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A Framework for Information Overload Research in Organizations

Insights from Organization Science, Accounting, Marketing, MIS, and Related Disciplines

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ABSTRACT

Based on literature from the domains of organization science, marketing, accounting, and management information systems, this review article examines the theoretical basis of the information overload discourse and presents an overview of the main definitions, situations, causes, effects, and countermeasures. It analyses the contributions from the last thirty years to consolidate the existing research in a conceptual framework, to identify future research directions, and to highlight implications for management.

INTRODUCTION

In this article, we present a literature review on the topic of information overload in management-related academic publications. The main elements of our review approach are literature synopsis, analysis and discussion (Webster & Watson, 2002). These three elements serve, in our view, the three main purposes of a literature review, namely to provide an *overview* of a discourse domain (e.g., compiling the main terms, elements, constructs, approaches and authors*)*, to *analyze* and compare the various contributions (as well as their impact), and to highlight current research *deficits* and future research directions. These three objectives should be met with regard to the topic of information overload, as a clear overview, an analysis of the major contributions, and an identification of future research needs are still missing for this domain. The literature review should also help readers (researchers and managers alike) to recognize information overload symptoms, causes and possible countermeasures in their own work environment, as the flood of potentially relevant information has become a ubiquitous

research and business problem, from reading relevant articles or reports, to screening e-mails or browsing the Internet.

While this is not the first review article on the topic of information overload (see Edmunds & Morris, 2000), it is the first one to analyze the problem of information overload with a clear focus on *interdisciplinary* insights within the management domain. Unlike other literature reviews on the topic, we will review literature from various management disciplines, such as organization science, accounting, marketing, or MIS, as well as influential contributions from closely related areas, such as economics, law, psychology, or library and information sciences. Other review articles on the subject follow a discipline-based approach. Malhotra, Jain and Lagakos (1982) and more recently Owen (1992) focus on the field of consumer research (see also Malhotra et al., 1982; Meyer, 1998), Schick, Gorden, and Haka (1990) examine relevant accounting literature, and Edmunds and Morris as well as Grise and Gallupe or Nelson concentrate on the field of management information systems (MIS) (Edmunds & Morris, 2000; Grise & Gallupe, 1999/2000; Nelson, 2001). Our review of contributions in the area of information overload is interdisciplinary because it aims at compiling a comprehensive list of diverse overload situations, causes, symptoms, and effects. It also aims at identifying *similarities and differences* among the various management perspectives and show to what extend they have discussed information overload. We hope that by doing so, we can identify synergies between the different streams of information overload research and highlight future research areas. Another benefit of an interdisciplinary literature review is that it can provide a more (cross-) validated and general collection of possible symptoms, causes, and countermeasures and thus lead to a more complete understanding of the phenomenon. This literature-based understanding can then be used to construct testable models on information overload.

A second difference of our review in relation to prior contributions is the way that the literature is summarized and analyzed, as we present the results of our review in a highly compressed and often *visual format*. By providing various diagrammatic overviews of the reviewed literature, patterns in the development of the field can become visible. The major benefit of this visual approach is a more concise representation of the discourse domain which allows for easier comparisons and hopefully also leads to a reduction of information overload for our readers.

METHODOLOGY

Before we provide the context of this literature review by describing information overload as an object of management-related research, we will briefly outline how we gathered and analyzed the reviewed literature.

To screen the pertinent articles within the literature on information overload, we used the electronic database provided by EBSCO*host* and limited our research to the articles included by the Business Premier Source. This database provides full-text access to 3000 journals, of which more than 1000 are peer reviewed. EBSCO*host* enabled us to search in the title or abstract with the following keywords: information overload, information load, cognitive overload, and cognitive load, which resulted in a total number of 548 retrieved articles. In order to reduce this large number to a more relevant sub-set, we introduced further criteria (see Figure 1) which were: first, a publication date after 1970 (the number remained at 548 articles, even if EBSCO*host* includes articles dating back to 1922), second, that the article is peer reviewed (which resulted in 205 articles remaining), third, that information overload is a dominant and systematically addressed subject of the article (resulting in 184 articles), and finally, that the article approaches the subject within the context of one of the four areas of interest, namely

accounting, marketing, MIS, and organization science (with regard to the article's topics and its publication journal). This selection procedure has led to a total number of 97 considered articles. Figure 1 reveals that the greatest number of retained articles is from the marketing domain, followed by articles within organization science, then accounting and finally, MIS that shows the smallest number of articles on the subject.

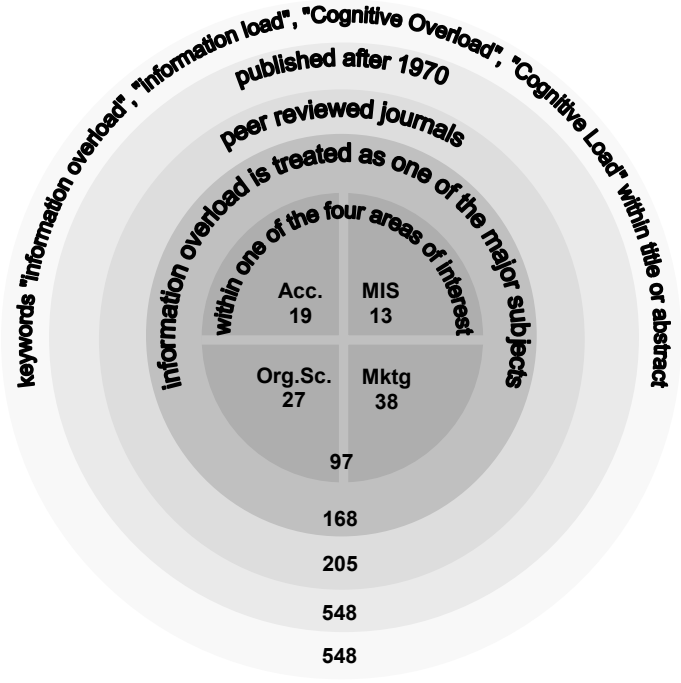

FIGURE 1: Selection criteria and article base

One limitation of this method of data collection and analysis is that some articles that have dealt with the issue, but have used other labels than the four terms we used as key words, are not taken into consideration (i.e., labels such as data smog, information fatigue/overkill/ overabundance/breakdown/explosion/deluge/flood/stress/plethora, document tsunami, sensory overload etc., see Eppler, 1998, for these and other labels). These different terms, however, have not reached wide acceptance within the scientific community and hence do not represent core contributions to this scientific debate. Another limitation of our approach is that contributions on information overload that discuss the phenomenon in other contexts (such as in psychology,

health care or in mass communication) are not extensively addressed. Examples of such important contributions are Miller's "The magical number seven plus or minus two" (Miller, 1956), or Herbert Simon's seminal "Information processing models of cognition" (Simon, 1979), to name but two crucial contributions. In order to moderate this limitation, we have used an additional inclusion criterion: If a publication is cited repeatedly in other overload articles, we have screened it to see whether information overload is indeed a major topic of the publication, and if that is the case, we have included it in our article base. We have proceeded likewise for books that have often been cited in relevant journal articles (such as Wurman, 1990/2001, or Shenk, 1997).

THE CONCEPT OF INFORMATION OVERLOAD

In ordinary language, the term 'information overload' is often used to convey the simple notion of *receiving too much information*. Within the research community this every day use of the term has led to various constructs, synonyms and related terms as for example cognitive overload (Vollmann, 1991), sensory overload (Libowski, 1975), communication overload (Meier, 1963), knowledge overload (Hunt & Newman, 1997), or information fatigue syndrome (Wurman, 2001). These constructs have been applied to a variety of situations, ranging from auditing (Simnet, 1996), strategizing (Sparrow, 1999), business consulting (Hansen & Haas, 2001) management meetings (Grise & Gallupe, 1999/2000) to supermarket-shopping (Jacoby, Speller, & Berning, 1974; Friedmann, 1977), to name but a few overload contexts (for an extended list of the contexts in which information overload has been discussed in management-related academic literature see Table 1).

	Context/Overload Situation	Reference
Information Retrieval, Organization, and Analysis Processes	• Searching on the Internet	Berghel, 1997
	• Screening medical information	Bawden, 2001
	• Financial distress analysis	Chewing & Harring, 1990
	• Evaluating the variety of product functions	Herbig & Kramer, 1994
	• Analysis activities (strategic portfolio -, environmental -, new product analysis, service decisions)	Meyer, 1998
	• Investment analysis	Tuttle & Burton, 1999
	• Library management	Meier, 1963
Decision Processes	• Managerial decisions in general	Ackoff, 1967; Iselin, 1993
	• Management (project, strategic, production management)	Chervany & Dickson, 1974; Haksever & Fisher, 1996; Meyer, 1998; Sparrow, 1999
	• Supermarkets (choice of product)	Friedmann, 1977; Jacoby et al., 1974
	• Bankruptcy prediction process	Casey, 1980; Iselin, 1993
	• Capital budgeting process	Swain & Haka, 2000
	• Welfare assistance (decisions about type and amount)	O'Reilly, 1980
	• Innovation choice	Herbig & Kramer, 1994
	• Price setting	Meyer, 1998
	• Advertising media selection	Meyer, 1998
	• Strategy development	Sparrow, 1999
	• Physician's decision making	Hunt & Newman, 1997
	• Financial decision making	Iselin, 1988; Revsine, 1970
	• Brand choice (consumer decision making)	Jacoby et al., 1974, 1987; Malhotra, 1982; Owen, 1992; Scammon, 1977; Wilkie, 1974
	• Aviation	O'Reilly, 1980
Communication Processes	• Meetings	Schick et al., 1990
	• Telephone conversations	Schick et al., 1990
	• The use of Groupware applications	Schultze & Vandenbosch 1998
	• Bulletin Board Systems	Hiltz & Turoff, 1985
	• Face to face discussions	Sparrow, 1999
	• Telephone company services	Griffeth et al., 1988
	• Electronic meetings	Grise & Gallupe, 1999/2000
	• Idea organization	Grise & Gallupe, 1999/2000
	• E-mail	Bawden, 2001; Speier et al., 1999; Denning, 1982
	• Management consulting	Hansen & Haas, 2001
	• city interactions	Milgram, 1970
	• Disclosure law, contract complexity, legal disclaimers	Grether, Schwartz, & Wilde, 1986

TABLE 1: Information overload situations

Research on information overload relevant for the realm of management has mainly been undertaken in the areas of *accounting* (e.g., Schick et al., 1990) *management information systems (MIS)* (initially highlighted by Ackoff, 1967), *organization science* (e.g., Galbraith, 1974; Tushman & Nadler, 1978), and *marketing* or more specifically *consumer research* (Jacoby, 1984; Keller & Staelin; 1987, Malhotra, 1984). The main focus of these disciplines is the question of how the *performance* (in terms of adequate decision making) of an individual varies with the *amount of information* he or she is exposed to. Researchers across various disciplines have found that the performance (i.e., the quality of decisions or reasoning in general) of an individual correlates positively with the amount of information he or she receives – up to a certain point. If further information is provided beyond this point, the performance of the individual will rapidly decline (Chewning & Harrell, 1990). The information provided beyond this point will no longer be integrated into the decision making process and information overload will be the result (O'Reilly, 1980). The burden of a heavy information load will confuse the individual, affect his ability to set priorities, or makes prior information harder to recall (Schick et al., 1990). Figure 2 provides a schematic version of this discovery. It is generally referred to as the inverted u curve, following the initial work of Schroder, Driver and Streufert (Schroder et al., 1967).

