THE INFLUENCE OF PRINT ON SOCIAL AND CULTURAL CHANGE

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INTRODUCTION

Tracing the sociocultural influence of any technology is fraught with problems. First, many of the influences cited are likely to be too large and diffuse to be tested under experimental conditions in the laboratory. Second, the technology is likely to be, at most, an accessory to many other influencing factors rather than a singular cause. Third, insofar as the technology can be isolated as a factor of influence, the direction of the influence is often two way. The technology may cause changes in sociocultural states, but existing sociocultural states are also likely to result in the technology being used and evolved in unanticipated ways.

A case in point is the literature on the sociocultural effects of print technology. Various historians of media (Eisenstein 1979, Ong 1958) have used historical methods to begin to answer what print did to, and for, sociocultural processes. The question is too large for the laboratory and is more often addressed through historical methods. The historiography, moreover, has often been interspersed with much psychological speculation. This is because there is a significant gap between the evolution of print technology from an engineering perspective on the one hand (that is, the history of mechanical print) and the metaphysical questions about consciousness and consciousness-raising that print, since Gutenberg, was supposed to have spawned. Cultural historians of media tend to take this metaphysical leap. They associate print with the evolution of spatial representations of knowledge, with a greater attentiveness to textual accuracy and fixity, and with a more Cartesian mindset in print than in pre-print societies (see especially Ong 1958).

While there is much to recommend approaches to print that bear on the history of consciousness, there are limitations to this approach. The inferences
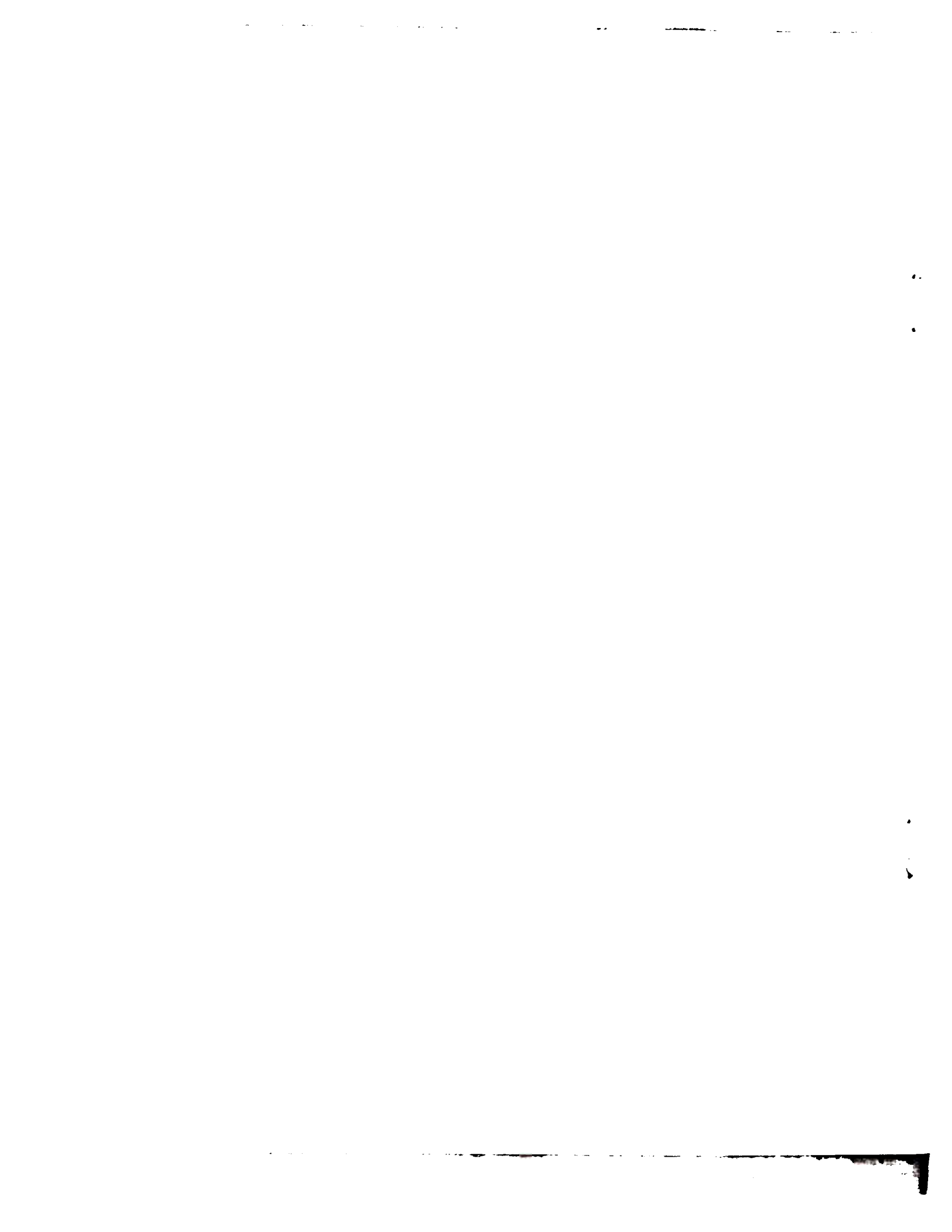
about consciousness are drawn from historical records but they also incorporate theoretical assumptions that can not themselves be justified by these records. More specifically, the inferences are underlain by an assumption we call technological determinism. Technological determinism is the belief that the human cognitive architecture is reliably affected by the external technologies that are used to augment and extend cognitive processes. Applied to print, technological determinism means that print had a signature impact on mental processes and not just the knowledge held by individuals. The theorist advocating technological determinism envisions the history of literacy as a history of evolving communication technologies (Bolter 1991). The goal of the theorist seeking to explain this impact is to trace this impact historically.

