2000

Diffusion of Innovations: A Longitudinal Study of a Virtual Community

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Abstract

The exponential growth and global access of the Internet may have signaled a basic change in human sociology. Increasingly, people are choosing to relate to each other through computer-mediated channels by forming virtual communities. As these virtual communities become more pervasive, it is important that we gain an understanding of the nature of these social systems. This study will analyze the content of warehoused electronic communications to study these communities. The preliminary analysis examines the viability of the community and the diffusion of innovations. The ongoing inquiry will use computerized content analysis to gain deeper insight into community dynamics, leadership and communication character.

Introduction

The Internet reduces barriers to communication by allowing individuals to communicate with a minimal level of difficulty or expense. Low communication barriers foster the development of an almost endless variety of special interest groups. These groups allow the formation of virtual "*communities of interest*" centered on the common interests of the participants despite their location or status (Armstrong and Hagel, 1996). Members join because they want to learn or share information. A major focal point of virtual communities would be the special form of communication that is associated with new ideas or innovations (diffusion of innovation). Traditionally, research has defined innovation diffusion as "the process by which an innovation is communicated through certain channels over time among the members of a social system. It is a special type of communication in that the messages are concerned with new ideas" (Rogers, 1983, p. 5).

Innovation research has identified several characteristics that have been historically associated with the diffusion of innovation. The rate of diffusion or the speed in which a community accepts an innovation is a widely examined component of innovation. It has been found that the number of individuals that accept a new concept tends to begin gradually and with increasing intensity until a point of inflection, in which the relative numbers of new adopters begins to decline. This pattern of individual adoption follows a bell shaped cure. A cumulative graphical representation of adopters would then form a sigmoidal "S" shaped curve (Brancheau and Wetherbe, 1990; Rogers, 1983). It is anticipated that the communication of innovations in a virtual community would also follow a sigmoidal pattern.

Other research has consistently found that some people are more willing and able to perpetuate an innovation than others (Safdie, 1998; Teece, 1998; Teece, 1998). These members could be the champions of change in the virtual community. It has been assumed that virtual communities would reflect traditional communities. As such, some individuals should stand out as sources of organizational innovation. The unique characteristics of computer mediated communication (CMC) might allow leaders within a virtual community to have qualities different from those associated with more traditional social systems. Unlike traditional communities, CMC is status and gender neutral and an increased importance may be placed on the skill of literary persuasion. Additionally, leaders may have physical or personal aspects that might make it difficult to take on a similar role in a traditional organization. CMC also allows for leaders to transmit their insight to the entire group, which affects more people.

This study examines a virtual community whose members share a common interest in Desktop Video Conferencing (DVC). DVC allows individuals to share video, audio and text communications from their personal computers. By examining the warehoused electronic communication of this community, we will determine if the group is stable and viable, and then examine the diffusion of several innovations. Future research will further examine the nature of this virtual community, its champions of innovation and the nature of specific communication topics.

Background

Ongoing studies of virtual communities are based on the assumption that the group is viable and stable over time. A viable virtual community would be expected to meet the following four conditions: (1) a minimum of interactivity; (2) a variety of communicators; (3) a minimum level of sustained membership; and (4) a virtual common-public space where interactions occur (Jones,

1997; Rafaeli, 1998). The numbers of people who communicate electronically are clearly related to interactivity. That is, we need more then two communicators to be interactive (Jones, 1997).

Innovation diffusion scholarship often discusses the importance of leaders. These communicators share their expertise and guide the community membership toward some implicit or explicit goal. "Opinion leadership is the degree to which an individual is able to influence other individual's attitudes or overt behavior" (Rogers, 1983 pg.27). We should expect to see this leadership in a virtual community (Rafaeli, 1998). Leaders would be essential toward maintaining the minimum level of membership in a virtual community for it to survive over time. Additionally, the survival and the very existence of virtual communities are dependent upon a public common space in which these interactions occur. An illustrative example would suggest that if the server died, and it either were not replaced or replaced quickly, a virtual community might not recover its membership, no matter how dynamic.

Research Methodology

The study of information systems is the examination of the relationship between technology and humanity. Traditionally, this research has been carried out through the active participation of users (e.g. Delphi, survey, and case). Because participants know they are being observed this may alter their responses, as noted in the "Hawthorne effect" (Babbie, 1989; Mayo, 1933). In addition, a respondent may not express a true concern because it could be perceived as foolish or politically sensitive. Potential temporal limitations may exist because the subject is required to recall and synthesize concerns after the fact. This could result in responses being colored further by hindsight. The participant's response might also be altered by the general deterioration of memory. The research can also be limited by self-selection that may cause appropriate participants to decide not to respond. CMC offers an opportunity to use unobtrusive techniques that access a wider pool of candidates, which would include subjects that would normally not participate in a study. The longitudinal study of e-mail messages warehoused in an online database offers this opportunity.

