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This paper characterizes the need for a theory that links context to information through the behaviors rooted in cultural identity and social awareness. Based on hypermedia objects and four methods of social communication, I develop a framework for a theory of social linking. This theory assumes that social interaction is the plinth from which we communicate and argues that studies in human computer interaction and information retrieval require ongoing exploration of social communication.

Headings:

Hypermedia

Social network analysis

Human computer interaction

Information retrieval

A FRAMEWORK FOR THE DEVELOPMENT OF SOCIAL LINKING THEORY

by
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I. Introduction: The Need for Social Linking Theory

Society needs people who take care of the elderly and who know how to be compassionate and honest. Society needs people who work in hospitals. Society needs all kinds of skill that are not just cognitive; they're emotional, they're affectional. You can't run the society on data and computers alone.

-- Alvin Toffler

External communication is necessary for transactions of economy, the dissemination of information, and for the development of institutions, organizations, and communities. Internal communication is necessary for critical thought, memory, assimilation of information, and decision-making.

Most communicative interactions can be illustrated as *push-pull* exchanges. While pull-based communications do not always compliment pushes, hyperlink communication generally entails pushing information onto the Web and pulling that information from *index space*[1] to a destination node. Communication methods that push information include broadcasting (Acharya et al., 1997), continuous media streaming (Amir et al., 1998), and publication applications (Banavar et al., 1999; Malan, et al., 1997). The pull of desired information has been illustrated through e-commerce research (Dasgupta et al., 2005) and studies on personal communication technologies (Aoki and Woodruff, 2005; Afonso and Silva, 2004). As we introduce,

[1] Within a book, an index is a collection of materials and its classification, linking between subject classes and information objects in the book. An *index space* consists of all the methods and devices that humans can use to store thoughts, feelings, and other information to archive them for later use. A link can be understood as a kinetic force defining the boundary between the index space and the message (Penland, 1974).

develop, focus, expand, redesign, and rebuild communication systems over time, the tasks required to push and pull information change with these systems.

A central hypothesis of social linking theory is that there exists some optimal level of information that can be pushed and pulled. An implication of this hypothesis is that the study of social linking can be used to design archetypical communication models. This hypothesis is based on at least three assumptions. First, information assumes kinetic properties when it enters a communication system. These properties allow an organism or adaptive mechanism to produce a measurable quantity of new information. Second, information is communicated through index space and contains inert properties that result in measurable entropy. In other words, some measurable amount of desirable information is lost each time a message is transmitted. Third, the rapid expansion of communication technology has surpassed the development of organizational schemes for human classification. Absent adequate means of classification and a conceptual understanding of modern information transfers, humans are often unable to pull and assimilate available information. Results include increased entropy, *information overload*[2] and societies that operate in new realms of social and economic inefficiency.

It is important to recognize at the outset that levels of information and entropy are subject to the many variables of culture and social identity. These variables are not innumerable, however, and can be measured within social communication networks. The facets of culture and facets of identity (boyd [sic], 2002) are thus an essential element in the development of social linking theory.

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[2] Coined by Alvin Toffler in *Future Shock* (1970), the term "information overload" refers to the state of having *too much* information to make a decision or remain informed about a topic. http://en.wikipedia.org/wiki/Information_overload.

Motivation

Motivations for the study of social linking are twofold. First, annotation has been interpreted as link making, commentary, markings of text, decentering of authority, a record of reading and interpretation, and as a community memory (Marshall, 1998). When embedded in text or media to convey the descriptive organizational structure of an information landscape, annotations comprise hyperlinks and hypermedia. Through this lens, these annotations represent message channels that reveal the associative interconnections among the nodes of an information network. Accordingly, a hyperlink becomes a measure of this channel.

Michael Buckland's 1991 work on the nature of information operationalized "annotation" as process, thing, and knowledge (MacMullen, 2005). From this perspective, hypermedia is defined as an information object with two properties; social properties that convey meaning to others and ipsative properties that have meaning for the self. Such annotations, which have quantifiable dimensions, can be used for empirical studies of social linking. This framework recognizes that some annotations, particularly personal annotations, are not necessarily communicative. However, exploring the social and personal benefits of recursive annotation and self-reference are interesting threads to pursue in developing this theory.

The second motivation is an approach from the field of operations research called systems thinking. Social communication considerations adopted during the design stage of development can support sustainable systems, achieve goals, and lead to theoretical optimization of communication systems. Combining annotation theory

and systems thinking, social linking theory can be used to develop meta-methodologies for the study of technologically augmented social networks.

Purpose and Scope

A theory of social linking seeks to address the confusion of social communication enhanced by technology and interpose clarity about how we push and pull information. The development of a social linking theory draws upon Web link taxonomies (Chu, 2005; Thelwall, 2003; Kim; 2000), hyperlink evolution (Carr et al., 1999; Lewis et al., 1999) and applied research in computer mediated social networks (Lada and Adar, 2005; boyd, 2004; Gorton et al., 1997). Combining these existing areas of information science research, social linking theory focuses on social communication to classify elements of cognitive experience and quantify human correspondence with technology.

This paper identifies the need for a theory that describes information exchanges through social networks on the Web. Based upon the classification of human social behavior, the theory begins with annotation and includes all tasks and activities that result from socially motivated hypermedia. As this theory is condensed and articulated through empirical research, we might better understand the process of human communication.

II. Understanding the Methods of Social Linking

In most social contexts, there exist four methods through which scholarship and societal communication are conveyed: consultation, educational experiences, mass communication, and information retrieval (Penland, 2003 *citing Butler, 1949 and Burke, 1953*). Social methods of communication can also be characterized by relationships among entities (Figure 1). Conditioning the four methods of social communication in this way yields four types of interaction: one-to-one, one-to-many, many-to-one, and many-to-many. These four types of social communication can be characterized by their interactive relationships and used as a lattice for social linking theory design.

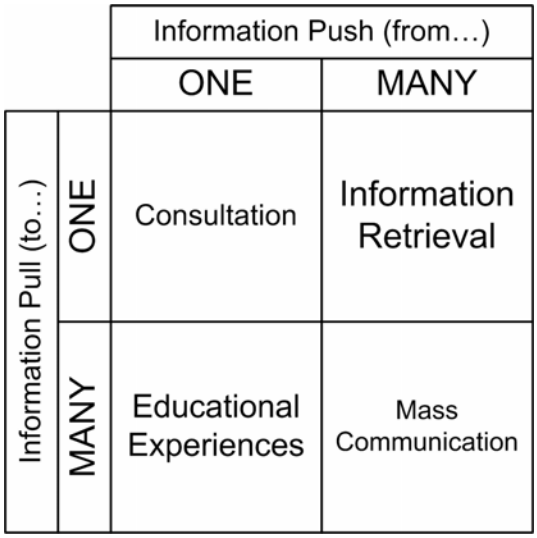

Figure 1. Four Social Methods of Classification

Figure 1 shows how entity relationships can be used to classify the mode of information transfer. A one-to-one relationship is considered *consultation*. Many-to-one and one-to-many relationships are considered extensions of consultation and are classified as *educational experiences* and *information retrieval* respectively. Many-to-many relationships exemplify the pivotal role technology has played in social communication and are classified as *mass communication*.