The weakness with technological determinism is that it places technology—in this case print—at the center of sociocultural change without taking into account the many other processes of sociocultural change (e.g., population size, migration, language, cultural specialization, differentiation, etc.) in relation to which technology is a factor. Technological determinism also tends to assume that the causal direction between technology and sociocultural processes is one way when the relationship seems more realistically to be one of mutual influence.

MAKING PRINT A MECHANISTIC ACCESSORY OF COMMUNICATION

Any tracing of print's influence must use the historical record, yet it must also make assumptions that elaborate the historical record. The previous literature has tended to anoint to print an exotic influence because it annotates the historical record with exotic assumptions. Our approach (Kaufer and Carley 1993; 1994) has been to access print's influence by annotating the historical record only with the most prosaic, mechanistic assumptions about print. We believe that there is more to be gained if, from prosaic assumptions about print's interaction with other sociocultural processes, we can derive profound and pervasive conclusions about its contribution.

We proceed from the assumption that print changes the physical character of face-to-face communication. Some of these assumptions have been elaborated by theorists of written literacy (Brandt 1990, Nystrand 1989) who note that texts do not strip communication from context; rather, they require one to understand the meaning of communicating in contexts that lack proximity. Like writing, print creates an externalized agent called a text. We use the word "agent" in the sense of artificial intelligence, as an encapsulation of an author's cognition. The fact that the agent is "externalized" means that it is disembodied from the speaker and can engage in interactions in the speaker's absence, even after the speaker's death. The fact that the agent is the product of mechanical print makes it distinct from writing in the multiplicity of its interactions. Because of the numerous copies made possible by print, print interaction allows one-to-many communication; it allows many readers to interact with the text at the same time.

Reading the historical record from nothing more than this physical framework for print, constructural theory and simulation methods are used to develop hypotheses about print's potential influence on sociocultural processes.

CONSTRUCTURAL THEORY

In his synthesis of social interaction theory, Turner (1988) argues that there are three phases to interaction: motivation, action, and adaptation. Motivation involves how agents decide with whom to interact. Action involves the details of the interaction itself. Adaptation involves the longer term structural consequences of interaction. Constructural theory embeds all three of Turner's phases within a dynamic theory. All individuals are involved in a continuous interaction cycle in which individuals become motivated to interact, take action (communicate), and adapt in response to the consequences of this action.

