DOCUMENT RESUME

ED 427 778 IR 057 283

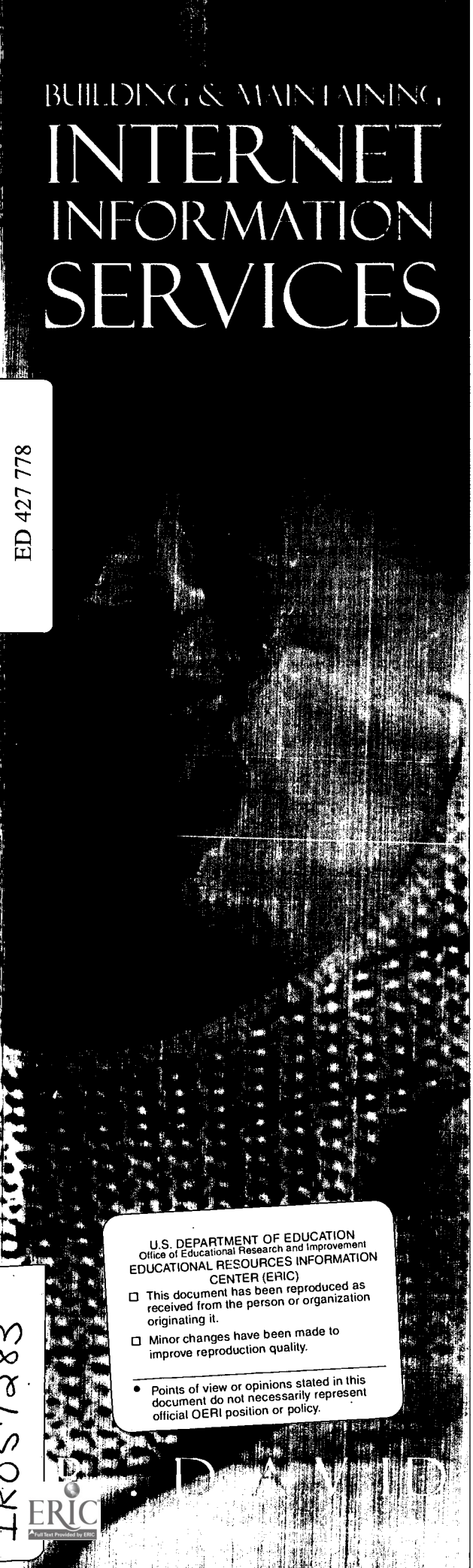
AUTHOR Lankes, R. David
TITLE Building and Maintaining Internet Information Services: K-12 Digital Reference Services.
INSTITUTION ERIC Clearinghouse on Information and Technology, Syracuse, NY.
SPONS AGENCY Office of Educational Research and Improvement (ED), Washington, DC.
REPORT NO IR-106
ISBN ISBN-0-937597-46-5
PUB DATE 1998-06-09
NOTE 224p.
CONTRACT RR93002009
AVAILABLE FROM Information Resources Publications, Syracuse University, 4-194 Center for Science and Technology, Syracuse, NY 13244-4100; Tel: 800-464-9107 (Toll-Free).
PUB TYPE Books (010) -- Reports - Research (143) -- Tests/Questionnaires (160)
EDRS PRICE MF01/PC09 Plus Postage.
DESCRIPTORS Access to Information; Educational Research; Educational Resources; *Elementary Secondary Education; *Information Dissemination; *Information Management; *Information Services; Information Sources; *Internet; *Reference Services; User Needs (Information)
IDENTIFIERS AskERIC; Digital Data

ABSTRACT

This study addresses the problem of Internet information services having to meet the increasing information demands of users in the dynamic Internet environment. The purpose of this research was to use K-12 digital reference services as a starting point to better understand the process of building and maintaining Internet information services. The study has three specific objectives: (1) to build and apply a conceptual framework based on complexity research, literature, and the researcher's experience; (2) to use this conceptual framework to empirically describe how organizations, specifically K-12 digital reference services, build and maintain services in the dynamic Internet environment; and (3) to seek commonalties across these descriptions. Qualitative methods (elite interviews and document analysis) were used to elicit descriptions of six exemplary K-12 digital reference services. These descriptions were then compared across organizations to find commonalties. Appended are the Pre-Test Interview Transcript, quality criteria developed by the expert panel, the AskERIC Pre-Test, Internet sites for further information, and a synopsis of data gathering. Eighty-nine tables and figures are included throughout the text. Contains an index. (Author/AEF)

BUILDING & MAINTAINING

INTERNET INFORMATION SERVICES



D. A. M. D.

K-12 DIGITAL REFERENCE SERVICES

LANKES, PH.D.

Building and Maintaining Internet Information Services: K–12 Digital Reference Services

R. David Lankes

A Study Submitted to:
The National Library of Education, U.S. Department of Education

ERIC ® Clearinghouse on Information & Technology
Syracuse University
Syracuse, New York
IR–106

Building and Maintaining Internet Information Services:
K–12 Digital Reference Services

by R. David Lankes

This publication is available from Information Resources Publications, Syracuse University, 4-194 Center for Science & Technology, Syracuse, New York 13244-4100, 1-800-464-9107 (IR-106).

ISBN: 0-937597-46-5

U.S. Department of Education
Office of Educational Research and Improvement
National Library of Education

ERIC is a program administered by the National Library of Education, a unit of the Office of Educational Research and Improvement, U.S. Department of Education. This product was prepared under contract no. RR83002009. The content does not necessarily reflect the views of the Department or any other agency of the U.S. Government.

Eric Plotnick, Editor in Chief
Susann L. Wurster, Copy Editor
Abby Kasowitz, Editor
R. D. Lankes, Author and Illustrator

Building and Maintaining Internet Information Services: K–12 Digital Reference Services

ABSTRACT

This study addressed the problem of Internet information services having to meet the increasing information demands of users in the dynamic Internet environment. The purpose of this research was to use K–12 digital reference services as a starting point to better understand the process of building and maintaining Internet information services.

This study had three specific objectives: (1) to build and apply a conceptual framework based on complexity research, literature, and the researcher's experience; (2) to use this conceptual framework to empirically describe how organizations, specifically K–12 digital reference services, build and maintain services in the dynamic Internet environment; and (3) to seek commonalties across these descriptions. In order to accomplish these objectives the following research questions were asked:

1. What are exemplary K–12 digital reference services' detectors (i.e. inputs) for Internet agent types, internal inputs, and influences external to both the Internet and the organization?

2. What are exemplary K–12 digital reference services' rules for processing the input from detectors and, through resources, building and maintaining effectors (i.e. services)?

3. What are exemplary K–12 digital reference services' effectors (i.e. outputs) used to meet users' information needs?

This study used qualitative methods (elite interviews and document analysis) to elicit descriptions of six exemplary K–12 digital reference services. These descriptions were then compared across organizations to find commonalties.

Table of Contents

List of Tables

List of Figures

Acknowledgements

There are many people to thank for their contributions to this work. I would like to thank my wife who had to live with every word of this. I would also like to thank Mike Eisenberg, the greatest mentor and friend a person could ask for and Chuck McClure for "smacking me around." I would like to thank Stuart Sutton, Ruth Small, and Ray and Gisela von Dran for their time and insights. Lastly I would like to thank the staff of the Information Institute of Syracuse without whom this would never have been finished.

About R. David Lankes

"Virtual Dave" Lankes, Ph.D. is a co-founder of AskERIC, the award winning project that provides high-quality education information to educators via the Internet. Dave is currently the director of the ERIC Clearinghouse on Information & Technology. He is also an assistant professor at Syracuse University's School of Information Studies. Lankes speaks and consults nationally on Internet issues in education and business.

About the Book

The blueprint figures discussed in this book may be seen in full size at URL:
http://ericir.syr.edu/ithome/bmiis

As more users . . . look to the Internet to meet their information needs, Internet information service organizations must be able to build and maintain their own services to meet these users' expectations.

Introduction

Introduction

The Internet[1] and the number of organizations providing information to users via the Internet (Internet information service organizations[2]) are growing at a tremendous rate (Kantor & Neubarth, 1996, p. 46). Millions of users are connecting to the global network every year. Internet addresses are appearing everywhere from movie screens to television programs to soda cans. Internet information service organizations are seeking to meet users' information needs via this expanding global network.

The technologies used to deliver information services via the Internet are also rapidly changing as new users come online. Software life cycles are shrinking, and many information systems workers have begun to use phrases such as "Web years" and "Internet time" to refer to the incredibly compressed technological evolution being experienced on the Internet (Haar, 1997). This study addresses a specific problem: how Internet information services[3] meet the increasing information demands of users in the dynamic Internet environment.

Internet information service organizations are being increasingly called upon to meet users' information needs. This problem is further complicated by a lack of existing guiding knowledge about such organizations. Scholarship is exploring user behaviors in a networked world, and applied research is keeping pace with the technology required to implement Internet information services. Yet knowledge regarding how organizations balance and anticipate the shifting landscape of user needs and new technology is still vague and underdeveloped.

A recent article concerning methods for developing and deploying Web-based information systems underscores this point:

> "The architecture pieces are being nailed down, but [the new Web planning methodologies] are a long way from answering all the questions," says Richard Hunter, research director for applications development and management at Gartner Group, Inc., in Stamford, Conn. More thorough solutions will become available as the vendors in this segment garner more experience working with Web technologies. Still, analysts say it could be as long as two years before complete, leading edge methodologies become available (Callaway, 1997, p. 99).

Internet information services are experiencing more users, more information, and a greater impact. These Internet information services must have better information about the processes of building and maintaining services on the Internet.

---

[1]The Internet is defined as "a global computer network based on commonly derived computer languages, procedures, and protocols. Originally created as a secured fail-safe system [the ARPANET] to permit data transfer in order to survive nuclear attack, the Internet is now an open system facilitating universal data access by anyone possessing access to a computer and one of many Internet service providers on the market" (NLE, 1997).

[2]An Internet information service organization is defined for this study as a collection of resources (people, policy, technology, etc.) working together to meet the information needs of users via the Internet.

[3]Internet information services can be collections of documents, software, and activities delivered solely through the Internet infrastructure.

The purpose of this research is to use a specific community, K–12[4] digital reference services,[5] as a starting point to better understand the building and maintaining processes of Internet information systems in general.

Context of the Study

The Internet has existed in one form or another since the late 1960s. It began as ARPANET, a technological experiment (Zakon, 1995) and means of facilitating research (Cerf, 1993). For much of its history (until the early 1990s), Internet content and Internet research were primarily concerned with technology (i.e., software and hardware). As the Internet gained wider recognition outside the university and research communities, the focus of information service provision (i.e., specific uses of Internet technology to meet users' information needs) on the Internet shifted from technical issues to the uses and applications of Internet information (Parker & Radosevich, 1996). While technical issues usually have a set of identifiable answers, interactions among people (e.g., clients, users, coworkers, other organizations, etc.) present larger and more complicated problems.

As more Internet services become available and more information becomes published on the Internet, the challenge to effectively build and maintain this information and these services will increase. With the crude state of present Internet information service management tools and a serious lack of available knowledge about Internet information service processes, organizations will soon be overwhelmed by their own services. A recent *InfoWorld* article noted:

> Considering the recent spate of product announcements, you'd think that managing a site was as simple as preparing a pie. Not true, say IS managers, consultants, and Internet product vendors. A gap still exists between what's currently available and what users and analysts say is needed to deliver fast, reliable Internet and intranet sites around the clock (Jacobs, 1996).

There has also been little effort to build and share experiences with others (Liu, 1995). Internet information services are so busy creating their own services, and experimenting with maintenance processes, they do not take the time to document and communicate what they have discovered. Further, with the rise of commercial use of the Internet, these building and maintenance processes can be seen as strategic assets and counter to the goals of Internet information services to share organizational learning. Nevertheless, in the midst of this lack of documented knowledge, many organizations are succeeding in providing services to users.

[4]K–12 is short for Kindergarten through twelfth grade. It represents a wide range of institutions and activities focused on American pre-college education. These institutions may include public elementary and secondary schools, private and parochial schools, home schoolers, and the emerging charter schools.

[5]Reference is defined as "a service provided to. . .users who need assistance in locating information on a specific topic or topics. Reference services range from simply looking up a fact to extensive research counseling and information searches" (NLE, 1997). K–12 digital reference services are defined as a subset of Internet information services that meet the information needs of the kindergarten through twelfth grade community (teachers, students, administrators, school library media specialists, etc.) through reference services.

The task of building and maintaining Internet information services is further complicated by the lack of knowledge of and control over the dynamic Internet environment. The dynamic Internet environment is composed of the infrastructure that connects people together (the wires, routers and hubs), the software that utilizes this infrastructure to gain access to information, the services that provide information via the infrastructure and software, and the people who ultimately act as consumers of this information (Lankes, 1996). This environment is dynamic in the sense that all of these elements (infrastructure, software, services, and users[6]) change rapidly.

The infrastructure of this dynamic Internet environment provides little in the way of traditional cues for information service builders. There is a disconnect between users of a service and builders of a service. For example, many Internet information services have little idea of the true number of users they have. Further, the applications these organizations depend upon to build their services change rapidly with "new companies and technologies appearing at a dizzying pace" (Neubarth, 1996, p. 10).

Internet information services can draw little guiding knowledge in building and maintaining services from users and from the technology used to deliver services. An Internet information service must therefore deliver information to users whom they know little about and whose population changes rapidly with hardware and software tools that change as rapidly as the user population.

As an example of the Internet's dynamic nature, consider Netscape, a major supplier of software to Internet information service builders. Netscape released two major upgrades of its browser product within two months in 1995. Each upgrade had a substantially different feature set. In addition, both Microsoft and Netscape have established "public beta" processes where they widely distribute beta versions of software free on the Internet. This directly affects the work of the Internet information service organization. Not only does an organization have to be aware of major software versions but a myriad of interim releases as well (released daily in some cases). How do organizations cope with the Internet environment when most traditional information systems rely upon greater knowledge of and control over the environment of their services?

This research studied the processes put in place by Internet information services to survive the slippery, amorphous Internet landscape. By using K–12 digital reference services, the researcher has discovered how some Internet information services are built and maintained.

The Concept of Adaptation and Conceptual Framework

The volatile and dynamic nature of the Internet discussed above forces Internet information services to constantly anticipate the changing landscape of the Internet. By constantly adapting to the Internet's complex environment, organizations providing services via the Internet can better meet the needs of their users. For example, by anticipating the growth of the World Wide Web in the early 1990s,[7] many organizations could offer media-rich information[8] to their users and participate in the World Wide Web's standards and development

[6]This scheme of users, information services, application builders, and infrastructure providers is explored in great depth in the discussion of Internet architectures in Chapter 2.

[7]Prompted by the release of Mosaic in 1992 by the National Center for Supercomputing Applications.

[8]The introduction of Mosaic allowed information services to provide graphics, movies, and sound as well as textual information.

process.

The Internet's dynamic nature is not unique. A growing scientific movement has been looking at dynamic systems. This movement is known as "complexity research" (Waldrop, 1992). Complexity and the study of complex adaptive systems (Holland, 1992) seek to understand the commonalties among self-sustaining, self-organizing systems. Holland (1995) in particular has developed a series of properties and mechanisms (p. 10) that help explain how organizations cope in fast-changing and uncertain environments.

The Internet can be seen as a complex adaptive system. It is dynamic (as discussed above) and evolves (from the ARPANET to the non-commercial Internet, to today's Internet that has strong commercial overtones). It is self-sustaining, with no central funding source or owner. It is self-organizing, with no central enforcement component. Moore (1994) sums up the complex nature of the Internet when he states:

> The Internet is not an actual thing. It is a consensus of ideas, an agreement among friends and colleagues, a reflection of technological trends. It is evidence of the notion that communication among people is a good thing, and a quiet affirmation of anarchistic behavior. In short, the Internet is a VERY Large Concept (p. 3).

The Internet also meets the specific criteria set forth in complexity research in that it is composed of a large number of independent agents[9] that take on diverse forms, and share information (Holland, 1995).

Complexity research and Holland's notion of "agents" with their "internal models"[10] and "building blocks"[11] provides the foundation for the conceptual framework developed for this investigation. The framework, as seen in Figure 1-1, aids in understanding Internet information services as well as the methods employed in this research.

[9]An agent is a single unit. The term itself is meant to be context free and is further explained in the discussion of complexity in Chapter 2. An Internet information service is considered an agent.

[10]An internal model is the means by which an agent anticipates its environment. See the discussion of complexity in Chapter 2 for more details.

[11]A building block is the most basic part of an agent's internal model. See the discussion of complexity in Chapter 2 for more details.

