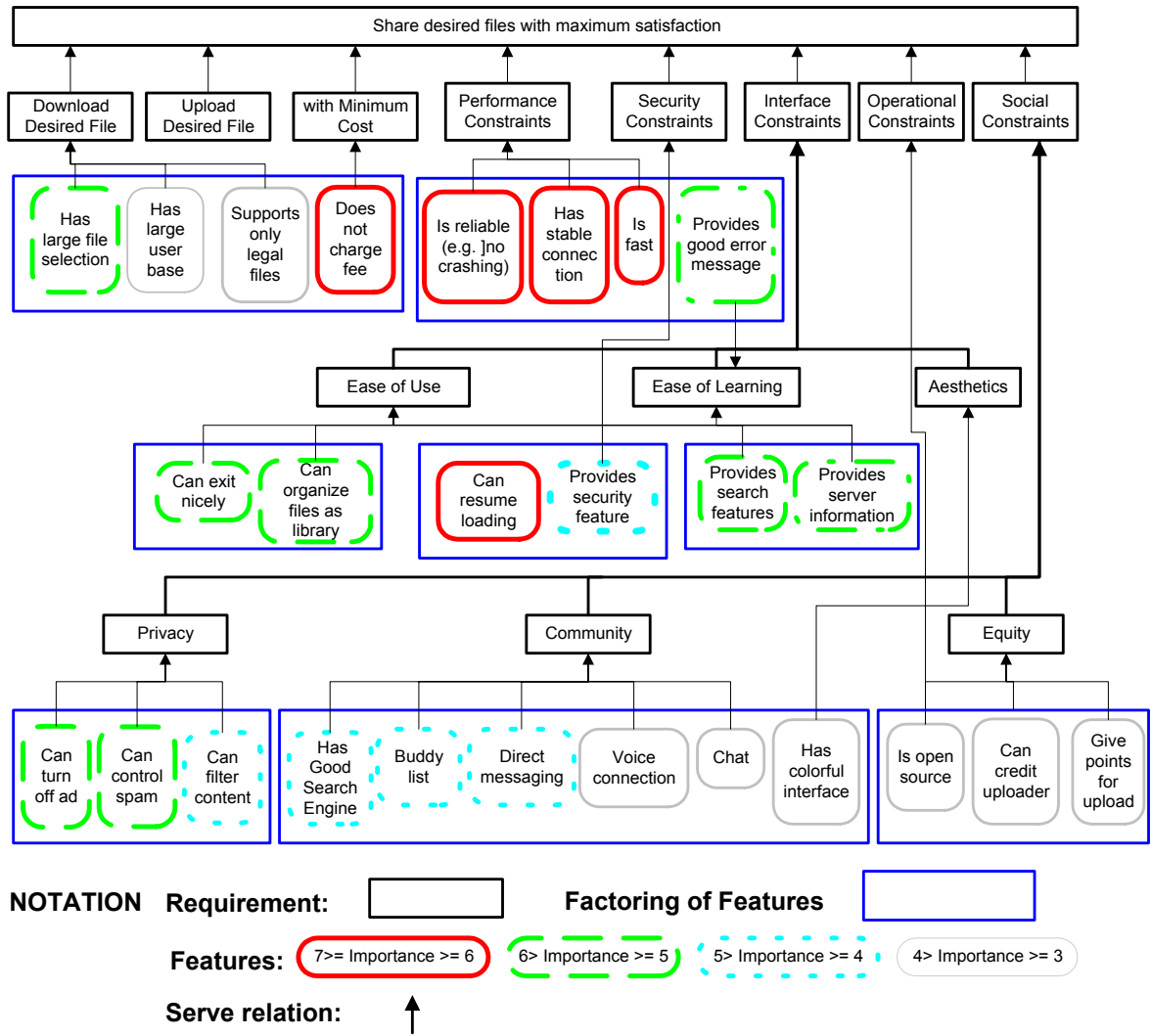
Here also women perceive *Supports Passive Search*, and *Has colorful interface* more importantly than men. The stepwise regression result shows that the effects of experience over gender on *Has colorful interface* and *Supports passive search* are also small but significant. *Has colorful interface* is more important to users with low self-efficacy.

The equity factor includes *Can credit contributors*, *Has points for uploading*, and *Is open source*. Users' rating of the first two features would reflect the importance that they feel about rewarding those who contribute files or more generally about whether there is an equity issue that needs to be addressed. The interpretation of the rating of *Is open source* is less clear. However, the most visible issue associated with open source is the equity issue—rewards for the contributors and free loading, which might explain the factoring of this feature with the other two.

Given the publicity that the equity and reward issues get from media, it is somewhat

surprising that these features rank the lowest as a factor (3.7 average) and also individually (3.44- 3.83). Those who upload at least one or more file per week however, significantly value these features more than those who do not. So it does not seem that those who upload are purely altruistic if that means being happy simply to see their files downloaded by others. It seems that if there were some incentives, there would be more uploading of the files.