Constructural theory (Carley 1990; 1991) is a process-based theory that relates, in mathematically explicit ways, all three of Turner's phases. It is a theory designed to show how the cumulation of ongoing concurrent interactions at any time period can impact the society over time. According to the theory, the concurrent interactions of individuals at any time period produce aggregate patterns of cognitive change in individuals, patterns of change that themselves depend on characteristics of both the larger environment (or context) in which the individuals interact and the technologies through which they interact. Constructural theory, in sum, relates aggregate sociocultural change and the concurrent interactions of arbitrary individuals. In this sense, it offers a specific theory for making the link between micro-action and macro-structure that has long occupied theoretical sociologists (Alexander, *et al.* 1987).

Within the assumptions of the theory, whether individuals communicate depends on the communicative distance between them. The greater the communicative distance between individuals, the less likely they will interact. Communicative distance depends on the relative availability of other potential communication partners and their relative similarity. Relative similarity refers to the extent to which the two communication partners share information with each other relative to what they share with everyone else. In other words, two communication partners are more likely to interact with each other if, regardless of how much information they share, they share more with each other than they do with others in the society. Availability and relative similarity determine whom or what the individual actually chooses as an interaction partner.

Individuals communicate using various communication technologies, such as face-to-face and print media. These technologies vary in their synchronicity, fixity, durability, and multiplicity, all of which affect the communicative distance between possible communication partners. Face-to-face interaction tends to be synchronous, low in fixity (oral messages are produced and quickly distorted or

forgotten), and low in multiplicity (accommodating few receivers in relation to the population. Print interaction, on the other hand, is asynchronous (reception lags after transmission), high in fixity (the message endures even after the life of the author), and multiplicity (accommodating many receivers in relation to the population). Kaufer and Carley (1993) is the first work to extend Carley's original theory to print as well as face-to-face interaction.

Printed texts in general can be thought of as the author encapsulated, an extract of the author's knowledge at a point in time that is unalterable. From an information processing perspective, our approach develops the notion that print creates artificial agents—texts—with a knowledge, a set of communicative properties, and a set of positions in a sociocultural landscape that is distinct from human agents. For example, unlike people, texts have knowledge that is bounded because they cannot learn. Unlike people, texts can impart information but they cannot acquire it. Unlike people, texts (assuming unlimited copying and feasible costs) are universally open for interaction.

As a result of the concurrent interactions taking place within a sociocultural landscape, some involving only human agents, some including print agents as well, the society adapts, leading not only to new patterns of knowledge throughout the society but to new sociocultural positions (and hence roles). Through concurrent and recurrent transactions, changes across individuals collectively construct social and cultural changes. In response to the reciprocity between interaction and cognition at the individual level, social structure and culture coevolve at the societal level. Technological, social, and cultural variations across agents, human and artificial, affect the rate and nature of sociocultural-historical evolution.

SIMULATION STUDIES

The constructural theory is realized as a simulation system. Using this system, the logic of the theory for societies with different sociocultural-historical-technological landscapes can be played out. This allows the researcher to engage in a series of historical *gedanken* experiments. We use this system to explore how print may have affected modern society. We ask, what are the expected differences between print and pre-print societies? These simulations both enforce and stimulate a logical framework for thinking through some of the key issues surrounding print. This framework establishes some firm logical relationships between print and other sociocultural-historical variables, and discriminates better and worse explanations about print current in the extant literature. The simulations also rule out possible explanations of sociocultural-historical change, and they generate a series of propositions about the impact of print that are capable of being tested using other scientific methods.

This method has been used to examine the general impact of print as well as the impact of print on the professions, on academe, and on intellectual migrancy. The measures for impact that are used are stability, consensus, and diffusion (Carley 1990; 1991; restated and elaborated in Kaufer and Carley 1993). Each of these have formal definitions but for present purposes informal ones will serve.

Stability is the degree to which the sociocultural landscape cannot shift. It can be measured as the fraction of available information shared by any two individuals, as averaged across all pairs of individuals in a society. The intuition here is that the more stable the society, the less new patterns of knowledge can form and so the less the society can change as a result of interaction.

