APPLIED THEORY

SUMMARY
- Describes how technical communicators can become involved in knowledge management
- Examines how technical communicators can teach organizations to design, access, and contribute to databases; alert them to new information; and facilitate trust and sharing

# Technical Communication, Knowledge Management, and XML

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In an attempt to empower technical communicators, Johnson-Eilola, Selber, and Selfe (1999) have encouraged them to see the rapid advances in computer technology as an opportunity to effect change, and to accomplish this change, to think in critically informed ways about how they use this technology. This need is driven by the fact that the pace of deploying these technologies in the workplace is accelerating and this phenomenon challenges technical communicators to hurriedly adopt new applications, thus cutting into their ability to examine their practices critically.

Additionally, it is becoming clear that the key factors associated with computers depend on the histories, contexts, and relationships that people who design and use these products have with technology as much as on the hardware and software themselves.

For example, hypertext is a medium that allows for a new emphasis on the roles of the reader and the writer, and it can function as a contractive or expansive communication technology (Johnson-Eilola and Selber 1996). A contractive technology assumes that in communicating, the sender packages information into "discrete, ideally unambiguous chunks"; the reader is essentially a passive receiver of information. In the expansive mode of communication, information is transferred in a process in which readers construct and deconstruct pieces of information, putting it into a context that is in part a function of the social and political environment in which they work.

Expansive communication is a recursive process that takes the "user, designer, technology and context" into consideration. Not to see communication technology in this perspective suggests a "technological determinism" in which technology can be used to send and receive only one kind of message, regardless of the needs of the people involved in the process (Johnson-Eilola and Selber 1996, p. 121).

Based on the premise that the design of a system has already been set by the engineers who built it, technical communicators have been traditionally relegated to learning just enough about a part of the system so they can explicate it clearly. Technical communicators are usually not understood as "authors"; at best, they are translators of the information that has been generated by others before them. This perception results from our culture's practice of attributing single ownership to those who are believed to have invented, designed, or written something that is not to be altered. However, when technical communicators engage in their work, it is understood that they are always "adding, deleting, changing, and selecting meaning" within the context of the communication medium they are employing to meet the needs of their audience. Their work is not neutral; they are authors, even when they write in a manner that makes their articulations seem invisible (Slack, Miller, and Doak 1993, p. 31).

Authorship comes with some responsibility, however. When they are articulating meaning, technical communicators need to think critically about the ethical responsibility of their work. Whom they work for and what they communicate also matter (Slack, Miller, and Doak 1993, p. 32).

If technical communicators do not understand this role and continue to document practices as mere translators, the ability of the user to employ the technology in an expan-

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sionist sense will be undermined (Johnson-Eilola 1996, p. 247). For example, hypertext products are generally framed in industry in "strictly automating terms"; users are asked to follow a series of steps to achieve a predetermined result that the technology can offer without teaching and encouraging its use for potential tasks not imagined by its designers (Johnson-Eilola and Selber 1996, p. 124).

Echoing Robert Reich (1991), Johnson-Eilola (1996) asks that technical communicators work to promote themselves as symbolic-analysts whose skills include the manipulation of information, a task that requires a greater understanding of that information in the abstract. This challenge is built on the premise that we have moved from an industrial to an information economy in which technical communicators are to a greater degree producing knowledge products. Instead of taking the traditional approach by breaking down problems into small, discrete parts such as a list of tasks that many software documentation professionals are asked to describe, symbolic-analysts work to make meaning out of information with an awareness of the larger system and its ability to serve them and the people who use the products.

Technical communicators need to ask themselves how the social and political context affects the use of the technology they are using, whether it be hypertext or XML, and how this context supports their ability to use this technology in an expansive manner. Wick (2000) challenges technical communicators to claim their role in the knowledge management game by emphasizing their considerable theoretical understanding of rhetoric and ability to communicate within, between, and across different sectors of an organization. To expand on Wick's premise, I believe that because technical communicators can go out, acquire information from people skilled in disciplines different from their own, and then synthesize, organize, and explicate this information for different audiences so that people can understand and use it, they are at the center of an organization's knowledge and can be knowledge managers.

To become more proficient at knowledge management, technical communicators have to look beyond their roles as architects of documents and developers of technological applications that produce and add value to texts. They also need to recognize their ability to help professionals throughout organizations interact with each other and to use knowledge from others inside and outside their organization.

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This knowledge can be shared in a manner that enhances or leverages not just the physical and financial resources of an organization, but its knowledge capital as well: "information assets and knowledge capital seem to be governed by a different law of economic returns: investment in every additional unit of information or knowledge created and used results in a higher return" (Malhotra, 2001, p. 13). The more people contribute to and take from a knowledge network, the greater the value of the network.

## PARADIGMS, ARTICULATION, AND DOABILITY

As described above, Johnson-Eilola, Selber, and Selfe (1999) have asked technical communicators to adopt a more critical understanding of communication technologies so they can be wiser consumers of these products and assume the roles of more effective symbolic-analytic workers. To better engage in this pursuit, they can benefit from examining how the use of tools and their relationship to the materials, assumptions, and methods of the scientific community contribute to the culture of research activity.

