# Diffusion of Innovations

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## INTRODUCTION

*Diffusion* is the process through which an innovation (an idea, product, technology, process, or service) spreads (more or less rapidly, in more or less the same form) through mass and digital media, and interpersonal and network communication, over time, through a social system, with a wide variety of consequences (positive and negative). Underlying the components of the diffusion process is the extent to which various actions, perceptions, communication processes and sources, social norms, and structures sufficiently reduce the potential adopter's *uncertainty* regarding the innovation. Diffusion of Innovations theory is probably the most cited, summarized, and applied communication theory. By 2003, there were already over 5,000 publications in this area, with about 250 new ones each year. A search for "diffusion of innovations" (obviously a very constrained search set) in November 2010 found 1,329 articles in the CSA Social Science databases with the phrase in abstracts and 8,053 if anywhere in the document, over 300,000 entries through a general Google search, and 43,700 citations in Google Scholar. The Web of (Social) Science found 1,428 citations (from all sources) to E. M. Rogers alone. With so many publications, no annotated bibliography can do justice to the topic. At the same time, this also means there are many comprehensive and useful general overviews and tutorials on the theory and research. The following sections provide annotated citations for a very small set of publications on the major components of the diffusion of innovations model.

## GENERAL OVERVIEWS

Several authors were beginning to integrate the disparate research on diffusion of innovations in the 1960s and 1970s. Brown 1981 reviewed three existing traditions. Of course, Rogers 2003 provides the most comprehensive explanation and review of the voluminous literature, while Rice 2009 condenses the main points into an integrated framework and indicates areas of extension. Greenhalgh 2005 summarizes research on health service innovations. Several edited books bring together state-of-the-art reviews. Fagerberg, et al. 2006 takes an interdisciplinary approach. Smith 2006 is a clear tutorial on the concept and process of innovation. Poole and Van de Ven 2004 places attention on the relationship of innovation to more general organizational process theories. Tushman and Anderson 1997 emphasizes the management approach, within historical contexts.

**Brown, Lawrence A. 1981. *Innovation diffusion: A new perspective*. New York: Methuen.**

Brown identifies three traditions of innovation diffusion: cultural geography/anthropology, Hagerstrand's mathematical modeling of spatial and

interpersonal contacts, and market/infrastructure (emphasizing the supply, availability, and distributing and marketing of innovations). He emphasizes the supply side, distinguishes consumer from firm/technology innovations, includes the product life cycle, and brings attention to innovation consequences.

**Fagerberg, Jan, David C. Mowery, and Richard R. Nelson, eds. 2006. *The Oxford handbook of innovation*. Oxford: Oxford Univ. Press.**

[DOI: 10.1093/oxfordhb/9780199286805.001.0001]

The twenty-one chapters include a broad interdisciplinary range of approaches to understanding innovation. The four sections cover creation of innovations (especially by firms and networks); contextual, institutional, and organizational influences on innovation; variations in innovation across economic sectors and time; and consequences of innovation (focusing on economic and competitive aspects).

**Greenhalgh, Trisha. 2005. *Diffusion of innovations in health service organisations: A systematic literature review*. Malden, MA: Blackwell.**

[DOI: 10.1002/9780470987407]

The first half of this book reviews the components and concepts of diffusion of innovations theory. Then it systematically reviews, using both individual studies and meta-analyses, specific innovations in health service practice and organization, highlighting implications for dissemination and implementation. The analyses use mixed methods.

**Poole, Marshall Scott, and Andrew H. Van de Ven, eds. 2004. *Handbook of organizational change and innovation*. Oxford: Oxford Univ. Press.**

The primary focus of the thirteen chapters in this edited book is on concepts and methods for developing and evaluating organizational process theories, integrating both levels of analysis (from the individual to the nation) and time (change and process).

**Rice, Ronald E. 2009. Diffusion of innovations: Theoretical extensions. In *SAGE handbook of media effects*. Edited by Robin L. Nabi and Mary Beth Oliver, 489–503. Thousand Oaks, CA: SAGE.**

This chapter proposes an integrated model of central components of the diffusion of innovations perspective, and reviews multidisciplinary literature across those components: overview and history, communication, social systems, innovation development, potential adopters, initiation and implementation, innovation characteristics, adopter categories, forms of adoption, diffusion over time, consequences, and critiques.

**Rogers, Everett M. 2003. *Diffusion of innovations*. 5th ed. New York: Free Press.**

The best source for understanding Diffusion of Innovations theory and research. The chapters cover elements of diffusion, history, contributions and critiques, generating innovations, innovation-decision process, innovation attributes, adopter categories, diffusion networks, change agents (individuals and agencies), organizational innovation, and consequences. Includes many case examples and research results.

**Smith, David. 2006. *Exploring innovation*. London: McGraw-Hill.**

An overview of innovation: nature (types, the nature of technological change), activities (innovation theories, innovation sources, intellectual property), managing (technology strategy, entrepreneurs, funding, organizing for innovation), and fostering (innovation policy, innovation clusters, and national innovation systems). This is designed particularly for undergraduate management and business programs, with a British emphasis.

**Tushman, Michael, and Philip Anderson, eds. 1997. *Managing strategic innovation and change: A collection of readings*. 2d ed. New York: Oxford Univ. Press.**

The forty-two chapters discuss the evolution of technologies within historical contexts, and how that generates organizational change and adaptation. Sections include overview, technology cycles, discontinuous innovations, dominant designs, incremental change, organizational architectures/change culture, temporal and historical perspectives, innovation and strategy, learning/intellectual capital, internal and cross-organizational linkages, and leadership/managing innovation.

## JOURNALS

Because of the vast domain of innovation and diffusion studies, many social science journals will include articles in this area. The following journals focus more specifically on aspects of innovation and diffusion. Creativity and Innovation Management provides multidisciplinary coverage of most aspects, especially organizational issues. Implementation Science specializes in the implementation stage. Information, Communication & Society is a general journal, but does include studies on adoption of new media. International Journal of Technology Diffusion covers all the diffusion stages of management information systems. Though not a journal, the Estabrooks, et al. 2004 resource guide provides extensive resources, including journals, to the field of knowledge utilization. New Directions for Evaluation is not primarily a diffusion journal, but is relevant because of its focus on assessing changes and interventions. New Media & Society takes multiple disciplinary and paradigmatic perspectives in its articles on new media adoption, use, and consequences. Science Communication is the new name of the long-lived and influential journal *Knowledge*, discussing the diffusion of science information.

**Creativity and Innovation Management.**

Taking a management perspective, this journal publishes research on all the stages from fostering creativity through to implementation and business development, discussing both technical development as well as human resources management, at the organization, community,

market, and global levels.

**Estabrooks, Carole, Rejean Landry, Harley Dickinson, and Karen Golden-Biddle. 2004. Knowledge utilization resource guide. Edmonton, Canada: Univ. of Alberta.**

This report provides a comprehensive resource for publications and sites on knowledge utilization, including a general overview, nursing and health sciences, social sciences and humanities, organization studies, and policy studies. Materials in each section include books/monographs, reports, articles, journals, primary researchers, centers and funding agencies, keywords, bibliographic databases, and glossaries. Also see the journal Science Communication: Linking Theory and Practice.