Consensus is the degree to which individuals share some belief about a focal concept or decision point. It is a more sensitive measure of shared knowledge than stability because it depends on common patterns of shared *and unshared information* across individuals, rather than only on the absolute percentage of shared information. Two individuals who are stable relative to some piece of knowledge K can still fail to agree on decision D because of other knowledge they do not share, which leads to different decisions.

Diffusion (see Rogers 1982 for a classic study) is the fraction of the population that has received some percentage of a communication at some time period. Over-time measures of diffusion involve the amount of time that elapses before some percentage of the population knows some percentage of a communication.

The work of the simulations in this research has been to determine the relative effect of print (compared to face-to-face) interaction on 'societal impact measures' such as stability, consensus, and diffusion within a society. The purpose of this simulation work is not to test empirical hypotheses, but to develop such hypotheses from a mechanistic framework without resorting to metaphysics. In these simulations, we vary the sociocultural-historical landscape, for example, by altering the size of the population, the complexity of the culture, and the degree of cultural integration. These variations permit us to address the robustness of our results.

With respect to print in general, we find that print can speed diffusion, stability, and consensus. However, the ability of print to speed diffusion and consensus depends on the extent to which the texts contain knowledge and norms already familiar to the readers. The completely novel text has little impact on society. These results suggest that for any technology supporting communication at a distance to be more than a "novelty" medium, it must accommodate assimilated information and facilitate the community-building aspects of language. Further, we find that the advantage of print over face-to-face communication in

affecting the rate at which information is shared is greatest in large societies with complex and highly integrated cultures. Print, however, is not a panacea. Indeed, when the population is small, or the culture simple, or the population highly heterogeneous, print may have little ability to effect sociocultural-historical change.

PRINT AND PROFESSIONAL DISCOURSE

Using the constructural perspective, a profession is defined as a collection of individuals who are more culturally integrated than the population at large and who have access to information not generally shared by outsiders. Past attempts in the literature to define professions in terms of necessary and sufficient conditions have failed (Abbott 1988, Bledstein 1976). We thus offer a novel parameterized definition of a profession, characterized using two dimensions—cultural integration and specialization. Prototypical professions are high on both dimensions. Using this approach, the reality of a profession can be distilled from its rhetoric. Using simulation we explore the impact of print on the reality of the profession. Two hypotheses suggested by our analyses are the Expanding Member and the Expanding Culture Hypotheses. In the absence of print, professions composed of few individuals and with relatively simply cultures (little specific professional knowledge) are quite stable and able to generate consensus among their members quickly. Print makes it possible for a professional group to have more members and a more complex culture and still attain stability and consensus as rapidly as a small simple professional group without print. Print makes the growth and stability of a profession less dependent on its relative size.

Print also helps a profession maintain itself when its members are few or isolated, even if it is culturally complex. Face-to-face communication encourages professions to remain small, as in this case consensus is achievable. Print, however, makes consensus within a profession less dependent on the group's absolute size. Moreover, print facilitates the growth of professions as it confers a decided advantage to professions that are relatively large. These results suggest that print may have allowed professions to grow larger than ever before even in the absence of high cultural integration and may have allowed professions to become more specialized than ever before without paying the price of cultural isolation. These results comport well with the findings of organizational theorists (Powell and Dimaggio 1991) and historians (Beniger 1986) on the relationship of professions to institutional and information monitoring.

The above results speak to professional structure in general. An interesting literature is beginning to accumulate on the evolution of printed text genres based on the historical contingencies of specific disciplines (Bazerman and Paradis 1991). An interesting extension of our simulation results would be to specialize them across different professions.

PRINT AND ACADEMIC DISCOURSE

Academic specialties can be thought of as professions. However, the academic specialist is distinguished from the ordinary professional in that the academic is concerned with innovation, the generation and diffusion of new ideas. By considering the relationship between discovery and diffusion, we examine the role that professional communication can play in building the professional scientific community. Simulations are used to examine how the sociocultural-cultural landscape of the scientific specialty affects the rate of information diffusion in that specialty.