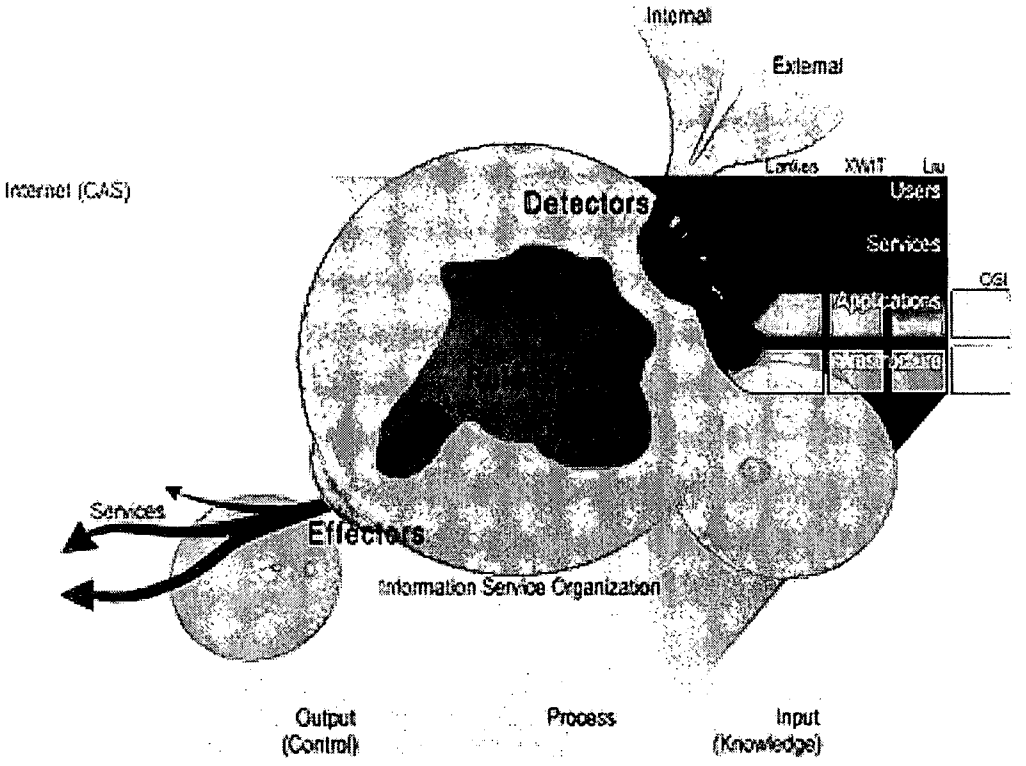


Figure 1-1 Conceptual Framework: Complexity forms the base of the conceptual framework used in this study. This framework looks at the input (detectors) to an organization, the processes (rules) used by the organization to build and maintain information services, and the output of the organization (effectors) in the Internet environment.

Holland established a "performance system" (Holland, 1995, p. 87) that can describe an agent (organization) in a complex adaptive system (here the Internet). This system has a set of detectors for gathering information from the environment, a set of rules for reacting to the environmental information, and a set of effectors for manipulating (controlling) the environment. In this framework, the researcher's experience and the literature have been used to further refine detector types. These types are other Internet agents (divided into users, other information services, application builders, and infrastructure providers) as well as input from members of the Internet information service organization, and input coming from beyond the organization and the Internet.

As will be shown, this framework of detectors, rules, and effectors matches the dynamic nature of the Internet quite well. It further provides a useful structure for building comparable descriptions of organizations while allowing for the latitude necessitated by the unexplored nature of the Internet. One of the objectives of this study was to explain and ground this conceptual frame in theory, literature, and experience, then to apply this framework to Internet information systems.

K–12 Digital Reference Services

The recent emphasis by the federal government to connect every classroom to the Internet by the year 2000 highlights the need for better information on building and maintaining Internet information services. President Clinton's call to connect every school to the Internet emphasizes the need for Internet information services focused on the K–12 education community to be organized and prepared.

> In our schools, every classroom in America must be connected to the information superhighway, with computers and good software, and well-trained teachers. We are working with the telecommunications industry, educators and parents to connect 20 percent of California's classrooms by this spring, and every classroom and every library in the entire United States by the year 2000. I ask Congress to support this education technology initiative so that we can make sure this national partnership succeeds (Clinton, 1997).

As more users, in this case educators and students, look to the Internet to meet their information needs, Internet information service organizations must be able to build and maintain their own services to meet these users' expectations.

Organizations of varying types are using this dynamic electronic environment to meet the information needs of the education community. For example, publishers are building Web sites for delivering product information to school library media specialists.[12] The federal government is using the Internet to broadcast funding opportunities through mailing lists.[13] Professional teaching organizations (such as the National Education Association) are building databases that match technical teacher mentors to other teachers just getting online.[14] They are taking advantage of the unique benefits of the Internet (such as low publication costs versus potential audience, the interactivity of the medium, etc.) to build and maintain services.

Another example of organizations using the Internet to meet educational user needs are K–12 digital reference services. Digital reference services are question and answer services (sometimes referred to as "Ask-A" services such as Ask-A-Scientist) that seek to fulfill the reference needs of the K–12 education community. They use a broad range of approaches and Internet capabilities (e-mail, the World Wide Web, Gopher, etc.) to answer the questions of students and educators on the "net."

Some digital reference services are linking questions from the K–12 education community to expert respondents. These services have been enormously successful. The Ask Dr. Math site (Dr. Math, 1997) run from Swarthmore College and the MAD Scientist Network (MAD Scientist, 1997) operated out of Washington University in St. Louis have received enthusiastic reviews. Two other question and answer services, AskERIC (Lankes, 1995) and KidsConnect (KidsConnect, 1997), both run from Syracuse University, are extremely popular resources for students and educators and have won recognition and awards. However, these question and answer services run the risk of being overwhelmed if the nation succeeds in connecting its classrooms by the end of the century. KidsConnect alone experienced a 1,000% increase in its questions in the month of September 1996 (from 20 questions a week to 200). By

[12]For example, see Scholastic Corporation at <http://www.scholastic.com>.

[13]Kirk Winter's *EdInfo* from the Department of Education.

[14]Through the 21st Century teacher site at <http://www.21ct.org>.

the year 2000, projections indicate that there will be approximately 54 million students enrolled in elementary and secondary schools in the US; 39 million in grades K-8 and 15 million in grades 9-12 (Lankes, Bry & Whitehead, 1996). Considering that only a fraction of today's students have Internet access from their schools, the size of this potential burden on Internet-based educational resources is daunting.

By understanding how these and other exemplary K–12 digital reference organizations build and maintain services in the complex Internet environment, new strategies and solutions can be developed. New Internet information services might use the existing digital reference services as models for meeting future needs of the K–12 education community. Existing Internet information services might also use these descriptions of reference services to improve present activities.

K–12 digital reference services can be one starting point for the larger investigation of building and maintaining Internet information services. K–12 digital reference services are particularly relevant to the larger question of Internet information services because:

- These services tend to involve many different Internet technologies (e-mail, the World Wide Web, etc.)
- Digital reference services cover the range of static information resources (such as marked-up HTML pages) to dynamic communications (such as e-mail reference transactions)
- Digital reference services on the Internet are becoming increasingly important as people realize the present limitations of automated information location services (such as AltaVista and Yahoo)
- The population of these services is relatively easy to identify, and
- These services tend to be willing to share information on their processes and activities.

There is also an identifiable need for this type of study within the education community. Services such as KidsConnect, the MAD Scientist Network, and the Library of Congress have expressed to the researcher a need to better understand (and document) digital reference services for the K–12 audience. The U.S. Department of Education has also outlined digital reference as a priority in the newly formed National Library of Education (NLE, 1997). Therefore, this study may have a direct impact on these K–12 services as well as informing the larger Internet community.

The overall purpose of this study, as stated previously, was to investigate the building and maintaining of Internet information services using these K–12 digital reference services. One of the specific objectives within this purpose was to create a set of detailed descriptions of Internet digital reference services meeting the reference needs of the K–12 community. Such descriptions are valuable not only in meeting the increasing reference needs of the K–12 Internet community, but also to other organizations seeking to build and maintain Internet information services. By understanding the processes in a specific population, these descriptions can be explored in other contexts, and a systematic series of studies can explore the larger activities related to building and maintaining Internet information services in general.

Benefits of Descriptions

One objective of this study was to empirically describe how Internet information services, specifically K–12 digital reference services, build and maintain services in the dynamic Internet environment (the other objectives were to explain and apply a conceptual framework based on complexity research and seek commonalties among the empirical descriptions). This objective involved the construction of inductive descriptions[15] of what Holland refers to as an Internet information service's performance system. These descriptions are inductive in that they emerged from existing services and were not deduced from theory or literature. Documenting (describing) these services has yielded the following:

- Provided a beginning point in the systematic research of the information service building and maintaining process in complex environments
- Provided valuable information to those seeking to build and maintain Internet information services, particularly digital reference services, by providing empirically grounded descriptions
- Highlighted the interaction between organizations and the complex Internet environment, and
- Created a pedagogical tool for those training future Internet and information professionals to build and maintain Internet information services.

These activities are important to building, teaching, and researching the Internet as the Internet and its effects are increasing. The global network is changing how and what we teach, how organizations deploy and support information systems, and how consumers get their information. These changes and their impacts are predicted to continue to increase in the near future. Evidence of this increased impact can be seen by the following:

- The large and continued investment by organizations into building and managing Internet services (Gartner Group, 1995)
- The increased attention to the Internet by the trade and popular press
- The increase in pedagogical activities related to the Internet, specifically on building and maintenance of Internet information services (Green, 1996), and
- The development of the Internet into a delivery platform not only for technical and scientific information, but for information pertaining to a wide spectrum of activities (government, education, entertainment, etc.) (Liu et al., 1994, p. 6).

This study of digital reference services for the K–12 education community has provided a succinct and in-depth empirical basis for building, teaching, and researching Internet information systems. It has also provided a direct benefit to the population under investigation.

[15] See Blueprints in Chapter 4.

Research Questions

As stated above, the overarching purpose of this study was to investigate how Internet information services are built and maintained using K–12 digital reference services as a starting point. This purpose is in response to the problem of Internet information services, specifically K–12 digital reference services, having to meet the increasing information demands of users in the dynamic Internet environment. This study had three specific objectives: (1) to build and apply a conceptual framework based on complexity research, literature, and the researcher's experience; (2) to empirically describe, by applying the conceptual framework, how Internet information services, specifically K–12 digital reference services, build and maintain services in the dynamic Internet environment; and (3) to seek commonalties across these descriptions. In order to meet the purpose and objectives of this study the following research questions were asked:

1. What are agents' (K–12 digital reference services') detectors for Internet agent types, internal inputs and external influences?
2. What are agents' rules for processing detector input, and through resources, building and maintaining effectors?
3. What are agents' effectors used to meet users' information needs?

These questions cover the three components of Holland's performance system (from the conceptual framework): anticipation of environment (detectors), processing of information (rules), and fulfilling user needs (through effectors). This structure was derived from the detectors, rules, and effectors previously discussed.[16] It stresses the interaction of these K–12 digital reference services in the Internet environment.

The notion of environment is pervasive in information systems and services (Buckland, 1991; Taylor, 1986). Organizations are expected to scan the external and internal environment to make choices that will improve their services. This is no different in the Internet environment. The differences are the rate at which that environment changes and the manner in which it is organized. Digital reference services cannot simply look at a set of common variables, or informants, to predict what comes next. The common axiom of "know thy users," for example, becomes problematic when the total number of users on the Internet is unknown and tools such as the World Wide Web treat every interaction as unrelated and unique. Services have difficulty in choosing applications and tools in a world where everyone is potentially a publisher and the next software innovation is as likely to come from a college undergraduate as it is from Microsoft. The Internet is a complex system with dynamic interactions, unprecedented change, and an amazing amount of ambiguity.

Research question 1 asked what sources of information are used by K–12 digital reference services to build and maintain their services. Do they use quantitative information such as Web usage statistics? Do these organizations prefer anecdotes, focus groups, feedback through electronic forms, and/or e-mail? It should be noted that these inputs (detectors) were derived inductively from the K–12 digital reference services themselves.

Research question 2 addressed the next step, asking what organizations do with this

[16]This structure will be discussed in further detail in Chapter 2.

input. How do they process this information and translate it into actual services? This research question sought to elicit specific rules, processes, and policies that take input from the environment and translate it into services. This research question also sought to identify the resources (people, technology, policies, etc.) used in these processes.

The researcher used data from research question 3 to create a list of services used by K–12 digital reference services to meet users' information needs. These outputs are called effectors in the language of complexity.

Method of the Study

To address the question of how K–12 digital reference services build and maintain Internet information services in the complex Internet environment, the researcher developed inductive descriptions of the performance systems of Internet information service organizations (specifically exemplary K–12 digital reference services). This was done through a series of qualitative methods in the form of elite interviews and document analysis. These techniques elicited the detectors, rules, and effectors used by K–12 digital reference services. The performance system represents the coping rules and mechanisms for these organizations. From semi-structured interviews and document analysis, the researcher developed a series of initial descriptions of six exemplary K–12 digital reference services. These descriptions were verified by the organizations themselves and then compared to one another. This method is detailed in Chapter 3.

Delimiters and Assumptions

The researcher made several decisions in the preparation of this study. These decisions both focused the study (delimited) and reflected assumptions of the researcher. In order to maximize the understanding of this study and its results, the delimiters and assumptions are made explicit. These factors effect the ability of these results to be transferred to settings other than K–12 digital reference services, and strictly speaking, to K–12 digital reference services other than those chosen to be studied.

Delimiters

Creswell states, "boundaries are necessary in a study to provide direction for the terms used, for the scope of the study, and for the potential audience" (1994, p. 105). These boundaries are known as delimiters. Delimiters provide ". . . parameters for a research study [that] establish the boundaries, exceptions, reservations, and qualifications inherent in every study" (p. 110). The researcher identified four factors that delimit this study:

1. Organization as the unit of analysis
2. Literature and previous research used
3. Sample used for the study, and
4. Methods used to elicit information.

Each of these delimiters is discussed below in terms of justification and effect on the study.

Organization as the Unit of Analysis

The study's unit of analysis is the organization that provides K–12 digital reference services. An organization may provide several services (a Web site and a listserv for example) to the K–12 community. However, these services are seen as a part of the larger organization. This organization is self-defined (by way of the elite[17] as discussed in Chapter 3), although a single service (in this case an organization's question answering service) is used to identify the organization initially.

This unit of analysis limits the study's ability to abstract to a larger population (say to all reference services). It also limits the researcher's ability to specify characteristics of individual functions within organizations (of Webmasters for example). The researcher believes, however, that a study of organizations provides the most benefit to the audience of this research. A great deal of information already exists on the role of individual members of organizations, for example the Webmaster (examples include Spainhour & Quercia, 1996 and Sullivan-Trainor, 1996), and there are broad discussions related to entire industries (for example Cronin's [1995] discussion of business on the Internet or Eisenberg & Ely's [1993] discussion of education on the Internet). The researcher found little, however, related to organizations.

Literature and Previous Research Used

There is a tension created in naturalistic studies between the amount of knowledge used to inform the research process and the amount of bias introduced by previous knowledge. Creswell (1994) wrote:

> In qualitative research the literature should be used in a manner consistent with the methodological assumptions; namely, it should be used inductively so that it does not direct the questions asked by the researcher. One of the chief reasons for conducting a qualitative study is that the study is exploratory; not much has been written about the topic or the population being studied, and the researcher seeks to listen to informants and to build a picture based on their ideas. (p. 21)

So literature must be used inductively to frame a study but should not interfere with the potential inductive results. This principle guided the selection of literature for this study.

There are five areas of literature drawn upon for this study: digital reference services, complexity research, General Systems Theory, management literature (as it relates to the concepts of knowledge and control), and Internet architectures. These literatures either better defined the study's area of investigation (K–12 digital reference services) or aided in the creation of the study's conceptual framework. The conceptual framework is a "context free" structure that allows for the examination of an Internet information service without predetermining the actual structure of that service (or, in Holland's terminology, the performance system). Literature for this study was not used to predict or create hypotheses, but rather to inform inductive inquiry. Looking for detectors, for example, did not predispose the researcher to finding a particular type or set of detectors.

[17]An elite (as will be discussed in Chapter 3) is an individual that represents an Internet information service.

Sample Used for the Study

K–12 digital reference services are not the only sample that could have been used in an investigation of Internet information services. Silverstein (1997), for example, used "online storefronts" (p. 7) to investigate how for-profit companies using the World Wide Web to market their products create strategy for their organizations. Carroll (1996) looked at how organizations build and manage services using Internet technologies within the confines of the organization itself (so called "intranets").

The choice of K–12 digital reference services, in the strictest interpretation, delimits the study and its results to Internet information services that are available on the open Internet,[18] and that are serving the K–12 community through question answer services. These services tend to be not-for-profit and freely available on the Internet. These services also tend to be small.[19]

However, these services are also clearly related to library reference services (whether in a public, academic, special, or school library) and reference services in general. For example, a recent analysis of "help-desk" software conducted by WebTop Systems (1997) revealed much of the software being produced today to support question/answer services are geared around telephone interactions. These help-desk packages are now increasingly incorporating Internet-based transactions. The researcher feels this study could aid these software manufacturers.

Methods Used to Elicit Information

The primary data for this study came from a series of elite interviews. The elites interviewed represented the entire organization. Within an organization, however, there are multiple perspectives. Management literature, for example, makes a distinction between strategic and tactical views. It was assumed that members within a single organization could have differing views. This study concentrated only on the view of the builder and maintainers of a digital reference service.

Other methodologies, such as case studies, would have captured a larger cross-section of these views. The researcher, however, decided the "deeper" views of decision-makers were more important than a broader perspective.