**Implementation Science.**

Relevant to the implementation stage of the organizational diffusion process, this high-impact, online, open-access, peer-reviewed, interdisciplinary journal emphasizes the transfer of biomedical research results into health care in both clinical and policy contexts, with attention to evaluation, effectiveness, and interventions. It also provides debate/discussion articles about innovative approaches.

**Information, Communication & Society.**

The eight issues per year of this global interdisciplinary journal consider the social, economic and cultural implications of new media. This journal would be particularly relevant for the diffusion topics of development and consequences associated with communication and information technologies (such as globalization and digital divide).

**International Journal of Technology Diffusion.**

This new international journal from the Information Resources Management Association includes research on all domains of innovation development, adoption, diffusion, and knowledge transfer of management information systems and applications in e-commerce, e-government and mobile applications. It covers technical development (from standards through supply chains) to social aspects (from privacy through work careers).

**Mathison, Sandra, ed. 2009. Special Issue: Knowledge utilization, diffusion, implementation, transfer, and translation: Implications for evaluation. *New Directions for Evaluation* (Winter) 124:3-100.**

The articles discuss the utility and validity of diffusion of innovations theory in evaluating interventions in general, by articulating the multiple components of the diffusion, adoption, and outcomes process.

**New Media & Society.**

One of the frequent topics discussed and analyzed in this journal is the adoption, diffusion, use, and consequences of new media, a particular set of innovations. The journal has eight issues per year, has a high impact factor, and is explicitly interdisciplinary and diverse in both topic and method.

**Science Communication: Linking Theory and Practice.**

Formerly *Knowledge: Creation, Diffusion, Utilization*, this well-established interdisciplinary journal covers the diffusion of expert knowledge related to communication within research communities, communication of scientific and technical information to the public, and science and technology communications policy. "Science" here includes social science, engineering, medical knowledge, and physical/natural sciences.

## COMMUNICATION IN THE DIFFUSION PROCESS

Central to the diffusion of innovations process, and what makes this theory and associated research especially relevant to communication studies, is that information about the innovation must spread through one or more channels in order for adoption to occur. Further, this information may be positive or negative, and more or less accurate, timely, and appropriate. Different channels may be more effective at different stages in the process, and for different subgroups. Mass media have typically been the primary channel for diffusion, and several mass media effects theories are related to diffusion theory. Local media may be more effective in some physical and cultural settings. Of course, new media (online, digital, social) provide new ways and approaches for sharing information about innovations (in particular, interactivity, connectivity, and user-generated content), and are themselves innovations being diffused. Many ideas (such as rumors and gossip) not only spread quickly through interpersonal channels and social networks, but also are more likely to be persuasive and engaging in those forms.

### Mass and Local Media

Awareness, knowledge, attitudes, modeling, and outcomes of innovations spread through mass and digital media, and interpersonal communication. Some mass media effect theories can be seen as diffusion models, such as agenda-setting (McCombs and Shaw 1972), and bandwagon and underdog effects of media coverage of opinion polls on voting, news propagation (DeFleur 1987), uses, and gratifications (Lin 2002). *Local and community media* often play different roles than mass media (Lin and Burt 1975). *Community organizations* may be also conceptualized as media channels (Stephens, et al. 2004). *Communication campaigns* can be located in the diffusion of innovations tradition, as they aim to change knowledge, attitudes, and behavior through the diffusion of information through mass, digital and interpersonal communication (Rice and Atkin 2001; See also the article Communication Campaigns).

**DeFleur, Melvin L. 1987. The growth and decline of research on the diffusion of news 1945-1985. *Communication Research* 14:109-130.**

[DOI: 10.1177/009365087014001006]

Defleur reviews the research on the two-step diffusion of news, which is first presented through the media and then via word-of-mouth. The review identifies six broad generalizations but does not find much underlying theory. Raises the question of how this important phenomenon has not generated much research in recent years.

**Lin, Carolyn A. 2002. Perceived gratifications of online media service use among potential users. *Telematics and Informatics* 19.1: 3–19.**

[DOI: 10.1016/S0736-5853(01)00014-4]

As with many other media, perceived gratifications strongly explained online media service use, indicating this service is a functional supplement to traditional media. Unlike other studies, however, prior adoption/use of a related communication technology cluster was not associated with potential online service adoption.

**Lin, Nan, and Robert S. Burt. 1975. Differential effects of information channels in the process of innovation diffusion. *Social Forces* 54.1: 256–274.**

[DOI: 10.2307/2576092]

This study first critiques the limited range of what are conceptualized as communication channels in the diffusion process. The authors add the category of local media and find that in underdeveloped areas, the use of *local media* had different influences on participation in adoption than do interpersonal or mass media.

**McCombs, Maxwell E., and Donald L. Shaw. 1972. The agenda-setting function of the mass media. *Public Opinion Quarterly* 36.2: 176–187.**

[DOI: 10.1086/267990]

Agenda-setting research analyzes how policy and other social issues become part of the mass media agenda through frequent and highlighted coverage, which in turn may raise these issues higher on the public's agenda, and how both of those agendas reflect actual occurrences or magnitude of the topic.

**Myers, Daniel J. 2000. The diffusion of collective violence: Infectiousness, susceptibility, and mass media networks. *American Journal of Sociology* 106.1: 173–208.**

[DOI: 10.1086/303110]

Networks related to mass media distribution provide the pathway along which riots, collective violence, and protest waves diffuse. Riots are a

series of interdependent events, which diffuse in different patterns depending on the contexts and characteristics of the riot and the location where it occurs.

**Rice, Ronald E., and Charles K. Atkin. 2001. *Public communication campaigns*. 4th ed. Thousand Oaks, CA: SAGE.**

A major area of media effects research is the study and implementation of programs intended to change knowledge, attitude, and behavior, at both the individual and social levels, through well-designed and evaluated communication-based interventions, or communication campaigns. See also the OBO article "Communication Campaigns."

**Stephens, Keri, Rajiv N. Rimal, and June Flora. 2004. Extending the reach of health campaigns: Community organizations as meta-channels for the dissemination of health information. *Journal of Health Communication: International Perspectives* 9.6: 97–111.**

Using data from the Stanford 5-community project, the authors show that membership in community organizations was positively associated with the diffusion of health knowledge among community members. The authors therefore argue that such organizations may therefore be considered media channels in the diffusion process.

**Wirth, Werner, Thilo von Pape, and Veronica Karnowski. 2007. An integrative model of mobile phone appropriation. Paper presented at the 57th Annual ICA Conference, 24–28 May, 2007, San Francisco.**

*Metacommunication* is the general role of media and interpersonal communication in influencing the diffusion of innovations, through influencing *functional* (uses and gratifications), *symbolic* (social, psychological), *normative* (object, symbolic, pragmatic), and *restriction* evaluations (financial, technical, temporal, cognitive), and thus the agenda, language, and pathways of innovations.

### Digital/Online Media

Digital media (e-mail, Internet, mobile phones, social media, etc.) can overcome many traditional communication barriers, while offering message tailoring, interaction, searching, and sharing of knowledge among unknown others. Online media may increase the diffusion of rumors and gossip but also offer venues for correction and refutation (Bordia and DiFonzo 2004). Online social media are transforming the pace and reach of information and persuasive norms (Boyd and Ellison 2008). Much research concentrates on influences on adoption and use of new media (see the journal New Media & Society [cited under Journals] and Rice and Webster 2002).