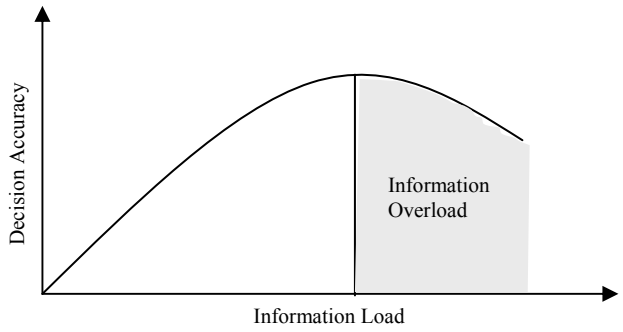

FIGURE 2: Information overload as the inverted u-curve

This inverted u-curve represents the first important, nevertheless controversially discussed (see Malhotra et al., 1982, Russo, 1974 or McKinnon and Bruns 1992), but finally confirmed definition of information overload. For an overview of the main definitions of this phenomenon, see Table 2.

Definitions	Components/Dimensions	References
The decision maker is considered to have experienced information overload at the point where the amount of information actually integrated into the decision begins to decline. Beyond this point, the individual's decisions reflect a lesser utilization of the available information.	• inverted u-curve: relationship between amount of information provided and amount of information integrated by decision maker • information utilization	Chewning & Harrell (1990) Cook (1993) Griffeth et al. (1988) Schroder et al. (1967) Swain & Haka (2000)
Information overload occurs when the volume of the information supply exceeds the limited human information processing capacity. Dysfunctional effects such as stress or confusion are the result.	• volume of information supply (information items versus - chunks) • information processing capacity • dysfunctional consequences	Jacoby et al. (1974) Malhotra (1982) Meyer (1998)
Information overload occurs when the information processing requirements (information needed to complete a task) exceed the information processing capacity (the quantity of information one can integrate into the decision making process).	• Information processing capacity • Information processing requirements	Galbraith (1974) Tushman & Nadler (1978)
Information overload occurs when the information processing demands on time to perform interactions and internal calculations exceed the supply or capacity of time available for such processing.	• Time demands of information processing; Available time versus invested time • Number of interactions (with subordinates, colleagues, superiors) • Internal calculations (i.e., thinking time)	Schick, Gordon & Haka (1990) Tuttle, Burton (1999)
Information overload has occurred when the information-processing requirements exceed the information-processing capacity. Not only the amount of information (quantitative aspect) that has to be integrated is crucial but also the characteristics (qualitative aspect) of information.	• Information-processing requirements • Information processing-capacity • Quantitative and qualitative dimensions of information (multidimensional approach)	Keller & Staelin (1987) Schneider (1987) Owen (1992) Iselin (1993)
Information overload occurs when the decision maker estimates to have to handle more information than he/she can efficiently use.	• Subjective component: opinion, job- & communication-satisfaction • situational factors and personal factors	Abdel-Khalik (1973) Iselin (1993) O'Reilly (1980) Haksever & Fisher (1996)
Amount of reading matter ingested exceeds amount of energy available for digestion, the surplus accumulates and is converted by stress and over-stimulation into the unhealthy state known as information overload anxiety.	• Subjective cause component: energy • Symptom: stress, over-simulation • Subjective effect: information overload anxiety	Wurman (1990), Wurman (2001), Shenk (1997)

TABLE 2: Definitions of information overload and their components

Authors in the field of *marketing* define information overload by comparing the volume of information supply (e.g. the number of available brands) with the information processing capacity of an individual. Information overload occurs when the supply exceeds the capacity. Dysfunctional consequences (such as stress or anxiety) and a diminished decision quality are the

result. A similar way of conceiving the information overload phenomenon consists of comparing the individual's information processing capacity (the quantity of information one can integrate into the decision making process within a specific time period) with the information processing requirements (i.e., the amount of information one has to integrate in order to complete a task). This is the 'classic' definition of information overload that is based on the information processing view of the organization suggested by Galbraith (1974) and expanded by Tushman and Nadler (1978). Following their reasoning, information overload can be defined with the following formula: information processing requirements > information processing capacities. The terms 'requirements' and 'capacities' in the above definition can be measured in terms of the available time. The requirements refer to a given amount of information that has to be processed within a certain time period. If the capacity of an individual only allows a smaller amount of information to be processed in the available time slot, then information overload is the consequence. Tushman and Nadler define information processing in this context as the "gathering, interpreting, and synthesis of information in the context of organizational decision making" (Tushman & Nadler, 1978: 614). Many variations of this definition exist. Schick et al. (1990) also stress the *time factor* as the most important issue regarding the information overload problem. Interesting within this discussion is Schroder et al.'s (1967) view. They point out that information load and processing capacity are not independent, but that the first can influence the second, i.e. dealing with a rather high information load increases one's processing capacity up to a certain point (see also Schultze & Vandenbosch, 1998). In other studies (Iselin, 1993; Keller & Staelin, 1987; Owen, 1992; Schneider, 1987) it is not only the amount of information and the available processing time (i.e., the quantitative dimension), but also the *characteristics of information* (i.e., the qualitative dimension) that are seen as major overload elements. Keller and Staelin refer to the overall quality or 'usefulness of the available (...) information' (1987: 202)

while Schneider (1987) distinguishes various information attributes, such as the level of novelty, ambiguity, uncertainty, intensity or complexity. These information characteristics or quality attributes can either contribute to overload or reduce it.

Next to these definitions which try to conceptualize and measure the phenomenon of overload objectively, there are also approaches that conceive overload on the basis of *subjective experience.* Authors who have followed this approach are O'Reilly (1980), Haksever and Fisher (1996) or Lesca and Lesca (1995). In this 'subjective' view of overload, the *feelings* of stress, confusion, pressure, anxiety or low motivation are the crucial factors that signal the occurrence of information overload. Empirical research that follows this subjective view of the overload phenomenon typically employees interviews or survey methods (such as Haksever & Fisher, 1996) as opposed to experiments.

This brief overview of the most frequently used definitions and their background has delineated the intellectual territory which is examined in this literature review. Having outlined the background, scope and methodology of our discussion, we can now provide a conceptual framework which synthesizes and structures the empirical and conceptual contributions in this area and that can function as a testable model for future overload studies.

A CONCEPTUAL FRAMEWORK FOR INFORMATION OVERLOAD RESEARCH

In order to provide a more complete (and less fragmented) picture of the research conducted on information overload, the following framework visualizes the most important topic clusters of the information overload discourse and their relationships. These topic clusters are the main *causes* of information overload, the *symptoms* or effects as well as suitable *countermeasures* which help to avoid the dysfunctional effects of a heavy information load.

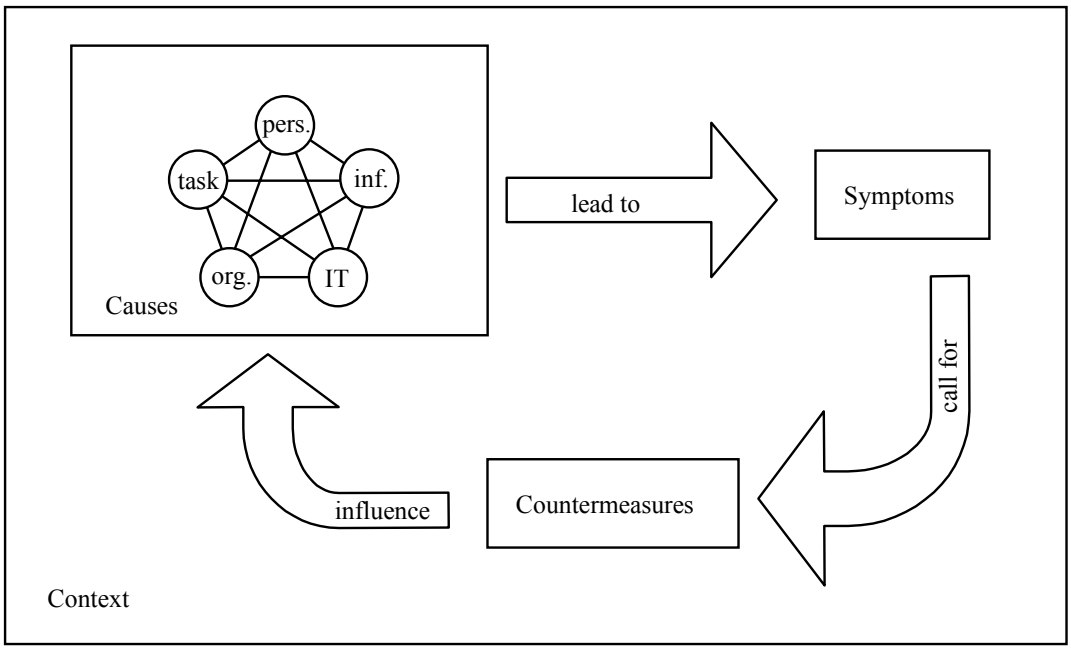

FIGURE 3: A conceptual framework to structure research on information overload

The framework depicted in Figure 3 does not represent a logic of linear causes and effects, but rather a system of circular, interdependent relationships. The framework thus stresses the fact that any countermeasure that is aimed at a specific overload cause can have significant side-effects on other causes. Although this fact is frequently acknowledged in current overload literature (e.g., Bawden, 2001), it has scarcely been explored empirically (for an exception, see Evaristo, 1993). Specifically, empirical overload research has so far not examined the effect of certain (new) information technology applications on the quality of information (see Wang et al., 1998), on the motivation of the individual, and on task parameters. As contextual factors (such as industry characteristics, the firm's development stage or the staff structure etc.) are of crucial importance for the occurrence of overload, research methods should be applied that can capture many of these contextual factors and thus highlight interdependencies. Research approaches that provide such a 'deep context' are missing, as most literature on the topic is either experimental, survey-based or purely conceptual.