This methodology allows researchers to unobtrusively study their subjects as their concerns are recorded. Content analysis has traditionally been a qualitative research technique that extracts data from communications via a set of predefined classification or categorization procedures. Historically, it has been used to examine all forms of both oral and written communication, however, the advent of virtual communities, which are supported by digitized text, afford the opportunity to use this analysis method to examine electronic communication. This would allow the researcher to overcome the temporal related weaknesses associated with other methodologies. These issues are captured at, the time of their occurrence via e-mail and stored as archives of the list-serve. Since the observation of the subjects actions or concerns are recorded unobtrusively, list-serve participant responses will be unaffected by the researchers' interest or indirect participation. Also, because the subjects' concerns are motivated by the desire to address immediate concerns, their inclusion in daily dialogue is not altered by their willingness to respond to a questionnaire or interview.

A primary weakness of content analysis centers on the establishment and application of appropriate classification techniques. The researcher could unconsciously bias classifications to support study objectives or vary the application of grouping criteria. Computerized content analysis will be used in the final study and as a methodology offering the potential for reducing the opportunity for researcher bias, the consistent use of coding schemes, the easy manipulation of text and the ability to process large amounts of data (Morris, 1994). While electronic classification techniques diminish the opportunity for coding bias, it does not diminish the importance of theory to guide the identification of appropriate criteria and the need to examine the results for reasonableness or "face validity" (Bailey, 1982).

One of the oldest and most widespread forms of CMC is the “list-serve.” Voluntary adoption and one-to-many asynchronous communication characterize Listserv's. We chose the CU-SEE-ME List-serve as an example of a List-serve supporting an innovative technology currently being diffused globally. The CU-SEE-ME List-serve supports understanding of DVC technology. All e-mail messages, including date, author, subject line and title (note all-inclusive nature of material) were downloaded from the CU-SEE-ME database from 1994 through 1998. Additionally, all message text was downloaded for 1997 and part of 1998. The subject lines and authors were stripped from the messages and analyzed. A sample of the subject lines were compared to the body of the message and appeared to be representative. Additionally, raw measures of message and author frequency were determined (Hackbarth, 1998).

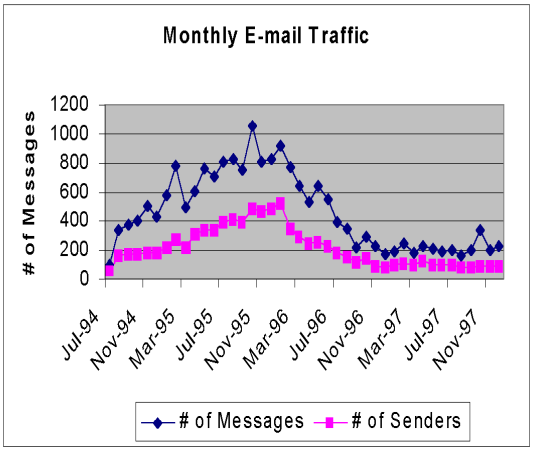
Current Status of the Project

The success of this research is based on the implicit assumption that the CU-SEE-ME List-serve is a valid virtual community dedicated to the understanding of DVC. The validity of this contention can be initially evaluated by examining the stability and relative commitment of the community. As shown in Figure 1, the frequency of messages and the numbers of list-serve

participants from 1994 through 1997 is shown. This suggests that the list-serve is representative of a stable and active virtual community of interested and dedicated DVC users. List-serves represent an environment where individuals could gain and share knowledge as well as concerns with other interested parties. The result is a network of interpersonal channels of communication that forms a virtual community.

The frequency analysis of senders in 1997 suggests that DVC leaders may have a substantial impact on the virtual community. 35.8% of the messages were sent by 2 people (427 of 1193). 34.3% of the messages (409 of 1193) were people who sent only one message the entire year. Similarly, Rafaeli's (1998) study of virtual communities found that the most frequent contributor was responsible for 39 messages, with the most frequent contributors averaging 12 messages. Authors appearing only once wrote more than two thirds of the messages.