Kuhn (1970) tells us that there is something invisible at work beneath the thinking of any group of scientists who agree on a methodology that can be used to explore the perplexing structure of nature:

> *Though many scientists talk easily and well about the particular individual hypotheses that underlie a concrete piece of current research, they are little better than laymen at characterizing the established bases of their field, its legitimate problems and methods. If they have learned such abstractions at all, they show it mainly through their ability to do successful research. (p. 47)*

What Kuhn calls "normal science"—the science that uses the existing and agreed on tools, materials, procedures, and assumptions to answer the kinds of questions and produce appropriate results within the context of the current socially constructed paradigm—can take place without scientists realizing the bases of their belief systems. Things just seem "right" in the context of that paradigm. In modern science, the paradigms are often based on what the tools and materials can measure.

For Kuhn (1970, pp. 185–187), each scientific paradigm shared by a scientific community is based on four socially constructed elements.

- **Every community member believes in the same "symbolic generalizations."** The mathematical entity F = ma (force equals mass times acceleration) establishes that there are three algebraic variables that can be manipulated for the puzzle-solving operations of modern physics that reveal the way nature operates.

- **Every community also has a set of "shared commitments," or a belief in models that furnish the group with an accepted type of metaphors and analogies.** Aristotelian mechanics found that movement of material bodies could be adequately explained just by assuming that it was their "nature" to do so, as if material bodies had a *natural* attraction to what was understood as "the center of the universe." What really made these bodies "fall" was never entertained as a legitimate scientific question in Aristotle's day.
- **The "shared values" of a community describe the social beliefs that scientists in a community agree on.** These could be as straightforward as the arguments that "science should (or need not) be socially useful."
- **"Shared exemplars" in a community of scientists are the agreed on examples and "problem-solutions."** These include the laboratory exercises and homework or exam questions used in the education of students.

Kuhn sees great value in the establishment of normal science paradigms that are built on these four elements. They allow a scientist to look at nature and test with great precision, and more importantly, they provide a scientist with a theoretical basis from which to generate hypotheses. When considering a certain body of data, scientists engage in activity that "tells a story" that makes sense within the context of prevailing theories that allow them to produce the claims or results that seem sensible. If they can produce such claims, they can assert that their work has scientific value and thus get it published or receives further support from corporate management. Without these hypotheses, scientists would not know what to test for or how to interpret their results; they could not even begin to practice science.

However, Kuhn draws our attention to these four elements because they often go unchallenged, thus producing an invisible set of practices that channel the way scientists think. If we still adhered to Aristotle's idea that the movement of material bodies could be adequately explained by referring to their "nature," scientists would not be able to develop the hypotheses and perform the experiments that allowed them to accurately gauge the effects of gravity and relativity.

Another example of a socially constructed paradigm can be seen in the practice of biology and the way it is affected by Darwin's theory of evolution. Biologists who are interested in understanding the distribution of organisms in the field often design their experiments around the underlying assumption that species live where they live because they have out-competed rival species. It is often difficult for well-trained biologists to think of other reasons that might describe why certain species exist where they are found because of the powerful influence of evolutionary theory, another "shared commitment."

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Similarly, the writers cited in the first section of this paper ask technical communicators to examine their unchallenged assumptions as they use communication tools and methods of documentation that explain communication technologies and products to others. For example, Selfe and Selfe (1994, p. 491) have suggested that IBM's DOS operating system leads us to believe that hierarchical ways of organizing knowledge are better than more intuitive methods. We could extend this insight to understand how this "logical" system or "shared commitment" would lead technical communicators to believe that the only information that they should document is information that can be captured in a table, ordered list, or set of definitions, not the kind of tacit knowledge that connects or explains procedures and ideas that are difficult to reduce to a numbered list.

Tacit knowledge is what we learn from making mistakes, developing our own workarounds that better describe how something can be done, and learning how to survive and even flourish by experiencing the complexity of our work cultures, things that cannot be taught to us by a book or a trainer. If technical communicators assume the role of symbolic-analytic workers, they can better understand how what they are told to believe is true is in fact a social construction. This construction allows technical communicators to convey knowledge in a certain way but perhaps keeps them from understanding their present methods and employing alternative techniques that might better allow them to share other kinds of knowledge.

The rivalry between Charles Child and Thomas Morgan over their competing theories of inheritance and physiology demonstrates the social construction of these "right" practices and tools (Mitman and Sterling 1992). Child based his research on *planaria* (flatworms), and Morgan chose *drosophila* (fruit flies). Technically, neither organism was harder to work with in the laboratory, but Morgan's *dro-*

*sophila* eventually became the subject of choice among research geneticists for several reasons.

First, Morgan's work was aimed at quickly getting concrete results that allowed him to publish many respectable papers even though his results did not allow him to make any significant theoretical pronouncements. In contrast, Child was always looking for more difficult-to-obtain results that would allow him to pose a grand theory of the physiology of inheritance; thus, he did not gain the publishing visibility that Morgan did.