Figure 1 provides an overall picture of how important the feature categories are, how they are related to the traditional software requirements (Maciaszek 2001) to promote the overall goal of getting desired files with maximum satisfaction at the top. The individual features are shown in rounded rectangles. The features whose importance average was highest (>6) are shown with red (or solid bold) boundary, the next highest (>5) in green (or dash bold) boundary, the next (>4) in blue (or dot bold) boundary, and the next (>3) in gray (or solid thin) boundary. The traditional requirement categories such as Usability, Reliability, and Performance are shown in rectangles. The arrows linking a feature or a requirement to another means 'serve' relation (Fischer et al. 1996). For example, *Download desired files* -> *Share desired files with maximum satisfaction* means that the former requirement serves the latter requirement. Or *Has large file selection* -> *Download desired files* means that the former feature serves satisfying the latter requirement. When a feature or a requirement has multiple serve relations, only major ones are shown in order to reduce cluttering of the diagram. The eight factors revealed by the principal component analysis are shown by the eight boxes, each of which surrounding the features that each factor contains.



4. IMPLICATIONS

The findings from this study present a very pragmatic picture of the user. The consideration of fee is the most important feature of p2p file sharing systems. Although a source of this perception may come from the ideology for freedom and desire to be unconstrained, its factoring with the other features such as *Large file selection* and negative factoring with *Supports only legal files* seem to indicate the pragmatic nature of this perception. This interpretation is buttressed by the lowest ranking in importance of the three factors addressing social concerns. The privacy, community, and equity factors are consistently lower in importance than the factors consisting of more practical features—such as reliability, availability, and usability.

The study also underlines the importance of recognizing that users will find ways of appropriating the features of the system not necessarily the way that the designers intend. For example, the passive search, which was designed to help users to formulate their search better by allowing them to examine the keywords other people use, seems to have more community significance as it is grouped with other community features like *Supports direct messaging*, *Supports chat*, and *Supports buddy list*. On the other hand, *Has large user base*, which might be perceived to be a community feature, seems to be viewed more for its utility—namely, for its effect of making a large number of files available. Organizational theorists (Giddens 1984, Orlikowski 1992) have pointed out the importance of recognizing this appropriation behavior and the findings seem to confirm it.

The study also reveals the group differences between male and female users, between experienced and non-experienced, between those with high and low self-efficacy, and between those who upload files and those who do not. Some of the major findings include: Experienced users are more concerned than women with pragmatic issues such as performance and reliability while inexperienced users are concerned more than men with social and interface features. Similar differences seem to hold for those with high and low self-efficacy. Also those who have uploaded at least a file per week consider the feature of rewarding the upload more important than those who do not. These findings should be important not only to the researchers but also to the business planners who might want to target specific user groups. For example, one might provide a customizable interface that is simple and efficient for expert users while making community features more salient to novice users. One might also devise an incentive mechanism that recognizes those who contribute resources at least among the contributors if not among all the users.

How does this picture of the user help us answer the questions raised at the beginning on freeloading and the fee-based business model?

Freeloading does not seem to be a major issue for most users including those who

upload. The features--*Can credit contributors* and *Has points for uploading*-- rank the lowest in importance, even for those who upload, although they do matter more for contributors than non-contributors. It is as if they are saying, "Yeah, it would be nice if we get recognized for our contribution but there are more important things such as no fee, reliability, and file selection."

Why, then, do people upload files? Probably not out of sheer altruism since they rank community features as low as non-contributors. The pragmatic picture that the study paints suggests an explanation. They might upload files because they fear the system will collapse unless they do. They refuse to risk such a collapse by waiting for others to supply them while they themselves take a free-ride. They would rather take the small trouble of ripping and uploading files, trusting that enough others will do so also. As long as this group of users gets what they need, other people free-riding does not cost them because shared files are replicable with little cost other than resources

Napster's Ingenuity

According to Adar and Huberman [5], free-loading will force a very small percentage of the hosts serve most of the desired files, thus congesting the network. As such, their analysis does not seem to depend on user psychology. However, in a way it still does. One of Napster's ingenious aspect was not only to make each user's computer a server as well as a client, but also to make the directory where the files are downloaded the default directory for uploading as well. Most of the current systems use the same technique. This feature makes most of the hosts share the burden of delivering the files unless the users explicitly remove the files from the default directory. However, a user would remove these files from the directory only if the performance of the user's computer suffers or the user is bothered by it in some other way and believes that removing the files will solve the problem. Further, the user must remember to remove these files after each download. I suspect that these conditions are not satisfied in most cases. Although there is no data to confirm this suspicion, the success of these systems even with their heavy and growing volume of traffic seems to support the suspicion.

already paid for, such as disk space, computing power, and internet access. This exploitation of The Cornucopia of Digital Commons (Bricklin 2001) is the real genius, more than any technical breakthrough, behind the design of p2p systems.