Assumptions

The researcher makes several assumptions in this study. These assumptions are based primarily upon the researcher's past experience. These assumptions are:

1. The Internet will continue to be complex and dynamic.
2. Understanding users does not equate to understanding information services.
3. Descriptions of digital reference services will be transferable.

These assumptions are discussed below. Also discussed are the perceived effects on the study and the study's results.

[18]As opposed to an intranet where only members of a given organization can access services.

[19]In number of employees.

The Internet will Continue to be Complex and Dynamic

As noted above, the researcher makes the case for the Internet as a complex and dynamic environment. Such environments (complex adaptive systems) must remain dynamic and flexible. The notion of complexity is perpetual novelty. Complex adaptive systems evolve and adapt. Complex adaptive systems, however, can end by evolving to a state of stability. On the other hand, these systems can also lose all structure and regularity and devolve into chaos. The researcher assumes that the Internet will neither stabilize to the point of predictability nor devolve into utter chaos. This assumption directly affects the "life span" of the conceptual framework used for this study. If the Internet does become static, or completely chaotic, the conceptual framework becomes invalid for studying the Internet.

Understanding Users Does Not Equate to Understanding Information Services

The understanding of user behaviors and user needs within the context of an information service is insufficient to understand the information service itself. Still and Campbell (1993) stated that the Internet can obscure the method by which reference needs are met. The same question (input) can be processed in a variety of methods and with a variety of sources. Therefore, merely knowing what users are doing in regards to an information service is insufficient in understanding the system itself.

Further, as seen earlier, many of these services know little about their users. They are building and maintaining services without much in the way of direct user input. Therefore, there was little attempt on the part of this study to gather user information or user evaluations of K–12 digital reference services.

Descriptions of Digital Reference Services Are Transferable

Descriptions of exemplary K–12 digital reference services are useful and transferable not only to other K–12 digital reference services but to the larger field of Internet information services. The delimiters above reduce the formal ability of this study's results to be transferred to other domains and other Internet information services. The researcher's experience, however, has demonstrated, on an informal basis, an ability of one Internet information service to learn from other services even though they may be involved in "other areas" (whether those be in other markets, industries, profit motives, audiences, etc.). Experiences from the AskERIC K–12 digital reference service have been used in industries varying from telecommunications to publishing to government. As stated in the introduction, information on the processes of building and maintaining Internet information services are scarce. It has been the experience of the researcher that services look for information based on building and maintaining in general, not based upon industry or other demarcations. K–12 digital reference services, a relatively small number of information services on the Internet, therefore can be used to begin a larger investigation of Internet information services in general.

Chapter Summary

This chapter provides a statement of the problem investigated in this study and the context in which that problem was studied. K–12 digital reference services are currently working in an Internet environment that changes rapidly and often make decisions in the absence of traditional management tools and information sources. There is a lack of empirical, scholarly information for these service builders to draw upon. This study explored the complex Internet service environment and built a series of descriptions. The study and its descriptions do not attempt to answer the question "how do *all* Internet information services operate?" Instead, the study serves as a first step and establishes a baseline description of exemplary Internet information services, specifically K–12 digital reference services.

Chapter 2: Conceptual Framework and Related Research

The Internet, however, serves as a new point on the knowledge/control continuum. There is virtually no knowledge of the environment . . . and even less control by the organization building and maintaining Internet information systems.

Chapter Preview

There is a tension created in naturalistic studies between the amount of knowledge used to inform the research process and the amount of bias introduced by previous knowledge. Creswell (1994) wrote:

> In qualitative research the literature should be used in a manner consistent with the methodological assumptions; namely, it should be used inductively so that it does not direct the questions asked by the researcher. One of the chief reasons for conducting a qualitative study is that the study is exploratory; not much has been written about the topic or the population being studied, and the researcher seeks to listen to informants and to build a picture based on their ideas (p. 21).

This principle, that literature must be used inductively to frame a study, but not interfere with the potential inductive results, guided the selection of literature for the study.

This study drew on five areas of literature: digital reference services, complexity research, General Systems Theory, management literature (as it relates to the concepts of knowledge and control), and Internet architectures. Each of these literatures either defined the study's area of investigation (K–12 digital reference services) or aided in the creation of the study's conceptual framework. The conceptual framework is a "context free" structure that allows for the examination of an Internet information service without predetermining the actual structure of that service (or, in Holland's terminology the performance system). Literature for this study was not used to predict or create hypothesis, but rather to inform inductive inquiry. Looking for detectors, for example, does not predispose the researcher to finding a particular type or set of detectors.

This chapter places this study within a variety of literatures and existing research. A review of digital reference services on the Internet outlines present thinking about the Internet's effect on reference services. It provides not only a backdrop to the study, but demonstrates the need for this study and builds a series of expectations in regards to the nature and skills of members in these digital reference services. Complexity research is reviewed and used as the foundation for the conceptual framework of this study. General Systems Theory is also reviewed in relation to complexity. This review places complexity research into a more widely understood and accepted framework of open systems. Management literature is also outlined briefly in relation to concepts of knowledge and control. These concepts demonstrate the unique nature of the Internet in regards to information systems and traditional management of information systems approaches. Lastly, Internet architectures are explored. The Lankes/Eisenberg architecture (Lankes, 1996) is developed as a means of better defining the Internet and the inputs (detectors) to K–12 digital reference services.

The researcher used this body of knowledge to meet the objectives of the research: (1) to build and apply a conceptual framework based on complexity research, literature and the researcher's experience; (2) to use this conceptual framework to empirically describe how organizations, specifically K–12 digital reference services, build and maintain services in the dynamic Internet environment; and (3) to seek commonalties across these descriptions. The descriptions were used to answer the following research questions:

1. What are agents' detectors for Internet agent types, internal inputs, and external influences?
2. What are agents' rules for processing detector input and, through resources, building and maintaining effectors?
3. What are agents' effectors used to meet users' information needs?

Ultimately, a methodology was created that is grounded in the existing literature, theory and the researcher's experience.

Digital Reference Services on the Internet

The examination of existing research and literature in the area of digital reference services via the Internet provides context for this study. This literature is provided as a "backdrop" for the research and builds a set of expectations for the researcher when examining K–12 digital reference services. It outlines present thinking in the field and how this thinking is related to K–12 digital reference services. It also demonstrates the need for a study of fully digital library reference services.

Defining Digital Reference Services

For the purposes of this study, reference services are defined as mediated interfaces between users in an "anomalous state of knowledge" (Belkin, 1980) and a collection of information (Sutton, 1996, p. 131-133). The user's anomalous state of knowledge, also referred to as a gap in cognitive understanding (Dervin & Nilan, 1986), is operationalized in this study as a question that needs to be answered. This question may be expressed as an e-mail request or a query to a system (Taylor, 1968). The collection is a set of information in the form of documents, files and/or knowledge (including human expertise). In this study, all information was delivered to a user electronically via the Internet.[20]

Mediation between the user and the query is the central topic of reference research. Mediation can be performed either through a human expert (such as a reference librarian) or an automated interface (such as an online catalog). The primary purpose of the interface is to match the user's information need to the system's organization and capabilities (Taylor, 1968). The mediator (once again, either automated or human) becomes the user's advocate to the system or collection. This view of reference is maintained in today's electronic reference environment (Sutton, 1996). This study concentrated on how organizations, specifically K–12 digital reference services, built Internet information systems that fulfilled users' reference needs. Restating the concentration of this study using language from the reference discussion above: how organizations built and maintained information services that mediated between a user's information need and a collection of information.

[20]This can be done through client/server systems like the World Wide Web or other systems such as e-mail.

Impacts of the Internet on Reference Services

The literature shows significant impacts on reference services prompted by greater access to the Internet and Internet tools. These impacts include new skills needed by information specialists and reference librarians (Bobp, Katzert & Richey, 1993). The Internet is also expanding traditional library collections and improving location and access[21] to reference resources (i.e, ready reference materials and pathfinders through World Wide Web sites, access to catalogs and electronic reference sources through telnet, etc). Most significant to this research, the Internet affords reference services the ability to conduct entire reference transactions (from specifying users' needs to delivering information from the collection) via the Internet (Still & Campbell, 1993).

A great deal of literature has focused on augmenting traditional reference services with Internet resources and capabilities. This literature ranges from evaluation criteria for online reference sources (Balas, 1995) to discussions of technology used to locate and access Internet resources (examples include Feeney, 1993; Bobp, Katzert & Richey, 1993; Gainor & Foster, 1993; Arms, 1990; Branse, 1993; Machovec, 1993). In these discussions, the interface to the user remains the same, but the collection is expanded to include Internet resources. These new resources change the reference environment. Mardikian and Kesselman (1995, p. 22-23) presented five "rationales for changing reference:"

- Increasing access to resources beyond the library (networked resources including the Internet).
- Lack of geographic constraints for users ("users may no longer need to come to the library to obtain information").
- The need to differentiate services to different populations of users (i.e., inside an organization and outside an organization) in the face of shrinking budgets.
- Increases in complexity of information resources and the need for specialized knowledge.
- New options (primarily in staffing) for answering reference questions.

All of these rationales concentrate on having librarians redefine their roles within a traditional, geographically defined library setting.

Changing Roles of Reference Librarians

These changes in the reference environment focus on the reference librarian and the training of that librarian in response to the "increasingly automated [library] over the past three decades" (He & Knee, 1995 p. 7). He and Knee presented the idea of an electronic services librarian. In regards to reference services, they stated, "It is important for electronic services librarians to be familiar with traditional as well as electronic reference sources. By learning traditional sources, they will be able to recognize which Internet resources may also be valuable" (p. 9). He and Knee called for librarians to update their skills in response to perceived changes to the reference environment. Librarians' skills must also include an ability to evaluate networked resources. McClure (1994) discussed the evaluation of networked resources. He drew upon VanHouse et al. (1990) to define evaluation as "the process of identifying and collecting

[21]For a discussion on location and access see Eisenberg and Berkowitz, 1990, p.7.

data about specific services or activities, establishing criteria by which their success can be assessed, and determining both the quality of the service or activity and the degree to which the service or activity accomplishes stated goals and objectives" (McClure 1994, p. 592).

The burden of learning and applying the application and evaluation skills of the Internet falls upon the librarian. The librarian must master the new Internet tools for his or her users. The reference librarian acts as "a bridge which has technology at one end and the user at the other" (Callahan, 1991). Learning, however, is not limited to just applications and technology. It also applies to learning to deal with change. McClure et al. stated "library staff . . . must learn from their colleagues in the computing services how to become more comfortable with the type and rate of change that will accompany the networked environment" (McClure, Moen & Ryan, 1994). This notion of change and the need for technical proficiency is echoed throughout most of the literature concerning reference services and the Internet. The use of complexity in this research was a reaction to the fact that digital reference services must also deal with a great amount of change.

Accompanying the changes in reference librarians' skills are changes in the reference librarians' roles, particularly in regards to staffing. Oberg states "paraprofessionals can and do perform well at a reference desk, freeing librarians to concentrate on higher-level tasks" (from Mardikian & Kesselman, 1995, p. 21). Mardikian and Kesselman presented a three level staffing model to reflect the changing role of the reference librarian (see Table 2-1).

Table 2-1: Mardikian and Kesselman's Staffing Levels

Level 1: Minimum Human Intervention
○ Self-guided building tours ○ Automated telephone answering machines ○ Better signage ○ Better floor maps ○ Library quick guides ○ Step-by-step guides ○ Computer-assisted instruction for self-service instruction ○ Computerized information kiosks
Level 2: Library Interns/Trained Paraprofessional Staff
○ General library orientation and general bibliographic instruction ○ Directional inquiries ○ Ready reference searching ○ Bibliographic verification on OCLC, RLIN, and the online catalog ○ Assist with search strategy formulation ○ Technical assistance with machine problems ○ Basic informational services with referrals as needed
Level 3: Librarians, Subject Specialists
○ Individual research consultations ○ Specialized reference services ○ Office hours in departments ○ Member of a research team with teaching faculty ○ Liaison activities with departments ○ Specialized instructional services ○ Integrate information literacy into the curriculum ○ Research and development efforts ○ Mediated online searching ○ Create CAI programs and expert systems for users ○ Ongoing evaluation and needs assessment

From this table the researcher assumed that most information specialists working in K–12 digital reference services would fall into category three with some in category two.

Accompanying this shift in responsibilities for reference librarians (to higher-level tasks) is a call for greater collaboration with other types of professionals. Lewis (1995) believed the infusion of new tools for location and access into libraries means "a significant upgrading of skills of most librarians and will mean professionals who are not librarians will have to be offered positions along side of, or in place of, librarians." McClure, et al. (1994, p. 67) listed partnering with computing services, faculty, and other "external organizations and companies" as critical success factors in building the virtual library. One would expect members of digital reference services to be highly knowledgeable in technology and Internet applications. However, as discussed in Chapter 4, few services have specific detectors for infrastructure issues such as hardware and wiring, instead relying on their larger organizations for such knowledge. Indeed, these services have formed strong relationships with computing centers and technical organizations as discussed by McClure et al. (1994).

The literature did, however, allow the researcher to anticipate that information specialists in K–12 digital reference services would have backgrounds other than library and information science. Indeed while the two pretest services of this study (AskERIC and the Internet Public

Library) claimed strong backgrounds in formal library training, only one of the six services studied (The National Museum of American Art Reference Desk) employed a professional librarian.

Digital Libraries

The Internet is also used to provide better access to a library's collection. The Internet is used to organize materials for reference patrons[22] (Jensen & Sih, 1995) and allow patrons access to reference sources such as OPACs[23] (He & Knee, 1995). This reference collection literature includes discussions of standards for information interchange (Moen, 1992). The literature seems to present a continuum for reference services and access in relation to the Internet. There has been a general belief that libraries and reference services are headed "towards a virtual future" (Strong, 1996). However, this future has not been widely explored.

Sutton's (1996) four-part typology of libraries anticipated the expansion of reference collections to include the Internet, as well as the use of the Internet to access an individual library's collection. This four part typology (see Figure 2-1) created a continuum from a paper-based ("traditional") library to a fully "digital" library without walls (Sutton, 1996, p. 129). It consists of:

- Traditional: "a specific place with a finite collection of tangible information bearing primary entities like books and journals . . . [denoted as] paper" (Sutton, 1996, p. 131).
- Automated: a mix of paper and digital reference resources and meta-information that "point to non-digital media" (Sutton, 1996, p. 135).
- Hybrid: typified by the use of both print and digital meta-information sources (increasingly digital) and the coexistence of both digital and paper primary resources. This type of library allows for the first time remote access to "some subset of the library's digital collection or to digital resources" (Sutton, 1996, p. 136).
- Digital: " . . . the library as a logical entity. It is the library without walls—the library does not collect tangible information bearing entities but instead provides mediated, geographically unconstrained access to distributed, networked digital information" (Sutton, 1996, p. 138).

From this typology, Internet information systems, specifically digital reference services, can be seen as "digital" libraries. Since such services transact all information delivery via the Internet, they are fully digital.

One interesting aspect of a digital library's reference services is the ability of the Internet to hide the process of reference services. Still and Campbell noted:

> . . . one big difference [between traditional reference interactions and using the Internet for reference work] was that e-mail has made the internal operations of the library invisible to the patron; they are unaware of which department handles each request. The patron simply asks the question" (1993 p. 16).

[22]Patron is a library term synonymous with user or customer.

[23]An OPAC is an Online Public Access Catalog. It is a computer database that allows library patrons access to information on a library's collection.

The present study was a direct response to the "black box" effect[24] of the Internet. K–12 digital reference services are being built and used, but it is impossible to determine more than the most rudimentary processes within the actual reference process.[25] Most services in their public documentation and description concentrate on what the service does, not how they are done.

Sutton (1996) stated that in a digital library the primary task of the librarian is to provide "context" (Sutton refers to Saffo's [1994] concept of context). That is to say, the collection becomes so large (it could be considered to consist of the entire Internet) that patrons no longer desire the full range of information available on a given topic, but the "best" information. The librarian's role shifts from advocate to a collection to a filter for the user. Since the patron is no longer bound by geography (or technology), the user will select services based on how well they create a context useful to that user. So the selection of K–12 digital reference services could be seen as a selection of contexts.

Digital Reference Services Summary

Reference librarianship and reference services have a long and rich history. It is clear from the literature that the Internet has a major impact on how reference services are accomplished in the networked world. A continuum appears to have been established (see Figure 2-1). The continuum starts at a library with no automation, unaware of the Internet, and ends in a library as "logical entity" (Sutton, 1996) where reference services provide context to a globally distributed, fully digital collection. Much of the discussions within this literature centers on the role of the reference librarian. The librarian or information specialist of the fully digital library appears to be technically literate, but versed in traditional reference resources; cooperative with organizations outside of the library; prepared to cope with great change; and able to provide context to patrons. These characteristics certainly apply to the services studied in this research, even though they do not have formal library training.

[24]A black box effect is used to refer to a system where only the input and output are known. However, one is unable to determine the means that transform input into output.

[25]Some services make such information explicit. For example, the AskERIC service not only includes information on who is answering a question, but also on the way in which that question was answered.