**Bordia, Prashant, and Nicholas DiFonzo. 2004. Problem solving in social interactions on the Internet: Rumor as social cognition. *Social Psychology Quarterly* 67.1:33–49.**

[DOI: 10.1177/019027250406700105]

The authors' analysis (coding based on both content and statistical patterns) of online message board discussions about rumors shows that nearly a third were attempts at collective problem solving, which in turn constrained the focus of subsequent messages. These rumor discussions followed four stages: introduction, offerings, discussion, and resolution/loss of interest.

**Boyd, Danah M., and Nicole B. Ellison. 2008. Social network sites: Definition, history, and scholarship. *Journal of Computer-Mediated Communication* 13:210–230.**

[DOI: 10.1111/j.1083-6101.2007.00393.x]

This review describes the history, features, and cultures associated with social network sites. It summarizes research about their role in maintaining existing relations, developing new relations through common interests, and fostering diverse or homogenous member participants. This is an introduction to a special issue of JCMC on social network sites.

**Rice, Ronald E., and Jane Webster. 2002. Adoption, diffusion and use of new media in organizational settings. In *Communication technology and society: Audience adoption and uses*. Edited by Carolyn A. Lin and David J. Atkin, 191–227. Cresskill, NJ: Hampton.**

Research on adoption, diffusion, implementation and use of organizational media (here, e-mail) from multiple disciplines identifies many significant influences: individual demographic and personality factors, task characteristics, contexts (such as other users, situational constraints), technical (including access) and subjective characteristics of the medium, social influences, organizational factors, and environmental influences (industry, standards).

### Interpersonal Communication and Social Networks

One of the roles of interpersonal communication in the diffusion process is reducing uncertainty about an innovation, as potential adopters turn to similar, trusted, or close (*homophilous*) others. The study of *rumors* (Allport and Postman 1975, DiFonzo 2008) looks at how the information may be distorted over time. Especially influential are *opinion leaders* (Coleman, et al. 1966, cited under Networks; Valente and Pumpuang 2007), change agents, and *technology champions* (Howell and Higgins 1990). Social networks—ranging from physical to communication to formal position and network thresholds—affect the pattern and speed of diffusion (Christakis 2010, Gladwell 2000, Rice 1993, Valente 1995, Valente and Pumpuang2007.

**Allport, Gordon W., and Leo Joseph Postman. 1975. *The psychology of rumor*. New York: Russell & Russell.**

One of the classic treatments of rumor, this book analyzes how rumors are shaped over time, to become shorter, progressively less detailed, differentially contextualized, filtered and highlighted, and shaped and distorted into one's expectations and projections—what the authors call leveling, sharpening, and assimilation. Originally published in 1947 (New York: Holt, Rinehart & Winston).

**Christakis, Nicholas. 2010. The hidden influence of social networks.**

Various traits (obesity, smoking, drinking, voting, altruism, happiness) can spread from person to person, directly and indirectly, based on one's location in various social networks. Possible explanations include contagion, homophily, common third context, reinforced norms, genetics, super organisms. Includes a thirty-second movie of the obesity network over time.

**DiFonzo, Nicholas. 2008. Selected scholarly books and articles on rumor.**

This website lists a wide range of articles, encyclopedia entries, book chapters, and books on rumor, gossip, memes, rumor control, commercial hearsay, behavioral finance, medical gossip, rumor and race, diffusion of news about crises, social cognition, denials and rebuttals, online rumor chains, and psychological and social influences on rumor transmission.

**Gladwell, Malcolm. 2000. *The tipping point: How little things can make a big difference*. New York: Little, Brown.**

The "tipping" point is when contagion becomes an "epidemic," generally fostered by extraordinary efforts of communicators. Crucial social roles include connectors (cosmopolites, large and diverse networks), mavens (information specialists who want to share their insights), salespeople (persuasive, through skills, nonverbal clues), and senders (good at expressing emotions, generating involvement).

**Howell, Jane M., and Christopher A. Higgins. 1990. Champions of technological innovation. *Administrative Science Quarterly* 35:317–341.**

[DOI: 10.2307/2393393]

Another adoption social influence is the *technology champion*. This study compares twenty-five pairs of technology champions and non-champions. Through idea ownership, activation of informal networks, articulation of the innovation's organizational potential, and risk to one's prestige, technology champions lead the effort in overcoming resistance and indifference to major innovation.

**Rice, Ronald E. 1993. Using network concepts to clarify sources and mechanisms of social influence. In *Progress in communication sciences: Advances in communication network analysis*. Edited by W. Richards Jr. and G. Barnett, 43–62. Norwood, NJ: Ablex.**

The influence of others' knowledge, attitudes, or behaviors on an individual depends on the frequency of communication with each other, the other's persuasiveness, the closeness and relative position (network or physical), and the number of others sharing the opinion, with different processes at the individual, group, and organizational levels.

**Valente, Thomas W. 1995. *Network models of the diffusion of innovations*. Cresskill, NJ: Hampton.**

Valente applies the network perspective (concepts, data, and methods) to understanding different innovation diffusion processes, and what

factors influence both the pattern and speed of that diffusion, at the individual and social system levels. He applies threshold and critical mass models, and discusses applications to communication campaigns and media effects.

**Valente, Thomas W., and Patchareeya Pumpuang. 2007. Identifying opinion leaders to promote behavior change. *Health Education & Behavior* 34.6: 881–896.**

[DOI: 10.1177/1090198106297855]

The authors categorize nearly two hundred studies that have focused on or used opinion leaders to promote behavior change into ten different techniques for identifying opinion leaders. They present the advantages and disadvantages of the ten methods for identifying opinion leaders and provide sample instruments for each.

## ROLE OF SOCIAL SYSTEM(S) IN THE DIFFUSION PROCESS

Increasingly, diffusion research and theory explores how the wider social system shapes, constrains, or facilitates innovations. MacKenzie and Wajcman 1999 specifically explicates the Social Shaping of Technology perspective. Aikat 2001 and Edgerton 2007 show how prior concepts and technologies provide the basis for what traditionally appear to be independent innovations. Fidler 1997 and Streeter 1996 apply this general approach specifically to the overlapping rise and adaptation of media. Garud, et al. 1997 provides many case analyses of how these factors both suppress, and foster, innovations. Regional clusters, with supporting infrastructure and policies, affect innovation and diffusion (Breschi and Malerba 2007).

**Aikat, Debashis. 2001. Pioneers of the early digital era: Innovative ideas that shaped computing in 1833–1945. *Convergence: Journal of Research into New Media Technologies* 7.4: 52–81.**

[DOI: 10.1177/135485650100700404]

This analysis of innovative concepts in the development and spread of computing covers Babbage, Boole, Hollerith, Turing, and Bush and applies actor-network theory and diffusion of innovations theory to show the main contextual influences on innovations (the era's needs, print and other media, and adaptive and evolutionary processes).

**Breschi, Stefano, and Franco Malerba, eds. 2007. *Clusters, networks, and innovation*. New York: Oxford Univ. Press.**

The focus of these sixteen chapters is on regional clusters (districts, high-tech regions) of competitiveness and innovation, and how network structures, industrial, geographical, and social contexts, entrepreneurial activities, and governmental policies can encourage or dampen the development of innovations.