The modern study of hyperlinks asks not where the link leads, but why it exists. This idea has been developed as link motivation theory, which adopts six hyperlink classifications as motivations for hyperlink creation: resource, expansion, social, gratuitous, ownership, and navigation links (Zuccala, 2005; Thelwall, 2003). Social linking theory embraces link motivation theory and perceives the social methods of communication as a subclassification scheme for socially motivated hyperlinks. Using these four methods to classify data and to study social behavior patterns will thus lead to a better understanding of why people link.

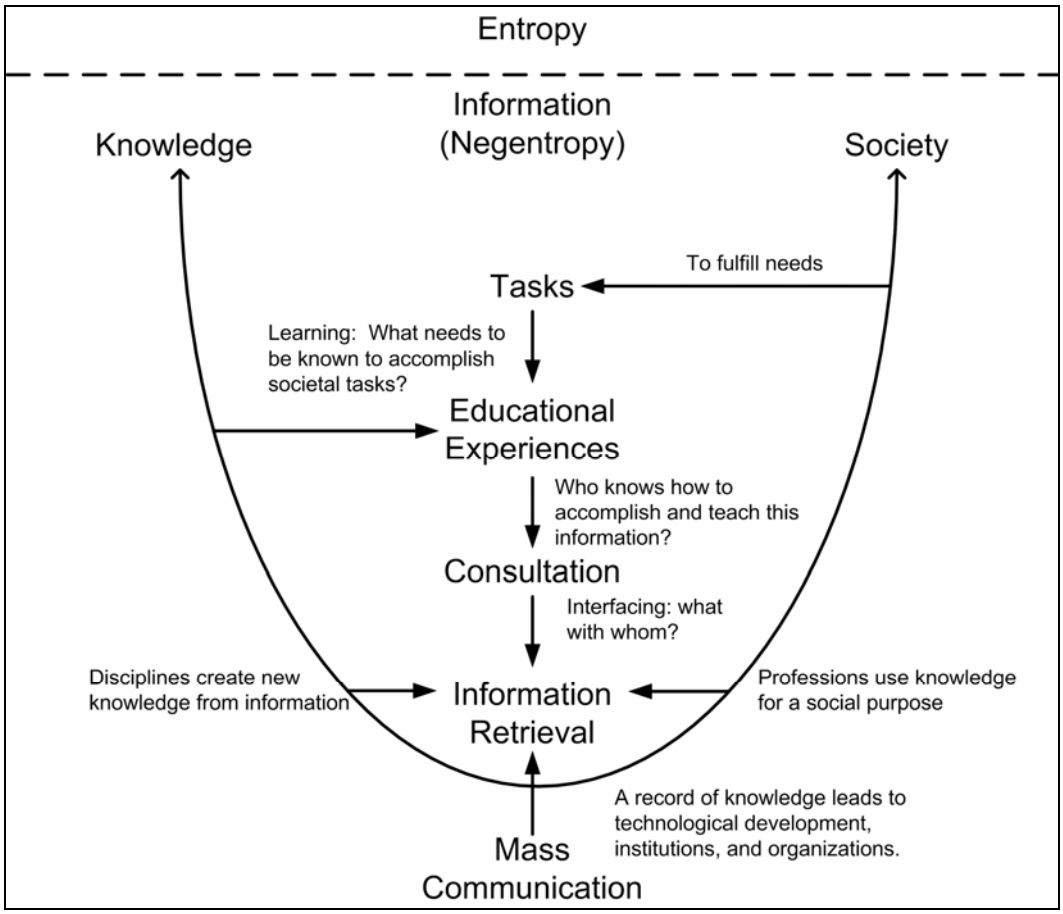

Figure 2. Technology and Culture - Social Methods of Communication[3]

Figure 2 illustrates how the four methods of social communication connect knowledge, information, and society. The process begins when society develops a need for information and defines a set of tasks to fulfill this need. As tasks of knowledge acquisition require social communication, the pull of information from index space will involve one or more of the four methods. The application of new information, called knowledge, satisfies the societal need. Figure 2 can also be used to illustrate that social linking looks not to the effects of tasks on social performance but rather observes the similar and dissimilar characteristics of social communication

[3] Inspired by Penland (1974), p. 100

itself (Fleishman, 1984). Viewing the model in this way, a social linking task is an activity that pushes or pulls information from an index space through relationships of singularity and plurality.

Educational Experiences (one-to-many)

One-to-many relationships diffuse information through a channel that is shared by an audience and moderated in some degree to manage information flow and content. Information pushed by educational experience is often mission oriented and requires an obvious and continuing need by some limited social group (Penland 1974). Examples of these social links include both verbal classroom lectures and e-mails sent to listservs.

Characterized by learning, educational experience seeks to find answers through extant social knowledge to accomplish tasks (Figure 2). The class of educational experiences is a social method of communication designed to reach large audiences. An educational experience requires scholarship and sometimes overlaps with consultation (Penland, 2003). Often provided through schools, libraries, and adult organizations or agencies, educational experiences allow a social connection for individuals who receive information this way.

As a result of technological advancement, much of the information traditionally found in one-to-many educational experiences is now pushed through social upchannels, many of which invite communicative responses. One example of this development is the advancement of educational experiences through mobile technology, which offers learners and teachers the ability to access educational

services anytime and anywhere (Chen and Kinshuk, 2005). As technologies develop, mobile devices will increase in functionality, and educational experiences will more often be characterized by many-to-many communications. The study of social linking should explore the evolution of educational experience and its transition towards mass communication.

Consultation (one-to-one)

Consultation involves the push and pull of accumulated social knowledge stored largely in the minds of specialists. Traditionally, consultation referred to communication between an information seeker and a learned professional. Through this process, information is made kinetic in the life of the individual motivated to pull it from a member of a helping profession. A person involved in a lawsuit does not read a legal treatise. Instead, he or she consults a lawyer to obtain the particular bits of professional scholarship applicable to the case (Penland, 2003).

To expose themes for potential study within the consultation process, imagine that you have a child in the fourth grade and that he or she approaches you for homework assistance. The assignment you review reads as follows:

> ***Instructions:*** *Please complete this sentence.*
>
> In my opinion, I think the death penalty is _____?

Consultation creates a series of one-to-one information transfers (Figure 1). In this case, there was a social push for homework assistance and a pull of words and

punctuation that remained in your index space until you, the learned consultant, perceived the need to access them. As a learned consultant, you would probably consider various additions and redactions. As a parent, it is also likely that you have concerns about whether this assignment is academically and socially appropriate, and you might ask your nine-year-old several questions to determine the author of the document and the context within which the assignment was given. If you are very concerned, you may have expressed concern about the content of the homework instead of providing homework assistance requested.

