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INFORMATION MANAGEMENT

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Human factors

Closing the cognitive gaps: how people process information

The question 'What do you want to know?' is only the starting point of the process of assessing a worker's information needs

SUMMARY

Information can be seen two ways: as an object that can be manipulated by technology; and as the outcome of social interactions that create meaning in the minds of human beings. In this article, Chun Wei Choo outlines a model of how people acquire and process information. The three basic steps are determination of information needs, information seeking and information use, each of which can be considered in terms of cognitive, emotional and situational factors. Information needs arise when people experience cognitive gaps that hinder their progress and induce uncertainty. To bridge these, they must seek good, accessible information sources. The way they use the information acquired depends upon their personality, organizational culture and emotional factors such as the desire to preserve group identity. If we can understand the social aspects of information we will be able to design better information systems.

We often see information described as a resource. This implies that information is a thing that resides in documents, information systems or other artifacts. The information is assumed to be constant, unchanging. Its meaning is fixed by its representation in the artifact.

A complementary view is to look at information not as an object but as the outcome of people constructing meaning out of messages and cues. Information resides not in

artifacts but in individuals' minds. Individuals actively create the meaning of information through their thoughts, actions and feelings.

When we treat information as an object, we are concerned with how to acquire the information that we need, and how to represent the information that we have in order to make it easier to use. When we treat information as constructed by people, we are concerned with understanding the social and behavioural processes through which it is created and used. The social settings in which information is encountered determine its value. A fuller understanding of information-seeking as social behaviour helps us design better information processes and information systems.

As shown in Figure 1, we can divide information-seeking into three processes: experience of information needs, information-seeking, and information use. In this article we will examine the cognitive, affective (emotional) and situational factors that influence each of these processes.

Since the Second World War, many studies have attempted to understand how different groups of people -- including scientists, engineers, doctors, academics, civil servants, managers and public sector employees -- experience and meet information needs. A convincing recent model of such behaviour is the "sense-making" model developed by Brenda Dervin of Ohio State University.

In the sense-making approach, a person moves through space and time, taking steps through experiences. As long as he or she can make sense of these experiences, movement ahead is possible. But from time to time, movement is blocked by the perception of a "cognitive gap" -- a situation that the person is unable to make sense of. To bridge this gap, the person seeks information to make new sense so that he or she can continue the journey.

Dervin and her associates have completed more than 40 studies in the past two decades based on the sense-making approach. Their research suggests that the ways in which people perceive cognitive gaps and the ways that they want information to help are good predictors of their information-seeking behaviour. Better yet, the ways people define these gaps fall into categories that apply across different groups of information users.

Cognitive needs are as much felt as thought about. When sense runs out, the lack of understanding creates uncertainty. Carol Kuhlthau of Rutgers University, N.J., has found that uncertainty causes anxiety, apprehension, confusion, frustration and lack of confidence, among other symptoms. These affective states in turn direct the way people seek and use information.

Affective responses influence, and are influenced by, individuals' ability to construct meaning, to focus on what information they need, to manage moods and expectations, and to feel personal interest in the search. People cope with the stress of uncertainty in different ways. Research into health information-seeking by Tom Wilson at Sheffield University contrasts "monitors", who prefer high levels of information to cope with stressful events, with "blunters," who prefer less information.

At the situational level, information needs arise from the problems, uncertainties and ambiguities encountered in specific contexts and experiences. These relate not just to the subject matter, but also to such things as whether objectives are clear and agreed upon, the magnitude of risk, the amount and structure of control, professional and social norms, time and resource constraints, and so on.

As a result, the determination of information needs must not stop at asking "What do you want to know?" but must also address questions such as: "Why do you need to know it?" "What does your problem look like?" "What do you know already?" "What do you anticipate finding?" and "How will this help you?" Susan MacMullin and Robert Taylor of Syracuse University, N.Y., suggest that situations should in fact be analyzed in terms of 11 "problem dimensions".

INFORMATION-SEEKING

Experiencing information needs may lead to information-seeking. This resembles a problem-solving or decision-making process. An individual identifies possible sources, selects which ones to use, locates or makes contact with them, and interacts with them to obtain the desired information.

In today's rich information environment, where human attention is a scarce resource,

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how do people allocate time and energy when searching for information? Research suggests that they weigh the amount of effort required to use a source against its anticipated usefulness. This cost/benefit evaluation is affected by the individual's personal interest and motivation, and by the complexity of the task at hand.