**Edgerton, David. 2007. *The shock of the old: Technology and global history since 1900*. New York: Oxford Univ. Press.**

This book argues that familiar conceptualizations of technological invention oversimplify both their sources and life cycles, focusing on well-known and sophisticated technologies while ignoring older and more mundane technologies (such as the rickshaw, ballpoint pen, and refrigerator) that are shaped through ordinary use and continue to shape the modern world.

**Fidler, Roger. 1997. *Mediamorphosis: Understanding new media*. Thousand Oaks, CA: Pine Forge.**

The mediamorphosis approach emphasizes that the form and rate of media diffusion are pervasively affected by many forces. These include, for example: competition between media; new opportunities and needs fostered by other innovations; regulation and technical standards; and economic factors, such as microprocessor chip costs, depression, and globalization.

**Garud, Ragu, Praveen Rattan Nayyar, and Zur Shapira, eds. 1997. *Technological innovation: Oversights and foresights*. Cambridge, UK: Cambridge Univ. Press.**

The probabilities of matching a company's internal capabilities to the external environment necessary for successful innovation are low. So, the eighteen chapters here discuss ways to improve these odds, by explaining technological, economic, and institutional factors underlying both oversights and foresights, using both familiar and novel cases.

**MacKenzie, Donald A., and Judy Wajcman, eds. 1999. *The social shaping of technology*. 2d ed. McGraw Hill Education.**

The Social Shaping of Technology perspective prioritizes the social contexts of the development, use, and consequences of technology. Using examples grouped into production, domestic/reproductive, and military technology, the thirty chapters underscore how workplace relations, male-dominated social science, and underlying assumptions of the military shape the form and meaning of innovations.

**Streeter, Thomas. 1996. *Selling the air: A critique of the policy of commercial broadcasting in the United States*. Chicago: Univ. of Chicago Press.**

Streeter explains how social, technical, economic, and regulatory forces shaped the development and diffusion of commercial broadcasting. He discusses cultural values, corporate liberalism, laws and policies, the role of Washington, DC, lobbyists and consultants, the commoditization of the audience, giving and selling broadcast frequencies, and copyright in the digital age.

## INNOVATION DEVELOPMENT PROCESS

During the *innovation development process*, actors from individual entrepreneurs and collaborative users through governmental agencies and

corporations attempt to identify needs and/or problems, conduct research on the ways to solve those problems, develop the innovation, and commercialize or otherwise promote it (Andriessen 1994, Larsen and McGuire 1998). Similar to aspects of the social system (see Role of Social System(s) in the Diffusion Process), many factors play a role here, including tensions between order and uncertainty (Lievrouw 2006). Partially because of the complexity and unpredictability of the social systems and innovation development processes, forecasting the shape and success of innovations is fraught with peril (Klopfenstein 1989). Also, innovations can come from non-traditional sources, such as user-producers and lead users (Leadbeater 2005, Von Hippel 1995). A particular challenge is transferring technological innovations from the developers to the market (RAND Institute 2002, Williams and Gibson 1990).

**Andriessen, J. H. Erik. 1994. Conditions for successful adoption and implementation of telematics in user organizations. In *Telematics and work*. Edited by J. H. Erik Andriessen and Robert A. Roe, 409–439. Hillsdale, NJ: Lawrence Erlbaum.**

This review, and the resulting integrative model, are organized around *creation in the industry* (research and development), *transfer to the organization* (diffusion often requiring adoption, by a cluster of organizations, then adoption within a particular organization), and *introduction into the organization* (design/implementation and incorporation, within different contexts).

**Klopfenstein, Bruce C. 1989. Problems and potential of forecasting the adoption of new media. In *Media use in the Information Age: Emerging patterns of adoption and consumer use*. Edited by Jerry Salvaggio and Jennings Bryant, 21–41. Hillsdale, NJ: Lawrence Erlbaum.**

Although technological forecasting is an important tool of innovation development as well as for modeling diffusion, it is also a good source of data for insight into why particular media, and even of forecasting itself, may fail.

**Larsen, Tor Jermund, and Eugene McGuire, eds. 1998. *Information systems innovation and diffusion: Issues and directions*. Hershey, PA: Idea Group.**

International authors provide eighteen chapters on the innovative development and diffusion of information systems. Topics include influences on the innovation and diffusion process, the diffusion of software application packages, facilitating technology diffusion, and conceptualizing innovation and diffusion processes. Chapters offer implications for research on information systems innovation and organizational change.

**Leadbeater, Charles. 2005. Pro-am innovators.**

This presentation discusses the rise of professional-amateur innovators and the ability of new collaborative forms (especially online and open source) to allow people to contribute and participate how they can, often resulting in greater insight and creativity than formal organizations can manage. The full transcript is available on the same page.

**Lievrouw, Leah. A. 2006. New media design and development: Diffusion of innovations v. social shaping of technology. In *Handbook of new media: Social shaping and social consequences of ICTs*. Updated student ed. Edited by Leah A. Lievrouw and Sonia M. Livingstone, 246–265. London: SAGE.**

Lievrouw compares and contrasts diffusion of innovations and social shaping theories, using e-mail and videotex as two case studies. Both the development and use of new media are embedded in an iterative, dynamic, and interdependent tension between order (determination) and uncertainty (contingency), because knowledge, science and technology are essentially social.

**RAND Institute. 2002. Technology transfer forum bibliography. Santa Monica, CA: RAND Institute.**

A comprehensive alphabetical bibliography of a wide range of discussions, research, theory, policies, case studies, and reports about technology transfer.

**Von Hippel, Eric. 1995. *The sources of innovation.* New York: Oxford Univ. Press.**

Innovations develop from different sources in different industries ranging from end users who find new uses or needs for services or products, and may even develop the modified or new products and processers, to suppliers. *Lead users* contribute to product concept and design and foreshadow needs of the general marketplace.

**Williams, Frederick, and David V. Gibson, eds. 1990. *Technology transfer: A communication perspective*. Newbury Park, CA: SAGE.**

The chapters apply interpersonal, group, organizational, and media perspectives on explaining the processes (and obstacles) of transferring technology innovations in one domain (such as universities) to another (such as industries). Topics range from overviews of technology transfer and intraorganizational environments to cases in the United States, Mexico, India, Italy, and Japan.

## POTENTIAL ADOPTERS

The characteristics of and influences on potential adopters affect their adoption perceptions and behaviors. Roehrich 2004 analyzes measures of innovativeness. Andriessen 1994, Rogers 2003 (cited under General Overviews), and Van den Hooff, et al. 2005 review individual traits associated with greater innovativeness. Agarwal and Prasad 1998 considers the moderating role of innovativeness. Organizational characteristics also influence innovation adoption, such as size, formality, complexity, centralization, vertical integration, and slack resources, as well as managerial characteristics and organizational culture (Schein 1994). Powell and Dimaggio 1991 introduced the concept of organizational isomorphism, while Zahra and George 2002 reviewed the concept of absorptive capacity.

**Agarwal, Ritu, and Jayesh Prasad. 1998. The antecedents and consequences of user perceptions in information technology**

**adoption. *Decision Support Systems* 22:15–29.**

[DOI: 10.1016/S0167-9236(97)00006-7]

This study tests the moderating influence of personal innovativeness on the relationship between perceptions of an innovation and adoption decisions, as opposed to the traditional direct effect on adoption. It also tests the influence of mass media and interpersonal communication channels on the development of those perceptions.