Knowledge pulled through consultation is fact specific and time sensitive. The process of accessing needed information through a consultant is often difficult and inefficient. For this reason, information once available only through one-to-one consultation is increasingly available through the Internet and through other methods of social linking. Information science research in this area should explore the tasks related to one-to-one communications, the development of free information with annotation (e.g., open-source databases) and the spread of consultative information through alternative communication methods. Furthermore, social linking theory should trace the consultative information disseminated and the effects of *noise*[4] on message transfer.

Information Retrieval (many-to-one)

Information retrieval is the method whereby the individual extracts an exact piece of scholarship needed from a corpus of information objects (Penland, 1974). It

[4] Noise refers to other devices or information sources that interrupt or distort the channel of communication from Bob to Alice. In this case, noise could be a distortion of the vocal signal (perhaps the parties communicate on a VoIP phone) or an alternative source that offers different information.

employs index space that is mapped to specific content. This method of social communication includes browsing, which is characterized by tasks that scan lists, skim tables of contents, or page through topics, but it does not usually include analytical searching (Penland, 2003; Campagnoni and Ehrlich, 1989).

The many-to-one relationship of information retrieval is generally achieved where knowledge was once is available through a single source method, namely educational experience or consultation (Figure 1). As such, the study of information retrieval focuses on the pull of that information and may also important patterns of human behavior. The following example of information retrieval encourages the development of many social linking themes, some of which are not unique to many-to-one relationships.

Imagine that I have a website and display the following information on my home page:

I'm a Tar Heel born
I'm a Tar Heel bred
And when I die
I'm a Tar Heel dead.
So it's Rah, Rah, Car'lina-lina
Rah, Rah, Car'lina-lina
Rah, Rah, Car'lina-lina

Rah! Rah! Rah!

Images from: www.sas.upenn.edu/~gbrake/tarheel.GIF

There exists a population that values the official fight song of the University of North Carolina. If you are a UNC student or alumnus seeking these lyrics, they are published routinely and available at many locations. You may, however, be attracted

to my website for the ease of fight song or Ramsey image retrieval. As explained in the sections that follow, the downloader subsection of my viewer population can be identified through computer interactive data collection.

On the other hand, you may attend a rival university like Duke and find my home page offensive or uninteresting. Perhaps you are a UNC student who has already memorized the song or someone who visits my site often and no longer stops to consider this information. These are a several reasons you may decide not to pull the information that I push. Information gathered through collect of annotation from those who surf my website but do not seek this information can be used to identify another social group.

Beyond information retrieval, this example presents additional facts about me that are worthy of analysis. My home page advertises a cultural experience; my push brings me closer to it as well as to you. In addition, because the pull of this information is not likely to result in a reciprocal link from you, my index space is unaffected by your decision to pull or not to pull. You, on the other hand, have now formed an impression about me, Tarheel Tom, and will classify me in a certain social way within your index space.

Mass Communication (many-to-many)

Mass communication is the newest social method of communication. It emerged through the widespread distribution of newspaper publications. Recently, mass communication became available through electronic transmissions. Primordial systems of mass communication maintained one-to-many relationships with the

public at large. Mass communication channels expanded quickly, however, and mass media now generates the method of communication through which social links are most easily measured. Mass communication is often bi-directional and includes a plethora of complex communication technologies.

Mass communication is characterized by interactions between many people and many sources of information (Figure 1). Scholars have concluded that television shapes our beliefs and conceptions of reality and that televised representation of social realities reflects the structural norms of society, ideological interpretations of social relations, and human nature (Bandura, 2001; Adoni and Mane, 1984; Gerbner, 1972). Since television, a unidirectional communication channel , has these consequences, bidirectional communications can be said to cause new human behaviors through upchannel response.

The Internet is the newest source of bidirectional mass communication channels. The Web offers universal access to information, current events, and email communication (Anderson et al., 1995). As a result, information distributed through mass communication now arrives through many channels and can affect information received through other social methods. However, rapid growth of Web activity has also created a cacophony of mass communication that pushes identical content from many sources and makes it difficult to extract and absorb relevant information.

While there is extensive research on the effects of mass communication in society, studies have measured without uniformity and results are thus difficult to compare. Social linking theory can be used to develop standards for the uniform measurement of mass communications. Under such standards, the influence of

communication media may be quantified as the content pulled and pushed through bidirectional channels.

Too many links

Consider spam. Generally, online communication provides a forum in which I can create a social link that invites response. When I send information to your website, blog, inbox, or other push mechanism, for example, I expect that you will receive that information and respond with your own. However, the push of electronic information to your inbox often raises questions of privacy, security, property, and identity that you cannot answer. Absent understanding of the medium through which I communicate, you may choose not to respond and believe that some spammer (who also pushes into your inbox and awaits the opportunity to pull social information from it) will flood your inbox with unsolicited messages like the one I recently received about Cialis:

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Cialis is a new impotence drug used to improve Men's Health.
Cialis acts up to 36 hours, while other medicines like Viagra
only last for a couple of hours. The active ingredient is
Tadalafil, same as in brand Cialis.

Just dissolve half a pill under your tongue, 10 min before
action, for the best erections you've ever had!  Cialis also
have less sidebacks (you can drive or mix alcohol with them).
No prior prescription is needed.

 * Save up to 80% compared to the pharmacies.
 * Worldwide shipping
 * Impress your woman today!

Read more here: http://megabargainsplus.com/gcs/?cia

No thanks:  http://megabargainsplus.com/r.php
own to a logged host CMC to the your have implications technologies
of
urge My across fax events close are future cultural fed be crew
live? the
counterculture is acts
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In truth, few of us understand just how we are spammed, but our Internet service providers know enough to capitalize on the fact that most of us are willing to go to great lengths to avoid it. The measure of link avoidance behaviors will be a vital component to the development of social linking theory. Study of spam avoidance and similar behaviors can be used to identify inefficiencies that exist when social link classification schemes are not employed. This information is used to determine an order of importance for the study of socially motivated links creating a practical theory of communication that prioritizes the freedom of information and can achieve social change.

As we advance in a world of machine-driven communication systems, the need to establish understandable classification schemes for information transferred becomes paramount. Through promotion of social linking theory, such schemes may be adopted by the public and used to alleviate the confusion that leads to avoidance behavior.

As the global brain emerges, individuals must develop ways to think collectively (Berners-Lee, 1997). Using social networks to classify and organize links, hypermedia can enhance individual communication and promote collective knowledge.

III. Philosophical Perspectives on Communication Theory

The theory of social linking must answer questions of epistemology, ontology, and axiology. Toward each of the areas, social linking theory must be properly posited as a tool for the study of knowledge and the role of human experience. It should be a practical theory of communication that seeks to achieve social change. As such, the framework for social linking theory must include a philosophical understanding of knowledge, social communication, external reference, and personal relationships. Social linking theory must also explore antisocial linking behaviors and advocate for annotation.