At the cognitive level, an individual selects a source that he or she considers most likely to provide relevant, usable and helpful information. Relevance and usability in turn may depend upon how up-to-date and comprehensive the information is. Another important factor is the perceived reliability of the source. Research into information-seeking often groups some or all of these attributes under the rubric of "perceived source quality" in order to examine their effect on source use.

At the affective level, an individual's personal interest in a problem determines the amount of energy he or she invests in seeking information. Carol Kuhlthau has noted that as information searches progress, initial feelings of uncertainty and anxiety fall as confidence rises. If a clear theme is developed to focus the search, the individual may become more highly motivated.

Drawing on social learning theory, Tom Wilson argues that since a feeling of personal mastery about using a source leads to greater use of that source, doubt about one's ability to use a source would conversely lead to that source not being used. This may be the case even if the source is perceived to contain relevant information.

Selection and use of sources is influenced by the amount of time and effort required to locate, contact and interact with them. At least three different kinds of effort or costs may be pertinent: physical effort (to travel to the source, say); intellectual effort (for example, to learn a classification system or computer application); and psychological effort (for example, to deal with an unpleasant source).

These situational attributes can be bundled together as "perceived source accessibility." The selection of sources then depends on their perceived quality and perceived accessibility. Other factors that influence information-seeking are the complexity of the task and environment. A task with many interdependent elements which interact unpredictably may require broader information gathering and processing. Similarly, a volatile external environment may necessitate more information scanning.

INFORMATION USE

Just as there are eight categories of information need, Brenda Dervin and Robert Taylor propose that there are eight general categories that describe how people use information: to develop a context; to understand a particular situation; to know what to do and how to do it; to get the facts about something; to confirm another item of information; to project future events; to motivate or sustain personal involvement; and to develop relationships and enhance status or personal fulfilment.

An individual's cognitive style and preferences affect the way he or she processes information. A number of classifications have been developed to differentiate personality types and cognitive preferences. A widely used method is the Myers-Briggs Type Indicator.

Another common cognitive style variable is "field dependence." Field-dependent individuals respond uncritically to environmental cues, whereas field-independent people orientate themselves correctly in spite of environmental cues. Daniel Kahneman (Princeton University) and Amos Tversky (Stanford University, Calif.) have discovered that when people use information to make judgments, they take cognitive shortcuts to make the information easier

The Myers-Briggs personality matrix

One of the most widely used personality assessment instruments in the world is the Myers-Briggs Type Indicator (MBTI) classification, which is developed from the work of Carl Jung. MBTI analyzes personality types on the basis of four pairs of traits:

Introversion versus extroversion Introverts draw mental energy from themselves whereas extroverts draw energy from others.

Sensing versus intuiting Sensing types rely on information perceived through their five senses. Intuitive types rely more on patterns, relationships and hunches.

Thinking versus feeling Thinking types use

to process. Unfortunately, these simplifications are fallible.

For example, to judge whether an event belongs to a given category, people rely on mental stereotypes, but they often ignore other relevant information, such as the distribution of categories in the general population. To judge the frequency or likelihood of an event, people over-rely on recent, vivid, easy-to-recall information. To estimate a quantity, they make adjustments from an amount initially measured or suggested, but these adjustments are often inadequate.

information to make logical decisions based on objective criteria. Feeling types depend on personal values to decide between right and wrong.

Judging versus perceiving Judging types move quickly to closure by making use of the available information. Perceiving types keep their options open by taking their time to gather sufficient information.

These four pairs of attributes are combined to create a matrix of 16 personality types. Each personality type is expected to have a distinctive way of processing and using information.

At the affective level, people avoid using information that will arouse strong, negative emotions in others or in themselves. People use information selectively to avoid embarrassment, conflict or regret; to maintain self-image; and to enhance personal status or reputation.

For example, decision-makers will positively evaluate and continue a course of action even when the available information indicates that they should withdraw to cut their losses. One psychological factor behind such "escalation of commitment" is the desire to save face. Decision-makers persist because they do not want to admit to themselves (let alone others) that they have made an error. In organizations where error-free decision making is valued, managers may attempt to hide their mistakes or postpone their discovery.

Another example of using information selectively to minimize unpleasant feelings is the "not-invented-here" syndrome: the tendency of a long-standing group to reject new information from outside. Over time, people increase the amount of order and stability in their work environments to reduce stress and uncertainty. As a result, the longer individuals have belonged to a group, the stronger their emotional attachment to group beliefs and decisions that they helped create, and the more resistant they are to new ideas and information from outside.