**Andriessen, J. H. Erik. 1994. Conditions for successful adoption and implementation of telematics in user organizations. In *Telematics and work*. Edited by J. H. Erik Andriessen and Robert A. Roe, 411–439. Hillsdale, NJ: Lawrence Erlbaum.**

Adoption may be influenced by a wide range of individual factors such as media use, technology ownership/experience/expertise, demographics, personality, obstacles to innovation, needs and expected gratifications, task characteristics, contexts (other users, situational constraints), technical, social influences (peers, status), communication competence, mental models, and user attitudes (expected benefits, costs).

**Powell, Walter W., and Paul J. Dimaggio. 1991. *The new institutionalism in organizational analysis.* Chicago: Univ. of Chicago.**

Institutional theory proposes that organizations adopt innovations for both formal and actual reasons: while early adopters may do so for instrumental/efficiency, later adopters do so to be seen as similar, or isomorphic, with industry leaders, as imitation and legitimacy. This behavior is called *isomorphism* or organizational mimicry.

**Roehrich, Gilles. 2004. Consumer innovativeness: Concepts and measurements. *Journal of Business Research* 57.6: 671–677.**

[DOI: 10.1016/S0148-2963(02)00311-9]

This article reviews and evaluates a variety of theoretical definitions and measurement operationalizations of the concept of consumer innovativeness. It assesses the validity and compatibility of the conceptualizations, and the extent to which each of the measures correspond to their theoretical foundations.

**Schein, Edgar H. 1994. Innovative cultures and organizations. In *Information technology and the corporation of the 1990s: Research studies*. Edited by Thomas John Allen and Michael S. Scott Morton, 125–146. New York: Oxford Univ. Press.**

An innovative culture is necessary for achieving the potential of organizational content or role/process innovations. Schein discusses seven characteristics of such cultures (manage environments, proactive human activity, pragmatism, medium-length time horizons, positive assumptions about people, diversity and participation, and diverse but connected subcultures) and interactions among these and information technology characteristics.

**Van den Hooff, Bart, Jasper Groot, and Sander de Jonge. 2005. Situational influences on the use of communication technologies: A meta-analysis and exploratory study. *Journal of Business Communication* 42.1: 4–27.**

[DOI: 10.1177/0021943604271192]

This thematic meta-analysis of e-mail studies assesses the influence of several categories of variables (user, task, social environment, medium, mediating role of perceptions of the innovation) on adoption from three theoretical approaches (contingency, subjectivist, situational) with several theories each, then designs and tests a model integrating these factors.

**Zahra, Shaker A., and Gerard George. 2002. Absorptive capacity: A review, reconceptualization, and extension. *Academy of Management Review* 27.2: 185–203.**

Absorptive capacity is the cumulative (individual, group, firm, nation) ability to acquire and understand the value of new information, assimilate/integrate or transform it, and apply it. Influences include prior relevant knowledge (content and relations), organizational routines and processes, communication, and background diversity (allowing new insights and associations).

## INITIATION AND IMPLEMENTATION PROCESSES

Individuals and organizations must both go through several adoption phases, generally categorized as initiation and implementation processes. Afuah 2003 explains the process of managing innovation, from development through worldwide implementation. O'Callaghan 1998 and Rice and Webster 2002 provide comprehensive models of organizational technology innovation. And Van de Wijngaert, et al. 2008 compares the Diffusion of Innovations and the Technology Acceptance models, which Venkatesh, et al. 2003 reviews and extend.

**Afuah, Allan. 2003. *Innovation management: Strategies, implementation, and profits*. 2d ed. Oxford: Oxford Univ. Press.**

This book is concerned with the management of technology, related to the management strategy and profitability literature. Sections include: Fundamentals (models of innovation, companies more likely to innovate), Strategizing (financing, strategies for sustaining profits), Implementation (of the decision to adopt, human resources), and Globalization (the role of national governments).

**O'Callaghan, Ramon. 1998. Technology diffusion and organizational transformation: An integrative framework. In *Information systems innovation and diffusion: Issues and directions*. Edited by Tor J. Larsen and Eugene McGuire, 390–410. Hershey, PA: Idea Group.**

This comprehensive model of technology diffusion within and across organizations includes preexisting organizational and environmental context, technology assessment, planning and adoption decision, usage or internal diffusion, and organizational changes. It also emphasizes the often extremely time-consuming, risky, and unsuccessful technology implementation process.

**Rice, Ronald. E., and J. Webster. 2002. Adoption, diffusion and use of new media in organizational settings. In *Communication technology and society*. Edited by Carolyn A. Lin and David J. Atkin, 191–227. Cresskill, NJ: Hampton.**

This reviews three perspectives in organizational adoption. *Diffusion of innovations* studies (innovation characteristics, role of communication channels); *media choice* studies, which focus on the interaction between individual characteristics and social influences; and *implementation* studies, which assume that the variables such as technology design or ease of use will affect media adoption.

**van de Wijngaert, Lidwien, Karianne Vermaas, and Harry Bouwman. 2008. Accumulating IS theories using a network approach towards meta-analysis. Paper presented at the European Conference on Information Systems (ECIS), Galway, 9–11 June 2008.**

This ingenious meta-analysis assesses the extent to which Technology Assessment Model (TAM) and Diffusion of Innovations (DOI) variables influence household information systems adoption. They create and test two networks based on significant relationships among the variables. TAM seems fairly self-reflexive, whereas DOI makes explicit distinctions between independent and dependent variables.Available online for a fee.

**Venkatesh, Viswanath, Michael G. Morris, Gordon B. Davis, and Fred D. Davis. 2003. User acceptance of information technology: Toward a unified view. *MIS Quarterly* 27.3: 425–478.**

The Technology Adoption Model initially emphasizes the psychological predispositions and perceptions of ease of use and usefulness of organizational information technologies, though it later incorporated social influences. The two main predictors are perceived usefulness, similar to relative advantage, and perceived ease of use, similar to complexity.

## INNOVATION CHARACTERISTICS

The likelihood and form of adoption are influenced by how potential adopters perceive the primary *innovation characteristics* of relative advantage, complexity, trialability, compatibility, and observability/communicability. Other central characteristics include *ease of use* and *usefulness* (Moore and Benbasat 1991), and *bridges of familiarity* (Fidler 1997). Other distinctions among innovation characteristics include *incremental* versus *radical/discontinuous*, *administrative* vs. *technological*, *process* versus *product*, and *content* versus *role/process* (Cooper 1998, Robertson 1971); *technology clusters* (LaRose and Atkin 1992); and *inherent* vs. *actualized* (Lin 1998). Springwise uses a collaborative approach to maintain a directory of innovations. Damanpour and Schneider 2009 tests for direct versus moderating influences of innovation characteristics.

**Cooper, Juett R. 1998. A multidimensional approach to the adoption of innovation. *Management Decision* 36.8: 493–502.**

[DOI: 10.1108/00251749810232565]

Cooper argues that diffusion may be different depending on where the innovation lies in a three-dimensional attribute space: incremental

versus radical innovation, administrative versus technological innovation, and process versus product innovation.