Aristotle, Disposition and Knowledge of Knowledge

In Section Two of *Categories*, Aristotle discusses a select group of human characteristics as forever expressed in relation to something else. Among these relative characteristics, two are especially relevant to a theory of social linking: disposition and knowledge.

Aristotle first defines disposition as "a condition that is easily changed and quickly gives place to its opposite." Dispositions include heat, cold, disease and health and are ephemeral in nature. Other definitions of human disposition are, however, more permanent. Permanent dispositions, Aristotle explains, can be habits or inherent qualities. "[T]hose who have some specific habit may be said also, in virtue of that habit, to be thus or thus disposed." Similarly, the term 'disposition' can

be used to describe one's inborn capacity to look or act a certain way or to accomplish some task with relative ease. Aristotle explains that blackness and whiteness are dispositions, that some men are said to be hard while others are soft, that some are called 'good boxers' because they can fight better than others, and that some have a 'disposition for knowledge' because they possess a greater ability to learn new information. Aristotle also explains that the relative nature of dispositions leads to variation in degree:

> [I]t is an incontrovertible fact that the things which in virtue of these qualities are said to be what they are vary in the degree in which they possess them; for one man is said to be better versed in grammar, or more healthy or just, than another, and so on.

While a transient mood swing may have a lesser effect on social linking than permanent minority status, all dispositions affect social interaction and create variables within the formulas of social linking theory.

Aristotle also explores human knowledge as a term with multiple meanings. In one definition, knowledge is an area of acquired information that stands alone:

> The knowledge of grammar is not relative to anything external, nor is the knowledge of music, but these, if relative at all, are relative only in virtue of their genera; thus grammar is said be the knowledge of something, not the grammar of something; similarly music is the knowledge of something, not the music of something. Thus individual branches of knowledge are not relative.

Conversely, Aristotle explains that knowledge within an existing branch is necessarily "explained by reference to something else… a knowledge of something." Under this definition, information that could lead to knowledge is elusive if its details are not connected to something already known. Knowledge of an information object

describes something about the relation of that object to another. Knowledge of the object and knowledge about the object offer bases for classification.

In his third definition of knowledge, Aristotle refers to proficiency. Here knowledge is effectively the consultation status of individuals who possess it at an expert level. Only learned professionals (e.g., those who possess rabbinical knowledge of the Talmud or the legal knowledge of the licensed attorney) have knowledge in this sense.

The employment of a knowledge classification scheme requires the development of cognitive structure, a stimulating situation, and a subsequent pull response. The pull of new information validates the existing knowledge structure and increases its scope. Aristotle's ideas about knowledge can thus be applied to social linking theory, which studies the utilization of existing knowledge to relate and gain new information.

Leibnizian Classifications through Space and Time

In *Principia*, Sir Isaac Newton of 17th Century England wrote,

> Absolute space, in its own nature, without relations to anything external, remains always similar and immovable. Absolute, true, and mathematical time, of itself, and from its own nature flows equably without relation to anything external.

Orthogonally, Gottfried Wilhelm von Leibniz of 17th Century Germany claimed that space and time exist as discrete devices for classification and that classification could be used to summarize relationships between objects and events. Leibniz theorized that the location of an object in space and in time has meaning only when compared to another object in space and in time.

Newton's perspective on space and time drew support from his laws of motion, which were accepted for many years. However, theory advances with improvements in scientific classification, and it is now widely believed that Leibniz's conceptions on space and time were more accurate than Newton's.

Another example of theoretical advancement is illustrated by the method Leibniz developed for solving the quadrature of a circle. Using a scientific formula, Leibniz constructed a square from a circle while preserving the total area of each object. The equation Leibniz employed to turn circles into squares remains a commonly cited proof and formulation for pi (π).

$$\sum_{n=0}^{\infty} \frac{(-1)^n}{2n+1} = \frac{1}{1} - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} - \frac{1}{11} + \ldots = \frac{\pi}{4}$$

Leibniz conceived that universal characteristics could be understood as a form of communication. He attributed his discoveries in mathematics to his invention of proper symbols for the conveyance of communicative relationships. Similarly, the creation of a universal language through links can be understood as a way to communicate social relationships.

Schopenhauer and the Nature of Antisocial Linking

The writings of 19th Century German philosopher Arthur Schopenhauer include a fable of social porcupines. The porcupines articulate a human need for solitude and defend their antisocial behavior.

> It is really a very risky, nay, a fatal thing, to be sociable; because it means contact with natures, the great majority of which are bad morally, and dull or perverse, intellectually. To be unsociable is not to care about such people; and to have enough in oneself to dispense with the necessity of their company is a great piece of good fortune; because almost all our

sufferings spring from having to do with other people; and that destroys the peace of mind, which, as I have said, comes next after health in the elements of happiness.

The prime reason for social intercourse is mutual need; and as soon as that is satisfied, boredom drives people together once more. If it were not for these two reasons, a man would probably elect to remain alone; if only because solitude is the sole condition of life which gives full play to that feeling of exclusive importance which every man has in his own eyes,--as if he were the only person in the world! a feeling which, in the throng and press of real life, soon shrivels up to nothing, getting, at every step, a painful démenti. From this point of view it may be said that solitude is the original and natural state of man, where, like another Adam, he is as happy as his nature will allow.

The dilemma of the porcupine has human value, but Schopenhauer's philosophical station in the framework of social linking theory arises with the introduction of human computer interaction. Social intercourse on the Web can ameliorate the suffering of porcupine-like humans by accommodating their preference for solitude. Social linking theory must encompass the study of the antisocial behaviors now accommodated by the binary, on/off power switch of computer-based communications. The power switch is often overlooked, as most of us assume that *on*, the state in which virtually all information is accessible via the Web, is better than *off*, which effectively terminates external communication and the risk of information overload.

Escher and Annotation

M.C. Escher's *Drawing Hands* were created long before the Web, but his illustration of a right hand that draws a left hand drawing a right hand offers a visual for a self-referencing annotation.