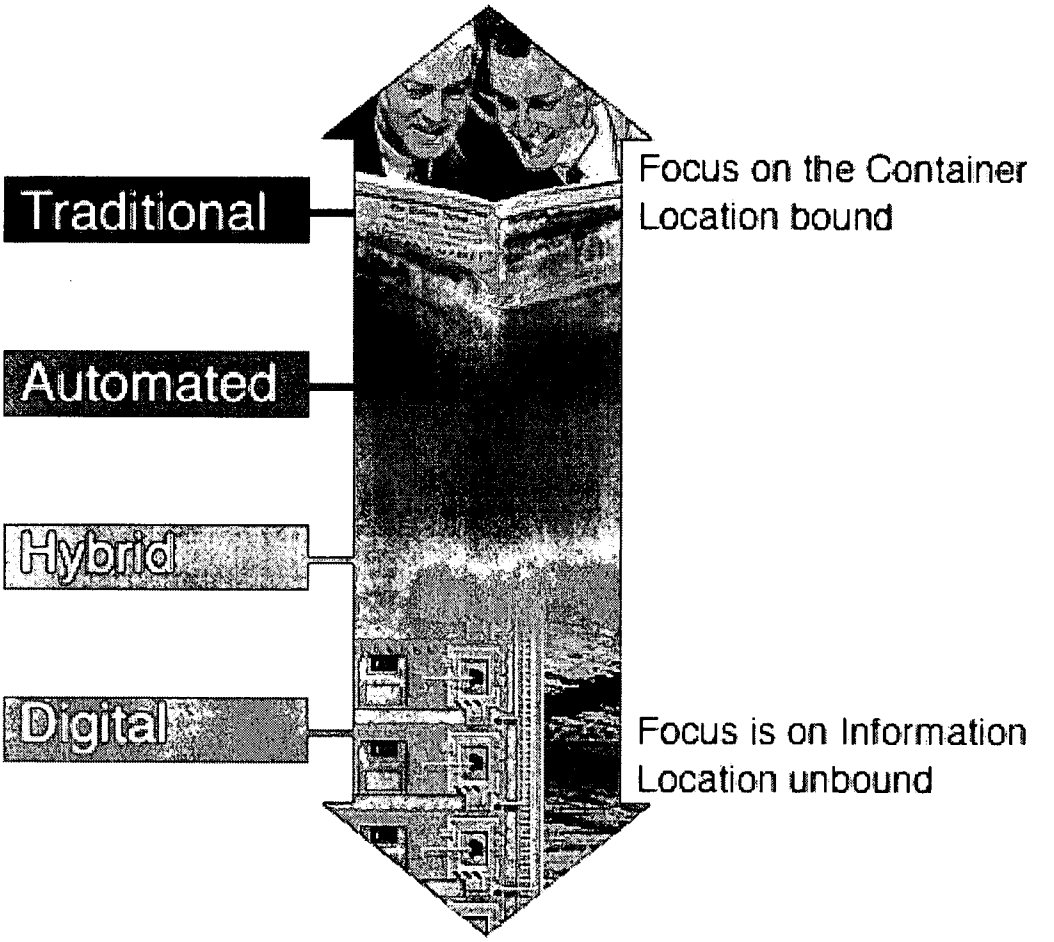


Figure 2-1 Continuum of Libraries: Sutton (1996) establishes a continuum of libraries from "traditional" that is bound by its physical facilities and concentrates on "objects" such as books to "digital" in which the network and electronic documents make objects and location irrelevant.

This literature informed the researcher as to the importance of this study (to counteract the black box effect created by Internet digital reference services) and built a set of anticipated characteristics of information professionals within these digital reference services. This literature led the researcher to expect information specialists would be technically literate and from a wide variety of backgrounds. The expertise on the part of digital reference service workers was accounted for in the methodology. However, the researcher could also expect the builders and maintainers of these services to be able to understand and explain both the processes of their Internet information services and the technology resources used. This combination (process knowledge and technical knowledge) supported the choice of K–12 digital reference services as the population for this study. The following sections build a conceptual framework used to explore the "digital library" environment facilitated by the Internet.

Conceptual Framework

The purpose of this research was to use K–12 digital reference services as a starting point to better understand the building and maintenance processes of Internet information services in general. The examination of development processes in information services is not unique. A great deal of effort has been placed into researching and documenting the information system process and specific information systems (Taylor 1986). This body of research, in conjunction with literature about the Internet and digital reference services, provided a significant amount of background for this study.

However, as stated in Chapter 1, the Internet presents unique challenges for system builders and managers. The Internet is a complex adaptive system. Using Complexity Theory as the underlying theoretical framework for this research, specifically Holland's (1995) performance system of agents, the researcher constructed a conceptual framework for the study. This framework, represented in Figure 2-2, served as the starting point to understanding the phenomena at hand. Existing concepts from research and trade publications were incorporated into the complexity foundation. The final construct served as the organizing metaphor for the study, its research foundation as well as the mechanism used to inform the methodology. This section presents a broad overview of the conceptual framework followed by in-depth discussions of the framework's component literatures.

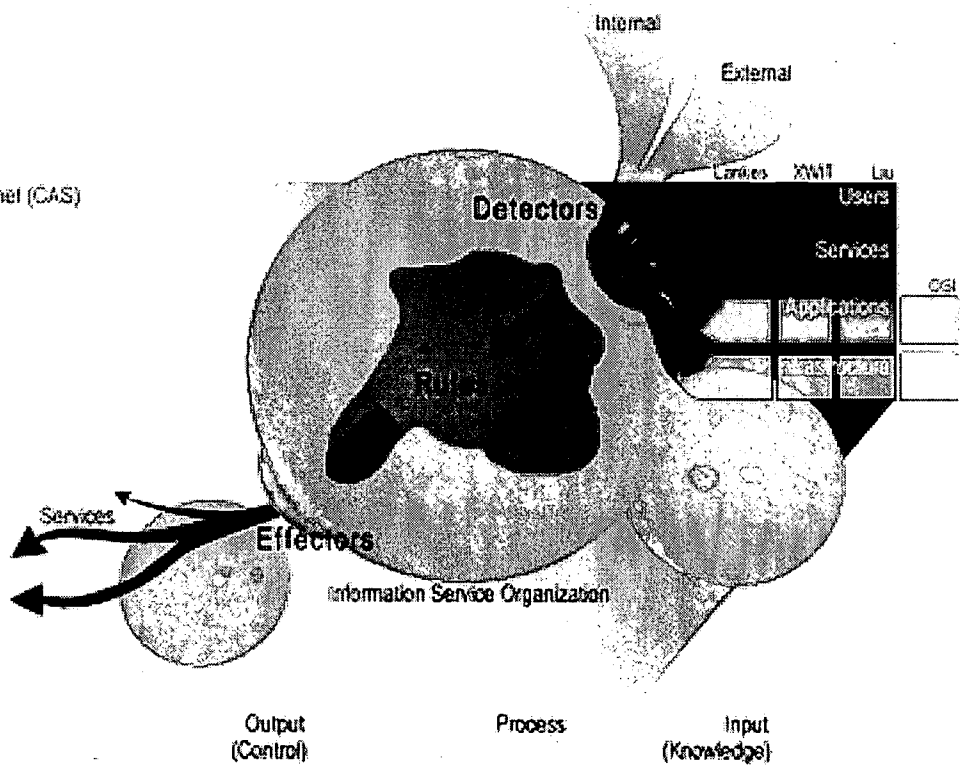


Figure 2-2 Conceptual Framework: Complexity forms the base of this organization-centered framework. The framework is grounded in theory and existing research.

The major components of the framework are:

- *Holland's performance system*: an overview model of organizations as detectors, rules, and effectors. The performance system of an organization represents its internal model and the way the organization interacts with the environment (the Internet).
- *General systems theory*: general systems theory, with inputs, processes, and outputs, provides a common starting point for understanding complex adaptive systems.
- *Knowledge and control*: what an organization can know and the control of that organization on its environment are two of the major factors differentiating the Internet from other environments organizations seek to supply with information services.
- *Internet inputs*: the Internet is central to this study, and a clearer understanding of the agents operating on the Internet will clarify the types of inputs K–12 digital reference services can receive.

The following sections of this chapter explore the literature used to construct this conceptual framework. This exploration begins with complexity theory.

Holland's Performance System and Complexity Research

Complexity Theory, and the notion of "complex adaptive systems" (Waldrop, 1992) provided the foundation for this study's conceptual framework. The following section presents a discussion of complexity theory from its most abstract concepts to the specific portion of the theory used in this study, Holland's performance system.

Within the complexity literature there is a perceived match between Complexity Theory and the Internet. In Holland's book, Hidden Order, (Holland 1995, p. 4), he describes the Internet as a complex adaptive system. Mayer-Kress and Barczys (1994) even went so far as to present the Internet as a complex adaptive system with striking similarities to another complex adaptive system, the human brain. Moore (1997) emphasizes the complex nature of the Internet in creating new strategies and leadership styles in organizations. Later in this chapter, the connection between complexity theory and the Internet will be illustrated with examples.

Complexity Theory seeks to address the paradox presented to physicists and economists alike: that while entropy dictates that all things will seek to a lower level of order (a state requiring less energy) many systems in the world are increasing in complexity (a higher level of order and energy). This is seen in almost every area of life: from politics that have evolved from town meetings into representative democracies; to life itself that formed from simple compounds and amino acids to today's dizzying array of animals and plants. How does one explain why the world seems to be getting more complex—not less? If it is true that entropy will eventually reduce all things to a homogeneous, static, and simple form, why do things seem to become increasingly diverse, changeable, and more organized (Holland, 1995)?

Stasis, Complexity, and Chaos

Complexity Theory is often confused with Chaos Theory. Complexity Theory states that while things are getting more complicated, they are not getting so complicated that they are completely random and unpredictable (Casti, 1994 p. 3). Both complexity and chaos state that as

things get more complicated, the number of agents at work within a system increase (we have more cells in our bodies than, say, a worm). Each agent (part, person) contributes something to a system's operation and its outcome (or output). As the number of agents increases, it becomes more difficult to account for the contribution of a single agent, much less the interaction among these agents. Why was something done the way it was? How can you trace a decision back to its origin when so many people or agents contributed to the decision? In Chaos Theory it would appear that if things are getting more involved and consisting of more parts, all causality and predictability must eventually vanish. However, complexity theorists noted (Allen, 1994) that life is not chaotic. We live our daily lives based on assumptions of regularity and predictability (e.g., my car will start in the morning, my computer will work, my job will still be waiting for me).

Complexity lies between the deterministic (static) and the chaotic (random). This is represented in Figure 2-3. Complexity is the acceptance that the world can seem chaotic in nature, but that things tend to organize themselves. However, such organization is not pre-determined. There is order, but that order changes over time; it is dynamic. Further, while this order lends itself to regularity, it does not imply predictability based upon causality.

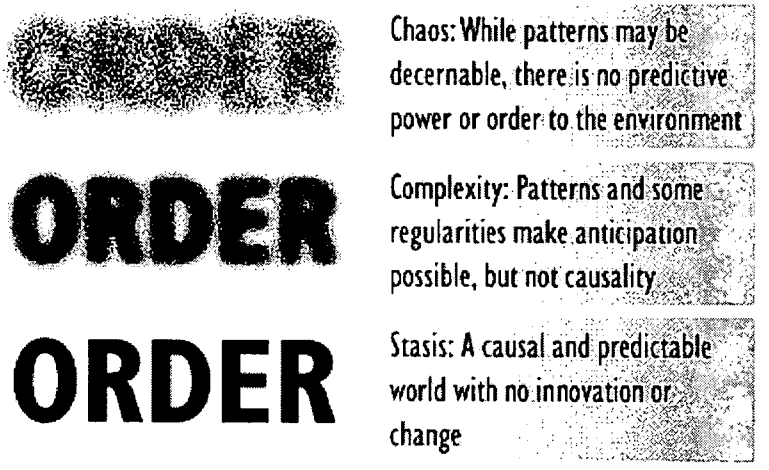


Figure 2-3 Chaos, Complexity, and Stasis: Complexity lies between total chaos, and total order.

Complexity is elegantly described by Waldrop (1992):

> Think of the quadrillions of chemically reacting proteins, lipids, and nucleic acids that make up a living cell, or the billions of interconnected neurons that make up the brain, or the millions of mutually independent individuals who make up a human society.
>
> In every case, moreover, the very richness of these interactions allows the system as a whole to undergo spontaneous self-organization. Thus, people trying to satisfy their material needs unconsciously organize themselves into an economy through a myriad of individual acts of buying and selling; it happens without anyone being in charge or consciously planning it . . . Furthermore, these complex, self-organizing systems are adaptive, in that they don't just passively respond to events the way a rock might roll around in an earthquake. They actively try to turn whatever happens to their advantage. Thus, the human brain constantly organizes and reorganizes its billions of neural connections so as to learn from experience (sometimes, anyway). Species evolve for better survival in a changing environment—and so do corporations and industries. And the marketplace responds to changing tastes and lifestyles, immigration, technological developments, shifts in the price of raw materials, and a host of other factors.

> Finally, every one of these complex, self-organizing, adaptive systems possesses a kind of dynamism that makes them qualitatively different from static objects such as computer chips and snowflakes, which are merely complicated. Complex systems are more spontaneous, more disorderly, more alive than that. At the same time, however, their peculiar dynamism is also a far cry from the weirdly unpredictable gyrations known as chaos. In the past two decades, chaos theory has shaken science to its foundations with the realization that very simple dynamical rules can give rise to extraordinarily intricate behavior . . . Instead, all these complex systems have somehow acquired the ability to bring order and chaos into a special kind of balance. This balance point—often called the edge of chaos—is where the components of a system never quite lock into place, and yet never dissolve into turbulence, either. The edge of chaos is where life has enough stability to sustain itself and enough creativity to deserve the name of life. The edge of chaos is where new ideas and innovative genotypes are forever nibbling away at the edges of the status quo, and where even the most entrenched old guard will eventually be overthrown. The edge of chaos is where centuries of slavery and segregation suddenly give way to the civil rights movement of the 1950s and 1960s; where seventy years of Soviet communism suddenly give way to political turmoil and ferment; where eons of evolutionary stability suddenly give way to wholesale species transformation. The edge of chaos is the constantly shifting battle zone between stagnation and anarchy, the one place where a complex system can be spontaneous, adaptive, and alive" (p. 11).

Complexity is often referred to as the "edge of chaos." The delicate state that lies between the impregnable mess of chaos and the boring predictability of stasis. It is what makes one's life interesting to live, but not impossible to cope with.

A Note on Agents

Complexity relies heavily upon the notion of agents; therefore it is necessary to explain this concept from the outset. Holland defined agents as "active elements that . . . are diverse in both form and capability" (Holland, 1995, p. 7). In simple terms, agents are basic units of a system. The term is loosely defined because ultimately these units are context specific. The term agent was coined to discuss generalities of complex adaptive systems without invoking context. Agents can be aggregated to form larger "meta-agents" or broken down further into another level of agents. This notion of agents' abilities to aggregate is central to complexity. The notion of agent and specific attributes of agents will be examined later in this chapter after the larger concepts of Complexity Theory are discussed.

Acceptance of Complexity Theory

Complexity Theory, as previously stated, is in development (Cohen & Stewart, 1994 p. 326). It has been a very popular approach widely covered in the popular press and print (Sardar & Ravetz, 1994). While many see true merit in the study, not all agree to every part of Complexity Theory (Horgan, 1995). The primary bone of contention is the claim that complexity is a "Theory of Everything" (Cohen & Stewart, 1994, p. 440). Many question the notion that high-end computing can devise a system of algorithms and formulae to explain any phenomena in any field (Horgan, 1995).

The researcher did not seek to prove or disprove all of Complexity Theory's claims. In fact, one major thread of complexity research was not used at all (that of computational modeling). Instead, the researcher used complexity as a useful guide in understanding a changing environment. Complexity concepts, particularly the discussions on agents' performance systems, were useful in revealing the process of building and managing Internet information services. Complexity has been shown to be an effective framework when approaching dynamic

environments (Funtowicz & Ravetz, 1994). The researcher believes it is a useful base for the conceptual framework used throughout this study because it is:

- Adaptive: complexity allows for an environment that is constantly changing. It provides insight into the notion of organizations constantly evolving to meet the dynamic Internet world. The theory itself deals with complex adaptive systems. It seeks to understand dynamic environments that constantly change (Packard, 1988).
- Inclusive: complexity is sufficiently abstract to explain a wide variety of phenomena. Yet it still sees these disparate events and trends as part of a larger system. This is important because the Internet itself is a collection of activities, procedures and functions. Complexity theory is a result of a multidisciplinary investigation into phenomena that cut across domains (economics, physics, etc.) (Allen, 1994; Cohen & Stewart, 1994, p. 442).
- Open: since the literature and previous research provided little in direct conceptual and/or theoretical support for this investigation, one had to be "borrowed" from another area of investigation. To apply an existing model from another field, it must be sufficiently open to new environments so that it does not force the original field's values and preconceptions on the phenomena under investigation. The theory of complexity is still in development and flux (Cohen & Stewart, 1994, p. 326). As such it is open for new investigation and input. The theory itself is also about discovery and investigation.