Furthermore, at a social level, Morgan's personality, social background, institutional affiliation, and position on the editorial board of the premier journal in the field allowed him to succeed in getting people in the wider genetics community to adopt *drosophila* (Mitman and Sterling 1992). If a young geneticist did not choose *drosophila* as her primary tool or material, she would be less likely to gain the resources to continue her research.

As certain tools or materials become adopted by a community—whether they be Microsoft Office XP applications or a certain organism—their use instills a series of socially constructed or unquestioned assumptions that allow those who use them to better articulate the claims they make; the "*logic* of justification or discovery" seems more apparent or "right" (Griesemer 1992, p. 52). *Drosophila* are still widely used in university laboratories as the primary tool for teaching biology students how genetic traits are passed from generation to generation; the species has become, in Kuhn's terminology, a "shared exemplar." Similarly, Microsoft Office tools have now become shared exemplars in most universities; for example, students learn how to produce spreadsheets, present tables, plot graphs, and crunch large bodies of numerical data using Microsoft Excel.

Clark and Fujimura (1992, p. 6), like Kuhn, ask scientists to expand their vision of the scientific process by paying attention to all the elements of research; "tools, jobs, and rightness" are a function of the socially constructed situation in which science is done. In fact, they are co-constructions of the interplay between the elements of the work situation, and sometimes the distinctions between these elements become blurred. For example, Clark and Fujimura ask, "What is a technology versus a material versus a theory?" and "When is a scientist a technician, when is a technician a scientist, and when are both technologies?" We could extend these questions to the field of technical communication by asking, "What is a technology versus information versus an organizational strategy?" and "When is a technical communicator a technician, and when is her work shaped by the technologies she employs?"

Fujimura (1987, p. 258) argues that to solve a complex scientific problem, scientists must incorporate more than just a productive technical methodology; instead, they should also take into account the *articulation* work needed to align the different levels of work organization. In this sense, articulation is the combining of all work activities one must perform to complete a production task between these levels. These would include "planning, organizing, monitoring, evaluating, adjusting, coordinating, and integrating activities" *between*, in the realm of industry and science, the organization levels of the experiment, laboratory, and social worlds. Fujimura emphasizes this aspect of articulation so scientists can better understand why—outside of technological constraints—things do not always work out just because scientists have acquired the proper instrumentation.

> The social construction of science is better understood when scientists can stand back and examine the context.

The social construction of science is better understood when scientists can stand back and examine the context. To do this, they need to ask the following questions (Clark and Fujimura 1992, p. 5):

- Who is doing the work and how is it organized?
- What is understood as necessary to do the work?
- Who cares about the work? How will it allow them to take action?
- What are the sources of sponsorship at regional and other levels?
- What are the planned products for the market, and who will be the consumers?
- When products leave the workplace or laboratory, what happens to them?
- What interpretations of the work do the participants create over the run of the project?

Answering these questions makes one aware that large-scale projects are successfully completed not because of the work done in one location—a laboratory, the corporate marketing division, the production line, or out in the field by sales and customer service specialists. For a product to come to market and be successful, or for a study or theory to take hold in the field of science, scientists and technical communicators need to be aware of how each of these questions can suggest concerns that are important across all levels of an organization and the community that this organization serves.

In the example I used previously, Morgan was more successful than Child at getting his subject species adopted because he was able to situate himself politically and thus better promote his ideas in arenas outside the laboratory. In the context of the questions posed by Clark and Fujimura, Morgan knew what was necessary to perform work, how the work should be organized, who would care about the work, how he could use the work to gain further sponsorship, and how it would be interpreted after it left his lab.

Analogously, technical communicators should know how the business practices of Microsoft executives have allowed their Windows operating system and applications to gain a near monopoly as the tools used in government, education, and industry, and why they are now the primary tools used by technical communicators.

Embedded in the questions listed above are the elements of these workplaces or laboratories (Clark and Fujimura 1992, p. 5):

- Scientists, graduate students, technicians, clerical staff, computer programmers, artists
- Theories, models, and representational entities (These include the tacit knowledge of the actors.)
- Technologies, instruments, skills and techniques, research materials, and work organization (How do the participants fit into the larger structure—university, federal agency, the professional discipline in general?)
- Intramural and extramural funding entities
- Regulatory groups
- Audiences and consumers toward whom the work is directed

Scientists pursue problems that are "doable" because their careers depend on it (Fujimura 1987, p. 257), and to articulate their work they have to juggle all these questions and elements long enough to secure resources and stay on task until they finish their work (Clark and Fujimura 1992).

When a complex scientific or industrial process is broken down into a series of self-contained steps that lead to an end result, it is easier to procure funds from corporate management because the project seems more doable. This process also allows the scientists and technicians who are working at each level to solve their own modular piece of the puzzle and to believe that their work will meet the needs of those at other levels in the process.

However, Fujimura (1987) demonstrates in a case study of a private biomedical company that results, demands, and ideas do not neatly transfer between separate social worlds engaged in the production of human healthcare products, thus causing disruption in the production process. There are three social worlds involved in this study: oncogene researchers, protein biochemists, and commercial pharmaceutical executives.