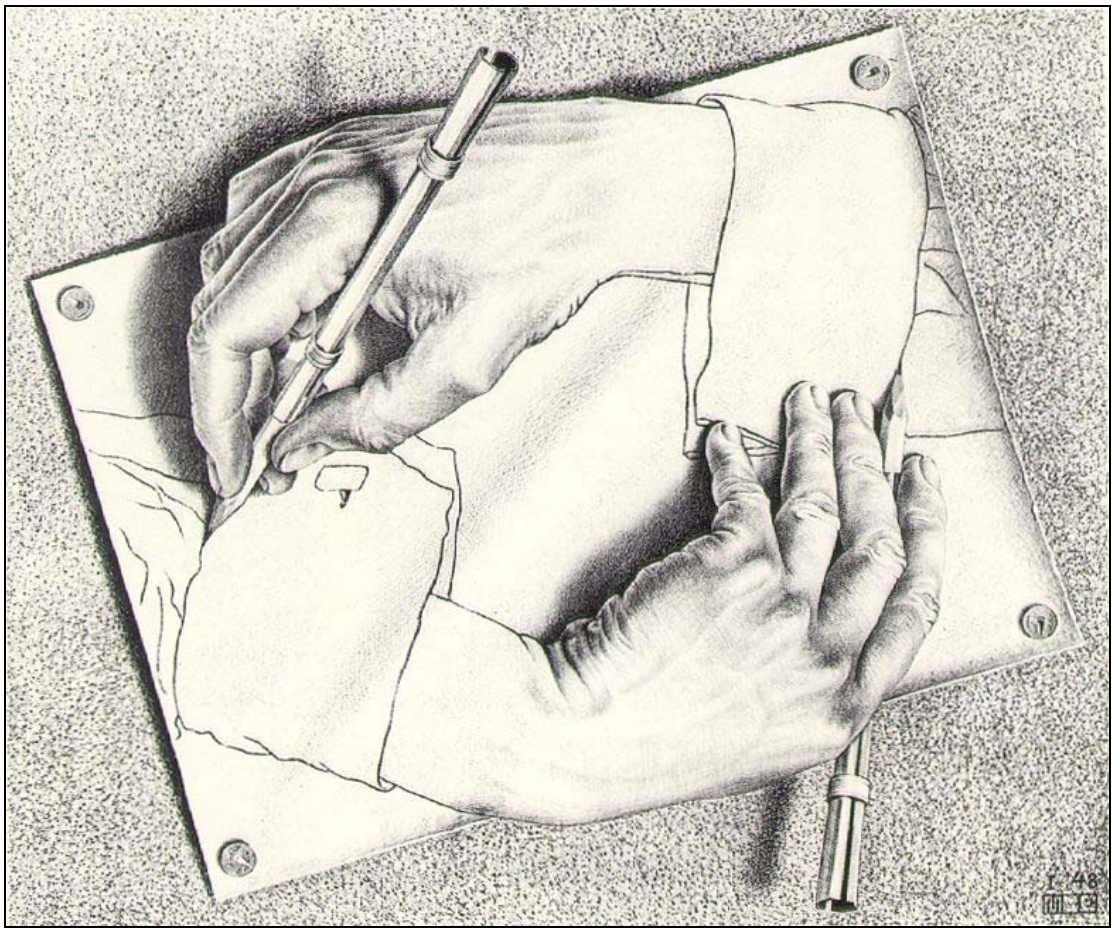

Figure 3. M.C. Escher's "Drawing Hands" [5] **(lithograph, 1948)**

A later observation of *Drawing Hands* led one scholar to theorize that when perceptions fail to establish identity in a hierarchical system, a loop is formed. Like Escher's hands, this loop leads to a Tangled Hierarchy (Hofstadter, 1980). The recent expansion of sources and a virtual eradication of time between publications have made the dangers of Tangled Hierarchy (e.g. identity-theft, plagiarism) ever-present. The idea is this: knowledge is cumulative and humans are capable of conveying information through space and time. The acquisition of new knowledge, on the other hand, may require active references. Like the canvas on which Escher's *Drawing*

[5] M.C. Escher's "Drawing Hands" © 2005 The M.C. Escher Company – the Netherlands. All rights reserved. Used by permission. www.mcescher.com

Hands remain forever in progress, information that exists without external reference is at best incomplete. The systematic study of social links is made possible by annotation; without it, the Web becomes a place where fictional novels written by a fictional authors become real.

IV. Hypermedia and the Classification of Social Links

Hypermedia annotations have shaped the Web and drive its development. Web authors establish relationships with hyperlinks and create dimension, meaning and direction in index space. Hypermedia technology has the potential to augment social communication and human intellect.

--Thomas Ciszek

The Evolution of Hypermedia

Ted Nelson defined hypertext as non-sequential reading and writing (Nelson, 1981). More recently, hypertext has been defined as the science of relationships and relationship management (Isakowitz, 1995). Since the era of Xanadu (Nelson, 1981), in which links were created by the author and permanently fixed to the document, hypermedia has evolved alongside information communication technologies. The primitive links of other early systems like Guide (Brown, 1987) and HyperCard (Goodman, 1987) were replaced by link architectures, link models (Halasz, 1994)[6] and link typing strategies (Nanard, 1991). While each of these hypermedia strategies was effectively supplanted by the next, the simple, fixed, point-to-point nature of hypertext systems and linking strategy have endured. Today, links remain explicit relationships between resources or portions of resources, and linking is still generally described as the passage of a message from its origin to a receiver.

[6] This citation refers to a discussion of the Dexter model. The Dexter model (1994) was designed to provide a principled basis for comparison of hypertext systems and to develop standards for system interchange and interoperability.

Most hyperlinks are static pointers embedded in source documents and accessible through the Internet. There are exceptions, however, as some systems maintain their links in databases that are separate from the documents that reference them. The Intermedia system at Brown University was likely the first to introduce this database design (Haan, 1992), which has since become a central feature of open hypermedia systems (Davis, 1998). Within these map-based systems, database links may be manually or automatically created and can exist as static or dynamic entities. The more recent development release of XLink by Eve Maler and Steve DeRose allowed for the use of open hypermedia links with XML and demonstrates the ongoing utilization and development of links as explicit entities that act between resources. (DeRose, 2000; Maler 1998).

Use of map-based hypertext systems also led to new discoveries about the relationships between nodes as some made efforts to avoid explicit linking mechanisms of map-based hypertext. This practice led to the realization that relationships among different nodes can be determined by relative location. Using spatial and visual cues, users found not only the ability to link through the implicit and transient relationships that develop between nodes but also an ability to manipulate the nodes themselves (Shipman, 2000). From the need to support and study this new way of linking came spatial hypertext systems, and research has shown that linking through spatial hypertext has major benefits that are applicable to human social linking. Specifically, spatial hypertext systems appreciate the visual recognition and intelligence of human users and reduce overhead during social

communications. In addition to these benefits, social linking theory should also study the use of spatial hyperlinks to facilitate constructive ambiguity.

Typologies of Hypermedia

Previous research suggests that the motivations behind links are an important component in understanding the quality of a document. To provide a social linking framework and further the validity of webometric research, it is necessary to study the underlying factors and the reasons for linking. Despite intuitive similarities, the motivations for hyperlinking and citation differ. Prior research shows that creation of links in an electronic environment differs from that in the paper environment. Discrepancies arise because links in an electronic environment can be fashioned "to give a graphical image," "provide readers with an easy and immediate access mechanism," or were created purely because "the technology enabling the link to be made is there" (Kim, 2000).