Complexity research underlies the conceptual framework of this study. It provides a useful means of investigating the Internet and Internet information services without forcing preconceived notions and variables upon the investigation.

Attributes of Complex Adaptive Systems

The following discussion of complexity seeks to build towards a single aspect of complex adaptive systems, the performance system of agents. This component, while basic to the study of complexity, is only a small part of a larger body of research and theory. A funnel approach is used to place this "performance system" within the larger complexity research and generate context for the reader.

This discussion begins with the broadest understanding of complex adaptive systems. Holland (1995) identified a series of properties and mechanisms that must exist within a complex adaptive system. Properties describe the environment, or larger system, whereas mechanisms are devices used by agents of a system to exist within, adapt to and modify this environment.

Holland identified four properties that can describe any complex adaptive system. These are listed in Table 2-2.

Table 2-2: Holland's Properties of a Complex Adaptive System

Aggregation	The ability to group agents within a system into common categories. The ability of agents within a common category to act together to produce large effects or trends within a complex adaptive system.
Nonlinearity	The underlying assumption that there is not a direct and easily predictable linear relationship between an agent's actions and the consequence of that action.
Flows	The notion that things can flow from one agent to another (one node to another). This "thing" is information (though it may be encoded in electrical impulses or chemical exchanges in the case of biology). This concept is vital in that it demonstrates that while agents may be autonomous, they can interact. Flows are the interactions.
Diversity	Agents within a given system will take on different forms to match the environment. Since the environment is changing, the array of agent forms will also change, but match the environment in some way.

Holland then identifies and discusses three mechanisms used by agents (the inhabitants of the complex adaptive system). These are discussed in the Table 2-3.

Table 2-3: Holland's Mechanisms of Agents in a Complex Adaptive System

Tagging	Mechanisms that agents utilize for aggregation and flows of information.
Internal Models	A representation of the environment used by an agent to anticipate and adapt to the environment.
Building Blocks	Components of internal models combined to build, test and re-build internal models.

This study assumed the larger properties while concentrating on the mechanisms. While properties are invaluable in building a model of a complex adaptive system, this study concentrated instead on how organizations interact with the larger environment. The only parts of Holland's basic elements that are specific to an organization or service are those that deal specifically with agents (since these services are agents). Only the mechanisms are specific to the study of agents. These mechanisms will later be refined and discussed in greater detail.

Match of Attributes to the Internet

Table 2-4 matches examples of Internet elements to Holland's attributes. These examples are not exhaustive, but illustrate how Complexity Theory can be applied to the Internet environment.

Table 2-4: Internet Examples of Holland's Complexity Attributes

Aggregation	The Internet has been defined as a "network of networks." This is an example of defining the system as an aggregation of its components (or agents).
Tagging	Today, URLs and Internet addresses are common. URLs are tagging mechanisms. You can divide the Internet by ".com vs. .edu" or even "Gopher versus World Wide Web" through these tags.
Non-linearity	The growth of the Internet itself demonstrates non-linearity. The population of the Internet is estimated to be growing exponentially.
Flows	The Internet is a network of flows, that is communication. The purpose of a network is to allow the flow of information (in the form of electrical impulses or pulses of light).
Diversity	There are Internet services that seek to serve all types of populations, from K–12 to adult entertainment. One of the commonly mentioned strengths of the Internet is the diversity of information.
Internal Models	The AskERIC model, presented later in this chapter, is an example of one organization's internal model used to anticipate the Internet environment.
Building Blocks	TCP/IP is an example of a building block. It serves as an open standard that does not restrict innovation, but provides the basic foundation for new ideas. TCP/IP serves as the foundation for both the World Wide Web, FTP and telnet; yet they all represent radically different end-user experiences.

Figure 2-4 represents the Internet using Holland's attributes. Note that the purpose of this study was not focused upon the Internet environment itself, but on agents within the system, specifically K–12 digital reference services.

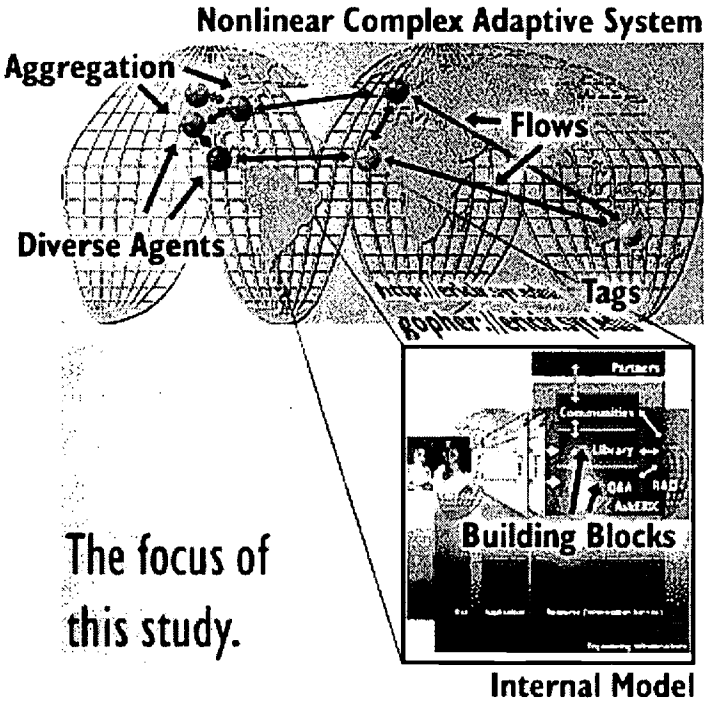


Figure 2-4 Holland's Attributes and the Internet: While Holland's properties relate to the general Internet environment, his mechanisms concentrate on the agent.

Holland's Performance System

We have moved from the most abstract concepts of complex adaptive systems (properties) to the more specific (mechanisms). This section describes the most specific concepts in complexity, agents and their performance systems. Even at this level, descriptions and definitions will be broad. The goal of Complexity Theory, as with General Systems Theory, is to find commonality across many different environments. The researcher provides specific references to Internet information systems or K–12 digital reference services to provide linkage for the reader to the subject at hand.

Describing an agent and discovering its mechanisms is done by examining an agent's "performance system" (Holland, 1995, p. 87). This system describes an agent's coping mechanism towards a complex adaptive system. This system has a set of detectors for reading the environment (gathering knowledge), a set of rules for reacting to environmental information, and a set of effectors for manipulating (controlling) the environment. It is this framework of detectors, rules, and effectors (seen is Figure 2-5) on which this study relied to elicit how organizations build and maintain Internet information services.

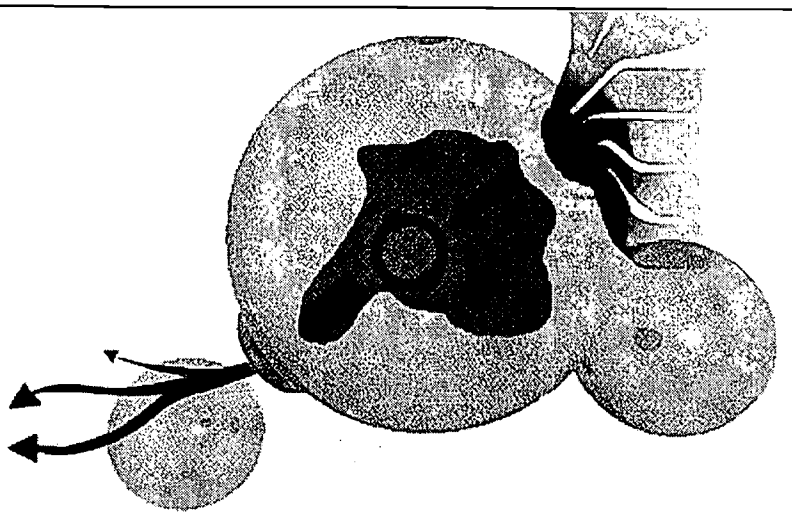


Figure 2-5 Holland's Performance System of an Agent: The basics of Holland's performance system.

As will be shown later in this chapter, the notion of detectors, rules and effectors is not an altogether new idea in the study of systems. These concepts are analogous with General Systems Theory's input, process, and output and will be discussed in the next section.

Detectors

Holland describes the role of an agent's detectors as:

> . . . [the mechanism used] to filter the torrent of information its environment produces. To describe this filtering operation, I adopt the common view that the environment conveys information to the agent via a set of detectors (Holland 1995, p. 44).

Detectors are the senses (the eyes and ears) of an agent. They are a series of selective sensors used to gather information. This implies some discrimination (not all information is absorbed).

There can be many types of detectors used by an Internet information service. Holland described the scope of detectors in the following quote:

> An antibody employs detectors that depend on local arrays of chemical bonds, while an organism's detectors are best described in terms of its senses, and a business firm's detectors are usefully described in terms of the responsibilities of its various departments. In each instance there are interesting questions about particular mechanisms for extracting information from the environment . . . (Holland, 1995, p. 88).

Research question 1 of this study sought to elicit these detectors within the context of K–12 digital reference services.

Some illustrations are presented here from the researcher's experience. World Wide Web servers, for example, create log files of usage. These logs contain a record of the files that were retrieved, the addresses that retrieved these files, and the software used to retrieve these files. These files are considered detectors. That is, they record a certain type of information (files accessed) from the environment and other agents (in this case users). In digital reference services, e-mail provides another common type of input to an agent. Information specialists who respond to this input act in conjunction with hardware and software to receive this information from the environment (once again from a user). System managers often rely upon other detector types, such as trade journals and research reports, to detect trends and information from the systems community.

Rules

Complexity Theory spends a great deal of time on the rules used by agents. Much of complexity research is about how rules are created, re-used and passed on in complex adaptive systems. Holland spent a great deal of time on rules. Holland described two aspects of rules in regard to agents: a static set of rules as part of an agent's performance system and the dynamic creation and testing of rules which consists of what Holland called an agent's "credit-assignment algorithm" (Holland, 1995, pp. 49–60) and "rule-discovery algorithm" (Holland, 1995, pp. 60–87). While both static and dynamic rule discussions are important in the larger study of complex adaptive systems, this study concentrated on the static rules. The performance system is a point in time and cannot be used to describe the dynamic and evolutionary effects of agents within a complex adaptive system. The researcher decided that while a longitudinal study could begin to capture the dynamic rule-making procedures, a baseline description of the present state of K–12 digital reference services was needed. With static descriptions of organizations at one point in time, succeeding research can begin to judge the evolutionary effects of the complex Internet environment. A longitudinal study, however, would not allow for the same depth of description needed to capture a point in time.

For the purpose of this study, the rules are descriptions of the process whereby detector input is prioritized, and then acted upon to influence effectors. Given the population under investigation, K–12 digital reference services, this process can be summarized as the steps, policies, and actions taken to meet students' and educators' reference needs on the Internet. The rules are composed of a series of reactions to stimuli (detectors).

These actions are performed by use of resources. Resources are the components of an agent that allow an agent to operate in the larger system. This is a very loosely defined term because every agent's resources are context sensitive. Resources were defined within the context of this study to mean the people, software, hardware, and policies available to an agent to respond to stimuli from the environment. The agent's detectors provide the stimuli for the rules, and effectors provide the response to stimuli.

Effectors

Effectors "represent [an agent's ability] to act on its environment" (Holland, 1995, p. 88). These are an agent's tools for interacting with other agents. In terms of Internet information services these effectors can be seen as the set of services, or interfaces, offered to users and other agents on the Internet. From a technical perspective these effectors could be software services such as Web sites, e-mail services, and the like. An organization may define services in terms of audience: a Web site for users, an internal Web site for employees, and a Web site for vendors. For the purpose of this study specific effectors were determined inductively from K–12 digital reference services. However, the overarching effector was defined by the primary purpose of the sites selected: to meet the reference needs of the K–12 community through the Internet.

Use of Complexity in This Study

Complexity Theory is an informing theory, not a predictive one. It assisted the researcher in understanding the nature of the environment but not the specific nature of the organizations under examination. That is to say, Complexity Theory did not allow the researcher to build a testable hypothesis (i.e., "an Internet information service organization will be structured according to X"). Complexity highlights the dilemma of working on the Internet and then provides a high-level approach to exploring the agents within a larger environment.

Complexity Theory provided the mechanisms for investigation. It anticipated a set of internal models and building blocks that could be identified, examined, and aggregated by investigation of an agent's performance system. It is this set of performance systems that the study explored in six K–12 digital reference services. The concept of a performance system served as the foundation of the conceptual framework used in this study.

The next section on General Systems Theory provides a greater context for complexity as well as situating this study within general systems research and literature.

General Systems Theory

This discussion of General Systems Theory is presented to form a common set of references. General Systems Theory has a longer history and is more commonly known throughout the information science field than Complexity Theory. This discussion concentrates on the commonalties of complex adaptive systems and general systems (particularly General System Theory's concept of open systems). This linkage is primarily intended to clarify vocabularies, situate this study within a General Systems Theory context, and further clarify the conceptual framework.

Complexity and complex adaptive systems can be seen as a special case of a general "open" system (as seen in Figure 2-6).

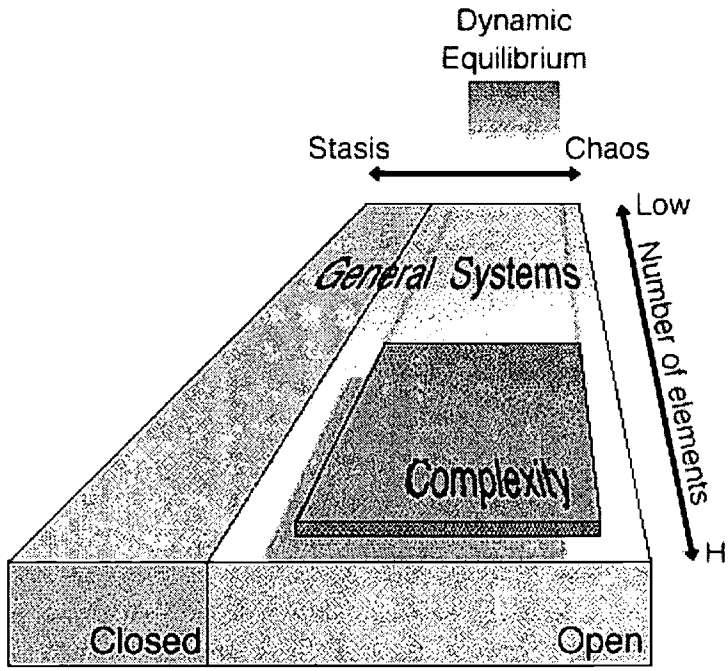


Figure 2-6 Comparison of General Systems Theory: Complexity is considered a special case of General Systems theory where there are a large number of elements in an open system at dynamic equilibrium.

Both approaches (general systems and complexity) deal with elements interacting within a larger environment. Holland (1995) calls these elements "agents." Both approaches deal with interactions between organizations by looking at how agents (or elements) receive input from the environment (in general systems, this is called input; in complexity this input is received by use of detectors). Both approaches recognize that agents act upon this information. In complexity, action is taken through a set of rules (Holland, 1995) and in general systems through a set of transformations (Bertalanffy, 1968). Both approaches also recognize that agents impact the environment (in Complexity Theory through effectors, and in General Systems Theory, referred to in the abstract through outputs [Bertalanffy, 1968, p. 42]). Complexity and general systems also refer to a process of changing or evolving an organization through feedback (Bertalanffy, 1968 p. 43). This feedback process is also referred to as cybernetics[1] (Mattessich, 1982).

The parallels between complexity and General Systems Theory become obvious when the key concepts of the two approaches are placed side by side. Table 2-5 matches complexity concepts to Kast & Rosenzweig's (1972) description of key concepts of General Systems Theory.

[26]Though cybernetics normally deals only with negative feedback.