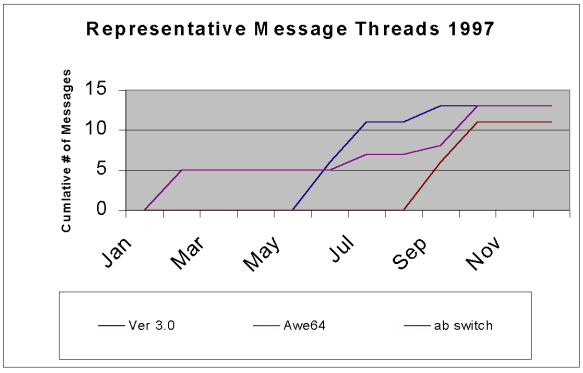
Figure 1



These people were interested in getting their concerns addressed and did not participate in addressing the concerns of other members. Preliminary analysis suggests that a few key members of this list-serve represent a repository of expertise for the DVC community.

In order to study the diffusion of innovations in the community we looked at a representative sample of threads that dealt with new ideas. A thread is a multi-message communication dealing with a common topic. 693 separate threads were identified out of a total of 3800 messages for the year 1997. A subgroup of 30 threads was then chosen that appeared to deal with focused and new topics. The subjects of these 30 conversations were then compared to all the topics discussed in the community since its inception in 1994 to determine if the topics were new to the group and would thus qualify as innovations. As part of the initial analysis of this project,

Figure 2



3 representative threads were chosen. The thread topics pertain to, 1."Version 3.0" refers to a discussion of the characteristics of a newly released version of CU-SEE-ME software, 2."AWE64" discusses the implementation strategy and incompatibility problems associated with a new software driver, 3. "AB switch" is a discussion of the difficulties associated with a new hardware configuration. Figure 2 shows a cumulative plot for the 3 representative threads. To further evaluate the nature of the diffusion process in virtual communities, the distribution pattern of communication of an innovation was examined through the use of regression analysis to estimate the shape of the plot. It was anticipated that the diffusion of innovations in a virtual environment would mimic the sigmoidal pattern found in traditional social systems. To explore this proposition, the regression function was calculated and compared for a linear and then a nonlinear function for the communication associated with each innovation. In the first analysis, a simple least-squares methodology was used to determine the regression equation. In the second analysis, a logistical function was applied to the analysis. The results of the regression analysis are summarized in Table 1.

Table 1.

Curve Estimation

Innovation	Model	R Sq.	D.F.	F	Sig.
Ver 3.0	Linear	0.187	11	2.54	0.139
Ver 3.0	S/Logistic	0.506	11	11.27	0.006
Awe64	Linear	0.193	11	2.63	0.128
Awe64	S/Logistic	0.455	11	9.18	0.011
AB Switch	Linear	0.273	11	4.13	0.067
AB Switch	S/Logistic	0.503	11	11.15	0.007

The anticipation of a nonlinear, S shaped, distribution was supported by the regression analysis. The logistic function consistently fits the data pattern better than the linear model in terms of both a larger R squared statistic and the level of significance of the resulting calculation. In addition, an examination of the resulting distribution of

the residuals against time appeared to be randomly dispersed and was not significantly correlated.

Future Directions & Expected Contributions

Future research will expand the data set to include messages from the community's inception beginning in 1994. This richer database, in combination with a more detailed analysis of the e-mail messages shared by the members, should allow for a more complete understanding of the roles of innovation champions, concerns and interactions of the community. This analysis should increase the accuracy of topic and subject identification and classification. We intend to further segment messages by a variety of taxonomies. The CMC literature suggests messages can be either on-task or off-task. Furthermore, messages can be segmented by their degree of interactivity. Messages can be agreeable, supportive, informative, and humorous, or provide self-disclosure (Rafaeli, 1998). We will further explore differences in the variety of communications by using "CATPAC", a computerized content software package.

CATPAC is a self-organizing artificial network program that is optimized for reading text. CATPAC is able to identify the most important words in a text and determine patterns of similarity based on the way words are used in the text. It does this by assigning a neuron to each major word and then by forming a pattern of weights representing complete information about the similarities among all words in the text. Neural networks have been successfully used in medicine, marketing, accounting, and finance (Swales and Yoon, 1992).

Our contribution represents another step and an alternative path towards understanding the nature of these emergent social structures. In the future, the study of cyber-sociology or the study of the history, development, organization and problems of people living together as computer mediated social groups will become increasing important. Our study provides MIS researchers another window through which to observe CMC as well as an alternative technique for understanding these phenomena.

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