If we accept the above interpretation, then a large user base is critical for two reasons. First, it increases the number of contributors and, hence, the size of file selections. Secondly, it increases the pool of resources; even though free-riders do not contribute files, their computers act as servers and routers in sharing these files (see the sidebar, Napster's Ingenuity). In this light, FastTrack, an Amsterdam-based file-trading network, has made a very smart move in combining the user base of three different popular applications using its network technology. The network has boasted traffic growth of 60% a month over the last year or so. At the time of this article's publication, it is expected to surpass the 1.57 million simultaneous users that Napster enjoyed at its peak.

If so, one should guard against anti-freeloading mechanisms limiting the user base, thereby deterring instead of promoting the success of the system. Such a mechanism can cause user frustration or quality control problems when, for example, downloading privileges are tied to uploading contributions. Such a regulatory measure could result in a psychological transaction cost (Shirky 2000) such as when the user has to assign desirability points for a given file. It might also induce the perception of inequity even among the contributors if it makes them feel they deserve more recognition than what they receive. Whatever incentives that such a mechanism is designed to provide may not warrant these potential risks, especially when the importance of recognition ranks so low even among the contributors.

What does this picture tell us about the future of the new fee-based business model of file sharing applications? As mentioned earlier, this fee can fund better performance features for the new model. Given the high ranking of these features, users might buy into it provided that the fee is reasonable. However, there is a potential show-stopper for this business model. Because the record labels and publishing companies do not own the rights to music from the most popular artists, it might be difficult to provide a library

nearly as complete as the current free systems. A WiredNews article (King 2001) reports that the test trial of current selections finds Britney and Nsync but not Cypress Hill or John Lennon, for example. Given the importance of the large file selection (6th in rank) and its higher importance for experienced users, ensuring the large available selection seems critical for their success.

With the recent attention and promises of P2P systems, many more will be built in the future. In the last two years, about half a billion dollars has been invested in the companies that build p2p systems (Shirky et al. 2001). Many of these systems build on the features of file sharing systems. For success, these companies need to do more than solve technical challenges. They need to know what their potential users consider important. This article has reported a study that sheds some light on the user perception of p2p systems. It also points to the need for further studies like this one and the ones pursued by human computer interaction researchers that examine end user perceptions of technologies, especially innovative technologies such as peer-to-peer systems.

References

- Adar, E. and Huberman, B.A. (1998) *Free riding on Gutella*. First Monday, (5_10):
- Baecker, R., ed. (1993) *Readings in Groupware and Computer-Supported Cooperative Work*. San Francisco, CA Morgan Kaufmann. .
- Bricklin, D. (2001) *The Cornucopia of the Commons*, in Oram 2001
- Compeau, D. R. and Higgins C.A. (1995) "Computer Self-Efficacy: Development of a Measure and Initial Test," MIS Quarterly (19:2)
- Fischer, G., et al. (1996) *Making argumentation server design.*, in *Design Rationale: Concepts, Techniques, and Use*, T.P. Moran and Carroll, J.M., Editors. Mahwah, N.J.:Lawrence Erlbaum Associates
- Giddens, Anthony. (1984) *The Constitution of Society: Outline of the Theory of Structuration*. Berkeley, University of California Press.

- King, B. (2001) Good Beat, But Can't Dance to All. Wired News, Oct. 9
<http://www.wired.com/news/print/0,1294,47401,00.html>
- Maciaszek, L.A. (2001) *Requirements Analysis and System Design: Developing Information Systems with UML*. Reading, MA: Addison-Wesley
- Oram, A., ed. (2001) *Peer-to-Peer: Harnessing the Power of Disruptive Technologies*. Cambridge, MA O'Reilly.
- OpenP2P (2001). *O'Reilly openp2p.com*. <http://www.openp2p.com> (access date Nov. 14, 2001)
- Orlikowski, W. (1992). The Duality of Technology: Rethinking the Concept of Technology in Organisations. *Organisation Science* 3(3):pp. 398-427.
- Schonfeld, E. (2001), *Future Boy: The Napster Legacy*, in *Business 2.0* Sept. 25
- Shirky, C. (2000) *In Praise of Freeloaders*. in OpenP2P (2001)
- Shirky, C. (2001), *What is P2P... And What Isn't*. in OpenP2P (2001)
- Shirky, C., Truelove, K., Dornfest, R. & Gonze, L. (2001) *2001 P2P Networking Overview. The Emergent P2P Platform of Presence, Identity, and Edge Resources*. O'Reilly & Associates.