Table 2-5: A Comparison of General Systems Theory Concepts to Complexity Concepts

General Systems Theory (derived from Kast & Rosenzweig, 1972, p. 362)	Complexity
Subsystems or Components: A system is composed of interrelated parts or elements. This is true for all systems—mechanical, biological, and social. Every system has at least two elements, and these elements are interconnected.	"CAS [Complex Adaptive Systems] are, without exception, made up of large numbers of active elements . . . " (Holland, 1995, p. 6). The primary difference between Complexity Theory and General Systems Theory on this point is the number of elements (agents) in question. Complexity deals with large systems composed of many agents.
Holism, Synergism, Organicism, and Gestalt: The whole is not just the sum of its parts; the system itself can be explained only as a totality.	"Complexity affords a holistic perspective." (Coveney & Highfield 1995, p. 13). Complexity is a direct reaction to the reductionist approach and seeks patterns in the whole of a system.
Open Systems View: Open systems exchange information, energy, or material with their environments.	Flows are one of Holland's seven basic attributes of complex adaptive systems. Flows state that resources and information are exchanged with the environment and other agents.
Input-Transformation-Output Model: In a dynamic relationship with its environment, it [an open system] receives various input, transforms these inputs in some way, and exports output.	This concept is analogous to an agent's performance system with detectors (input), rules (transformation), and effectors (output).
System Boundaries: Open systems have permeable boundaries between itself and a broader supra-system. Boundaries are relatively easily defined in physical and biological systems, but are very difficult to delineate in social systems, such as organizations.	The scope of an agent is fuzzy in complexity. Agents themselves are composed of building blocks, that may in themselves be agents.
Negative Entropy: In open systems, disorder and a decline in complexity can be overcome by importing "negative entropy" (energy or order) from the resources in the environment.	Complexity does not use the concept of negative entropy; instead it disputes the notion of entropy in general. It questions the "truth" that all things move to disorder in an open system. (Cohen & Stuart 1994, p. 252).
Steady State, Dynamic Equilibrium, and Homeostasis: An open system may attain a state where the system remains in dynamic equilibrium through the continuous in-flow of materials, energy, and information.	Complexity concentrates on this state of equilibrium whereas General Systems Theory incorporates the larger (and more abstract) set of possible systems (including closed systems that may reach a state of stasis).
Feedback: Output of the system is fed back as an input into the system. This positive or negative feedback can alter the transformation process and/or future outputs.	Feedback is an implicit part of complexity. While there are no specific mechanisms to monitor the output of an agent, changes to the environment as a result of output from an agent will cause the agent to adjust its rules. Two aspects of an agent's internal model, the "credit-assignment algorithm," and the "rule-discovery algorithm" (Holland 1995, p. 87) are specific processes to adjust the rules of an agent in relation to its environment.
Hierarchy: A system is composed of subsystems of a lower order and is also part of a supra-system.	Holland's aggregation property addresses the ability of agents to form supra-agents and be broken down into more agents.
Internal Elaboration: Open systems appear to move towards greater differentiation, elaboration and a higher level of organization.	Diversity is the characteristic of agents within a complex adaptive system to find niches and to develop a wide range of attributes.
Multiple Goal-Seeking: Systems have different goals within a single environment.	Diversity also covers the concept of agents seeking differing goals within a larger environment.

General Systems Theory (derived from Kast & Rosenzweig, 1972, p. 362)	Complexity
Equilinality of Open Systems: In mechanistic systems there is a direct cause and effect relationship between the initial conditions and the final state. Biological and social systems operate differently. Equilinality suggests that certain results may be achieved with different initial conditions and in different ways. This view suggests that social organizations can accomplish their objectives with diverse inputs and with varying internal activities.	The convergence process is accounted for within Complexity Theory. Different rules can be developed from common inputs, and different inputs can lead to common outputs. It acknowledges that in dynamic evolutionary systems, convergence can occur.

There are other commonalties between complexity and general systems. Both have been approached as "theories of everything" (Bertalanffy, 1968). Both have been criticized for their perceived inability to be applied to actual systems and planning processes (Churchman, 1968). There are many commonalties between the two approaches. This is expected. Both approaches seek to describe systems across a wide range of circumstances and create general guidelines. Both take a "holistic" approach in relation to perceived limitations in reductionism.

Why Complexity and Not General Systems Theory

A logical question to ask is why concentrate on the lesser-known Complexity Theory to build the conceptual framework for this study instead of the wider known General Systems Theory. The answer to this question is in the specificity of the approaches to the topic at hand. General Systems Theory is, as its name would imply, general. It covers both closed systems (where no resources or elements are added and interactions among agents are pre-determined) and open systems (where resources, elements and interactions are dynamic). The Internet is an open system. Complexity on the other hand deals only with open systems. Complexity also provides greater specificity in its approach to the problems of complex adaptive systems and agents. It provides specific properties and mechanisms that apply to the Internet. Holland's work, in particular, was simply easier to adapt to the problem of Internet information services.

Knowledge and Control

The conceptual framework utilizes two concepts from information systems literature, knowledge and control. These concepts informed the conceptual framework in two ways. First, these concepts grounded the conceptual framework within the information systems literature thus providing an "entry point" for those more familiar with information systems concepts than complexity. Second, these two concepts were used to highlight a dilemma of Internet information service providers thus reinforcing the inductive approach taken by the study.

Buckland noted:

> The notion of control is central to the study of systems. *Control*, however, may sometimes seem too strong a word in this context. What is of interest is what responses are made. How do parts of the system react to problems? How do the responses and interaction of parts combine to form the behavior of the whole? It is the process of response to stimuli that constitutes the means of change and adaptation by internal alteration, by changing relationships, or by influencing the external environment (p. 28).

In this quote, Buckland defines control as the reaction of a system to stimuli. For the purposes of

this study, control was defined as the actions of a system, while knowledge was defined as the stimuli upon which these actions are based.

Knowledge

Buckland (1991) treated knowledge as a construct of evidence, thought, and belief. It is that which a system or individual believes to be true. Knowledge can change over time or be reinforced by supporting evidence. Buckland also made a distinction between knowledge and recorded knowledge. Knowledge is (restricted for this study) the ability of an agent to obtain information on how, why, when, and where other agents are interacting with the environment (here the Internet). That is to say it is the ability to gather and analyze information about trends and developments in the context of the system in question. These larger questions are characterized by the questions of "what new technologies are available to me" or "what is my competition providing to users that I need to be aware of?" This knowledge can be represented in the form of official reports such as log files, surveys, focus groups, or informally through general awareness of managers within an organization.

In this study, knowledge of the organization was defined as an organization's (agent's) detectors. What an organization knows was based on the information it received. The information an organization received was a product of its detectors.

Control

Buckland's notion of control has both an internal and external sense. That is the ability of a system (or agent) to control itself (its component parts) and the ability of the agent to control its environment (other agents). Even Buckland conceded that "control" is often too strong a word. He refered to the ability of a system to influence its environment and organization.

The conceptual framework for this study incorporated these notions of control in both its rules (the system of responding to stimuli) and its effectors (the mechanisms used by an agent to affect its environment).

Management, Knowledge, and Control

Several management approaches also assume varying degrees of knowledge and control. The authors in this section are discussing, in complexity terms, the interaction of an agent with its environment. This discussion does not add so much to the conceptual framework as it discusses the overall uniqueness of the Internet and Internet information services.

One extreme of a knowledge/control continuum is Weber's (1946) bureaucracy. In his work, Weber described a static environment where an organization, through strict control (hierarchical control), manages its services. Weber established five characteristics of a bureaucracy:

> I. There is the principle of fixed and official jurisdictional areas, which are generally ordered by rules, that is, by laws of administrative regulations . . .
> II. The principles of office hierarchy and of levels of graded authority mean a firmly ordered system of super- and subordination in which there is supervision of the lower offices by higher ones . . .
> III. The management of the modern office is based upon written documents ('the files'), which are preserved in their original or draught form . . .
> IV. Office management . . . usually presupposes thorough and expert training . . .
> V. The management of the office follows general rules, which are more or less stable, more or less exhaustive, and which can be learned. (pps. 196-198).

In order for this system to work within an environment, one must assume both a high level of knowledge of the environment and a great deal of control over the environment. One can have great knowledge of the environment due to the environment's static nature. Further, Weber advocated a great deal of specialization to allow an even greater depth of knowledge on all facets of the organization and its interface to the environment. Weber then concluded that one can have knowledge and must have a rigid control structure (top down) that steers the organization. Given Weber's beliefs, builders and maintainers of information services can be seen to have few problems. Information systems, like the larger system called the organization, like the still larger system called the environment, are predictable—and controllable. Senge (1990), on the other hand, presented the idea of the "learning organization" in his book The Fifth Discipline. In the book, Senge called for an organization that is flexible and remains open to new ideas from the environment, and from within the organization itself. He further called for an organization that exists in a sort of perpetual novelty, constantly innovating and adapting to the environment. This approach has been applied to the notion of information systems management. The logic would follow that systems must be evolutionary and flexible.

Placing Senge on a knowledge/control continuum one can see that he assumed a good deal of knowledge of the environment (i.e., he emphasized the need for good organizational detectors). One must be aware of innovations to capitalize upon them. This knowledge, however is certainly not as great as Weber's static environment. The main difference between Weber and Senge is redefining the role of control in management. Senge calls for less control in order to increase innovation and flexibility. The uncontrolled environment allows for novelty. Further, there is at the very least an implication that the environment cannot be controlled . . . why else would the organization need to be ready to change?

Ancona et al. (Ancona, 1996, p. 6) characterized Senge's perspective and others as the "New Model of Organizations." They described new features of the organization: networked, flat, flexible, and global. These new models are about reacting to an increasingly dynamic environment. Organizations are networked, flat, flexible, and global to allow themselves to change and adjust to changes faster and more effectively.

A more recent example of a management approach to information systems moves away from high knowledge and high control. Liu (1996) applied dissipative structure theory to the management of information systems. In the *Journal for the American Society of Information Science* (*JASIS*) Liu talked of the need for organizations to bring order to information, and yet use flexibility and uncertainty (which he refers to as entropy) to constantly adapt to an ever-changing environment. Such a strategy assumes some knowledge of the environment, but little control over it. The environment fluctuates due to larger forces than the agent (organization); therefore organizations must constantly adapt.

The Internet, however, serves as a new point on the knowledge/control continuum. There is virtually no knowledge of the environment (the Internet and its agents) and even less control by the organization building and maintaining Internet information systems. Some examples can show the extreme lack of knowledge and control the Internet provides.

Examples of Limited Knowledge and Control in the Internet Environment

One way to define an agent's success in meeting users' needs is through usage statistics. One could reason that the more used a service, the more successful it is. Libraries have long used the number of patrons "through the door" as a metric of their success. Computer systems seem to lend themselves to statistics of usage. One could, therefore, argue that the way to determine a successful Internet information service is by the number of times that service is accessed. In fact, many sites on the Internet do just that. They provide counters on their pages and trumpet the number of "hits" they receive in some time period (e.g., 200,000 hits per week). However, weaknesses in these measures become apparent upon closer examination.

While certainly the older Internet applications/protocols (e.g., FTP, e-mail and telnet) can accurately track usage by a single user, the new client/server architecture actually prevents accurate usage statistics. In client/server software design, files are retrieved in parts. Each time a file is retrieved (a text file, a graphic, etc), a separate connection is used. These connections are virtually impossible to "re-associate." It is impossible to determine the difference between ten people making one request and one person making ten requests if those users are using the same machine.

Further, as client software has become more sophisticated, it has begun to cache, or store, often-used information locally. Though a user may request information from a server, the client software itself may provide the information from a stored copy and never initiate a connection to the original server resulting in no "hits" to the server. This caching is also done of entire Internet information services by commercial access providers such as America Online. Certain transactions on these Internet services may never actually utilize the Internet at all. This leads to the paradox of the modern Internet: the more a service is used, the more likely that service's statistics will under-report their usage!

These statistics serve as an example of the limited knowledge an organization has of the Internet. Even when a single user can be determined (either through statistical analysis or the use of older protocols such as FTP or telnet) little demographic information about that user is obtained. This also demonstrates the lack of control an information system has in the dynamic and distributed Internet. America Online and Prodigy never asked popular services if they could cache Web sites; they simply did. The technology that runs the Internet also limits an information service's control within that environment.

Implications of Knowledge and Control on This Study

This study sought to explore how Internet information systems build and maintain their services. One of the reasons for this study in the first place is the fact that Internet information systems are seeking to meet increasing user needs in an environment of limited knowledge and control. From the literatures discussed (Buckland, 1991; Senge, 1990; Liu, 1996; Weber, 1946), the importance of knowledge and control in the study of information services is clear. It is also clear that the Internet presents new challenges due to the extreme limitations in knowledge and

control. This study explored these ideas by linking knowledge to detectors, external control to effectors, and internal control to rules. That is to say by describing a K–12 digital reference service's detectors, the research described the agent's knowledge-gathering mechanisms. By describing an agent's effectors, the research described an agent's means of controlling its environment. Lastly, the rules, as defined in the conceptual framework, were equivalent to the internal control of an information service.

Internet Inputs

The introductory sections alluded to a typology or architecture of the Internet. For example, the user was described as a separate entity from an Internet information service organization. This section makes clear the underlying architecture for these distinctions. This Internet architecture was also used to better define the types of detectors a K–12 digital reference service can use. Adding resolution to the conceptual framework made the methodology more precise and improved the quality of data.

Internet Frameworks

It was useful to view the Internet as a set of functional layers. Layers are often used when discussing electronic networks (see Figure 2-7). For example, TCP/IP, the set of protocols that define how information is exchanged on the Internet, is described as a series of layers. This division can add a level of resolution in identifying supporting literatures, significant stakeholders, and areas of investigation. The researcher begins the look at Internet inputs, or Internet detector types in the language of complexity, by looking at one of the most widely known layered models in electronic networking, the Open System Interconnect model. This model serves as a starting point and a common reference for those versed in electronic networks.

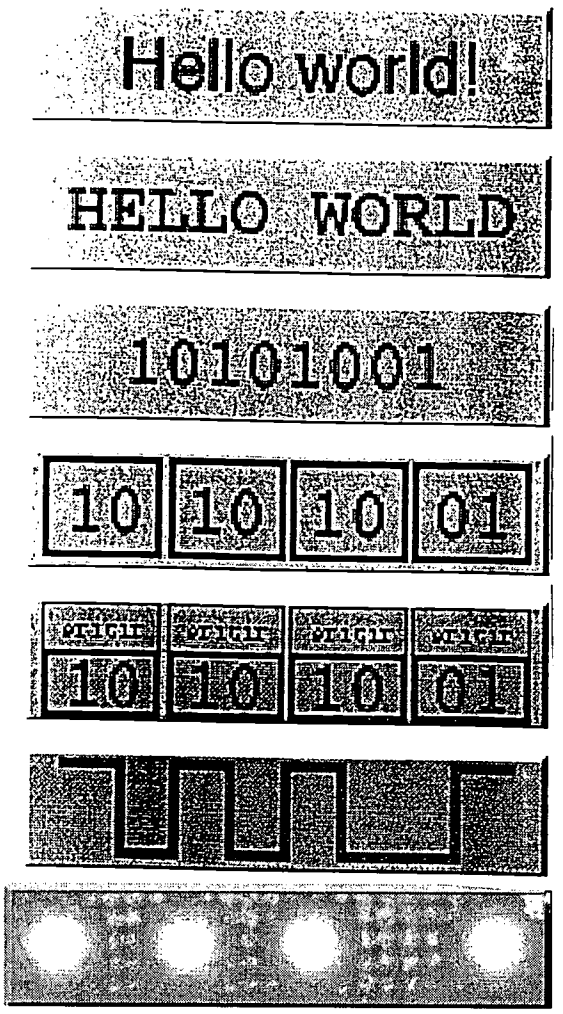


Figure 2-7 Layer Example: In this example of layered protocols a message ("Hello world!") is translated into machine readable forms as it progresses from one layer to a lower layer. Ultimately at the bottom of the layer electrical impulses are transformed into a medium specific form (such as pulses of light over fiber optic cable).

Open System Interconnect

The Open System Interconnect (OSI) model is composed of seven distinct layers:

Layer 1, *the physical layer*, is responsible for the physical connection of devices to a network.
Layer 2, *the data link layer*, mainly does error correction. It makes sure that no data is lost or garbled.
Layer 3, *the network layer*, routes transmissions to their destination.
Layer 4, *the transport layer*, ensures the integrity of each message—re-sequencing portions, if necessary, and handling flow control.
Layer 5, *the session layer*, controls the dialog for each application. It acts as a moderator, seeing that the messages are sent as directed and allowing interruptions, if necessary.
Layer 6, *the presentation layer*, translates data to and from the language and format used at layer 7.
Layer 7, *the application layer*, is the applications themselves (Sprague & McNurlin, 1993, p. 195).

These layers can be seen as a process for information interchange. When data is sent to another computer, it traverses the layers from layer seven to layer one. When information is received, it traverses the layers in the opposite direction from one to seven. Each layer transforms the information making it ready to use for the preceding or proceeding layer (see Figure 2-7).

While this framework provided an excellent view of how information moves from place to place on a network, it did not provide a full view necessary to assist in the study of building and maintaining Internet information services. The OSI model does not deal with issues such as users' needs, information organization, or interactions between stakeholders on the Internet. The OSI model focuses on electronic data interchange not the information itself or the people who both provide and use the information. The OSI model was, therefore, used to represent issues concerning the movement of data on the Internet.

Liu et al.'s Three Roles in the Internet

In their book *Managing Internet Information Services*, Liu et al. (1994) presented a three-part view of the Internet.

> There are three roles played on the Internet which we need to define. This book is about one of the roles, the *information provider*. The information provider makes information (like the weather) available for *users* (whom we sometimes refer to as *customers* of your information service), the second role. The third role is the *connection provider*, who provides the network connection for both information providers and for users. In other books and in the media, you sometimes see connection providers referred to as just 'Internet providers,' but we use the more specific term in this book (p. 2).

This view of the Internet adds user and service dimensions to the previous OSI model. The OSI model can be seen as entirely contained in the "connection provider" category. Liu et al. also transformed the notion of layers into a notion of stakeholders. They did not talk about a process or schema of data, rather they refer to roles, and state these roles as consisting of people and organizations. This idea of stakeholders is important in view of the conceptual framework, because it represents a shift in discussion from a partitioning of the environment (the Internet itself), to the actors, or agents, operating within the environment. This is significant because according to complexity, information interchange occurs between agents.