The framework depicted in Figure 3 also highlights the fact that there cannot be a definitive solution against information overload. In order to address the issue, there must be a continuous cycle of improvement and refinement. We discuss the main elements (the causes, symptoms and countermeasures) of the framework and the relevant literature in the subsequent sections. At the end of this section, we also demonstrate how the conceptual framework can be converted into empirically testable models.

Causes of Information Overload

The main *causes* of information overload are the result of a number of developments that are mutually interdependent and relate to various levels or scales. On a *societal* scale, these developments are mainly the *accelerated production* of information through institutions such as science, the media, or the globalized business community which operates on ever faster innovation cycles (see Castells, 1996), and the more efficient *distribution* of that information through information and communication technology. Such societal factors are usually not discussed extensively in information overload literature dealing with organizational or business-related issues. Literature from the domains of organization science, marketing, accounting, or MIS focuses on the *organizational* or (inter-) *personal* level. As far as the corporate context is concerned, the main reasons for information overload can be related to five issues, as shown in Figure 3. These inductively generated categories of major overload causes are the *information* itself (its quantity, frequency or intensity, and quality or general characteristics), the *person* receiving, processing or communicating information, the *tasks or processes* which need to be completed by a person, team or organization, the *organizational design* (i.e., the formal and informal work structures), and the *information technology* that is used (and how it is used) in a company. Usually, information overload emerges not because of one of these factors, but because of a mix of all five causes. All five causes influence the two fundamental variables of

information overload which are (according to the above definition by Galbraith, 1974 and Tushman & Nadler, 1978), the information processing capacity (IPC) – which is for example influenced by personal characteristics – and the information processing requirements (IPR) – which are often determined by the nature of the task or process. We will discuss these five causes and their influence on IPC and IPR briefly in the next paragraphs.

An important factor influencing the occurrence of information overload is the *organizational design* of a company (Galbraith, 1974; Tushman & Nadler, 1978). Changes in the organizational design, for instance due to disintermediation or centralization (Schneider, 1987) or because of a move to interdisciplinary teams (Bawden, 2001), can lead to greater IPRs because they create the need for more intensive communication and coordination. On the other hand, a better coordination through standards, common procedures, rules or dedicated coordination centers (Galbraith, 1974) can reduce the IPR and positively influence the IPC (Galbraith, 1974; Schick et al., 1990; Tushman & Nadler, 1978; for other organizational design elements that influence information overload see Schneider, 1987).

Next to the organizational design, another important overload cause is the *nature of information* itself. Schneider (1987) stresses the fact that it is not only the amount of information that determines information overload, but also the specific characteristics of information (see also Sparrow, 1998). Such characteristics are the level of uncertainty associated with information as well as the level of ambiguity, novelty, complexity or intensity (Schneider, 1987). Simpson & Prusak (1995) argue that modifying the quality of information can have great effects on the likelihood of information overload. Improving the quality (e.g., conciseness, consistency, comprehensibility etc.) of information can improve the information processing capacity of the individual, as he or she is able to use high-quality information quicker and better than ill-structured, unclear information.

The *person* and his or her attitude, qualification or experience is another important element to determine at which point information overload may occur. While earlier studies simply state that a person's capacity to process information is limited (Jacoby et al., 1974; Galbraith, 1974; Malhotra, 1982; Simon, 1979; Tushman & Nadler, 1978), more recent studies include specific limitation factors such as personal skills (Owen, 1992), the level of experience (Swain & Haka, 2000), or the motivation of a person (Muller, 1984). Personal traits thus directly affect the IPC.

Another influential cause are the *tasks and processes* which need to be completed with the help of information. The less a process is based on reoccurring routines (Tushman & Nadler, 1975) and the more complex it is in terms of the configuration of its steps (Bawden, 2001; Grise & Gallupe, 1999/2000), the higher the information load and the greater the time pressure on the individual (Schick et al., 1990). The combination of these two factors that increase the IPR can lead to information overload. Information overload is especially likely if the process is frequently interrupted and the concentration of the individual suffers as a consequence (Speier, Valacich, Vessey, 1999). Information overload is also more likely if managers face an ever greater number of parallel projects or tasks that they have to manage (i.e., quality management projects, Intranet initiatives, knowledge management issues, customer focus programs, etc., see Wurman, 2001). In this way, complex tasks or processes directly increase the IPR. This fact is aggravated by a reduced IPC as a result of frequent context-switching or distraction.

Finally, *information technology* and its use or misuse are a major reason why information overload has become a critical issue in the 1980s and 1990s within many organizations. The development and deployment of new information and communication technologies, such as the Internet, intranets and extranets, but especially e-mail are universally seen as one major source of

information overload (Bawden, 2001). There are, however, also arguments in favor of e-mail. They stress advantages like the fact that e-mail is an asynchronous form of communication and is less likely to interrupt the normal work flow (Edmunds & Morris, 2000). Closely related to the problem of e-mail overload is the discussion of pull- versus push-technologies and whether they have a positive or negative impact on an individual's IPC and IPR. To push selected pieces of information to specific groups reduces on the one hand their information retrieval time, but increases on the other the amount of potentially useless information that a person has to deal with (Edmunds & Morris, 2000). In addition, it causes more frequent interruptions (Speier et al., 1999). Information technology can thus potentially increase the individual's IPC while at the same time increasing the IPR.

A complete list of the specific overload causes that are mentioned in the relevant literature can be found in Table 3. It is structured according to the five categories discussed previously.

	Causes of Information Overload	Reference
Personal Factors	• limitations in the individual human information processing capacity	Herbig & Kramer, 1994
	• Decision scope and resulting documentation needs	Kock, 2001
	• motivation, attitude, satisfaction	Muller, 1984
	• personal traits (experience, skills, ideology, age)	Owen, 1992; Hiltz & Turoff, 1985; Muller, 1984; Schneider, 1987; Swain & Haka, 2000
	• personal situation (time of the day, noise, temperature, amount of sleep)	Owen, 1992; O'Reilly, 1980
	• Senders screen outgoing information insufficiently	Van Zandt, 2001
	• Users of computers adapt their way of interacting with computers too slowly in respect to the technological development	Maes, 1994
	• Social communication barriers break down	Schultze & Vandenbosch, 1998
Information Characteristics	• number of items of information rises	Bawden, 2001; Herbig & Kramer, 1994; Jacoby et al., 1974; Jacoby 1977, 1984; Malhotra, 1982
	• uncertainty of information (info needed versus info available)	Schneider, 1987; Tushman & Nadler, 1978
	• diversity of information and number of alternatives increase	Bawden, 2001; Inselin, 1988; Schroder et al., 1967
	• ambiguity of information	Schneider, 1987; Sparrow, 1999
	• novelty of information	Schneider, 1987
	• complexity of information	Schneider, 1987
	• intensity of information	Schneider, 1987
	• dimensions of information increase	Schroder et al., 1967

	• information quality, value, half-life	Sparrow, 1998, 1999
	• over abundance of irrelevant information	Ackoff, 1967
Task & Process Parameters	• tasks are less routine	Tushman & Nadler, 1975
	• complexity of tasks and task interdependencies	Tushman & Nadler, 1975
	• time pressure	Schick et al., 1990
	• task interruptions for complex tasks	Speier et al., 1999
	• too many, too detailed standards (in accounting)	Schick et al., 1990
	• simultaneous input of information into the process	Grise & Gallupe, 1999/2000
	• innovations evolve rapidly - shortened lifecycle	Herbig & Kramer, 1994
	• interdisciplinary work	Bawden, 2001
Organizational Design	• collaborative work	Wilson, 1996
	• centralization (bottle necks) or disintermediation (information searching is done by end-users rather than by information professionals)	Schneider, 1987
	• accumulation of information to demonstrate power	Edmunds & Morris, 2000
	• group heterogeneity	Grise & Gallupe, 1999
	• new information and communication technologies (e.g. groupware)	Bawden, 2001; Schultze & Vandenbosch, 1998; Speier et al., 1999
Information Technology	• push systems	Bawden, 2001
	• e-mails	Bawden, 2001
	• intranet, extranet, Internet	Bawden, 2001
	• rise in number of television channels	Edmunds & Morris, 2000
	• various distribution channels for the same content	Edmunds & Morris, 2000
	• vast storage capacity of the systems	Schultze & Vandenbosch, 1998
	• low duplication costs	Schultze & Vandenbosch, 1998
	• speed of access	Schultze & Vandenbosch, 1998

TABLE 3: Causes of information overload

Having reviewed the major causes of information overload and their impact on IPC and IPR, we can now look at their effects or observable symptoms.

Symptoms of Information Overload

Information overload can be perceived through a variety of symptoms that affect the person who deals with information as well as his or her work performance. One of the first researchers to examine the effects of overload was the American psychologist Stanley Milgram (1970) who analyzed signal overload for people living in large cities. In his study, he identifies six common reactions to the constant exposure to a heavy information load, which are the

allocation of less time to each input, the disregard of low-priority inputs, the re-drawing of boundaries in certain social transactions to shift the burden of overload to the other party in the exchange, the reduction of inputs by filtering devices, the refusal of communication reception (via unlisted telephone numbers, unfriendly facial expressions, etc.) and finally the creation of specialized institutions to absorb inputs that would otherwise swamp the individual (see also Weick, 1970).

In the organizational context, frequently described symptoms of information overload on the individual level are a general lack of perspective (Schick et al., 1990), cognitive strain and stress (Malhotra, 1982; Schick et al., 1990), a greater tolerance of error (Sparrow, 1999) , lower job satisfaction (Jacoby, 1984) or the inability to use information to make a decision (Bawden 2001) – the so called paralysis by analysis. Many other symptoms can be observed, they are listed in Table 4.