**Damanpour, Fariborz, and Marguerite Schneider. 2009. Characteristics of innovation and innovation adoption in public organizations: Assessing the role of managers. *Journal of Public Administration Research and Theory* 19.3: 495–522.**

[DOI: 10.1093/jopart/mun021]

Grounded in Damanpour's prior comprehensive reviews of organizational innovation and adoption, this study tests for the direct (supported) and moderating (not supported) influences of innovation characteristics and manager characteristics on the adoption of twenty-five innovations in 725 local US governments, supplemented by an expert panel.

**Fidler, Roger. 1997. *Mediamorphosis: Understanding new media*. Thousand Oaks, CA: Pine Forge.**

Another innovation characteristic, *bridges of familiarity,* includes links to the past (technological and social forms from prior media, though these then are elaborated, transformed, and replaced over time), and metaphors (messages and design elements provide ways of understanding and contextualizing new media characteristics through familiar metaphors, such as computer "desktops").

**LaRose, Robert, and David Atkin. 1992. Audiotext and the re-invention of the telephone as a mass medium. *Journalism Quarterly* 69:413–421.**

This study explicates the concept of *technology clusters*, or information technologies that are perceived as functionally similar to each other. If a new technology is perceived as belonging to a technology cluster from which people have already adopted, it is more likely to be adopted as well.

**Lin, Carolyn A. 1998. Exploring personal computer adoption dynamics. *Journal of Broadcasting & Electronic Media* 42:95–112.**

Innovativeness can be categorized parsimoniously into two types: *inherent* (tendencies or drives) and *actualized* (behaviors). Lin's study found that many typical adoption predictors (such as demographics, innovativeness, less TV viewing, other communication technology adoption) distinguished between non-adopters, likely adopters, and adopters.

**Moore, Gary C., and Izak Benbasat. 1991. Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information Systems Research* 2:192–222.**

[DOI: 10.1287/isre.2.3.192]

The authors develop and test a multidimensional scale of innovation characteristics of new information technologies, including relative advantage (similar to perceived usefulness), complexity (similar to ease of use), and compatibility. Their explanatory model also includes

personal innovativeness, exposure through mass media and interpersonal channels, and awareness.

**Robertson, Thomas S. 1971. *Innovative behavior and communication*. New York: Holt, Rinehart and Winston.**

Several authors were beginning to integrate the growing diffusion research in the 1970s. Robertson noted the relationship between media exposure, change agent contact, social influence, and early adoption, and also discussed innovation characteristics such as *incremental* versus *radical/discontinuous, administrative* versus *technological, process* versus *product*, and *content* versus *role/process.*

**Springwise.**

A rich resource for current innovations worldwide. Editors and more than eight thousand spotters identify emerging innovations and post brief descriptions and source site. Innovations can be searched by date, twenty categories (such as entertainment, lifestyle, media, telecom/mobile), title, related innovations, and popularity, and can be shared through social media.

## ADOPTER CATEGORIES

The location along the distribution of all adoption times by social system members is categorized into *innovators*, *early adopters*, *early majority*, *late majority*, and *laggards*. Another distinction central to some models is between *innovators* and *imitators*. Von Hippel 1995 introduced the category of *lead users*. Lin 1998 distinguished a *likely adopter* category between *nonadopter* and *adopter*. There may be a chasm between early and later adopters (Moore 2002). Later adopters differ from early adopters on perceptions of some of the innovation attributes (Viswanath and Goldhaber 2003). AtKisson 1991 provides a game involving a broad range of innovation roles.

**AtKisson, Alan. 1991. The innovation diffusion game. *In Context: A Quarterly of Humane Sustainable Culture* 28 (Spring): 58ff.**

An active re-creation of the messy process of attempting to diffuse an innovation, for groups of at least twenty-five. Participants play roles of innovator, change agent, transformer, mainstreamer, unwilling laggard, reactionary, iconoclast, spiritual recluse, and renunciate curmudgeon. Experiences in these roles used to assess the innovation and the process.

**Lin, Carolyn A. 1998. Exploring personal computer adoption dynamics. *Journal of Broadcasting & Electronic Media* 42:95–112.**

Applying diffusion theory to personal computers, Lin identifies barriers, prior media use, communication technology clusters, inherent and actualized innovativeness, innovation attributes, expected gratification, and social factors distinguishing among three categories of adopters: nonadopters, likely adopters, and adopters.

**Moore, Geoffrey A. 2002. *Crossing the chasm: Marketing and selling disruptive products to mainstream customers*. New York:**

**HarperBusiness Essentials.**

For discontinuous innovations, firms must *cross the chasm* from an early market dominated by a few *visionary* customers who are interested in sophisticated technology features or early adoption status, to a mainstream market dominated by *pragmatists* and *conservatives* who look for value, maintenance of ongoing practices, and ongoing vendor support.

**Vishwanath, Arun, and Gerald M. Goldhaber. 2003. An examination of the factors contributing to adoption decisions among late diffused technology products. *New Media Society* 5:547–572.**

[DOI: 10.1177/146144480354005]

This article uses perceived innovation attributes as mediators between typical influences on possible intention of adoption by mobile phone nonadopters in 2002. Compatibility and observability seem more salient for later adopters, as they attempt to reduce their uncertainty through its fit with current practices and how others use it.

**Von Hippel, Eric. 1995. *The sources of innovation.* New York: Oxford Univ. Press.**

Innovations develop from different sources in different industries ranging from end users who find new uses or needs for services or products, and may even develop the modified or new products and processers, to suppliers. *Lead users* contribute to product concept and design and foreshadow needs of the general marketplace.

## FORMS OF ADOPTION

Adoption may involve simple *one-time adoption*, *purchase*, *usage*, *acceptance*, *resistance, discontinuance, avoidance*, *reinvention/adaptation,* or *infusion.* Organizational adoption of a new medium may require usage but not gain acceptance (Hiltz and Johnson 1989), or may not achieve ongoing continuance (Bhattacherjee 2001). *Infusion* fosters greater organizational performance (Cooper and Zmud 1990). One form of adoption is *reinvention,* the adaptation of an innovation after adoption (Johnson and Rice 1987). Similar concepts include *adaptive/technology structuration* (Tyre and Orlikowski 1994, Poole and DeSanctis 1990), *domestication* (Silverstone and Haddon 1996), and *use innovativeness* (Girardi, et al. 2005).

**Bhattacherjee, Anol. 2001. Understanding information systems continuance: An expectation-confirmation model. *MIS Quarterly* 25.3: 351–370.**

[DOI: 10.2307/3250921]

Continuance is the ongoing use and integration of an innovation after adoption. This study reviews the concept and its measurement, and assesses factors fostering continuance, such as satisfaction with and usefulness of information systems (IS) use, and earlier confirmation of expectations based on prior IS use and usefulness.

**Cooper, Randolph B., and Robert W. Zmud. 1990. Information technology implementation research: A technological diffusion approach. *Management Science* 36.2: 123–139.**

[DOI: 10.1287/mnsc.36.2.123]

The *infusion* stage—where continued IT use increases organizational effectiveness at more integrated levels—is added to the end of the typical organizational adoption process. The infusion stage is likely influenced by political and learning factors, rather than the more traditional, rational aspects of the initial adoption decision.

**Girardi, Antonia, Geoffrey N. Soutar, and Steven Ward, 2005. The validation of a use innovativeness scale. *European Journal of Innovation Management* 8.4: 471–481.**

[DOI: 10.1108/14601060510627830]

Similar to the concept of reinvention is *use innovativeness*, or how existing, adopted products are used in novel and innovative ways. This article revises and tests an earlier measure, leading to a nine-item valid and unidimensional measure that is correlated with innovativeness, opinion leadership, and acceptance of new technology.