First, the timetables, acceptable variation in results, and the techniques that were originally agreed on were altered.

- At the executive level, the pressure to unveil a new product increased due to the competitive market and the demands of stockholders.
- At the scientific level, unforeseen technical problems arose due to the specificity of the research.

This is often the case in science; standardized techniques—such as the procedure for preparing DNA samples that are to be tested in large-scale projects in molecular biology—that are assumed to yield results that are consistent (that is, they are "black boxes") are often performed in different ways by different technicians in different laboratories dedicated to a project, thus potentially changing the nature of the results (Jordan and Lynch 1992).

In technical communication, when standards for documentation styles are not followed, different sections of an operations manual might vary in terms of meeting the designated audience's needs.

As problems continually surfaced as a result of these factors, the scientists, technicians, and executives in Fujimura's study had to continually realign their basic assumptions, techniques, and allocation of resources. As Kuhn's paradigms describe how scientists can better frame their work, standardized techniques increase the doability of a particular set of problems, but only to a point, as too many things change. Thus, articulation can never be eliminated from any equation that tries to describe how scientific work is done. There will always be changes in the complex processes carried out within and between associated levels of organization, and when these changes happen, work efforts need to be rearticulated within and between these levels (Fujimura 1987).

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## KNOWLEDGE MANAGEMENT

An awareness of Kuhn's socially constructed paradigms that constitute contemporary scientific practices and Clark and Fujimura's articulation activities that scientists need to perform can help technical communicators better understand the major underpinnings of knowledge management in industry. Many organizations now realize that the knowledge of their employees is their greatest asset, but because this intellectual capital is cataloged in the minds of people, it is more difficult to direct and leverage.

To better take advantage of this intellectual capital, organizations are instituting knowledge management systems that make it, like traditional forms of capital, more readily available to all members of the organization. Knowledge repositories in areas such as product design, technical support, employee skills, customer relations, and problem diagnosis can be analyzed and better used to decrease costs and increase revenues if they can be accessed by everyone.

For example, Arthur Andersen, an international business auditing and consulting firm, employs a Proposal Toolbox, an online repository of proposals its members have submitted to their business clients (Dutta and De Meyer 2001, p. 390). This tool enables their consultants to reutilize parts of these proposals and also allows them to collaborate with the primary writers of each proposal as needed. Additionally, Andersen stores the general correspondence and intermediate work-in-progress documents in a file system dedicated to each client being served, and all Andersen employees are granted access to the file. This approach supports the one-firm concept where teams of consultants work "across practice, across offices, and across countries if necessary." The approach allows them to leverage their human capital as it reinforces informal networks of people exchanging insights and skills.

The knowledge that a healthy organization possesses can be divided into four categories (Zack 2001, pp. 25–27):

- **Declarative knowledge** is knowledge *about* things—the empirical data, terminology, and distinctions between ideas and objects important to the business of the firm.
- **Procedural knowledge** describe *how* things are done in an organization—the bureaucratic, industrial, or legal steps that need to be performed in a prescribed sequence.
- **Causal knowledge** includes the *why* of things and might include factors that influence product quality or customer relations. These factors are often best described by stories or narratives about a corporation's employees.
- **Relational knowledge** is the awareness of how the declarative, procedural, and causal elements of knowledge above relate to one another. Evolving new products or establishing relationships with new clients is often most readily accomplished by a fusing of existing resources and skills that the company possesses.

The last three forms of knowledge in this list—procedural, causal, and relational knowledge—can include elements of tacit knowledge. The most complex form is relational knowledge, and it is often the knowledge that we acquire by articulating our activities within an organization.

Knowing the kinds of knowledge is one thing, but to collect, store, and transmit knowledge is another. Additionally, organizations need to show workers how they can share their knowledge. For example, each local office of Arthur Anderson has its own knowledge manager who oversees the collection and dissemination of archived knowledge (Dutta and De Meyer 2001, p. 392). When a project has been completed, project team members are asked to write reports for the knowledge manager summarizing what they have learned and to identify the best practices that they have observed in their client's organization. This knowledge is then passed on to Andersen global knowledge managers who filter, distill, and then apply it to firm-wide knowledge bases.

In an attempt to bring together employees in large organizations with specific skill sets, Microsoft has employed a "knowledge map" (Davenport and Prusak 1988, pp.75–77). This is a complex undertaking because an individual's knowledge is complex and changes over time.

The five major components for building and maintaining a knowledge map include

1. Building an organization-wide structure of varying knowledge competencies and levels
2. Describing the skill-sets needed for different tasks
3. Gauging the performance of different employees after a project is completed
4. Integrating these knowledge competencies in an online information system
5. Connecting this information to training programs

Explicit competencies are those that describe an employee's ability to use certain tools such as Excel or SQL 6.0. Higher-order, implicit competencies characterize the abstract reasoning skills that an employee might possess. These implicit skills might include knowledge of data warehousing and network administration (Conway 2002). This knowledge mapping system describes 137 implicit and 200 explicit competencies.