The dominant effect of print on academic structure is to increase the rapidity with which ideas diffuse. Print is simply more efficient than face-to-face communication for the diffusion of new ideas, regardless of the shape of the sociocultural-cultural landscape. Through simulation, some potentially interesting relationships between print and the size, absolute or relative, of a specialty are isolated. The advantage of print to speed the flow of information increases as the absolute size of a specialty increases. Face-to-face communication (i.e., word of mouth) breaks down as a vehicle of dissemination as the absolute number of individuals who must be reached goes up. Face-to-face communication also degrades with the relative size of a specialty. Under face-to-face assumptions, larger is slower, whether one refers to absolute or relative numbers.

However, there is no such simple story about print's advantage when relative size is considered, that is, the size of a specialty relative to the rest of society. Under either face-to-face assumptions or print assumptions, diffusion within a specialty requires the help of some knowledgeable outsiders, individuals who share knowledge with insiders but not as much as insiders share with one another. Within the context of the simulations, specialties could be too small, relatively; that is, the number of outsiders may be so high that communication from the outside distracted the diffusion of new ideas by the internal specialists. Specialties that were too large, on the other hand, may have too few outsiders to make a useful difference. The communication of internal specialists may be too inbred, preoccupied with ritual ideas that delay communication of a new idea. Under print assumptions, new ideas diffuse fastest when the specialty is only moderately sized relative to the outside society.

Print's advantage with respect to internal diffusion accrues, then, when the absolute number of specialists increases but the relative number of such specialists do not. There are some crude historical analogs to this pattern. The Royal Society, the first scientific society to move to print, encouraged the recruitment of specialized scientists but, in addition, continued to add lay readers to its correspondence lists (Lyons 1968, Roediger 1987). Such analogies are not meant to offer new historical interpretations; rather, we believe that simulation

techniques such as ours can inspire historians of print to take up these questions as sites of focused investigation.

Beyond the number of individuals, print also has a decided advantage when one considers the number of ideas in a specialty, its complexity. The more complex the specialty, the more advantageous is print communication. This follows directly from the multiplicity of print. Print allows many ideas to be communicated at once with less risk of forgetting.

These results about print in specialties suggest two reasons why written texts have remained a medium of choice for scientific communication (Meadows 1978), both converging on the timely diffusion of new ideas. First, historical changes in science (whether by choice or accident) created an environment where scientists could benefit from the rapid diffusion of discoveries: Print made such rapid diffusion possible. Second, the scientific text has evolved to a form, especially through the use of citation (Cronin 1984, MacRoberts and MacRoberts 1986, Small 1978) that allows authors to engineer the diffusion of their ideas to the scientific community. Being able to engineer a text allows the researcher not just to diffuse the new idea (and so establish priority; see Geisler 1994, Kaufer and Geisler 1989) but also to diffuse it to the "right" people (and so establish prominence).

PRINT AND INTELLECTUAL MIGRANCY

Within science, there is a myth that scientific advance is often attributable to individual migrant scientists who move between disciplines. The myth was given some intellectual respectability by Mulkay (1973) who found, studying innovation across a variety of disciplines, that all examples of innovation depended on certain migrants just having moved into the discipline. Simonton (1988) more recently has established a link between scientific genius, mavericity, and migrancy. Through simulation, the conditions under which migrants can, and likely won't, make a difference are examined.

We find that, regardless of whether print or face-to-face communication is used, the greater the intellectual cohesiveness of the migrant's home discipline, the more difficult it is for the migrant to spread the novel idea to the target discipline. Greater cohesiveness in the home discipline will tend to keep the migrant's "strange" ideas in house. Conversely, regardless of whether print or face-to-face communication is used, the greater the cohesiveness of the target discipline, the easier it is for the migrant to spread the novel idea to it. Greater cohesiveness in the target discipline will increase the level of indirect diffusion of the migrant's novel idea. Many individuals in the target group will facilitate the spread of the migrant's idea through their local interactions. Finally, the migrant's novel idea diffuses slightly more rapidly when there is highly distinct specialization across groups (i.e., little cognitive overlap between the home and

target disciplines). This is counter-intuitive because it seems that the migrant's potential for diffusive impact would increase as the overlap between the source and target group increases: But to the extent that there is already wide overlap across specialties, the migrant loses his or her distinctiveness from others. The migrant's new ideas must compete with the new ideas of the many others whose knowledge is distributed across groups.