The biggest research issue regarding the effects or symptoms of information overload concerns the question whether and how information overload affects decision accuracy, decision time, and performance in general. While research results have often been contradictory, especially among the groundbreaking studies within the field of marketing (the inconsistencies were due in part to methodological problems, see Jacoby et al., 1974; Malhotra et al., 1982; Muller, 1984), there is a wide consensus in academia today that a heavy information load can indeed affect the performance of an individual negatively (whether measured in terms of accuracy or speed). When information supply exceeds the information processing capacity, a person has difficulties in identifying the relevant information (Jacoby, 1977), he or she becomes highly selective and ignores a large amount of information (Bawden, 2001; Herbig & Kramer, 1994; Sparrow, 1999), she has difficulties in identifying the relationship between details and the overall perspective (Schneider, 1987), or needs more time to reach a decision (Jacoby, 1984) and

finally does not reach a decision of adequate accuracy (Malhotra, 1982). Because of these many potential negative effects, it is essential to devise effective countermeasures. These activities should address not only the symptoms of information overload, but also its causes. In the next section we provide an overview of such mechanisms.

	Symptoms	Reference
Limited Information Search and Retrieval Strategies	• Search strategies through information sets become less systematic (this is less true for more experienced searchers)	Swain & Haka, 2000
	• Limited search directions	Cook, 1993
	• Move from compensatory search patterns to non-compensatory search patterns	Cook, 1993
	• Identification and selection of relevant information becomes increasingly difficult	Jacoby, 1977; Schneider, 1987
	• Difficulties to reach target groups (sender perspective)	Herbig & Kramer, 1994
Arbitrary Information Analysis and Organization	• Overlapping and inconsistent information categories	Eppler, 1998
	• Ignore information and be highly selective (omission)	Bawden, 2001; Edmunds & Morris, 2000; Herbig & Kramer, 1994; Hiltz & Turoff, 1985; Sparrow, 1999
	• Loss of control over information	Bawden, 2001; Wurman, 1990
	• Lack of critical evaluation (become too credulous) and superficial analysis	Shenk, 1997; Schick et al., 1990; Schultze & Vandenbosch, 1998
	• Loss of differentiation	Schneider, 1987
	• Relationship between details and overall perspective is weakened and peripherical cues get overestimated	Owen, 1992; Schneider, 1987
	• Higher time requirements for information handling and time delays	Jacoby, 1984; Hiltz & Turoff, 1985
	• Abstraction and necessity to give meaning lead to misinterpretation	Sparrow, 1999; Walsh, 1995
Sub-optimal Decisions	• Decision accuracy/quality lowered	Malhotra, 1982; Jacoby, 1984, Hwang & Lin, 1999
	• Decision effectiveness lowered	Schroder et al., 1967
	• Inefficient work	Bawden, 2001
	• Potential paralysis & delay of decisions	Bawden, 2001; Schick, 1990
Strenuous Personal Situation	• Demotivation	Baldacchino et al., 2002
	• Satisfaction negatively affected	Jacoby, 1984; Jones, 1997
	• Stress, confusion & cognitive strain	Jones, 1997; Malhotra, 1982; Schick, 1990
	• Lacks to learn since too little time is at disposition	Sparrow, 1999
	• Greater tolerance of error	Sparrow, 1999
	• Lack of perspective	Schick et al., 1990
	• Sense of loss of control leads to a breakdown in communication	Schneider, 1987
	• False sense of security due to uncertainty reduction (over-confidence)	Meyer, 1998; Jacoby, 1984; O'Reilly, 1980

TABLE 4: Symptoms or effects of information overload

Countermeasures against Information Overload

Literature on information overload does not only discuss major causes and effects, but also proposes possible effective countermeasures to address the issues related to information overload. These countermeasures range from general suggestions concerning attitude to very specific software tools (such as filtering agents, automatic summarizers, or visualization algorithms) that help to process large amounts of information. A list of the countermeasures mentioned in the reviewed literature can be found in Table 5. It is based on the same categories that were used structure the causes, so that the two (causes and countermeasures) can be directly related to one another (keeping in mind possible side-effects).

Regarding *information* itself, the essential mechanisms to fight information overload are to assure that it is of high value, that it is delivered in the most convenient way and format (Simpson & Prusak, 1995), that it is visualized, compressed and aggregated (Ackoff, 1967; Meyer, 1998;), and to use signals and testimonials to minimize the risks associated with information (Herbig & Kramer, 1994). On the *personal* level, it is important to provide training programs to augment the information literacy of information consumers (Bawden, 2001; Koniger & Janowitz, 1995; Schick et al, 1990) and to give employees the right tools so that they can improve their time management (Bawden, 2001) and their personal information management (Edmunds & Morris, 2000). As far as improvements for the *organizational design* are concerned, various authors take on conflicting positions. While earlier contributions stress the importance of self contained tasks and lateral relationships (Galbraith, 1974), more recent studies see this focus on collaborative and interdisciplinary work as a cause rather than as a countermeasure of information overload (Bawden, 2001; Wilson, 1996). If the cause of information overload relates to *process* problems, several authors suggest to standardize operating procedures (Bawden, 2001; Schick et al., 1990; Schneider, 1987), to collaborate with information specialists within the

process teams (Edmunds & Morris, 2000), or to use facilitators or collaborative tools (such as virtual team rooms) as 'process enablers' for cognitive support (Grise & Gallupe, 1999/2000). Finally, at the level of *information technology*, several authors advocate the use of intelligent information management systems to foster an easier prioritization of information (Bawden, 2001; Meyer, 1998; Schick et al., 1990) or to provide quality filters (Ackoff, 1967; Edmunds & Morris, 2000; Grise & Gallupe, 1999/2000). Examples of such intelligent systems are Decision Support Systems (DSS) that reduce a large set of options to a manageable size (Cook, 1993). In concluding this brief survey, one can state that many authors list a multitude of possible countermeasures, but that they do not provide specific suggestions on how to combine organizational, technological, personal or information- and task-based improvement actions. Clearly, a systematic methodology (comparable to other standardized problem solving approaches) to prevent or reduce information overload is still missing. Such a methodology should combine insights from various disciplines to provide effective countermeasures that can be adapted to various contexts. Rigorous empirical research must be at the basis of such a methodology. How to establish such empirical research on the basis of the developed framework is outlined in the next section.

	Countermeasures	**Reference**
Personal Factors	• Improve personal time management skills and techniques	Bawden, 2001
	• Training programs to augment information literacy: information processing skills such as file handling, using e-mail, classification of documents etc.	Bawden, 2001; Jones, 1997; Schick et al., 1990; Koniger & Janowitz, 1995
	• Improve personal information management	Edmunds &Morris, 2000
	• Systematic priority setting	Schick et al., 1990
	• Improve the screening skills for information	Van Zandt, 2001
Information Characteristics	• Raise general quality of information (i.e. its usefulness, conciseness) by defining quality standards	Allert, 2001; Keller & Staelin, 1987; Meglio & Kleiner, 1990; Simpson & Prusak, 1995
	• Focus on creating value-added information	Simpson & Prusak, 1995
	• Promulgation of rules for information & communication design (ex. e-mail etiquette)	Bawden, 2001
	• Compress, aggregate, categorize and structure information	Ackoff, 1967; Grise & Gallupe, 1999/2000; Hiltz & Turoff, 1985; Iselin, 1988; Koniger & Janowitz, 1995; Scammon, 1977
	• Visualization, the use of graphs	Chan, 2001; Meyer, 1998

	• Formalization of language	Galbraith, 1974
	• Brand names for information	Berghel, 1997
	• Form must follow function must follow usability	Herbig & Kramer, 1994
	• Simplify functionalities and design of products	Herbig & Kramer, 1994
	• Customization of information	Ansari & Mela 2003; Berghel, 1997; Meglio & Kleiner, 1990
	• Intelligent interfaces	Bawden, 2001
	• Determine various versions of an information with various levels of detail and elaborate additional information that serves as summaries	Denning, 1982
	• Organize text with hypertext structures or gophers	Nelson, 2001
	• Interlink various information types (as internal with external information)	Denton, 2001; Meglio & Kleiner 1990
Task & Process Parameters	• Standardize operating procedures	Bawden, 2001; Schneider, 1987 Schick et al., 1990
	• Define decision models developed for specific decision processes (e.g. decision rules)	Ackoff, 1967; Chewning & Harrel, 1990
	• Install an exception-reporting system	Ackoff, 1967
	• Allow more time for task performance	Schick et al., 1990
	• Schedule uninterrupted blocks of time for completing critical work	Sorohan, 1994
	• Adequate selection of media for the task	Schick et al., 1990
	• Handle incoming information at once	Sorohan, 1994
	• Collaboration with information specialists within the teams	Edmunds & Morris, 2000
	• Bring decisions to where information exists when this information is qualitative and ambiguous	Galbraith, 1974
	• Install process enablers for cognitive support	Grise & Gallupe, 1999/2000
	• Use simpler information processing strategies	Schick et al., 1990
	• Regulate the rate of information flow	Grise & Gallupe, 1999/2000
	• Search procedures and - strategy	Ackoff, 1967; Bawden, 2001; Meyer, 1998; Olsen et al., 1998; Revsine, 1970
	• Define specific, clear goals for the information in order to contextualize it and turn it meaningful	Baldacchino, 2002; Denton, 2001; Meglio & Kleiner 1990
	• Communicate information needs to providers	Meglio & Kleiner, 1990
	• Provide incentives that are directly related with decisions in order to make decision relevant information be processed more effectively	Tuttle & Burton, 1999
	• Install a measurement system for information quality	Denton, 2001
Organizational Design	• Coordination through inter-linked units	Tushman & Nadler, 1978
	• Augment info processing capacity through chances in org. design	Galbraith, 1974; Schick et al., 1990; Tushman & Nadler, 1978
	• Creation of lateral relationships (integrate roles, create liaisons between roles, teamwork etc.)	Galbraith, 1974
	• Coordination by goal setting, hierarchy, and rules depending on frequency of exceptions (uncertainty)	Galbraith, 1974
	• Creation of self-contained tasks (reduced division of labor, authority structures based on output categories) => autonomous groups	Galbraith, 1974
	• Reduce divergence among people (e.g., with regard to expectations) trough socialization (e.g., frequent face-to-face interactions)	Schneider, 1987
	• Install appropriate measures of performance	Ackoff, 1967
	• Hire additional employees	Schick et al., 1990
	• Create slack resources	Galbraith, 1974