**Hiltz, Starr Roxanne, and Kenneth Johnson. 1989. Measuring acceptance of computer-mediated communication systems. *Journal of the American Society for Information Science* 40.6: 386–397.**

[DOI: 10.1002/(SICI)1097-4571(198911)40:6<386::AID-ASI2>3.0.CO;2-V]

Actual acceptance of computer-mediated communication systems, beyond initial adoption, includes three dimensions: use, subjective satisfaction (interface, productive performance, ability to support expressive communication, and problems as a mode of communication), and benefits (productivity impacts, career advancement impacts). Further, these three dimensions are only moderately interrelated.

**Johnson, Bonnie McDaniel, and Ronald E. Rice. 1987. *Managing organizational innovation: The evolution from word processing to office information systems*. New York: Columbia Univ. Press.**

Based upon a large field study, the book's topics include information work, innovation, implementation stages, levels of reinvention, principles of job design and sociotechnical systems, the design of word-processing jobs, reinvention and adaptation in word processing work, managing word-processing boundaries, and transforming word processing into office information systems.

**Poole, M. Scott, and Gerardine DeSanctis. 1990. Understanding the use of group decision support systems: The theory of adaptive structuration. In *Organizations and communication technology*. Edited by Janet Fulk and Charles William Steinfield, 173–193. Beverly Hills, CA: SAGE.**

This research program applies structuration theory to the case of adopting and using organizational technology. Group members use rules and resources in their interactions and appropriations of structure to adapt, within structural constraints, the nature of the innovation, which in turn affects later use and outcomes.

**Silverstone, Roger, and Leslie Haddon. 1996. Design and the domestication of information and communication technologies: Technical change and everyday life. In *Communication by design: The politics of information and communication technologies*. Edited by Robin Mansell and Roger Silverstone, 44–74. Oxford: Oxford Univ. Press.**

*Domestication* is the process of appropriating a new technology into everyday life—as a special case, into the private space of the home. This appropriation is an innovation process itself, and also feeds back into larger technology design and development. Thus innovations are material, functional, symbolic, and aesthetic social products.

**Tyre, Marcie J., and Wanda J. Orlikowski. 1994. Windows of opportunity: Temporal patterns of technological adaptation in organizations. *Organization Science* 5.1: 98–118.**

[DOI: 10.1287/orsc.5.1.98]

This review argues that the general implementation/adoption process actually involves a discontinuous process of mutual adaptation among technology, users and organizational contexts, where stable utilization periods are punctuated by both external and internal change triggers during *windows of technological opportunity*.

## DIFFUSION THROUGH A SOCIAL SYSTEM OVER TIME

Different models represent varying underlying assumptions about the forms, influences, speed, and nature of the diffusion process. Using over-time data or simulations, these models add to or adapt the traditional S-curve, or logistic, cumulative diffusion over time. Indeed, the timing or shape of the slope of diffusion has major implications for the success or penetration of both commercial innovations (e.g., products) and social innovations (e.g., health behaviors). The inclusion of social networks in these models adds more complexity but also more realism. Specific aspects of networks, such as weak ties, thresholds, opinion leaders, and social influence, help explain differences in adoption rates across social systems.

### Models

*Adoption* is an individual or organizational action, while *diffusion* is the spread over time of the innovation. To the extent that the adoption times are normally distributed (the basis for the five adopter categories), the cumulative number of adopters over time is the well-known *S-shaped diffusion curve*. However, online diffusion can create a *long tail* to the adoption curve (Anderson 2006). Hannemyr 2003 reanalyzes historical data on the diffusion rate of the Internet, and Kalba 2008 provides extensive analysis of the diffusion of mobile phones. Kotler and Roberto 1989; Peres, et al.

2010; and Wirsan and Muller 2006 describe different kinds of diffusion curves, including the Bass model (Bass 1969). Fan 1988 developed a diffusion approach to analyzing agenda-setting.

**Anderson, Chris. 2006. *The long tail: Why the future of business is selling less of more*. New York: Hyperion.**

Due to the Internet and digital markets, the diffusion curve has been extended temporally and conceptually, resulting in the *long tail*. Storage and distribution costs approach zero; potential adopters can access the product globally; collaborative filtering provides awareness and evaluation. Thus companies can successfully offer otherwise obscure and niche products.

**Bass, Frank M. 1969. A new product growth for model consumer durables. *Management Science* 15.5: 215-227.**

[DOI: 10.1287/mnsc.15.5.215]

The basic model uses three parameters—market potential, external influences (e.g., media), and internal influences (, e.g., social influence, word-of-mouth, innovativeness)—to model the expected shape and penetration of the diffusion curve. More complex versions take into account other parameters. (See Bass model demonstration.)

**Fan, David P. 1988. *Predictions of public opinion from the mass media: Computer content analysis and mathematical modeling*. New York: Greenwood.**

Fan's *ideodynamic model* provides a methodology for comparing time-series of computer-based content analysis of media coverage with time-series of opinion poll results about various issues, essentially showing both the diffusion of a public agenda issue and the prior media influences, over time.

**Hannemyr, Gisle. 2003. The Internet as hyperbole: A critical examination of adoption rates. *The Information Society* 19.2: 111-121.**

[DOI: 10.1080/01972240309459]

An historical and interpretive analysis of adoption rates of media, using actor-network theory, this rejects frequent claims that the Internet has diffused much faster (e.g., four years to reach fifty million users) than all prior communication media/technologies. It also critiques the general global, context-free, and fixed-technology use of this claim.

**Kalba, Kas. 2008. The global adoption and diffusion of mobile phones. Cambridge, MA: Harvard Univ. Program on Information Resources Policy.**

A wide variety of factors influence mobile phone diffusion in different countries, such as number of competitors, gross domestic product (GDP),

fixed/landline phones, incoming call fees, transferable SIM cards, asymmetrical interconnection fees, and fractionalized use, whereby users may share a phone and pay only for their individual calls.

**Kotler, Philip, and Eduardo L. Roberto. 1989. *Social marketing: Strategies for changing public behavior*. New York: Free Press.**

The *rapid-penetration* model identifies the likely percentage of total adopters and remaining potential adopters over time. The *gradual-penetration* diffusion model is the typical S-curve, with an initial adoption rate, a rapid take-up, and a leveling off. The *contagion-like* (Bass) model considers the influence of adopters and media on nonadopters.

**Peres, Renana, Eitan Muller, and Vijay Mahajan. 2010. Innovation diffusion and new product growth models: A critical review and research directions. *International Journal of Research in Marketing* 27:91–106.**

[DOI: 10.1016/j.ijresmar.2009.12.012]

Comprehensively reviews prior models of the various influences (such as word-of-mouth, network externalities, social signals, social networks, takeoffs and saddles, technology generations, and competition) on the diffusion of innovations within and across their life cycle, markets, and brands. The authors particularly underscore the importance of interdependencies among consumers.

**Wirsan, Jan, and Christina Muller. 2006. Applicability and assessment of adoption and diffusion models: Review of the models of Bass, Milling and Maier, Rogers and Frambach and Schillewaert. *International Journal of Enterprise Network Management* 1.1: 62–78.**

[DOI: 10.1504/IJENM.2006.010066]

This article compares two adoption and two diffusion models, on the basis of spatiotemporal aspects, explanatory power, assumptions about diffusion system, assumptions about diffusion process, assumptions about influences on the decision, assumptions about form of the innovation, forecasting approach, influence of networks, and temporal consideration.