To sum up, our simulations indicate that there must be minimal intellectual cohesiveness in the home discipline, maximal in the target discipline, and high specialization (i.e., low overlap across groups) to promote the rapid diffusion of the migrant's new idea. The effect of these conditions is most pronounced for face-to-face (or one to one) interaction. Yet print greatly mitigates the effect of all these conditions. Print erodes the communication barriers between groups of any sociocultural composition and thereby attenuates the negative effects of internal cohesiveness and specialization on diffusion.

The result, we conclude, is that the migrant hypothesis, insofar as it is true, must refer to some (as yet) unspecified factors that result when people have rich (face-to-face) experience in multiple intellectual communities. The same hypothesis, insofar as it is more hype than substance, may simply restate the pedestrian truism that print, by flattening boundaries, has accelerated the potential for the cross-fertilization of ideas.

CONCLUSION

To understand the effect of print on sociocultural-historical change, one must understand how it plays out relative to the face-to-face technological context and across a variety of sociocultural-historical landscapes. Further, to understand the impact of print, one needs to understand the communication process more generally. This process, however, is sufficiently complex that it is difficult for humans to trace through the ramifications of even simple changes in communication technologies or sociocultural-historical landscapes. As an aid to such thought experiments, we employ a simulation model based on constructural theory. Using this model, it is possible to generate logically plausible hypotheses about print, professions, academe, and scientific migrants and to call attention to logical inconsistencies in other hypotheses. These analyses suggest that simple factors that make print-based communication different than face-to-face communication can result in major sociocultural-cultural impacts.

In closing, we would like to consider the enormous importance of two trivially simple physical factors about print. First, print increases the availability of the communication partner with a novel idea and so facilitates diffusion; that is, even when there is only one individual with a novel idea who can communicate with others, if that individual happens to be an author, the same idea can appear in multiple books. This multiplicity increases the chance that new

information will diffuse, but only if the book is written in such a fashion that some of the knowledge in it is already known to members of the society. Diffusing new ideas depends on the audience and reader sharing a good deal of knowledge. Thus, mechanisms of print foster, and are in turn fostered by, the norms of diffusing new ideas and social stability. Second, books, unlike people, cannot learn. Thus, the chance of learning the novel idea from a book remains constant; however, the chance of learning it from another individual decreases as that individual inevitably learns more information over time. The result is that in an oral society many communications become ritualized, and the ability of new ideas to diffuse is decreased. On the other hand, in a print society, such ritual time (insofar as it is spent seeking new ideas) can diminish because print eases the search for new information.

Our work has tried to reveal the lofty potential of print by means of the trivial mechanics through which it altered face-to-face communication. It remains for future historians and social scientists to tell us whether and how print has fulfilled this potential across time and place.

ANNOTATED BIBLIOGRAPHY

Abbott, A. 1988. *The system of professions: An essay on the division of expert labor.* Chicago: University of Chicago Press.

This volume overviews the major sociological theories on the professions. Abbott's thesis is that professions must be understood as groups that compete with others for the control of work. Unlike previous sociologists who seek essentialist definitions of professions, Abbott argues that professions must be understood historically. For a theory of print, Abbott's book is important because it documents the rise of professions at the end of the nineteenth century, when mechanical print allows groups to form across large geographical differences.

Alexander, J. C., *et al.* 1987. *The micro-macro link.* Berkeley: University of California Press.

This volume anthologizes the thinking of theoretical sociologists seeking to link micro-actions and macro-structures. Few of these articles relate this link with public communication, much less print. But the articles provide a framework for thinking through the many complexities in tracing the relationship between local actions and the larger cultural environment.

Carley, K. 1991. A theory of group stability. *American Sociological Review*. 5–6.331–354.