In this approach, however, Liu et al. grouped together organizations that produce software for accessing information with organizations that use applications to provide information to users. There is a difference between writing software and using software to manipulate information. So while Liu et al. provided a broad view of the Internet, further delineation was needed in order to achieve the proper emphasis on Internet information systems and the population under investigation in this study, K–12 digital reference services.

XIWT NII Architecture

The Cross-Industry Working Team (XIWT), "a multi-industry coalition committed to defining the architecture and key technical requirements for a powerful, sustainable national information infrastructure" (XIWT, 1995), developed an architecture for the National Information Infrastructure[27] (NII). They defined an architecture as a broad set of goals. This architecture had four parts:

> [1] Users, who use and may pay for system services . . . [2] Information service providers, who are commercial, governmental, or private providers of goods and services . . . [3] Network service providers, who provide connectivity . . . [4] Hardware and software vendors, who provide physical devices, appliances, and software platforms (XIWT section 4.1).

This architecture provided the closest fit to the needs of this study. It begins to add the resolution needed to describe the detectors used by K–12 digital reference services. While it applies to a larger National Information Infrastructure (that includes many services above and beyond the Internet), it provides key ideas for studying the Internet. This architecture once again describes the environment in terms of agents (or stakeholders) and adds the distinction between those who create hardware and software and those who provide information services.

The Lankes/Eisenberg Architecture

The previous set of Internet models and architectures provide a foundation for the Lankes/Eisenberg Architecture of the Internet (Lankes, 1994) used in this study. This architecture offers a four-part view of the Internet. Each part represents a different agent type (set of stakeholders) that requires different knowledge, language, and expertise. This approach can be seen as a combination of the previous Internet models, OSI, Liu et al., and XWIT (see Figure 2-8).

[27]The National Information Infrastructure is a concept used to address how information is exchanged in the United States. It is an inclusive notion that includes the Internet, but also other telecommunications technologies such as the phone system, cable, satellite communications, and a variety of services yet to be developed.

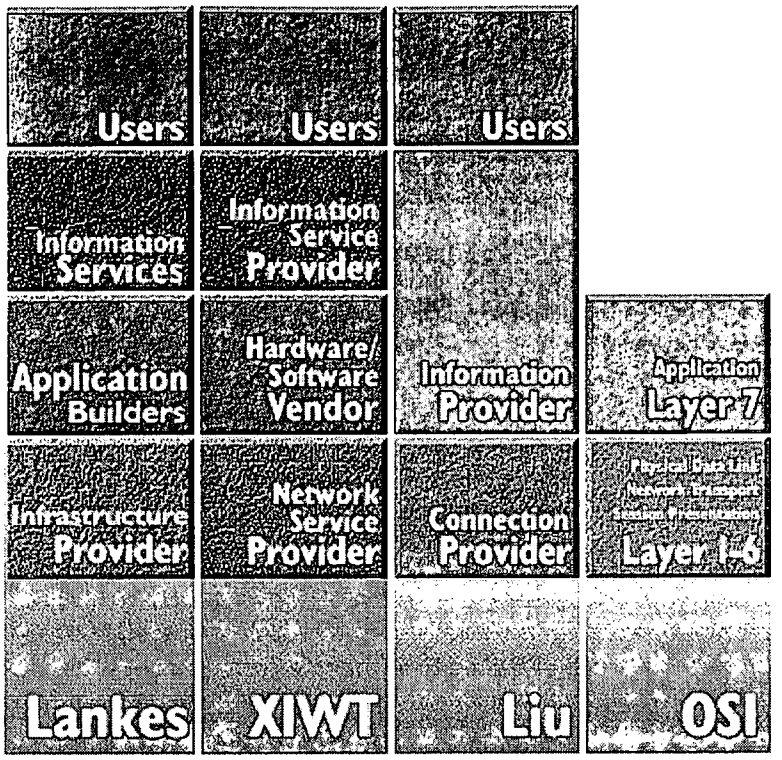


Figure 2-8 Comparison of Internet Architectures and Models: The relationship between the Lankes/Eisenberg Architecture and other Internet models.

Table 2-6 represents the Lankes/Eisenberg Architecture:

Table 2-6: Lankes/Eisenberg Architecture of Internet Agent Types

Agent Type	Description	Example
Infrastructure Providers	Infrastructure Providers are agents (organizations) that build and maintain hardware and protocols used to move bits from one place to another on the Internet. This group represents the first six layers of the OSI model. It would also be considered the "Internet connection provider" discussed by Liu, et al. (1994).	Internet Engineering Task Force, AT&T's WorldNet Service, and Cisco Systems.
Application Builders	Application Builders allow information to be exchanged. This agent type is concerned with the seventh layer of the OSI model (Sprague & McNurlin, 1993). It would also be included in Liu et al.'s (1994) information provider role.	Netscape Corporation and Microsoft Corporation.
Information Services	Information Services builders use applications and infrastructure to meet users' needs on the Internet. This layer would also be included in Liu et al.'s (1994) information provider role.	AskERIC, KidsConnect, and the MAD Scientist Network.

Agent Type	Description	Example
Users	Users are agents that primarily consume information and seek to meet their own information needs on the Internet. This would be Liu et al.'s (1994) user or customer role.	Teachers, school library media specialists, and students.

These agent types are discussed in greater detail below.

Infrastructure Providers

This agent group provides the basic infrastructure required for information flow from one location to another (Institute for Information Studies, 1992). It is the "road" of the "Information Superhighway" metaphor. These agents deal with a wide range of issues and technologies. These technologies include the wires and hardware used to make network connections (leased lines, routers, bridges, modems, etc.).

One focus of this group is TCP/IP (Transmission Control Protocol and Internet Protocol). This standard (in reality a series of standards) moves *all* data on the Internet (for information on TCP/IP see Liu et al., 1994). Infrastructure providers control the foundation for later software such as the World Wide Web and Gopher.

A primary property of this group is its "content free" nature. That is to say that while there are significant information issues and information contained in and about this agent type, in operation this information is transparent to the end user.

Application Builders

These are the agents devoted to software development. An application produces software that uses the infrastructure provider's services to produce, provide, capture, and organize information on the Internet. Application builders significantly differ from the previous group in that applications produced by these agents provide the interface for users acquiring information. The software produced by these agents becomes the resource for other agents (primarily users and information services).

Software, for the purpose of this study, is considered content free. That is not to say that this software does not provide information to the user. Rather, the information provided does not directly match the information needs of the user (Dervin & Nilan, 1986). The user utilizes these applications as means to access other information. Applications created by application builders are a means to an end. For example, when someone uses Netscape Navigator to access a weather report, they are interested in the weather, not the Netscape software itself. To continue the Information Superhighway metaphor, software is the vehicle used to traverse the road.

Not all the software created by these agents, however, is visible to the end user. Software used to provide and organize information within agents is also included in this category. Servers, for example, are vital to the new client/server paradigm used in today's Internet information services (for more information on client/server see Gagliardi, 1994 and Smith, 1992). It is the server's ability to remain invisible to the end user that makes the client/server model so powerful.

Information Services

This set of agents combine software from the application builders with an organization's information for distribution to users via the infrastructure established by the infrastructure providers. K–12 digital reference services, the focus of this study, are members of this group. Information services represent a synthesis of software, information, and the process for maintaining this synthesis.

Information Services can use traditional library and information science skills and research in the production, selection, organization, storage, retrieval, and intermediation of information (Taylor, 1968). Continuing the Information Superhighway metaphor, information services provide the cargo for the vehicles on the road.

Users

Users have received a great deal of attention in the library and information science field. The user focus of today's library and information science programs has prompted an extensive investigation into how users are accessing information via the Internet. These agents deal with issues of information access (Buckland, 1991) and seek to match information on the Internet (represented by the Internet information services) to their own information needs (Dervin & Nilan, 1986). These agents are concerned not only with access issues, but with methods of employing this information into their situations. For example, K–12 teachers are not only interested in getting lesson plans online; they are also concerned with how to use these Internet lesson plans in their classrooms. To finish the Information Superhighway metaphor, users are the drivers on the road.

Architecture Summary

The Lankes/Eisenberg Architecture provides a four-part view of the Internet. It is based on related models and approaches, but adds the important dimension of the Internet information service agent type. Internet information services have a unique vocabulary and needs (especially their reliance on building and maintenance activities). The Lankes/Eisenberg Architecture serves to better delineate (and anticipate) the detector types of Internet information services. Figure 2-8 presents the relationship between the Lankes/Eisenberg Architecture and other Internet models.

Internal and External Input

The conceptual framework also provides for two additional input types: internal and external. These categories are not well defined and were gathered inductively from the field. They represent an acknowledgment that factors other than those associated with the Internet influence how digital reference services build and maintain their services. Internal inputs were defined as ideas and decisions from members of an organization that impact that organization's building and maintenance activities. These detector mechanisms included coordination meetings, focus groups, and other means of soliciting input from members of an organization.

External input types represented a sort of "other" category. These were inputs that came from neither Internet agent types nor internal sources. Changes in markets, stockholder decisions, political decisions, and outside funding sources are examples of external influences on an Internet information service.

Using the Lankes/Eisenberg Architecture to Anticipate Detector Types

By defining agent types within the conceptual framework the researcher not only better understood the interactions between organizations on the Internet, but also anticipated types of detectors used by information services. Table 2-7 represents an example of applying the Lankes/Eisenberg Architecture to detector types for an information service. A more precise example will be given in the next chapter when the conceptual framework is applied to the AskERIC service.

Table 2-7: Lankes/Eisenberg Architecture and Internet Detectors

Agent Type	Detector Type	Explanation
Users	Statistical Logs	While usage logs created by such applications as World Wide Web servers cannot be seen as a precise representation of individual users, they can be used to detect trends in user behaviors. These types of detectors can indicate often-used files for example, or a general "feel" for the number of users.
Users	Questions	In digital reference services, user questions serve as a primary means of input. These predominately one-to-one interactions give services rich data to determine information needs of users.
Information Services	Surfing	Many Internet information services get building and maintenance ideas from other information services. By monitoring other information services, both within a given field (such as K–12 digital reference services) and outside of that field, services can gather ideas and expertise from Web sites and other Internet tools.
Application Builders	Trade Journals	Trade journals provide a wealth of information on upcoming applications and strategies of application builders. This trade information allows agents to make purchasing and technical decisions that have a direct impact on how they maintain their services and meet users' information needs.
Infrastructure Providers	Telecommunication Charges	The cost of bandwidth is a strong criterion in deciding what services to offer. Bandwidth provided by infrastructure providers constrains service types, and often, cost constrains bandwidth.

This chart is not meant to be exhaustive. The actual detector types were determined inductively in the study.

Chapter Summary

This chapter outlined a set of literatures and research: reference services, Complexity Theory, General Systems Theory, information systems literature, and Internet architectures. Reference service research and writing was used to provide a context and justification for this study. It demonstrated a black box effect of digital services, a shift in the role of the reference librarian, and a continuum of library types (from traditional to digital). This research explored the digital library through K–12 digital reference services. The descriptions created in this pursuit counter the black box effect.

The literature was also used to develop, expand upon, and illustrate a conceptual framework based on Holland's (1995) performance systems of agents. The conceptual framework, built from Holland's performance system, embodies the researcher's beginning understanding of the Internet information services process. Complexity theory was framed in a General System Theory context that expanded the concept of input, process, and output. Information systems and management literature was also used to provide context for the conceptual framework and the inductive nature of this research. Lastly, Internet architectures were discussed as a means to increase the specificity of the conceptual framework's detector types. Detectors were refined by agent types (e.g., users, other information services, application builders, infrastructure providers, internal and external).

In the next chapter, the conceptual framework further serves as the grounding for a method used to describe K–12 digital reference services. Interview schedules and coding schemes are tied directly to the conceptual framework.

Chapter 3: Methodology and Research Design

The flexibility of inductive, descriptive, exploratory research was valuable in this investigation of K–12 digital reference services.

Introduction

The previous chapters outlined the scope of this study, the relationship of the investigation to existing research, and the conceptual framework used in this study. This chapter explores the research design and methodology implemented in this study. This design sought to elicit the detectors, rules, and effectors of an agent's (a K–12 digital reference service's) performance system (Holland, 1995). It was the intention of the researcher to synthesize a larger meta-description or set of meta-descriptions from these K–12 digital reference services. A meta-description was a synthesis of patterns and commonalties among the K–12 digital reference services investigated. The end of this chapter reports on the use of pre-tests.

Overview of Method

This study used a set of qualitative methods to elicit empirically-based inductive descriptions of exemplary K–12 digital reference services. The methods included elite interviews (Marshall & Rossman, 1995, p. 83) and document analysis (p. 85). Qualitative methods, as discussed below, are appropriate to a study involving the Internet due to both the network's dynamic/unfolding nature, and to the lack of guiding research in the field. The method used is represented in the Table 3-1.

Table 3-1: Steps of the Study Methodology

	Step in Method	Description
1	Construction of an AskA Locator	The researcher first constructed a list of K–12 digital reference services. Descriptions of each service were developed utilizing the Gateway to Educational Materials (GEM) standard (Sutton & Oh, 1997). This list was based upon Pitsco Corporation's Ask-An-Expert list (Pitsco, 1997), Web surfing, and an ongoing solicitation of service information. This list is the most comprehensive source of "AskA" services on the Internet.
2	Expert panel criteria development	An expert panel consisting of representatives from AskERIC, MAD Scientist Network, and other experts in the field of digital reference then determined selection criteria for exemplary services.
3	Expert panel site selection	The Expert Panel then chose six services for examination[28] based on the above criteria.
4	Site contact for elite	The selected sites were contacted and an elite (a key informant that represented a builder and maintainer of a digital reference service) was identified from the site via small interviews with service contacts.
5	Elites contacted for participation	Elites within the services were contacted and asked to participate. The researcher requested any documents used to build and maintain the service for review.
6	Document analysis against conceptual framework	Documents from the elite and any available Internet documentation (such as a Web site) were reviewed by the researcher. The initial coding scheme (Table 3-4) was used to try and construct a preliminary description of the K–12 digital reference service under investigation.
7	Elite interview	The elite was interviewed. The interview was in-depth and semi-structured using the preliminary interview schedule detailed below.

[28] Nine services were selected. However, AskERIC and the Internet Public Library were used in the pre-test, and the researcher disqualified KidsConnect due to his involvement in running this service.

	Step in Method	Description
8	Interview coding	Starting with the initial coding scheme (Table 3-4), the researcher coded the interview transcript.
9	Elite contacted for clarification	The researcher then re-contacted the elite for additional data and clarification as needed.
10	Description creation	A description of each K–12 digital reference service was developed using the conceptual framework and the previous document analysis. The description took the form of a large format "blueprint." See the service description in Chapter 4 for examples.
11	Description verification	The developed description was shown to the elite, and the elite was asked to verify the description. This verification took place through follow-up phone interviews, walking the elite through the descriptions asking for verification, additions and/or deletions.
12	Description write-up	Final descriptions were created, consisting of Locator information (from step 1), the large format blueprints, and a narrative.
13	Cross description analysis	Once descriptions were created for all selected sites, the researcher used the site descriptions to seek commonalties across K–12 digital reference services.

Table 3-2 outlines the time-line for the study with outcomes at each step.

Table 3-2: Time-line with Outcomes

July-October	October-November	December	January-March	March-May	Outcome
1					Initial list of K–12 digital reference services
2					Expert criteria
	3				10–15 sites selected
	4				List of elites
	5				Participating site list and initial documentation
		6			Document analysis and preliminary description
		7			Elite interview data
			8		Coded interview transcripts
			9		Clarification transcripts
			10		First site description
			11		Verified site description
			12		Meta-description
				13	Write-up

Role of Complexity in Method

This research was not a direct test of Complexity Theory. Nor did this study seek to build a model of the Internet itself as a complex adaptive system. Instead, this research looked specifically at the structure of agents within the complex adaptive system of the Internet. Complexity Theory states that the interaction of an agent with a complex environment is accomplished through an internal model built from a relatively simple set of building blocks (here the agent's performance system [Holland, 1995; Waldrop, 1992]). This research, as guided by the research design, sought to uncover and describe these building blocks by creating empirical descriptions of these agents' performance systems (e.g., their detectors, rules, and effectors).

The Nature of the Internet Environment

The Internet environment is constantly changing. The researcher had to constantly be aware of these changes and be prepared to incorporate new situations and factors into the research design. For example, the researcher had to be able to react to new regulatory action (e.g., the Communications Decency Act in the latest telecommunications legislation[29]) and new software options (the introduction of real-time media such as RealAudio). Major shifts that affect Internet information services in the course of the research may have changed how Internet information services do their work. When eliciting information from informants, the researcher did not rely on a rigid set of questions that was unlikely to accommodate significant changes in the Internet environment. If new regulations, software, or cultural situations presented themselves in the midst of data gathering, the researcher had to be able to adjust to these changes[30] (for example by re-interviewing previous informants).

Strategies such as the use of a short time period for data collection minimized the dynamic effects of the Internet environment. However, the researcher still had liberty to accommodate unforeseen circumstances (Patton, 1990, pp. 39–62; Merriam, 1988, pp. 16–21).