There is a strategic difference between information and knowledge, and human attention is what is all too often left out of the equation that allows us to distinguish between them (Malhotra 2001, p. 8). Davenport and Prusak (1998, pp. 113–114) describe the tasks that knowledge managers will need to undertake to make this distinction.

- Advocate the value of knowledge management systems so that they become integrated into the organization's culture.
- Oversee the implementation of the firm's knowledge management infrastructure.
- Find and negotiate with the appropriate external providers of information that would best suit the needs of their corporation. For example, Monsanto provides its scientists with external market data that

> There is a strategic difference between information and knowledge . . . .

allows them to take the initiative in developing new products (Davenport and Prusak 1998, p. 129).

- Suggest and critique methods that describe how knowledge creation can be undertaken in endeavors such as market research and business strategy development.
- Implement ways to measure the value of the information stored in the organization's knowledge repository.
- Create standards for knowledge managers within organizations.
- Identify the kinds of knowledge bases the firm can best use and the types of knowledge of which the firm is in short supply.

To leverage an organization's human capital, Malhotra (1998) asks that we fine tune our ideas regarding knowledge management. The individuals who comprise organizations can provide diverse meanings to the outputs generated by existing technological systems. Diverse interpretations allow the potential for "constructive conflict mode(s) of inquiry." For this potential to develop, we need an information architecture that includes categories and metaphors that allow us to better identify skills and competencies of an organization's employees.

People who are "closer to the action" in organizations are able to offer ideas, not just top-level managers (Malhotra 1998, p. 60). For example, the Andersen Proposal Toolbox is a metaphorical description that allows people to understand that "tools" exist, and if those tools are shared and used thoughtfully, they may allow someone to accomplish the task of writing an effective proposal. On a metaphorical level, Microsoft's "knowledge map" suggests that there is knowledge "out there" in the organization. If the knowledge can be located, it can be used effectively. It also suggests that a corporation's knowledge belongs to everyone in the company, not just to one individual (Davenport and Prusak 1988, p. 76).

Malhotra (1998) also asks professionals to recognize the value of tacit knowledge, human creativity, and imagination. To do so, technical communicators need to implement technical architectures that allow them to be more social, open, flexible, and respectful of individual users. They also need application architectures that serve their problem-solving needs as opposed to merely allowing for the (re)generation of output transactions of simple archived data.

Because workers at Arthur Andersen are able to access the past proposals that have proven successful and then make contact with the colleagues in different Andersen corporate offices who generated these proposals, these workers can exchange and leverage their tacit ideas about the different clients/audiences for whom they have worked. For example, a proposal for a defense contractor in Denmark might need to amplify certain concerns that are important to people working in that particular European business culture. Or someone who wrote a proposal for an American dot.com corporation that specialized in disseminating information about agricultural markets might be able to suggest effective rhetorical techniques that she intuitively understood worked best for the needs of that unique corporate culture.

> XML allows professionals to connect with each other, or more precisely, with each other's databases.

The environments that workers find themselves situated within are often complex social constructions that cannot be learned from a book. When hard-to-come-by knowledge is not *articulated* between an organization's members, others have to "relearn" this knowledge on their own, and that process can be costly and inefficient. Finding someone with the know-how one needs can be facilitated with a well-integrated knowledge management infrastructure.

Prevailing practices that implicitly suggest that "this is the way things are done" need to be de-emphasized (Malhotra 1998, p. 60). To plan for the future, technical communicators need to free themselves from the idea that they use a limited number of ideas that, while perhaps effective in the past, might not be as effective in contemporary markets that demand continual innovation. I believe that if technical communicators are mindful of the articulation activity across the boundaries within and between organizations that Clark and Fujimura describe, and if they are aware of Kuhn's four socially constructed elements—the symbolic generalizations, shared commitments, shared values, and shared exemplars that shape their work environments—they will be better equipped to implement the brand of knowledge management that Malhotra advocates to effect change.

## XML AND KNOWLEDGE

One of the best ways to understand the nature of the knowledge that technical communicators are trying to manage is by finding out how it is articulated across different branches of an organization, closely examining it, and then breaking it down into its essential components. These practices are what we are compelled to do when producing XML code, and technical communicators can expand their territory into the realm of knowledge management by learning how to model knowledge using XML. XML offers them a way to provide not just data, but data with context, thus supporting knowledge management because data with context is knowledge.

XML allows professionals to connect with each other, or more precisely, with each other's databases. While HTML allows technical communicators to put information online, make it look stylistically appealing, and make imaginative links between different bodies of information, XML compels them to reexamine just what information is of value to their organizations. It also makes it easier to search within different databases for specific information that they might need as opposed to information that is encoded in HTML or embedded in a traditional database.