Information Technology Application	• Intelligent information management (prioritization)	Bawden, 2001; Meyer, 1998; Schick et al., 1990
	• Install voting structures to make users evaluate the information	Denning, 1982; Hiltz & Turoff, 1985
	• Prefer push- to pull-technologies	Edmunds & Morris, 2000; Denning, 1982; Friedmann , 1977; Herbig & Kramer, 1994
	• Facilitator support through (e-) tools	Grise & Gallupe, 1999/2000
	• Decision Support Systems should reduce a large set of alternatives to a manageable size	Cook, 1993
	• Use natural language processing systems (search with artificial intelligence)	Nelson, 2001
	• Information quality filters	Ackoff, 1967; Bawden, 2001; Denning, 1982; Edmunds & Morris, 2000; Grise & Gallupe, 1999/2000; Hiltz & Turoff, 1985; Jones, 1997
	• Intelligent data selectors (intelligent agents)	Berghel, 1997; Edmunds & Morris, 2000; Maes, 1994
	• Use systems that offer various information organization options (e.g. filing systems)	Hiltz & Turoff, 1985; Sorohan, 1994

TABLE 5: Countermeasures against information overload

Using the Framework as a Basis for Testable Models

The framework presented above serves primarily as an orientational map to structure central research findings. However, it can also serve as a basis for future empirical research. Specifically, three testable models can be derived from the framework

The first model relates to the *causes* of information overload and operationalizes the five cause categories as independent variables which lead to (or predict) information overload (the dependent variable). Each cause group consists of the individual items described in the causes summary table (see Table 3) that are asked as questions in a Likert-scale manner. In this way, the correlation between causes and the occurrence of information overload (measured as the subjective feeling of not being able to process all relevant information in the available time) can be measured. In addition, a questionnaire based on this model can be used to test whether we have allocated the individual causes to the right cause category (based on goodness of fit or Cronbach Alpha values).

The second model to be tested relates to the possible *symptoms* of information overload. The symptoms that are listed in Table 4 can be converted into questions. Based on questionnaire results, one can then build groups of symptoms through factor analysis and correlate these groups (and the individual symptoms) with the question regarding overload (e.g. "do you feel you suffer from information overload?.) This can help us to understand which symptoms may be most representative for the overload phenomenon and in can validate our symptom categories. In this model, the independent variables would be the identified symptoms, whereas the dependent variable would be the occurrence of information overload (in the opinion of the respondents).

The third model addresses possible countermeasures against information overload. It uses the five (cause) categories to ask respondents about countermeasures that may or may not be in place in their organization (and that may or may not help to fight overload). Based on the survey results, the effectiveness of these counter-measures (as well as their grouping) can be evaluated. The independent variables would be the already implemented countermeasures in a company, whereas the dependent variable would be the occurrence of information overload for the questioned individuals.

The main challenge in developing these three models consists of adequately converting the factors we have found in the literature to scaleable questions that can be answered accurately (and honestly) by the respondents.

The framework presented so far gives a systematic overview on the major findings of scientific research on information overload. The discussion on how our framework can be tested with the help of three individual models indicates how future studies in the field can proceed. In order to generate further suggestions on the future of information overload research, we will now

go beyond the mere description of the field and analyze its inherent discourse patterns. This will enable us to see other development needs and neglected areas.

LITERATURE EVALUATION AND FUTURE RESEARCH DIRECTIONS

In order to gain a deeper understanding of the phenomenon of information overload, we will employ two review visualization tools: the *publication and citation time line* for the analysis of the impact of relevant authors in various management domains and the nature of their contribution, and the *discipline Venn diagram* for the analysis of interdisciplinary research on the topic.

The Publication Time Line: Overload Research Patterns by Discipline

The next type of diagram does not focus on particular constructs, but on the authors and their impact. The time line is a good visualization tool if the historic or process perspective of a discourse is analyzed. It is used to illustrate the impact of the most important authors and their contributions in the field of information overload. We have drawn a time line diagram for each one of the four areas in which information overload research has been primarily conducted in the last thirty years, namely accounting, marketing, organizational behavior, and management information systems (MIS). This makes it possible to show schools of thought or controversial discussions and the level of transfer between conceptual and empirical research. The aim is not to visualize all the 23 to 41 articles per field and show all the references to other overload articles, since in this case the visualization would be too crowded and loose clarity and insight. Therefore, the purpose of these time lines is to illustrate the major contributions to the information overload discussion within the four areas of interest. The time lines – in contrast to the other tables or figures - do not strive for completeness but rather for overview. To determine

the ‘relevant’ contributions, we have limited ourselves to articles that were cited repeatedly by other articles. In the following, we look at each domain time line in detail and provide suggestions for future research.

Marketing

The topic of information overload within marketing, or more specifically within consumer research, has become crucial since the number of consumer brands has exploded in the early seventies. What strikes at a first glance at Figure 4 is that only a few studies have been done on a conceptual level and almost all the overload research in marketing is of empirical nature. For the theoretical base, the marketing researchers rely on the findings of psychologists and cognitive scientists, in particular on Miller’s study on our limited capacity of information processing (Miller, 1956). Moreover, the empirical research is, with the only exception of Muller (1984), exclusively based on experiments and neglects surveys or case studies.

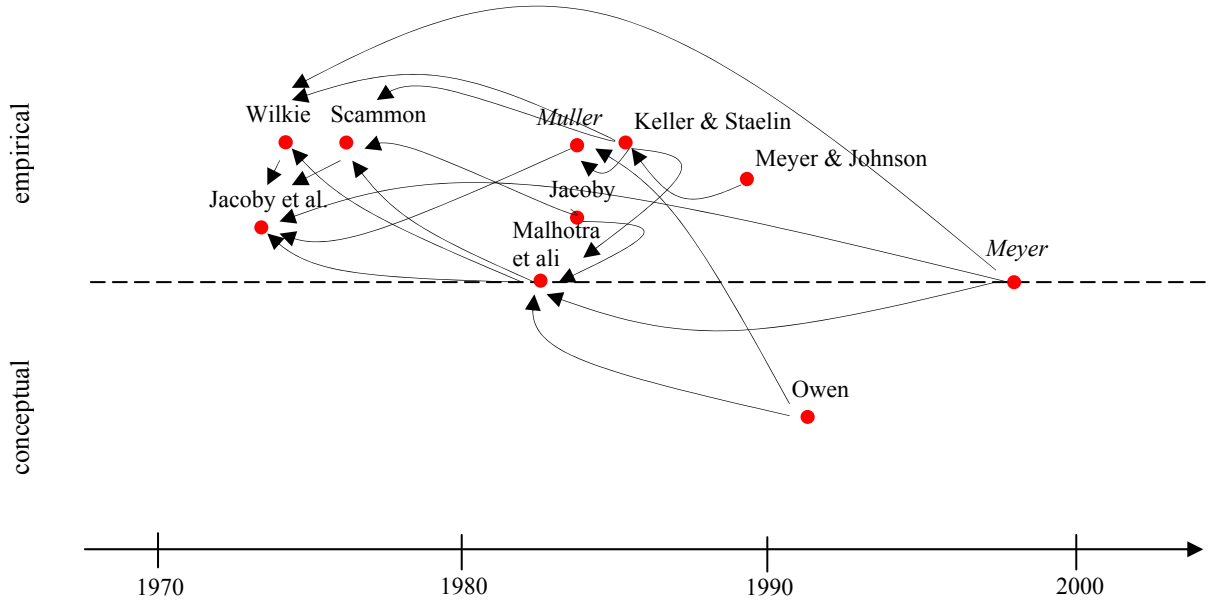

FIGURE 4: Time line of the publications and citations of information overload studies in the area of marketing

Characteristic for the field of marketing is the tangled structure of the references. This is due to the intensive discourse that has taken place around the first study of Jacoby et al. whose methodology has been contested especially by Wilkie (1974), Scammon (1977) and Malhotra (1984). Jacoby and Malhotra emerge to be the gurus within the field. The major activity of research has taken place from the mid 70ies to the mid 80ies and its main theme is whether the number of brands and their attributes (information load) influence product choice of consumers. Generally, the research in the field of marketing focuses on the impact of information overload on decision quality, decision time, and on the actual number of information items that can be processed in a typical purchase situation.

Accounting

The timeline of the contributions from the field of accounting (Figure 5) presents a similar picture as the one of marketing, in so far as the conducted research is almost exclusively empirical.

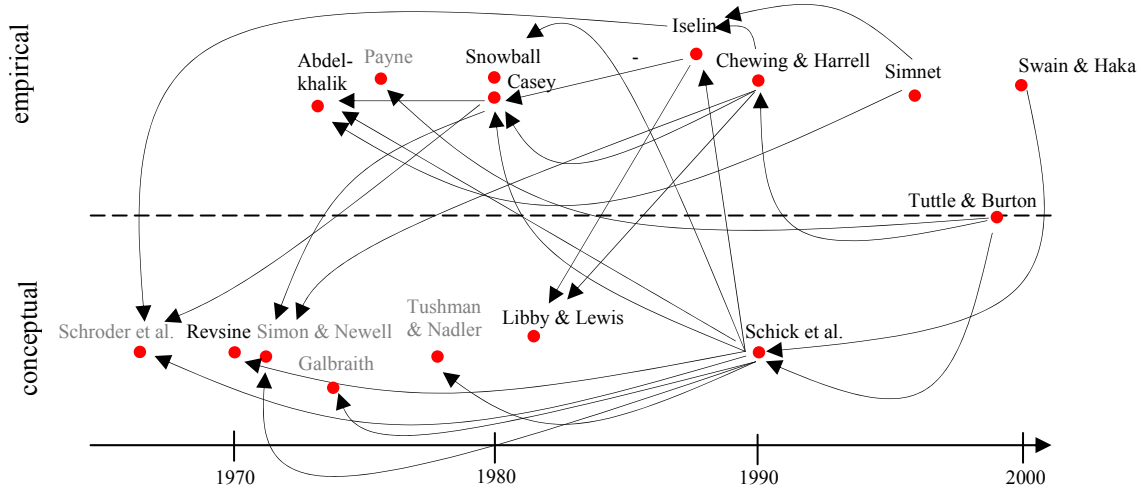

FIGURE 5: Time Line of the publications and citations of information overload studies in the area of accounting

Again, the theoretical basis is borrowed from psychologists and cognitive scientists as Schroder et al. (1967), Miller (1956) and Simon & Newell (1971). Apart from these fundamental insights from psychology, the research is not particularly interdisciplinary. Schick et al.'s article (1990) and to a smaller extent also Tuttle & Burton's article (1999) are exceptions to this general trend, are either fully or to an extensive part literature reviews, which include also important insights of organization scientists or from MIS. Still similar to the picture of marketing, the empirical research in the field of accounting is based on experimental situations and not on field research in organizations. Additionally, Figure 5 shows that Casey, Iselin, and Abdel-Khalik are authors with a high impact on the studies of information overload in the field of accounting. As a tendency, the researchers who conduct empirical research often refer to the findings of conceptual studies but this transfer from conceptual findings to empirical ones does not work in the opposite direction The main theme of the studies in the area of accounting is the impact of the level of information load on decision quality or accuracy for example regarding budgeting decisions (as in Swain & Haka, 2000) or predictions of bankruptcy (as in Casey, 1980).