Whereas, Web authors create links at the site or page level, those who cite refer to specific passages, paragraphs, or sentence fragments. In the same spirit, bloggers create links citing content contained within posts, hyperlink extensively internally, and externally in a social way (Ciszek and Fu, 2005). Hyperlinks tend to be more fact-oriented and less opinionated or judgment-oriented with the opposite being true in paper and electronic citation (Chu, 2005). This is hardly an acceptable generalization for hyperlink use in blogs. Hyperlinks within blogs were described as "emotional" and "controversial with respect to the author." My own research and

lengthy discussions on and off the record project the hyperlink as a geographical token serving as an anchor for its content and as a context for social intuition.[7]

Chu (2005), provides a thorough literature review of important papers on citation analysis and hyperlink analysis. The study introduced in the article probes the reasons for hyperlinking and compares them with reasons for citing. Haas and Grams (1998), develop a link type classification structure from an examination of the setting in which the anchor was placed, the anchor itself, and the apparent reason that a reader might follow the link. The four link types they identified are navigation, expansion, resource, and miscellaneous. Thelwall (2003) observes that motivations for hyperlinking are relatively trivial, primarily social, and without any cognitive aspect. However, four new types of motivation are postulated. The term "ownership" is coined for links acknowledging authorship or co-authorship of a resource, "social" for links with a primarily social reinforcement role, "general navigational" for those with a general information navigation function and "gratuitous" for those that serve no communication function at all. Another researcher suggests that there could be at least six link creation motivations: social, navigational, personal, geographical, historical, and prestige (Zuccala, 2005).

Zuccala observes that in Bar-Ilan's (2005) classification scheme, direct links are often created without the knowledge of the author. This is the same sort of phenomenon illustrated by M.C. Escher in Figure 3 and discussed at length by

[7] During the inspection of blogs in order to classify the genres of hypermedia, an idea emerged to divide the hyperlinks into two main categories, machine made, and human created (Ciszek and Fu, 2005). The purpose was to get a picture of how the two categories appear in the link structures of blogs. Not surprisingly, there were more machine made hyperlinks than those made by humans. This number of computer-generated links will only grow as a percentage of the total links on the Web as social networks become intertwined with information retrieval.

Hofstadter in *Gödel Escher Bach*. Zuccala's classification scheme is one that supports social linking, making a special case for the claim that people both inform and communicate with hyperlinks. All of these motivations form a role unique to the Web, albeit in varying degrees. Leydesdorff (1998) suggested that a theory of citer motivation on a macro level must be different from that on a micro level. On a macro level, the social networks of authors provide a description of the citation. On the author's individual level, the motivation is a unique ipsative assessment. Under a theory of social linking, the Web will continue to become more specialized with respect to social networks.

Any genre classification on the Web is a difficult task due to non-established, muddled and overlapping varieties of information encountered. Web pages and aggregations of pages often "conform to existing print genres, merge multiple genres together, or create new ones" on the unregulated Web (Thelwall, 2002). Hence, genres and the convention of hypermedia are "still in the process of becoming" (Agatucci, 2001).

V. Social Linking Optimization

It is hypothesized that social linking theory can be used to determine optimum levels of information transfer to advance the design of communication systems towards maximum information transfer, minimum entropy and prevention of information overload. This final section of framework development sets forth a basic model for quantitative thinking in the study of social links and offers an example of how the benefits of social communication behavior study are already being realized within the private sector.

The Development of a Social Linking Communication Model

While more recent communication theories exist,[8] the model developed by Claude Shannon (1948) accurately describes the natural and universal process of communication in information science. This model of communication (Figure 4) shows the path of a message from an information source to a target destination.

[8] Brenda Dervin, for example, argues that efficient communication requires understanding of the communication as process, not as entity and that the process of communication is dependent upon system reliability, regulation and control (Dervin, 1993). Another alternative communication theory was set forth by second-order cybernetic theorist, Heinz von Foerster. Von Forrester's model places significance upon the act of communication observation within cybernetic mechanisms and describes feedback loops between the observer and the observed (von Foerster, 1991).

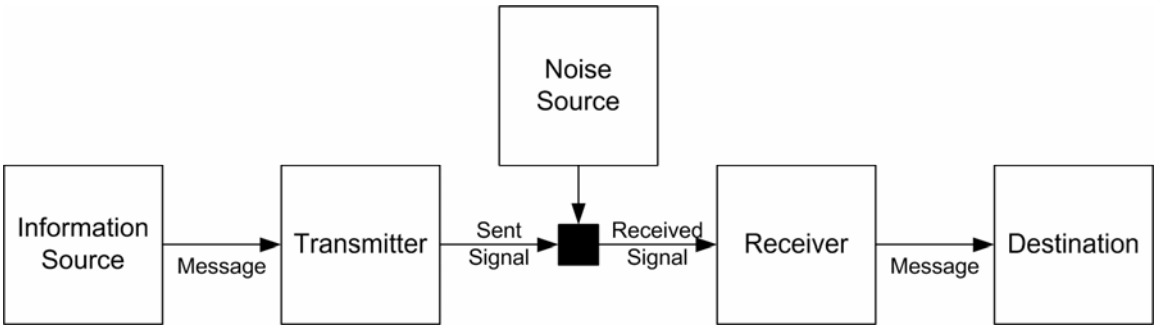

Figure 4. Shannon Model of Communication

The path of the message is often referred to as the *channel* of communication, a metaphor used to evaluate the quality of message transmission. This oversimplified design of communication shows the power transfer from source to receiver through a channel and offers a visual root for thinking about social links. When the Shannon/Weaver channel of communication is considered a channel of social interaction, the first step in the evaluation of efficient social linking is accomplished.

To develop the idea of social linking efficiency, first remember that hypermedia provides the annotation through which communication channels are indexed and consider the addition of links to the Shannon model. Link types provide information about the content of the destination node and belie the communicative properties of hypermedia. Specifically, the existence of links evidences an attempt to communicate information between the message source and the target recipient. Whether a link exists as citation, for navigation, as a spatial hypertext shortcut, or as a seemingly gratuitous transmission, it is a link, a quantitative communication, and a unit of data for study.

Having established a design for communication study through hyperlink analysis, we now turn to link motivation theory and recall the four methods of social linking:

information retrieval, consultation, educational experiences and mass media. Links motivated by any one of these social methods create social channels, also understood to be social annotations and/or social links. The Social Communication Model (Figure 2) illustrates the paths and modes of a social channels used for the acquisition of new information or knowledge. In this context, two or more active parties who share signs and symbols using information communication technologies represent social linking.[9] Through design and development, there is capacity to augment both the context and the content of communicative activity and reduce entropy through social linking.

Figure 5 offers a basic illustration of how hypermedia can be used to measure social linking.