There are several major types of information exchange that the deployment of XML can help technical communicators facilitate. We are probably most aware of business-to-consumer exchanges because the Internet is now heavily populated with organizations that provide commercial information to us as online consumers. Business-to-business exchanges allow one corporation's database to be accessed by strategic partners so these partners can better incorporate the products of other organizations to meet their own needs. Additionally, some organizations are allowing their own employees access to information generated from all their corporate branches so they can make sound decisions (Dick 2000). This last trend in particular suggests the rich potential of information access and transfer, but it also challenges technical communicators, as Malhotra suggests above, to be more accepting of the many kinds of knowledge that can be used for larger and more disparate audiences.

The basics of XML starts with designing document type definitions (DTDs) that specify the elements that will be allowed in databases and the relationships among these elements. Modeling knowledge can be facilitated with a DTD because it describes the allowable information structure of an XML document. DTDs contain no actual empirical data or information that might be needed; they contain only metadata—that is, data about data. For a simple memo, knowledge managers would want to include in their DTD the following elements.

```
<!ELEMENT memo (author, addressee, subject, date, text)>

<!ELEMENT author (given_name, family_name)
<!ELEMENT given_name (#PCDATA)>
<!ELEMENT family_name (#PCDATA)>

<!ELEMENT addressee (given_name, family_name)
<!ELEMENT given_name (#PCDATA)>
<!ELEMENT family_name (#PCDATA)>

<!ELEMENT subject (#PCDATA)>
<!ELEMENT date (#PCDATA)>
<!ELEMENT text (#PCDATA)>
```

The DTD demands a strict hierarchy. For example, the *given name* and *family name* of the *authors* and *addressees* are embedded under the *author* and *addressee* elements.

XML code that contains the actual information in a database needs to follow the arrangement set by the DTD that defines the database's information. Below is some XML code that would be used to store actual data in a fashion that would be considered *valid* by the hierarchy indicated by the DTD above.

```
<memo>

<author>

  <given_name>Condolezza</given_name>

  <family_name>Rice</family_name>

</author>

<addressee>

  <given_name>Colin</given_name>

  <family_name>Powell</family_name>

</addressee>

<subject>President's Speech</subject>

<date>September 22, 2001</date>

<text>Have you read the speech the President will give
tonight?</text>

</memo>
```

Between the XML tags above we have actual data. We know that this memo has been addressed to Colin Powell, and we can see that it was authored by Condolezza Rice.

Relative to traditional hierarchical databases and sequential database technology, XML is built on associative processing methods that allow it to be a more neutral arbiter of data. Traditional databases can only retrieve data that is coupled with other data that it is embedded within. For example, a traditional database that housed the information that describes the annual economic activity of a nation would contain elements such as gross domestic product (GDP) and all the components that when added up make up the GDP, components such as durable goods, nondurable goods, and services. If a knowledge manager wanted to examine the trend of durable goods through a

10-year period, he or she would have to retrieve the complete spreadsheets with all the information that describes the GDP, find the value of durable goods for each of the 10 years, then write them down and place them into another database or document.

While a DTD uses a hierarchical structure to identify the different elements by relation to each other, these elements that are coded in XML can then be extracted outside the context of the DTD with the use of XLink and XPointer, other tools in the XML family of object-oriented languages.

XLink allows knowledge managers to link to a database that contains a relevant kind of information, and XPointer identifies and extracts the specific element or piece of data within the database to which they are linked. If a knowledge manager was looking for durable goods for 1995, XLink could get her to the U.S. Department of Commerce's database that housed the table "Gross Domestic Product by Major Type of Product." Xpointer could find the element <1995_ DURABLE_ GOODS > 1,273.3 </1995_ DURABLE_ GOODS> and extract the number 1,273.3. Even though the DTD metadata element <!ELEMENT 1995_ DURABLE_ GOODS (#PCDATA)> would be embedded under the <!ELEMENT 1995_ GROSS_DOMESTIC_PRODUCT (#PCDATA)>, she could still find and extract the durable goods value or actual data.

Thus, data structures coded in XML are "omnimorphic"—that is, specific tagged elements can be selected from one or more databases and do not need to be accompanied by other kinds of data. In fact, the information that our technical communicator serving as knowledge manager for her 10-year study could be abstracted to produce a virtual document that contained only what she needed for this trends study (Simon 2001, p. 53).

In another example of XML technology and virtual documents, an epidemiologist concerned with a rare disease that she is studying might research the databases of agencies committed to keeping potentially relevant medical records. She could search for phrases, combinations of phrases, or unique patterns of verbal usage that might describe some of her intuitive assumptions about the symptoms of this disease, and this capability would allow her access to key passages in case studies that could further her research. She could then place this information in her organization's database or e-mail it to other scientists who are working on the same problem. By using XML, associative processing will allow for more multidirectional sharing of information (Simon 2001, p. 53).

Previous researchers on the required skills for data reporting, using widely employed spreadsheet tools, see it as much as a rhetorical enterprise as a procurement of discrete facts. To support the transmission and production of knowledge, information gathered from databases must be presented in meaningful patterns that meet the audience's needs, especially when tabular data is the sole content of the message. To accomplish this goal, we need to know, in terms of rhetorical invention (Mirel 1996),

- The value of the electronic data
- The meaning of the data relationships
- The appropriate level of detail required to meet the audience's needs

Problems that could result from a lack of attention to these ideas include information overload, overly narrow content, random data, unprocessed data, and unintelligible data (Mirel 1996, pp. 99–100). Procuring appropriate data to best meet the needs of an audience "is only feasible if the data are set up in a special way to allow writers to retrieve data from different databases" (Mirel 1996, p. 104), and this is something that XML readily affords.