Organization Science

What is striking in the area of organization science is that almost all the contributions on information overload are conceptual articles. Some of the few empirical papers are O'Reilly (1980) and Griffeth, Carson & Marin (1988). These two studies work with a subjective definition of information overload and focus on the satisfaction of the person loaded with information. The measurement tools are thus questionnaires and not experiments.

In general, Figure 6 depicts a rather loosely connected structure of citations, in which Galbraith and Tushman & Nadler gained a major impact within the research community. The main reason for this looseness of the structure is that the authors refer to organization scientists

who made important contributions for general organizational issues, but not specifically for the field of information overload. These contributions are therefore not visible in the diagram. The most intense research activity has taken place in the nineties. Possible reasons for this fact are the rapid propagation of information technologies as the Internet (e-mail) as well as the trend towards collaborative work and flat hierarchies which have turned information load into a major problem for managers, especially when confronted with complex tasks and environments (Meyer, 1998). The main interest of the research in this field is to show whether and how the information processing capacity of an individual can be expanded through changes in the organizational design and how this design influences the information processing requirements. Again, what has been said for the other research areas is also true for organization science, namely that the research in this domain is not highly interdisciplinary. This is surprising for a field that typically incorporates many concepts from related social sciences.

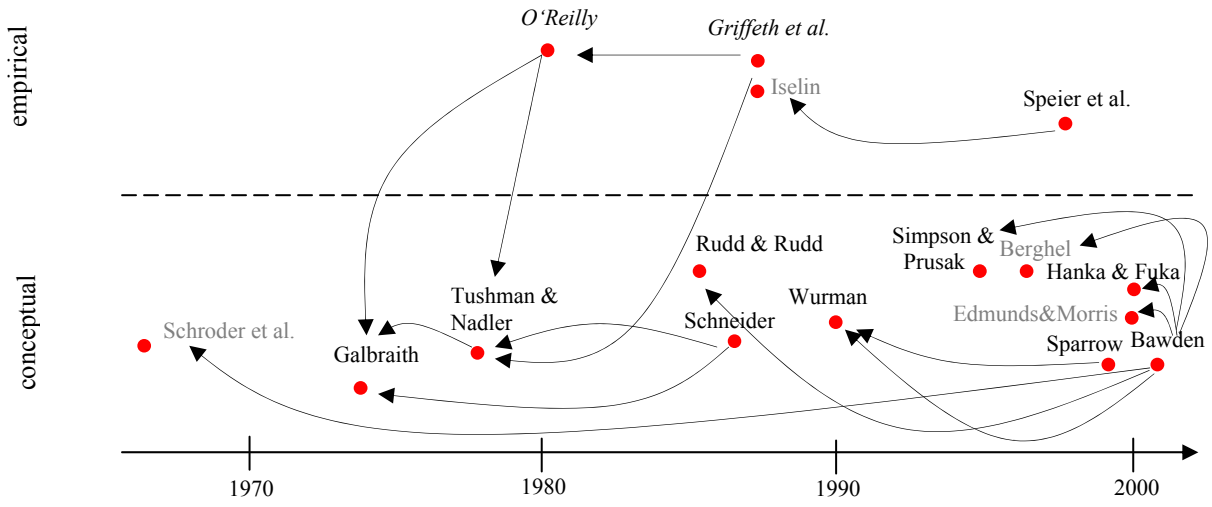

FIGURE 6: Time line of the publications and citations of information overload studies in the area of organization science

Management Information Systems

Surprisingly, the area of MIS has not been the discipline which has dealt with information overload in the most extensive manner. Authors in the field of MIS mostly use the concept of information overload as a starting point for their tool or technology application discussions. Information overload per se is mostly not systematically defined, discussed or analyzed, but seen as a given problem that has to be resolved. Consequently, the net number of articles dealing primarily with information overload in the MIS field is remarkably low when compared to the total number of MIS papers that address the phenomenon in their title or abstract.

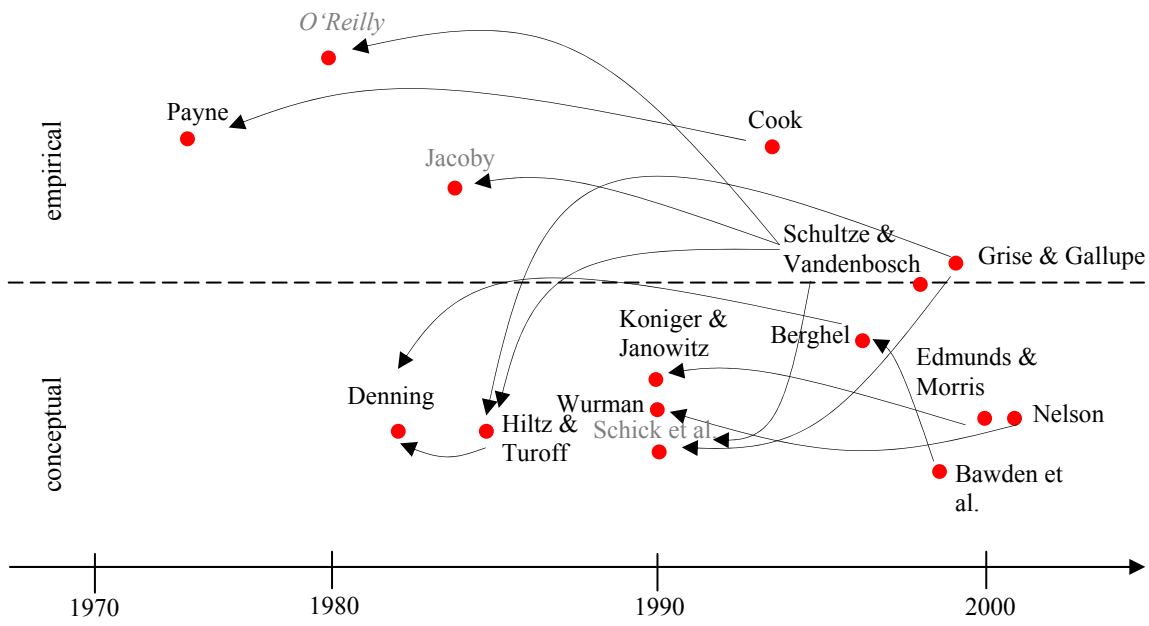

FIGURE 7: Time line of the publications and citations of information overload studies in the area of MIS

The major publication activity regarding overload in the MIS field has taken place in the nineties (except for Ackoff, 1967, Denning, 1982 and Hiltz and Turoff, 1985). In spite of this fact - and with the exception of Schultze and Vandenbosch's article (1998) that combines insights from accounting, marketing and organization science - the MIS researchers do not seem

to profit enough from already existing findings on information overload outside of their field. As mentioned earlier, the focus of MIS researchers has been to propose effective countermeasures, and not to study the root causes of the problem or its contextual factors.

Consequently, the MIS research is concentrated on conceptual studies and there is an obvious missing link between conceptual and empirical studies; the two approaches not often refer to one other. One very valuable exception is again the contribution of Schultze and Vandenbosch (1998), which combines both a literature review and a survey. The article refers to conceptual papers as well as to empirical findings from other areas outside the MIS domain. Aside from this exception, MIS researchers tend to be mainly interested in finding technical solutions for the information overload problem. Their contributions are thus interesting with regard to (technology-based) countermeasures against information overload.

From the analysis of the different time lines several conclusions can be drawn. It has been shown that the transfer between empirical and conceptual studies can be improved and should be intensified in future research. Most of the empirical research that has been conducted within the aforementioned disciplines is done in experimental settings and does hence not rely on authentic management contexts. This issue relates to our prior point that future research should move closer to the original overload context of managers. Interestingly, some research areas focus more on empirical studies and lack conceptual research, which is true for accounting and marketing, while the areas of organization science and MIS are more interested in conceptual approaches. But all the four areas, except to some extent the area of accounting, do not achieve a consistent transfer from empirical to conceptual research and vice versa. This, however, is a crucial prerequisite for cumulative research. Another prerequisite for cumulative research is the transfer of research findings between closely related disciplines. This important issue is further explored in the next section.

The Status of Interdisciplinary Information Overload Research

The final diagram of this literature analysis examines the interdisciplinary status of information overload research. The Venn diagram depicted in Figure 9 maps the cross-citations between major overload articles. The inclusion criteria are the same ones as for the publication time lines.