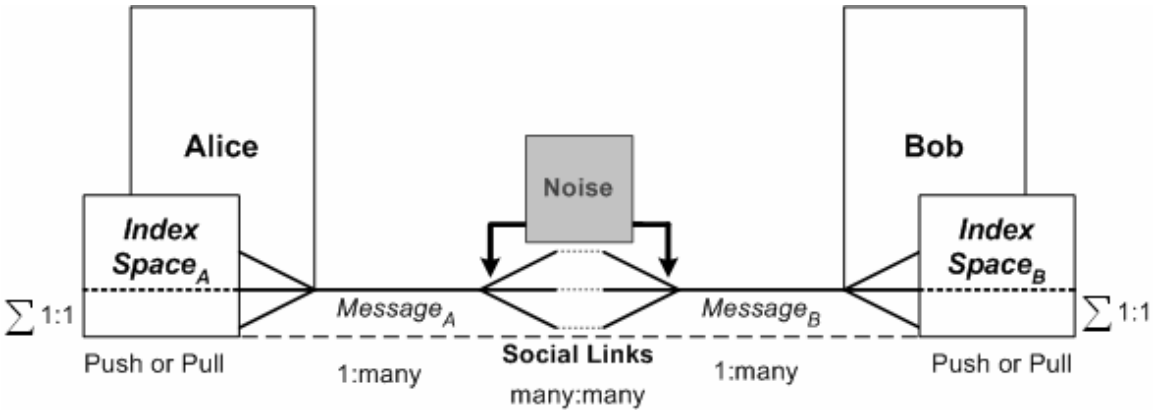

Figure 5. Social Linking Model of Communication

Figure 5 considers a conversation between two people, Alice and Bob. Communication between Bob and Alice is one-to-one and can be classified as

[9] From the perspective of data collection, a starting point from which to determine whether a hyperlink was socially motivated may be the status of the recipient node. Since a channel connected to a passive receiver is not characteristic of link communications between socially motivated humans, the elimination of links to passive recipients may be a first step in the process of determining which links are social.

consultative in nature. In a social communication model of link creation, there is an assumption of strong authorship, a notion that the author "knows best" (Bodner, 1999). When Alice is the listener, she believes that all messages she receives from Bob are true and correct. Likewise, Bob takes no notice of noise and assumes that all messages received from Alice are valid.

While easy to understand, viewing communication from this perspective omits many of the difficulties involved. In reality, Alice and Bob must first understand how to use the medium through which they communicate, and then they must navigate their communication channels appropriately. Figure 5 also ignores effects that the humans' sensory perceptions (vision and hearing), psychological states and physiological characteristics have upon the transfer of information. A miscomprehension of the author's message structure often results in disorientation, information overload, cognitive interrupt, and general sentiments of being "lost in hyperspace" (Parunak, 1991; Conklin, 1987). Finally, and central to the need for further study of social link behaviors, Figure 5 assumes away the existence of noise. All channels have noise. Absent study of noise, social linking theory cannot determine the defects in signal that can be tolerated, those that significantly devalue the information transferred or the amount of entropy is produced when information is transferred.

Facebook: A Model for Social Linking in the Private Sector

Significant exploration of social identity and social communication has reached the private sector, but discoveries in this area have been tied to economic investment

and proprietary technology. As a result, data about how and why we point and click is rarely shared. The absence of this data for public use is the central inspiration for a theory of social linking. The field of information and library science provides a research platform on which social linking can be studied for the promotion of general public knowledge.

Facebook.com (Figure 6) is a new social networking website for college and university constituents that became available in the spring of 2004. Today Facebook hosts more than 20,800 profiles for students, faculty and alumni who possess a valid email address ending unc.edu (*Raleigh News and Observer*, October 26, 2005). Facebook research exposes the nature of technology adoption trends as well as information about social and political trends that students are communicating to each other in a many-to-many fashion (Stutzman, 2005). The rapid rise of Facebook at the University of North Carolina is mirrored at colleges and universities across the nation. My analysis (Figure 7) shows the rapid growth of this social networking tool at the University of North Carolina and at Duke University. At the University of North Carolina (Figure 7, top), the near linear adoption rate has exceeded the population of students at the school. The pervasive adoption of such tools demonstrates the reality of achieving social communication and acquisition of information using social networks.