As far as situations are concerned, the norms and rules of the group, profession or organization can influence the way information is processed and used. For example, Irving Janis of Yale University has observed how highly cohesive groups are susceptible to "groupthink." This happens when group members seek concurrence to such an extent that they choose to ignore or undervalue information that threatens group beliefs and solidarity.

Donald Schon of the Massachusetts Institute of Technology has investigated how professions develop their own languages, values, overarching theories, and role definitions. Members adopt these as frames of reference through which information is processed to describe and explain reality, and to reaffirm professional identity.

Edgar Schein of the Sloan School of Managementdefines organizational culture as a pattern of assumptions developed by an organization as it learns to cope with problems of external adaptation and internal integration. Because these assumptions have worked in the past, they are taught to new members as the correct way to approach those problems. As a result, the organization develops a shared framework which its members can use to make sense of information collectively.

Another important feature of organizational culture is organizational politics. In contests for influence and power, information may be used as a resource to protect vested interests or to justify certain courses of action.

AN INTEGRATED MODEL

The three processes described so far can be integrated into a general model of how humans seek information. As shown in Figure 2, individuals experience information needs when they perceive gaps in their knowledge or their ability to make sense. This experience is shaped by cognitive, affective and situational factors. People may choose

to suppress the need by, say, avoiding the problem situation, or they may decide to bridge the gap through purposive information-seeking.

During information-seeking, sources and information are selected according to their perceived accessibility and quality, the complexity of the task and the personal interest of the seeker. Information may also be received incidentally -- through a casual conversation, say, or when idly channnel-hopping -- rather than through deliberate efforts. The outcome of information-seeking is a set of information that is a very small proportion of the total considered.

How this information is then put to use depends on the individual's habits of thought, his or her emotional responses, and the social and cultural context around information use. The final outcome of information use is a change in someone's knowledge, allowing that person to make sense of a situation or to take action. This in turn gives rise to new experiences and new information needs, so that the cycle is continuous.

IMPLICATIONS FOR PRACTICE

The discussion here suggests several ways to improve information management:

1. Design information systems not just to answer queries but to provide useful information that will help people solve work-related problems and deal with the specific requirements of problem situations. System designers need to move beyond analyzing flows of data to understanding how people construct the meaning of information and how they negotiate the context of organizational work. For example, users should be able to query systems not just with account numbers or keywords but also with task descriptions ("I am writing a project plan on x -- get me information that will help me") and sense-making questions ("What are the assumptions guiding our interpretation?").

2. Increase awareness of the nature of human information-seeking and processing; this involves understanding cognitive styles and limitations, and the ways that routines and emotional defences can block learning. Cognitive diversity invigorates an organization, so the intention should be not to pigeonhole people according to their presumed strengths and weaknesses. Instead, the goal should be a lively mix of styles, skills and sensitivities in a group so as to heighten vigilance in information processing.

3. Educate everyone to manage information quality and information quantity. System designers need to understand how people assign value to information. Users need to know how to evaluate the quality of sources and how to trade this off with their accessibility. In restricting the quantity of information to prevent overload, users should also guard against premature closure: Divergent information gathering (which consults many sources) is necessary to prepare the ground for convergent action.

4. Develop an organizational culture that values and encourages information sharing. Some of the best information sources are one's colleagues. Yet paradoxically, as organizations become more information-intensive, the less likely it is that members will share their information freely. Organizations must now work at creating and sustaining cultures that promote the sharing of information and knowledge.

QUALITY VERSUS ACCESSIBILITY: HOW CHIEF EXECUTIVES KEEP UP TO DATE

Most studies of how people use information sources have found that a source's perceived accessibility is a major determinant of whether it is used or not. For example, scientists, engineers and managers are often sensitive to source accessibility, so that a library or information centre on the next floor or even a few offices away may be infrequently visited, even though people recognize that it contains more complete and up-to-date information than their close-at-hand sources.

However, a recent study of how chief executives in the Canadian telecommunications industry scan their business environments for information about trends and developments found a different pattern. For these chief executives, the perceived quality of a source (in terms of reliablity and relevance) was a more important predictor of whether it was used or not than its perceived accessibility.

The study observed that chief executives invested time and effort in contacting and interacting with less accessible sources such as customers, competitors and business associates.

The chief executives rated these personal sources highly for their ability to provide accurate and usable information. The study suggested that the switch of emphasis from accessibility to quality was because the executives were trying to make sense of a complex and ambiguous business environment, and were personally interested in learning about external trends and developments.

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