Employing appropriate heuristics for breaking down information and reconstituting it in XML can aid the technical communicator functioning as knowledge manager who is working to meet the rhetorical and information needs of the company. For example, we can use some of the techniques of archiving professionals in library science to parse information coded in XML (Applen 2001). The list below summarizes the basic questions professionals need to consider when indexing complex documents (O'Connor 1996, p. 56), and it can be modified and implemented by knowledge managers who are working within an organization to decide how different forms of knowledge can be tagged using XML.

1. How many elements should be extracted from various bodies of information?
2. Which elements should be extracted?
3. Should the elements be extracted in their natural form or translated?
4. Should elements be in their natural order or constructed order?
5. Should generalizations of individual concepts take place?
6. What are the rules that guide extraction?

Answering these questions challenges knowledge managers to identify the many small parts that make up the whole of their material, but it also calls on them to think about how the material needs to be organized in the hierarchy of a DTD. Moreover, breaking information down into its elementary parts and then asking whether they are in fact "objects" also challenges professionals to more critically frame their use of object-oriented languages such as XML (Price 1997, p. 71).

This challenge parallels Kuhn's concern that scientists thoughtfully examine the essential nature of the socially constructed elements they are working with before they deploy those elements; if they ask whether something is in fact an object, what they are doing is asking themselves whether a "symbolic generalization" commonly believed to be of value in a socially constructed environment really meets their needs.

For example, a small but vocal minority of economists challenge the prevailing socially constructed notion of how they should gauge the economic health of a nation. Traditionally, the value of all goods and services in 1 year are added together to determine a country's gross domestic product. The larger the gross domestic product, the healthier the economy.

However, economists with environmentalist leanings believe that certain goods and services should be subtracted from the gross domestic product if they are in fact employed to clean up the environment. If a large portion of the economy is devoted to cleaning up the mess people generate in the production of other goods and services, our standard of living is actually diminished; we have fewer goods and services such as homes and medical care available to offer us comfort.

While this idea did not come about because the U.S. Department of Commerce decided to employ XML technology, it describes how knowledge managers may always think about the potential for including new objects, such as goods and services devoted to environmental restoration, into such a complex matrix. In the context of O'Connor's heuristics, this example asks that knowledge managers working with economists consider whether or not environmental costs should actually be made into an XML object or element (whether or not it should be "extracted") and actually used to calculate the GDP formula. These professionals are also asking how objects relate to one another hierarchically (one object would be subtracted from the added value of the other objects), and it challenges the very idea that there is a set natural order of elements that they can all agree on to determine what we know as our standard of living.

Additionally, it would be naïve to assume that one professional could code data in such a way that all potential users would find the information meaningful. After all, different organizations (and branches within organizations) have their own take on just what the information in their databases means, and the more databases that are linked, the greater the potential for confusion. As a result, the promise of universal connectivity that the Internet or intranets offer us is not readily available.

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For this promise to be realized, technical professionals need to collaborate, or as Fujimura would put it, articulate their needs with the needs of others across different branches of their organizations. If people are willing to work out the formatting of data for each application with each other, there would be no problem, but such cooperation takes a considerable amount of time. The more people seeking to connect with each other, the greater the effort of negotiating their differences in perspective.

These differences in perspective can be negotiated by ensuring that data set *between* U.S. durable goods XML tags for the year 1995 (for example, <1995_ DURABLE_ GOODS > 1,273.3 </1995_ DURABLE_ GOODS>) indicates that we mean 1,273.3 billions of U.S. dollars, not 1,273.3 trillions of Italian lire. We might also need to negotiate whether or not to include an element in a DTD that indicates, in the memo example used earlier, the titles of the author and addressee (<!ELEMENT title (#PCDATA)>). With this element in place, we could indicate in XML code that Colin Powell and Condelezza Rice are, among other things, important people (<title>Secretary of State </title> and <title>National Security Advisor</title>).

Technical communicators who serve as knowledge managers need to understand that the strength of XML as a tool can also be its weakness. Although XML allows them the ability to more ably store and transfer information, if they do not implement an integrated design method in the early stages of their development phase, they run the risk of creating a system that is too complex and trouble ridden to use effectively.

One method for using XML efficiently is to create an architecture that would represent how an organization does business. To accomplish this goal, knowledge managers need to understand that an XDA (XML Document Design Architecture) should consist of three layers (Simon 2001, p. 130):

- A conceptual layer
- A logical layer
- A physical layer

To develop a *conceptual layer*, knowledge managers need to acquire all the documents that are currently in use throughout their organization. By doing so, they may be able to identify and combine certain documents, and also come to realize that there are other kinds of documents not in use from which they could benefit. This realization would require that they engage in the articulation activity that Clark and Fujimura describe across different branches of an organization, but this would yield a better sense for how their organization is represented using texts and data.