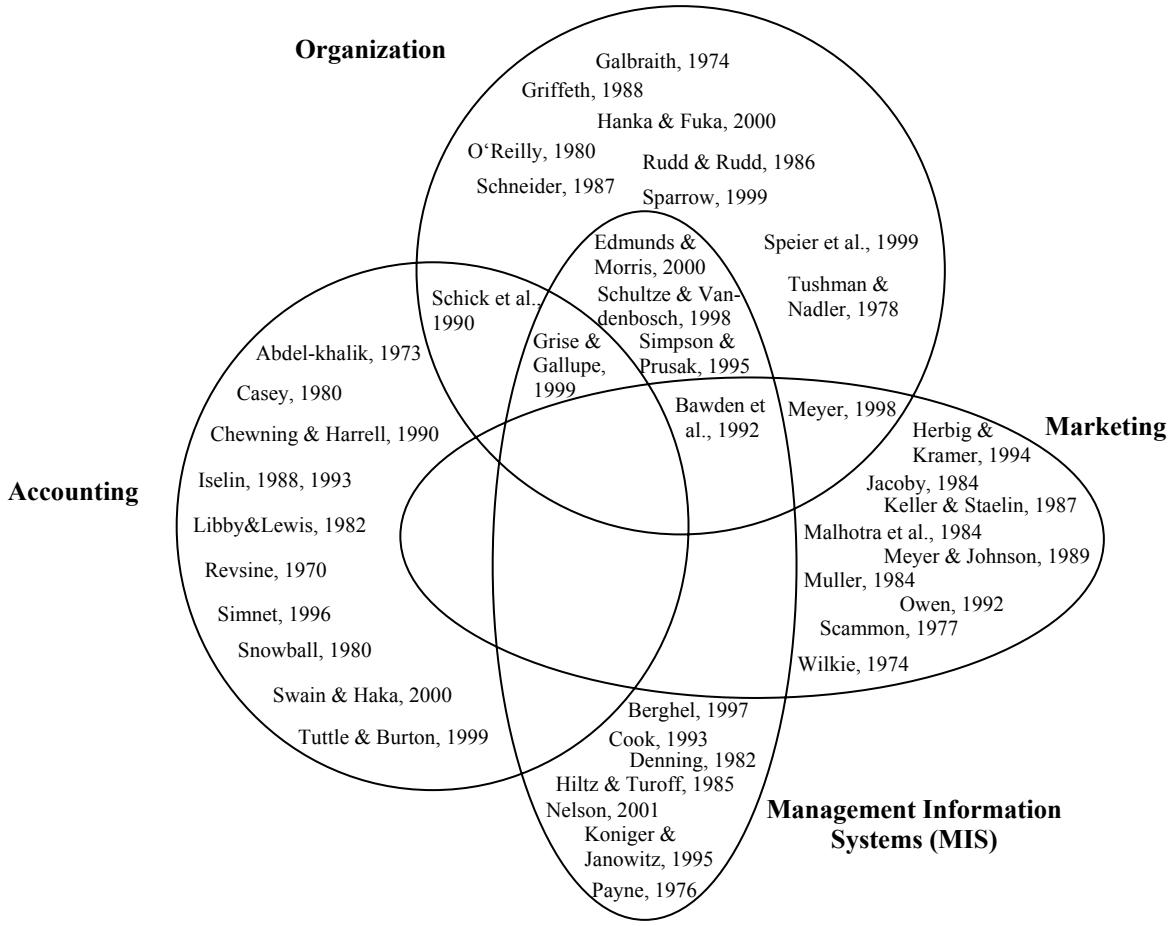

FIGURE 8: Cross-referencing among major information overload studies

In general, only a few authors integrate various management perspectives to study the problem of overload. In fact, no intersections between the area of accounting with the one of marketing or the one of MIS exist to our knowledge, neither between marketing and MIS. Most of the intersections (in terms of citing and using relevant work from other domains) are visible

within the area of *organization science*. Some authors of the other three fields integrate findings from the organizational context. The diagram doesn't show the entire scope of interdisciplinary research, because it does not show whether authors integrate perspectives of other research disciplines, such as cognitive science or psychology. The diagram merely visualizes the (weak) links among the four chosen management fields. In this respect, it can be stated that future research should be more oriented on approaches that use the insights of already existing findings of information overload obtained though different contexts (Akin, 1997, p. 9). This is especially true as some research areas of information overload (such as marketing) have been conducted much earlier than others (such as MIS).

In the final two sections of this article we summarize the findings and highlight their implications for researchers and managers.

IMPLICATIONS

From the literature analysis on information overload, future research directions have emerged. In the first part of the article, the presentation of the information overload framework has shown that the analysis of information overload should no longer be studied using models of linear cause and effect, but should rather be represented with *cyclical* structures and a focus on *interdependencies*. This is important since the complexity of the phenomenon is mainly given by the interconnectedness of its various variables.

Secondly, the analysis of the time lines showed that there is a need for overload research beyond disciplinary boundaries: Research on overload in the MIS context should be further developed, especially with regard to the analysis of overload root causes. MIS research may also find overload a fruitful research topic with regard to new media such as intranets and with regard

to various IT-related job profiles (such as IT analysts or project managers). The *transfer between conceptual and empirical studies* must be intensified in order to assure cumulative research progress. The time lines and the discipline Venn diagram have shown that *interdisciplinary* approaches have not yet been fully exploited. This holds true both for empirical and for conceptual contributions. As far as empirical research is concerned, it is often too detached from the specific overload contexts. Thus, we advocate more *context-rich, qualitative research methods* (such as case studies or ethnographies) in addition to the already used experiments and surveys. Our approach, however, has been implicitly based on the 'disease' metaphor of information overload, representing the phenomenon as something that shares the characteristics of an illness that must be fought. Effective methodologies to prevent information overload may need to approach the problem in more diverse ways, seeing it not only as a possible individual disorder, but as a systemic, emergent pattern of certain behaviors, expectations and structures. This alternative, constructivist view of overload could eventually lead to a *methodology* that outlines specific steps to avoid information overload in organizations. As mentioned earlier, such a systematic methodology does not yet exist and a sound empirical basis must first be established (we have discussed three testable models for such research). Suggestions for management can nevertheless be deduced from the current findings. They are outlined below in the final section of the article.

This literature review can provide some guidance for managers who are facing the problem of information overload in their workplace. First of all, simple recipes to fight information overload seem handy but usually do not embrace the complexity of the problem. One should therefore keep in mind that a specific countermeasure (such as introducing e-mail standards, installing filtering devices, offering training courses, or setting up personalized information portals) does not just act at a single variable of information overload, but has

repercussions on many other variables. Because of this, it is better to opt for solutions that take into account the various causes of information overload. In this paper, we identified five major causes of overload: the person dealing with information overload (be it as a sender or as a receiver of information), the information technology (if and how it is used), the organizational design (the co-ordination mechanisms), the processes and tasks that need to be completed, and finally the characteristics of information itself (ambiguity, uncertainty, complexity, intensity). Ideally, all of these variables should be addressed if an organization is determined to reduce the problem of overload. New IT-applications, for example, should be accompanied by adequate process changes, organizational adaptations, and training. Countermeasures should consequently not focus on the symptoms of overload (e.g., too many e-mails, too much reading material), but on the *root causes*, such as unclear or ambiguous information (regarding information itself), unstructured data repositories (regarding IT), unclear responsibilities (regarding the organization), or ineffective personal management techniques (regarding the person). Another key implication for management besides focusing on the root causes is thinking of information overload not just in terms of quantity, but also in terms of *quality*. Thus, managers should not only be interested in reducing the number of exchanged messages, but more importantly in assuring certain quality standards for information that is communicated or documented. This could be one of the most effective ways to close the gap between (perceived) information requirements and information processing capacity. In this context, the stream of research focusing on information quality (see Simpson & Prusak, 1995, Wang et al. 1998) could be and should be connected with the information overload discourse to match a crucial success factor with a key impediment for effective business communication.

REFERENCES

Abdel-Khalik, A. R. 1973. The effect of aggregating accounting reports on the quality of the lending decision: An empirical investigation. ***Journal of Accounting Research***, 1973 Supplement, 11: 104-138.

Ackoff, R. L. 1967. Management misinformation systems. ***Management Science***, 14: 147-156.

Akin, L. K. 1997. ***Information overload. A multi-disciplinary explication and citation ranking within three selected disciplines: Library studies, psychology/psychiatry, and consumer science 1960-1996,*** PhD Thesis, Texas Woman's University.

Allert, J.L. 2001. A 12-step (or so) Program for Information Junkies. ***Training & Development***, 55: 32-37

Ansari, A., & Mela, C.F. 2003. E-Customization. ***Journal of Marketing Research***, 15: 131-145

Baldacchino, C., Armistead, C., & Parker, D. 2002. Information overload: It's time to face the problem. ***Management Services***, 46: 18-19

Bawden, D. 2001. Information overload. ***Library & Information Briefings***, 92, Online [6/10/02] http://litc.sbu.ac.uk/publications/lframe.html.

Bawden D, Holtham C, Courtney N. 1999. Perspectives on information overload. ***ASLIB PROCEEDINGS,*** 51 (8): 249-255.

Berghel, H. 1997. Cyberspace 2000: Dealing with information overload. ***Communications of the ACM***, 40: 19-24.

Casey, C. J., Jr. 1980. Variation in accounting information load: The effect on loan officers´ predictions of bankruptcy. ***The Accounting Review***, 55: 36-50.

Casey, C.J. 1982. Coping with Information Overload: The Need for Empirical Research. ***Cost and Management***, 4: 31-38.

Castells, M. 1996. ***The Information Age: Economy, Society and Culture. Volume I: The Rise of the Network Society***. Oxford: Blackwell Publishers.

Chan, S.Y. 2001. The use of graphs as decision aids in relation to information overload and managerial decision quality. ***Journal of Information Science***, 6: 417-426.

Chervany, N. & Dickson, G. 1974. An Experimental Evaluation of Information Overload in a Production Environment. ***Management Science***, 10: 1335-1344.

Chewning, E. C., Jr., & Harrell, A. M. 1990. The effect of information load on decision makers' cue utilization levels and decision quality in a financial distress decision task. ***Accounting, Organizations and Society***, 15: 527-542.

Cook, G. J. 1993. An empirical investigation of information search strategies with implications for decision support system design. ***Decision Sciences***, 24: 683-699.

Denning, P.J. 1982. Electronic junk. ***Communications of the ACM***, 25: 163-168.

Denton, D.K. 2001. Better decisions with less information. ***Industrial Management***, 43: 21-26

Edmunds, A., & Morris, A. 2000. The problem of information overload in business organizations: A review on the literature. ***International Journal of Information Management***, 20: 17-28.

Eppler, M. 1998. Informative Action: An Analysis of Management and the Information Overload, PhD thesis, HEC Management Studies, Geneva: University of Geneva.

Evaristo, R. 1993. An Empirical Investigation of the Impact of Information Characteristics and Information Technology on Individual Information Load. PhD thesis, Carlson School of Management, Minnesota: University of Minnesota.

Friedmann, M. 1977. Consumer use of informational aids in supermarkets***. Journal of Consumer Affairs***, 78-155.

Galbraith, J. R. 1974. Organization design: An information processing view. ***Interfaces***, 3: 28-36.

Grether, D., Schwartz, A., & Wilde, L. 1986. The irrelevance of information overload: An analysis of search and disclosure. ***Southern California Management Review***, 59:277-303.