> This paper introduces the major assumptions and methods underlying constructural theory. It shows how Turner's 1988 synthesis of social interaction theory can be consolidated into a single dynamic theory and model.

Kaufer, D. and K. Carley. 1993. *Communication at a distance: The influence of print on sociocultural-cultural organization and change*. Hillsdale, NJ: Lawrence Erlbaum.

> Turner's model and Carley's original formulation of constructural theory took into account only face-to-face interaction. It made none of the assumptions needed to accommodate print interaction or communication at a distance. This volume fills in that gap by extending constructural theory to accommodate the assumptions required for print. Many of the ideas in the present article are elaborated at length in this volume.

Ong, W. 1958. *Ramus: Method, and the decay of dialogue: From the art of discourse to the art of reason*. Cambridge, MA: Harvard University Press.

> This book traces the rise of print to the decline of oral/aural sensibilities and to a new logic of the spatial/visual. The book is a tour de force of the historical imagination. However it is a prime example of reading an untestable metaphysics into the cultural analysis of a technology.

UNANNOTATED BIBLIOGRAPHY

Bazerman, C. and J. Paradis (eds.) 1991. *Texts and the professions*. Madison, WI: University of Wisconsin Press.

Beniger, J. R. 1986. *The control revolution: Technological and economic origins of the information society*. Cambridge MA: Harvard University Press.

Bledstein, B. 1976. *The culture of professionalism*. New York: Norton.

Bolter, J. 1991. *Writing space: The computer, hypertext, and the history of writing*. Hillsdale, NJ: Lawrence Erlbaum.

Brandt, D. 1990. *Literacy as involvement: The acts of writers, readers, and texts*. Carbondale, IL: Southern Illinois University Press.

Carley, K. 1990. Group stability: A sociocultural-cognitive approach. In E. Lawler, B. Markovsky, C. Ridgeway and H. Walker (eds.) *Advances in group processes*. Greenwich CT: JAI. 1–44.

Cronin, B. 1984. *The citation process*. London: Taylor Graham.

Eisenstein, E. 1979. *The printing press as an agent of change: Communication and cultural transformations in early modern Europe*. Cambridge: Cambridge University Press. [2 Volumes.]

Geisler, C. 1994. *The nature of expertise in academic writing*. Hillsdale, NJ: Lawrence Erlbaum.

Kaufer, D. and K. Carley. 1994. Some concepts and axioms about communication: Proximate and at a distance. *Written Communication*. 11.8–42.

_____ and C. Geisler. 1989. Novelty in academic writing. *Written Communication*. 8.286–311.

Kraut, R., C. Egido and J. Galegher. 1990. Patterns of contact and communication in scientific research collaboration. In J. Galegher, R. Kraut and C. Egido (eds.) *Intellectual teamwork: Social and technological foundations of cooperative work*. Hillsdale, NJ: Lawrence Erlbaum. 149–172.

Lyons, H. 1968. *The royal society 1660–1940: A history of its administration under its charters*. New York: Greenwood.

MacRoberts, M. H. and B. R. MacRoberts. 1986. Quantitative measures of communication in science: A study of the formal level. *Social Studies of Science*. 16.151–172.

Meadows, A. 1978. *Communication in science*. London: Butterworths.

Mulkay, M. 1973. *The social process of innovation*. London: Macmillan.

Nystrand, M. 1989. A social-interactive model of writing. *Written Communication*. 6.66–85.

Powell, W. and P. Dimaggio. 1991. *The new institutionalism in organizational analysis*. Chicago: University of Chicago Press.

Roediger, H. L. 1987. The role of journal editors in the scientific process. In D. N. Jackson and J. P. Rushton (eds.) *Scientific excellence: Origins and assessment*. Beverly Hills, CA: Sage. 227.

Rogers, E. M. 1982. *Diffusion of innovations*. New York: Free Press.

Simonton, D. 1988. *Scientific genius: A psychology of science*. New York: Cambridge University Press.

Small, H. G. 1978. Cited documents as concept symbols. *Social Studies of Science*. 8.327–340.

Turner, J. H. 1988. *A theory of social interaction*. Palo Alto, CA: Stanford University Press.