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To understand the *logical layer*, knowledge managers need to determine the data that their documents commonly contain and define how these pieces of information can be set in document data element types. For example, a memo would contain the elements that described the author(s), person(s) addressed, subject, date, and text. A spreadsheet that describes the annual economic activity of a nation would contain elements such as gross domestic product, durable goods, nondurable goods, services, and perhaps even goods and services devoted to cleaning up the environment.

The *physical layer* consists of the DTDs that the knowledge managers develop. These DTDs would designate which elements are to be used for each application and how they relate to one another.

What is key here is that each layer is kept separate so problems that might arise from creating too complex a database can be mitigated. As work is done on each layer, the information should be analyzed for comprehensiveness, consistency, and redundancy. If knowledge managers adhere to this development process, problems will be detected at each level or layer before they are sent on to the next level, thus eliminating wasted time spent on refurbishing the entire information architecture at a later date (Simon 2001, p. 131).

## CONCLUSION

Once this information is available, teaching organization members how they can access it for their own articulation needs can also be part of the responsibility of technical communicators serving as knowledge managers. Ensuring that this information is understandable is also important, and this is something in which technical communicators are well versed. Historically, technical communicators have produced documentation for disparate audiences, and part of their work has always been to ensure that the documents they turn out are used by others. Additionally, technical communicators working as knowledge managers can also keep people updated on new information as it is made available in databases that could potentially assist them with their work (Dick 2000), and because technical communicators have been traditionally assigned the task of updating and disseminating documentation, this task would mirror their traditional responsibilities.

Creating a culture is one thing. To employ knowledge management systems in organizations also requires significant costs as some organization's members will have to devote their workday to these endeavors. Other organization members not officially designated as members of knowledge management teams will also be asked to add their ideas to databases, thus drawing them away from their other responsibilities. However, there are significant long-term benefits.

- Knowledge management allows professionals to be more aware of the differences between branches of a large organization and challenges them to redouble their efforts to articulate their ideas across different sectors of an organization. As Clark and Fujimura have shown, there is often work done that has to be redone when this articulation is not accomplished.
- Knowledge management better allows professionals to leverage the knowledge capital of an organization. The organization does not need to hire new people or farm work out to expensive consulting firms to solve a problem that an existing organization member has already dealt with, and members within an organization can exchange new ideas and perspectives. This practice allows professionals to understand the value of seeking help from others in their organizations and would facilitate collaborative efforts in general.
- If used wisely, XML allows professionals to reexamine previous technologies that they might have taken for granted. XML technology demands that professionals who use it think about the very nature of data—how data is often embedded within other data—and it demonstrates the weaknesses of other technologies that would not allow them to do so with such ease. XML technology also allows us to understand, relative to previous technologies, that knowledge bases can be added to or reconfigured as Johnson-Eilola, Selber, and Selfe (1999) might suggest. As a result, professionals can be more critical of technology because they do not always have to accept the output of information-gathering and -representing technologies to which they are presently tied to in the workplace. Technical communicators who serve as knowledge managers can work with others in their organizations to rewrite the XML code.
- The very nature of XML allows technical communicators to think critically about knowledge. It demands that they break information down and reconsider its value. They are more than just translators of information, contrary to the opinion of Slack, Miller, and Doak (1993). As many of the critics in the first section of this article would hope, it also challenges all members of

an organization to become more critical about the way they organize information; they can become "symbolic-analysts" (Johnson-Eilola 1996). They can also become more aware of the socially constructed elements that constitute the workplace and that govern what they think of as successful work (Kuhn, p. 47).

Organizations that are served best by the implementation of intranets are the ones that have already established a culture of trust and sharing (Ruppel and Harrington 2001). At Buckman Labs, a privately owned company that specializes in proprietary chemical products, the initial attempts to deploy a knowledge management system were met with some resistance (Pan 2001, p. 436). Such resistance is common in the socially constructed "knowledge-hoarding" culture of many high tech firms; there is often resistance to knowledge management systems from middle managers who have traditionally thought of themselves as "information gatekeepers."

It was not until a code of ethics was instituted for knowledge sharing that common language developed to establish the "rights" of everyone to share information. Additionally, the chairman of Buckman Labs implemented a metaphor for knowledge exchange when he asked everyone to think of the company as a ship and the ship's waterline as the code of ethics:

> *You do not shoot below the waterline, because you can sink the ship. However, you are free to be as innovative as you wish in changing the superstructure of the ship to meet the needs of the customer. (Pan 2001, p. 437)*

This common language and metaphor established a new socially constructed vision of what knowledge management could be and had much to do with its successful implementation at Buckman Labs.

Because successful technical communicators possess the collaborative and interpersonal skills that their field has traditionally demanded, they would do well in helping to establish a culture that encourages employees to deposit information and take advantage of the ideas of their coworkers as it would indicate to all that everyone's ideas are valued. In the role of knowledge manager, technical communicators could help facilitate this environment. **TC**

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