Figure 6. Facebook Homepage

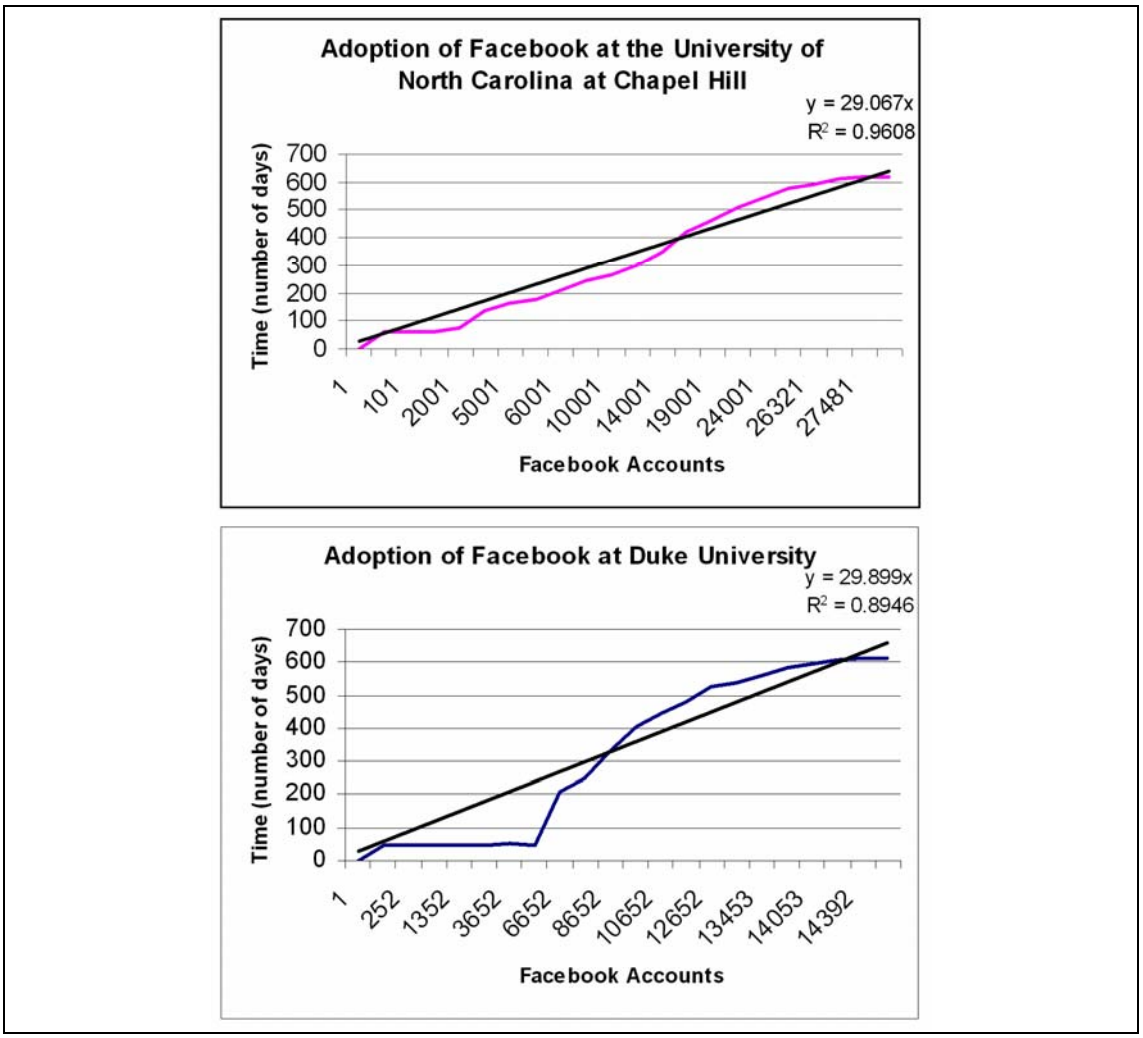

Figure 7. Adoption of Facebook at UNC and Duke University

In many ways, Facebook is similar to other popular social network websites like myspace.com and friendster.com, but Facebook differs from the competition in at least two important ways. First, as mentioned above, membership at Facebook is restricted to individuals with an email account that ends with the letters e-d-u. Second, less than 20 months after its introduction, 90% of the nation's undergraduate population is "on Facebook." Each of these characteristics is most easily explained as a result of social link analysis.

Facebook's email address constraints create an ideal population of users for the research and accommodation of social communication behaviors. All Facebook profiles have similar cultural identities, and since members classify themselves as undergraduate, alumnus, faculty, or staff at the initial stage of profile setup, Facebook can easily study the linking patterns of cultural subsets. Using information gained through annotation by users who generally link alike, Facebook can easily adapt its interface. Moreover, Facebook is more likely to please (or displease) all members when such changes are made. The result is an extensive social network that caters to the Internet bred undergraduates of America.

Beyond the .edu requirement, Facebook generally limits the scope of its network interface to the school of the member. An undergraduate at UNC, for example, can only access detailed information about other members of the UNC community.[10] Facebook offers additional privacy features, allowing a member to restrict the view of his profile by none, one, many, or all other members. Fast becoming a channel for the distribution of mass media information, Facebook offers links to national news

[10] Facebook does offer global searches, which provide access to general information (e.g. name, school, geographic location) from profiles system wide.

(the *New York Times* and the *San Francisco Chronicle*), local news, college news and, of course, news about Facebook.

To the 90% of the nation's undergraduate population with Facebook profiles, the central attraction of Facebook is probably its myriad social linking features. Among these features is profile access to Facebook "friends" and "friends of friends," which allows users to trace and expand their face-to-face relationships on campus with greater social efficiency. In addition, Facebook's interface invites easy search of other community members who share the information seeker's courses and friends. Through Facebook, the search for information about the beautiful blonde in your Chemistry 062 lecture has shifted from methods of consultation and education services to information retrieval.[11] Facebook's newest feature allows members to link the digital photographs they post to the profile pages of other users pictured. It is no small wonder, then, why more than half of Facebook's undergraduate student subscribers check their profiles daily.

The Facebook phenomenon has evolved into a social language and Metadialogue of Facebook culture. While the argument that Facebook's Web interface is an effective substitute for face-to-face meetings,[12] it should be noted that on college

[11] Note that administrators, faculty, staff, campus police, can also retrieve information about students in Chemistry 062, and university police have recently begun to use Facebook to identify and prosecute students who break laws. *See* http://www.collegian.psu.edu/archive/2005/11/11-10-05tdc/11-10-05dnews-09.asp.

[12] Face-to-face communication is a highly functional and natural way in which to communicate in a shared physical environment. In such an environment or location, the communicators can describe and refer to objects through deictic reference and conversation. A number of authors characterize physical environments as a highly influential variable and as important in the general study of communication (Nardi, 2005). This theory claims social context is another highly influential variable in the study of communication, particularly using network technology.

campuses, Facebook is not only a social linking network, it is a verb. A recent newspaper article about Facebook included this description of "Facebook Lingo."

FACEBOOK LINGO
Facebook, v. -- To add a Facebook friend. "Laura's really cool. I think I'll facebook her when I get to a computer."
Facebook friend, n. -- Someone on your Facebook list of friends but not necessarily someone you've met. "J.J. Redick, the basketball player, and I are Facebook friends, but I've never seen him on Duke's campus."
Poke, v. -- To let someone know you've contacted him or her." I found out Jane poked me when I logged onto Facebook, so then I poked her back."
Wall, n. -- A public place on a member's profile where you can leave a message. "I wrote on Alan's wall about how awesome his photo is!"
Raleigh News and Observer, October 26, 2005.

While claims to Facebook's popularity are made, information about its effects on the competition is less available. New college-oriented features on other social networking sites such as myspace.com and friendster.com, suggest that Facebook's influence on the social network website market is significant. While the potential for a control group shrinks daily (Figure 6), a study on the academic effects of Facebook membership would be a fine place to begin the application social linking theory in information and library science.

VI. Conclusion: Movement Toward a Theory of Social Linking for Information and Library Science

That society, which communications makes possible, supplies us with necessities we would otherwise have to obtain for ourselves. Communication with others conveys rewards far beyond the basic necessities of life.

--John R. Pierce

In the rapidly evolving communities that live on the Web, social links have become the universal annotation form; the term "social linking" is used to explain social motivations and transcends to social content and social contexts in Web-based communication. The development of tools for the study of social linking theory is needed to support the communicative components of information in social Web applications. Specialized social linking tools could offer social network researchers and users the traditional annotative functions of storage, organization and retrieval. Beyond this, classifications in social-linking theory could be used to differentiate between machine-generated links that clutter the information space and human generated hyperlinks. Because social links, unlike most other hyperlinks, are observable as annotations beyond the Web, they are a logical place to start in developing a meta-context to justify and develop a social-linking research system. Such a system, if carefully designed, could lead to the development of universal systems for discovery, management, interpretation and even regulation of Web-based real world communications.

Hyperlinks have endured and developed into universal points of connection and navigation across the Web. They have annotative value as information objects and as

activities. Methods of studying hyperlinks, often called "web structure mining" by computer scientists or "social network analysis" by sociologists, have resulted in the ability to determine authority among web pages, automatically generate archives and navigational content, and provide detailed content analysis of the structure of the Web (Thelwall, 2003; Wasserman and Faust, 1994; Park et al., 2002; Brin and Page, 1998).

In a social linking model of communication, link typology is designed from the motivations of link creation, the communicative uses of links (Figure 2). Information retrieval, consultation, educational experiences, and mass communications offer a sound set of social communication methods from which to build a theory of social linking. In an era of social linking theory, and as each target recipient approaches the task of pulling information, he or she will be equipped with a set of natural rules and related information not now known or available.

In the Information Age, where information travels faster than man and information communication technologies evolve on a continuum, the tasks of link measurement and classification have become the highest challenge (Leung et al., 2001) and the threat of information overload is genuine. This thesis argues that there is a need to explore the ongoing development and stratification of information technology through human behavior and that hypermedia can be used to conduct such study.

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