Griffeth, R. W., Carson, K. D., & Marin, D. B. 1988. Information overload: A test of an inverted U hypothesis with hourly and salaried employees. ***Academy of Management Proceedings***, 232-237.

Grise, M. & Gallupe R.B. 1999/2000. Information overload: Addressing the productivity paradox in face-to-face electronic meetings. ***Journal of Management Information Systems***, 16 (3): 157-185.

Haksever, A. M. & Fisher, N. 1996. A Method Of Measuring Information Overload In Construction Project Management. ***Proceedings CIB W89 BEIJING INTERNATIONAL CONFERENCE***, 310-323.

Hanka, R., & Fuka, K. 2000. Information overload and 'just in time' knowledge***. The Electronic Library***, 18: 279-284.

Hansen, M.T. & Haas, M.R. 2001. Competing for Attention in Knowledge Markets: Electronic Document Dissemination in a Management Consulting Company. ***Administrative Science Quarterly***, Nr. 46: 1-28.

Herbig, P. A., & Kramer, H. 1994. The effect of information overload on the innovation choice process. ***Journal of Consumer Marketing***, 11: 45-54.

Hiltz, S. and Turoff, M. 1985. Structuring computer-mediated communication systems to avoid information overload. ***Communications of the ACM***, 28: 680-689.

Hunt, R.E., and Newman, R.G. 1997. Medical knowledge overload: A disturbing trend for physicians. ***Health Care Management Review***, 22: 70-75.

Hwang, M.I., & Lin, J.W. 1999. Information Dimension, Information Overload and Decision Quality. ***Journal of Information Science***, 25 (3): 213-218.

Iselin, E. R. 1988. The effects of information load and information diversity on decision quality in a structured decision task. ***Accounting, Organizations and Society***, 13: 147-164.

Iselin, E. R. 1993. The effects of the information and data properties of financial ratios and statements on managerial decision quality. ***Journal of Business Finance & Accounting***, 20: 249-267.

Jacoby, J., Speller, D. E., & Berning, C. K. 1974. Brand choice behavior as a function of information load: Replication and extension. ***The Journal of Consumer Research***, 1: 33-43.

Jacoby, J. 1977. Information load and decision quality: Some contested issues. ***Journal of Marketing Research***, 14: 569-73.

Jacoby, J. 1984. Perspectives on information overload. ***Journal of consumer Research***, 10: 432-436.

Jones, B. 1986. Dying for information? ***Management Review***, 86: 9

Keller, K. L., & Staelin, R. 1987. Effects of quality and quantity of information on decision effectiveness. ***The Journal of Consumer Research***, 14: 200-213.

Kock, N. 2000. Information Overload and Worker Performance: A Process-Centered View. ***Knowledge and Process Management***, 4: 256-264.

Koniger, P., & Janowitz, K. 1995. Drowning in information, but thirsty for knowledge. ***International Journal of Information Management***, 15: 5-16.

Lesca, H. & Lesca, E. 1995. ***Gestion de l'information, qualité de l'information et performances de l'entreprise***. Paris: Litec.

Libby, R., & Lewis, B. L. 1982. Human information processing in accounting: The state of the art in 1982. ***Accounting, Organizations and Society***, 7: 231-285

Libowski, Z. 1975. Sensory and information inputs overload: Behavioral effects. ***Comprehensive Psychiatry***, 16:199-221.

Malhotra, N. K. 1982. Information load and consumer decision making. ***The Journal of Consumer Research***, 8: 419-431.

Malhotra, N. K., Jain, A. K., & Lagakos, S. W. 1982. The information overload controversy: An alternative viewpoint. ***Journal of Marketing***, 46: 27-37.

Malhotra, N. K. 1984. Reflections on the information overload paradigm in consumer decision making. ***The Journal of Consumer Research***, 10: 436-441.

McKinnon, S.M. & Bruns, W.J. Jr. 1992. ***The Information Mosaic***. Boston: Harvard Business School Press.

Maes, P. 1994. Agents that reduce work and information overload. ***Communications of the ACM***, 37: 31-40

Meier, R. L. 1963. Communications overload: Proposals from the study of a university library. ***Administrative Science Quarterly***, 7: 521-544.

Meglio, C.E. & Kleiner, B. E. 1990. Managing Information Overload. ***Industrial Management & Data Systems***, 1. Online [6/22/02] http: www.leporello.emeraldinisght.com.

Meyer, J. 1998. Information overload in marketing management. ***Marketing Intelligence & Planning***, 16: 200-209.

Meyer, R. J., & Johnson, E. J. 1989. Information overload and the nonrobustness of linear models: A comment on Keller and Staelin. ***Journal of Consumer Research***, 15: 498-503

Milgram, S. 1970. The Experience of Living in the Cities. In ***Science***, March, 13: 1461-1468

Miller, J. A. 1956. The magical number seven plus or minus two: some limits on our capacity for processing information. ***Psychological Review***, 63: 81-97.

Muller, T. E. 1984. Buyer response to variations in product information load***. Psychological Review***, 63: 81-97.

Nelson, M. R. 2001. We have the information you want, but getting it will cost you: Being held hostage by information overload. Online [6/14/02] http:// www. acm.org/crossroads /xrds1-1/mnelson.html.

O'Reilly, C. A. 1980. Individuals and information overload in organizations: Is more necessarily better? ***Academy of Management Journal***, 23: 684-696.

Olsen, K. A., Sochats, K. M., & Williams, J. G. 1998. Full text searching and information overload. ***Intelligent Information and Library Review***, 30: 105-122.

Owen, R. S. 1992. Clarifying the simple assumption of the information load paradigm. ***Advances in Consumer Research***, 19: 770-776.

Payne, J. W. 1976. Task complexity and contingent processing in decision making: An information search and protocol analysis. ***Organizational Behavior and Human Performance***, 16: 366-387.

Revsine, L. 1970. Data expansion and conceptual structure. ***The Accounting Review***, 45: 704-712.

Rudd, J., & Rudd, M. J. 1986. Coping with information load: User strategies and implications for librarians. ***College & Research Libraries***, 47: 315-322.

Russo, J. E. 1974. More Information is better: A Reevaluation of Jacoby, Speller, and Kohn. ***Journal of Consumer Research***, 1(3): 68-72.

Scammon, D. L. 1977. 'Information load' and consumers. ***Journal of Consumer Research***, 4: 148-156.

Schick, A. G., Gorden, L. A., & Haka, S. 1990. Information overload: A temporal approach. ***Accounting Organizations and Society***, 15: 199-220.

Schneider, S. C. 1987. Information overload: Causes and consequences. ***Human Systems Management***, 7: 143-153.

Schroder, H. M., Driver, M. J., & Streufert, S. 1967. ***Human information processing – Individuals and groups functioning in complex social situations***. New York: Holt, Rinehart, & Winston.

Schultze, U. & B. Vandenbosch. 1998. Information Overload in a Groupware Environment: Now you see it, now you don't. ***Journal of Organizational Computing and Electronic Commerce***, vol. 8, 2: 127-148.

Shenk, D. 1997. ***Data smog. Surviving the information glut***. London: Abacus.

Simnet, R. 1996. The effect of information selection, information processing and task complexity on predictive accuracy of auditors. ***Accounting, Organizations and Society***, 21: 699-719.

Simon, H. A. 1979. Information processing models of cognition***. Annual Review of Psychology***, 30: 363-396.

Simon, H. A., & Newell, A. 1971. Human problem solving: The state of the theory in 1970. ***American Psychologist***, 26: 145-159.

Simpson, C. W., & Prusak, L. 1995. Troubles with information overload – Moving from quantity to quality in information provision. ***International Journal of Information Management***, 15: 413-425.

Snowball, D. 1980. Some effects of accounting expertise and information load: An empirical study. ***Accounting, Organizations and Society***, 323-338.

Sorohan, E.G. 1994. Coping with overload. ***Training & Development***, 48: 13

Sparrow, P.R. 1998. Information Overload. Legge, K., Clegg, C., Walsh, S. (Eds.) The experience of managing: a skills workbook. London: MacMillian, 111-118.

Sparrow, P. R. 1999. Strategy and cognition: Understanding the role of management knowledge structures, organizational memory and information overload***. Creativity and Innovation Management***, 8: 140-149.

Speier, C., Valacich J. S., & Vessey, I. 1999. The influence of task interruption on individual decision making: An information overload perspective. ***Decision Sciences***, 30: 337-359.

Swain, M. R., & Haka, S. F. 2000. Effects of information load on capital budgeting decisions. ***Behavioral Research in Accounting***, 12: 171-199.

Tushman, M. L., & Nadler, D. A. 1978. Information Processing as an Integrating Concept in Organizational Design. ***Academy of Management Review***, 3: 613-625.

Tuttle, B., & Burton, F. G. 1999. The effects of a modest incentive on information overload in an investment analysis task. ***Accounting, Organizations and Society***, 24: 673-687.

Van Zandt, T. 2001. ***Information Overload in a Network of Targeted Communication***, INSEAD Working Paper, 2001/36/EPS.

Vollmann, T. E. 1991. Cutting the Gordian Knot of Misguided Performance Measurement. ***Industrial Management & Data Systems***, 1, 24-26.

Webster, J., Watson, R.T. 2002. Analyzing the Past to Prepare for the Future: Writing a Literature Review, ***MIS Quarterly,*** Vol. 26 No. 2 / June, pp. xiii-xxiii.

Walsh, J.P. 1995. Managerial and Organizational Cognition: Notes from a Trip down Memory Lane, ***Organization Science***, May-June, 3: 280-321.

Wang, R. Lee; Y.W., Pipino, Strong, D. (1998) Manage Your Information as a Product. ***Sloan Management Review***, 4: 95-105.

Weick, K.E. 1970 The twigging of overload. In Pepinsky, H.B. (Ed.): ***People and Information***, New York: Pergamon, 67-129.

Wilkie, W. L. 1974. Journal of Marketing Research. Analysis of effects of information load. ***Journal of Marketing Research***, 11: 462-466.

Wilson, P. 1996. Interdisciplinary research and information overload, ***Library Trends***, 45: 192-203.

Wurman, R. S. 1990. ***Information anxiety. What to do when information doesn't tell you what you need to know.*** New York: Bantam Books.

Wurman, R.S. 2001. ***Information Anxiety2***, Indiana: Macmillan Publishing.