### Networks

Integrating the role of social networks into diffusion models adds both conceptual and empirical explanatory power (see Valente 1996). Coleman, et al. 1966 is a classic large-scale network diffusion study, while Christakis and Fowler 2008 uses large-scale, over-time network analysis to study the cessation of smoking. Markus 1987 explains the central role of critical mass (a sufficient user network) in interactive media, and O'Callaghan 1998 argues that organizations adopt innovations within industry networks. Frick, et al. 2009 describes a diffusion simulation game that includes many of the complex communication and social variables, including networks, in the diffusion of innovations model. Valente 1995 provides a comprehensive overview of network models of diffusion.

**Christakis, N. A., and J. H. Fowler. 2008. The collective dynamics of smoking in a large social network. *New England Journal of Medicine* 358.21: 2249–2258.**

[DOI: 10.1056/NEJMsa0706154]

This analysis of 5,124 people and their network of 12,067 close others found that during 1971–2003, participants were more likely to quit smoking depending on which type of network partner quit: spouse 67 percent, friend 36 percent, and sibling 25 percent. Subnetworks of smokers quit almost simultaneously, and remaining smokers became more peripheral.

**Coleman, James Sameul, Elihu Katz, and Herbert Menzel. 1966. *Medical innovation: A diffusion study*. Indianapolis, IN: Bobbs-Merrill.**

A groundbreaking study in its use of both self-reported and actual adoption data within medical communities, applying the network concepts of close and weak ties. They make clear conceptual distinctions between traditional individual and social influences. Important results included the role of physician reputation and social and professional networks.

**Frick, Ted, Barbara Ludwig, K. J. Kim, and Rui Huang. 2009. Diffusion simulation game.**

Players attempt to diffuse a school tutoring program. You can communicate directly with (or get information about) the principal, secretary, and various teachers, including sociograms of their lunch patterns, social relationships, etc. You can provide workshops, demonstrations, pamphlets, and observe as each member increases awareness and may eventually adopt the program.

**Markus, M. Lynne. 1987. Toward a "critical mass" theory of interactive media, universal access, interdependence and diffusion. *Communication Research* 14.5: 491–511.**

[DOI: 10.1177/009365087014005003]

A *critical mass* of adopters is especially crucial for interactive media innovations, because extensive adoption generates an increasingly large network of interacting users, a public good (all can use without reducing benefits for others, and positive network externalities follow), and involves reciprocal interdependence (earlier and later users influence each other).

**O'Callaghan, Ramon. 1998. Technology diffusion and organizational transformation: An integrative framework. In *Information systems innovation and diffusion: Issues and directions*. Edited by Tor Jermund Larsen and Eugene McGuire, 390–410. Hershey, PA: Idea Group.**

Individual organizations rarely adopt an innovation in isolation of the surrounding industry. Diffusion of a technology throughout an industry can change perceptions through increased knowledge of the technology, applications, and benefits, and reduced risk, as well as developing network

externalities of supporting innovations, influencing later adaptations and adoption.

**Valente, Thomas W. 1995. *Network models of the diffusion of innovations*. Cresskill, NJ: Hampton.**

Valente applies the network perspective (concepts, data, and methods) to understanding different innovation diffusion processes, and what factors influence both the pattern and speed of that diffusion, at the individual and social system levels. He applies threshold and critical mass models, and discusses applications to communication campaigns and media effects.

**Valente, Thomas W. 1996. The diffusion network game. *Connections* 19.2: 30–37.**

A classroom game (for twenty to fifty students) illustrating the effects of network centrality and opinion leadership on knowledge–attitude–practice gap diffusion curves. The exercise begins with collecting network roster information, establishes simple rules about giving or receiving different colored chips, and then plots the progress of diffusion after each round of interaction.

## CONSEQUENCES

The timing and nature of adoption and the innovation's diffusion through the social system generate, as well as prevent, various kinds of individual/social, direct/indirect, short-term/long-term, intended/unintended, and positive/negative *consequences* (Tenner 1997). Familiar consequences include the knowledge gap (Tichenor, et al. 1970) and the digital divide (Katz and Rice 2002).

**Katz, James E., and Ronald E. Rice 2002. *Social consequences of Internet use: Access, involvement and interaction*. Cambridge, MA: MIT Press.**

Individual factors such as gender, race, education, income, urban/rural, and dial-up/broadband access generate the *digital divide* (markedly differential adoption of the Internet). In the United States, some of these are disappearing as significant factors, while others (age, income, education) persist. Large digital divides exist within and across countries. Rogers 2003) (cited under General Overviews) claims that, without proactive policies and diffusion strategies, innovations in general tend to *increase* socioeconomic inequalities, although via adaptive social systems with conscious policies and local reinvention, innovations can contribute to dynamic evolution of the system.

**Tenner, Edward. 1997. *Why things bite back: Technology and the revenge of unintended consequences*. New York: Vintage.**

Innovations, because they change current relationships (technical, social, biological, economic, and environmental), can generate long-term, unintended negative effects. Tenner discusses those that generate new problems, reverse existing solutions, or reinforce the initial problems, with examples from medicine, environment, pest spread and control, sports, hospital treatment, mechanization, computerization, and other areas.

**Tichenor, P. J., G. A. Donohue, and C. N. Olien. 1970. Mass media flow and differential growth in knowledge. *Public Opinion Quarterly* 34:159–170.**

[DOI: 10.1086/267786]

This study explicates the negative consequence of the *knowledge gap*, showing that although educational television programs such as *Sesame Street* did raise knowledge levels of children overall, it raised the levels significantly higher for children who already had higher levels (especially those with higher socioeconomic status), further widening the knowledge gap.

## CRITIQUES

Hider and Kreps 2004, Meyer 2004, and Rogers 2003, among many others, offer suggestions for improving the assumptions, scope, methodology, and consequences of the diffusion of innovations approach.

**Hider, Muhiuddin, and Gary L. Kreps. 2004. Forty years of diffusion of innovations: Utility and value in public health. *Journal of Health Communication* 9.6: 3–11.**

This review summarizes the main components of the diffusion of innovations model, for public health campaigns. Challenges to the diffusion perspective include broadening the scope of diffusion research to consider all the factors leading up to public access to the innovation, and involving relevant communities in any diffusion efforts.

**Meyer, G. 2004. Diffusion methodology: Time to innovate? *Journal of Health Communication* 9.6: 59–59.**

[DOI: 10.1080/10810730490271539]

This article suggests a wider array of methodologies than the traditional survey, studying one innovation, from the adopters' perspective, using recall data, from late in the process. Recommendations include panel studies, causal analysis, point-of-adoption data collection, archival records, quasi-experimental field studies, and qualitative evidence.

**Rogers, Everett M. 2003. *Diffusion of innovations*. 5th ed. New York: Free Press.**

Rogers identified the pro-innovation bias, the individual-blame bias, the problem of relying on recall by adopters after adoption, and issues of equality and knowledge gaps. So, researchers should develop ways of focusing on benefits to lower-resource audiences, and question the criteria for selecting, and possible consequences of, the innovation.

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