Lack of Guiding Research and Knowledge

The flexibility of inductive, descriptive, exploratory research was valuable in this investigation of K–12 digital reference services. These services, as well as the larger field of Internet information services, remains relatively under-developed in terms of formal empirical and scholarly research. By utilizing inductive descriptive techniques, exploratory research yielded results without the aid of formal, static hypothesis testing. Inductive methods allowed for the eventual development of specific coding categories and variables in the absence of such variables from the literature. This is not to imply there was no guidance in the investigation and analysis of data. The proposed conceptual framework from Chapter 2 provided a beginning point for instrumentation, data collection, coding, and forming a semi-structured interview protocol (to be discussed below).

[29]Telecommunications Act of 1996, Communications Decency Act of 1996: PL 104-104.

[30] It should be noted that no such events occurred during the research process. This discussion reflects the thinking process used in the creation of the researcher's method.

Linkage of Design to Research Questions

This research sought to address the problem of Internet information services having to meet the increasing information demands of users in the dynamic Internet environment. The purpose of this research was to use K–12 digital reference services as a starting point to better understand the building and maintaining processes of Internet information services in general. To achieve the purpose of this study three objectives were defined: to (1) build and apply a conceptual framework based on complexity research, literature, and the researcher's experience; (2) to use this conceptual framework to empirically describe how organizations, specifically K–12 digital reference services, build and maintain services in the dynamic Internet environment; and (3) to seek commonalties across these descriptions. In order to accomplish the objectives of this study, the following research questions, using the language of the conceptual framework, were asked:

- What are agents' detectors for Internet agent types (i.e., users, other information services, application builders, and infrastructure providers), internal inputs and external influences?
- What are agents' rules for processing detector input and, through resources, building and maintaining effectors?
- What are agents' effectors used to meet users' information needs?

These questions formed requirements in the methodology. The method had to incorporate three areas of data collection: techniques to identify detectors, techniques to identify rules and their relation to detectors, and techniques that identify effectors. Techniques related to detectors had to take into account detectors for Internet agent types, internal influences and external influences. Techniques related to rules also had to take into account resources. The method also had to identify "exemplary" K–12 digital reference services.

The Approach

This study, as noted, used qualitative methods due to its inductive, descriptive, and exploratory nature. Bogdan and Biklen (1992) described qualitative methods as:

> . . . an umbrella term to refer to several research strategies that share certain characteristics. The data collected have been termed, soft, that is, rich in description of people, places and conversations, and not easily handled by statistical procedures. Research questions are not framed by operationalizing variables; rather, they are formulated to investigate topics in all their complexity, in context (p. 2).

McClure and Lopata (1996) further stated a strong link between exploratory research and qualitative methods:

> Qualitative techniques are especially appropriate for use in situations where the research problem and the research setting are not well understood . . . When it is not clear what questions should be asked or what should be measured, a qualitative approach will be more useful (p. 11).

Marshall and Rossman (1995) also suggested the link between qualitative methods and exploratory and descriptive nature, particularly in cases of "contemporary" research, where the phenomenon unfolds at the time of the study. Because Internet information systems represent both a research setting that is "not well understood" and "unfolding at the time of the study," qualitative methods were appropriate for this study.

The Use of Elite Interviews

In-depth interviewing was the primary means of data gathering used in this research—specifically, the use of elite interviews. Marshall and Rossman (1995) defined elite interviewing as:

> . . . a specialized case of interviewing that focuses on a particular type of interviewee. Elite individuals are considered to be influential, the prominent, and the well-informed people in an organization or community and are selected for interviews on the basis of their expertise in areas relevant to the research (p. 83).

Marshall and Rossman then outlined the strengths of elites:

> Elites can usually provide an overall view of an organization or its relationship to other organizations. They are more likely than other participants to be familiar with the legal and financial structures of the organization. Elites are also able to report on an organization's policies, past histories, and future plans, from a particular perspective (p. 83).

This knowledge and perspective on Internet information services, specifically K–12 digital reference services, was precisely what this study sought to explore.

Several other qualitative methods were considered as the primary data gathering mechanism. Marshall and Rossman (1995) identified four "fundamental methods" of qualitative research:

1. Participation in the setting (where the setting is a geographical location of the phenomena)
2. Direct observation
3. In-depth interviewing (previously discussed), and
4. Document review.

Participation within a setting (extensively explored by Bogdan and Biklen [1992] as "participant observation") is a longitudinal approach requiring extensive time in observation. It seeks to gather the full richness and perspective of a setting over time. It further seeks to identify all salient perspectives on a problem. This method lacks the specificity and timeliness needed in this investigation.

Direct observation of the organization was both inefficient and potentially misleading for the purposes of this study. The researcher was not interested in gathering an "outsider's" view of an Internet information service organization (the outsider here being the observer). Rather, the researcher sought the constructs and insider's view of the Internet information service builder and/or maintainer.

The researcher also rejected document analysis and review as the primary data gathering mechanism (it was used in conjunction with elite interviewing in a secondary capacity), because, as previously stated, one of the primary reasons for this study was the lack of documentation by

the builders of Internet information services. This method has a place in supporting the views of builders and managers (see below) but did not represent the richness needed to create descriptions of an agent's performance system.

The Selection of Exemplary K–12 Digital Reference Services

As previously stated, K–12 digital reference services provided the sample. As also stated earlier in this chapter, the services selected had to be "exemplary." For the purposes of this investigation, exemplary was defined as "worthy of imitation; commendable. . . serving as an illustration or specimen" (Stein, 1982, p. 462). This definition has obvious utilitarian logic (i.e., when building descriptions, build descriptions others can and will use). Further, this definition deliberately avoided the notion of "best" or an objective scale on which to judge these services. Exemplary in the context of this investigation means noted as worthy of imitation. The concept of exemplary sites is strongly linked to Yin's (1989, p. 48) revelatory case where "a revelatory case is a case for which there is a belief or assumption that the problems discovered in a particular case are common to other cases as well" (Moen, 1998). The determination of exemplary services was done by an expert panel as described below.

The researcher used a three-part process to determine exemplary services for the sample. The first step defined, to the extent possible, the population of K–12 digital reference services. The most comprehensive list of digital reference services (commonly known as "Ask-A" services) at the beginning of the study was at Pitsco Corporation's Web site (http://www.pitsco.com). This list contains a wide variety of digital reference services answering user questions on topics ranging from astronomy to insurance to car repair. However, many services on this list are not K–12 specific. That is to say, they do not seek to primarily meet the information needs of K–12 students and educators (e.g., teachers, library media specialists, administrators). So, the researcher identified a subset of this list that is specifically K–12 oriented (as identified by the services themselves). The criteria for selection of K–12 digital reference services, beyond being part of the Pitsco list, were twofold: (1) they are digital reference services presently in operation, and (2) they explicitly state their mission as serving the K–12 population.

The second step was to assemble an expert panel to select exemplary services. This panel consisted of representatives from two noted K–12 digital reference services, AskERIC and the MAD Scientist Network. Both services have ample experience with the Internet (they have existed on the Internet for more than a year) and have been cited by other Internet information services (through awards and honors). In addition to members of these two organizations, other K–12 and reference experts were included in the panel (see Table 3-3 for a complete list of members).

Table 3-3: Expert Panel Membership

Name	Organization
Blythe Bennett	KidsConnect
Robin Summers	AskERIC
John D. Kosakowski	AskERIC
Lynn Bry	MAD Scientist Network
Joe Simpson	MAD Scientist Network
Steve Weimar	Math Forum
Ken Williams	Dr. Math
Peter Milbury	LM_NET, Chico High School
Martha Dexter	Library of Congress
Joan Stahl	Smithsonian

This panel created a set of criteria to evaluate K–12 digital reference services and selected exemplary services from the AskA Locator based on these criteria. They also were asked to add sites that were not found on the original Pitsco list or the AskA Locator.

The creation of criteria and selection of services occurred in a series of electronic discussions. The researcher posed the question, "what makes a good digital reference service" to the experts and then facilitated the discussion. All electronic discussions were archived. The final list of criteria was approved by the expert panel. Once the criteria were developed, the sample was selected.

Selection of Elites

An elite is a person recognized by the members of an exemplary K–12 digital reference service as primarily responsible for the structure and maintenance of an organization's Internet information service. The elite is a manager of the service that translates the vision or mission of an organization into day-to-day activities. The selection of elites was done through document analysis of the existing service (if available) and/or a series of short initial interviews with members of the organization under investigation. These initial interviews used probing questions to establish responsibilities of individuals. Table 3-4 outlines the criteria of elites and a preliminary set of probing questions used in the initial interviews.

Table 3-4: Elite Criteria and Selection Interview

Criteria	Probing Question
Manager	Who manages technical and editorial staff for your service? Who's in charge of this service?
Knowledgeable about implementation issues	Who sets up your Internet services?
Knowledgeable about mission and vision of the organization	Who makes policy decisions in your organization?
Able to represent the organization	Who is the primary contact for your digital reference (question answering) service? Who should I talk to about how your organization sets up and maintains its Internet services?

This process established one or two individuals within an organization who was interviewed for primary data collection. These initial interviews with members of the K–12 digital reference service determined the person (or persons) meeting the above requirements.

Elite Interview Schedule

Interviews can either be closed or open. Bogdan and Biklen (1992) stated on the topic of interview schedules:

> In keeping with the qualitative tradition of attempting to capture subjects' own words and letting the analysis emerge, interview schedules and observational guides generally allow for open-ended responses and are flexible enough for the observer to note and collect data on unexpected dimensions of the topic (p. 77).

The interview schedule used in elite interviews is presented in Table 3-5. It was created from the researcher's experience with the AskERIC project and the development of the AskERIC description presented at the end of this chapter. It is strongly related to the conceptual framework. The initial interview schedule itself was pre-tested with Joe Janes, director of the Internet Public Library (see Appendix A). Example responses are included. These open-ended questions are considered the "base" for an interview, not the entire interview.

Table 3-5: Preliminary Interview Schedule

Conceptual Framework Section	Sub-Section	Sample Question	Probes	Example Responses from Pre-Test[31]
Detector	Internet Agent Type (Users)	How do you keep track of your users? What type of information do you attempt to gather about users of your services? What are the specific mechanisms you have in place to gather this information?	How do you determine the number of users? How do you determine the demographics of your users? Do you use logs (such as logs from a World Wide Web server)? Do you keep archives of e-mail interactions? Do you provide online feedback forms? Do you conduct focus groups?	janes>>Yep—we think the largest component of our users are students, educators (at all levels) and library/info types. That's maybe 30–40%; the rest is everybody else, a fairly diverse group. lankes>>How do you figure these percentages out? janes>>Based on our hit pattern (from .com, .edu, etc.) and a survey done about 18 mos. ago; should be done again but hasn't been yet. lankes>>So to determine your users you look at logs from your Web server and survey the users?

[31]These examples are taken from a pre-test interview with Joe Janes of the Internet Public Library re-created in Appendix A.

Conceptual Framework Section	Sub-Section	Sample Question	Probes	Example Responses from Pre-Test[31]
Detector	Internet Agent Type (Information Services)	What do you keep track of in regards to other K–12 digital reference services? What do you keep track of with other Internet information services in general? How do you gather ideas from other Internet sites to incorporate them in your own services? What are the specific mechanisms you have in place to gather this information?	Do you surf the Web? Do you have specific responsibilities or staff with the responsibility of looking at other sites doing digital reference or simply building Internet sites? How much time do you spend looking at other sites on the Internet?	lankes>>I'd like to ask you for a second about what you look at in other sites. lankes>>Do you surf the Web for ideas in regards to the IPL? janes>>I wouldn't say I do that actively, but when I do surf I see things I like or don't and think about us in that regard. We redid our front page a few months ago because our . . . janes>>previous design was looking a bit dowdy, so we jazzed it up a bit. Our basic page design and layout haven't changed since the beginning, and I think it still serves us well . . . janes>>I do see things I think we could do, but resource constraints always intrude about there. <sigh> lankes>>Do you keep track of other digital reference sites? AskERIC, MADScientist and such? janes>>You mean espionage? :-) Not on a regular basis, but we do certainly use those resources for ref, etc. I'd say when we notice they change we pay attention and see what . . . janes>>is going on, but most of our ideas and initiatives have come from within. lankes>>How so?

Conceptual Framework Section	Sub-Section	Sample Question	Probes	Example Responses from Pre-Test[31]
Detector	Internet Agent Type (Application Builders)	How do you keep current on the software available on the Internet (such as World Wide Web servers and browsers)? How do you determine new trends in software (such as real-time media like RealAudio)? How do you determine what software to acquire for your K–12 digital reference service? What are the specific mechanisms you have in place to gather this information?	Do you use logs to determine the type of software being used to access your site? Do you query users about their technical set-up? Do you check certain Web sites for software specific updates? Have you developed any relationships with vendors specifically to "keep ahead" of the changing Internet software? Do you read trade journals for current trends and software news?	lankes>>Switching topics for a moment, how important are new trends or advances in Internet software? janes>>Less than you might imagine, for a couple of reasons. We don't have any Java applets or vibrating things, (a) because we don't like them and (b) because we feel a responsibility. . . janes>>to people who use us from low-connectivity connections, abroad, etc. Again, we pay attention to such things from the press, the Web, etc., but only when a technology . . . janes>>really matures would we include it in the site. We only just started using tables early this year, and we still don't use frames (some of that is a conversion /inertial thing, . . . janes>>but we also haven't found a truly compelling reason to use it, and there are only now some really good examples of worthwhile and appropriate uses). In many ways, we're very conservative. lankes>>You say "mature," how do you determine that? DO you look at agent logs or do some internal testing?
Detectors	Internet Agent Type (Infrastructure Providers)	How is your service connected to the Internet? Who is primarily in charge of this relationship? How do you monitor changes in your connection? Are you aware of standards setting processes such as the Internet Engineering Task Force? What are the specific mechanisms you have in place to gather this information?	What bandwidth do you have available to your service? Do new technologies such as routing and switching affect how you build and maintain your services? Do you spend much of your time concerned with TCP/IP issues?	lankes>>How about changes to the Internet infrastructure itself . . . do you have any mechanisms to look at infrastructure issues like protocol development or things like wiring? janes>>Our tech people have a pretty good handle on that, again at an observational level. I think we know what's going on, but don't necessarily do anything about it. We also hear things from people at the school, including students. lankes>>So you have a technical staff who keep on track of infrastructure issues? janes>>Yes, at present a .75 permanent staff member, a .25 student/temporary, and my collections guy is very savvy too.

Conceptual Framework Section	Sub-Section	Sample Question	Probes	Example Responses from Pre-Test[31]
Detectors	Internal Influences	How do you capture ideas generated from those working on your service? Do you find employee ideas have a role in determining how the service is run? What are the specific mechanisms you have in place to gather this information?	Do you look to someone on your staff (or yourself) to be an innovator? Who within your organization sets the vision for the organization?	lankes>>You seem to get quite a bit of input for the IPL, from Web logs, to brainstorming session, etc . . . how have you organizaed yourselves (IPL) to process this . . . . you mentioned a tech staff for example..do you have departments? janes>>Yes, though that's changed when we reorganized last month (i.e., 3 of my 5 staff were let go). It's been somewhat fluid, but has always revolved around 5 major areas: janes>>Reference, Collections, Young People, Technology, Administration/General/Teaching the Class (this last one mine) lankes>>Do all of these groups use the same information in determining their services, or do they act somewhat autonomously?
Detectors	External Influences	How do forces outside of the Internet effect your service? What non-Internet sources of information inform how to build and maintain your service? What are the specific mechanisms you have in place to gather this information?	Do funders influence the day to day agenda for your service? Are your services effected by larger marketing or systems concerns? If you are part of a larger organization, how do you determine the needs of the larger organization in terms of your service?	lankes>>How much influence would say people and organizations outside of the IPL have on how you build and maintain your service? janes>>Hmmm. Good question. I've never really thought about that. Probably less than there should be—we've thought on several occasions about having an advisory board or. . . janes>>something to help us, but it's never gotten done. It would have some real benefits, I think, but it's fallen between the cracks (resources again). lankes>>Does funding influence your service?
Rules	Detector Information Processing	From the methods of acquiring information from the Internet, internal sources and external sources just discussed, how do you prioritize this information? How does this information link into your daily procedures?	Do you value one type of information over another (such as users)? Do you have daily or weekly meetings to discuss what's happening outside of the organization?	lankes>>Which of your five departments is responsible for reference and which for library development. janes>>Reference is responsible for reference question answering, Collections for developing the Ready Reference collection and others. What do you mean by library development—planning, design?? lankes>>Both.

Conceptual Framework Section	Sub-Section	Sample Question	Probes	Example Responses from Pre-Test[31]
Rules	Process	How do you answer the questions of the K–12 community? How do you gather your questions, distribute the questions, then insure the user gets an answer?	Do you use volunteers to answer questions? How do you archive these questions? How do you either modify your existing service or create new services?	lankes>>Could you give me a sense on how you work together to answer reference questions . . . how does that process work? janes>>Sure. We take in questions either via email or a form in the Reference area of the library. They all come into a central repository, using software we developed (called QRC . . .)
Rules	Resource Types	What hardware and software tools do you use to build and maintain your service? How many people are involved within the organization in the digital reference service? Do you have policies in place that guide the operation of this service?	Do you use the Web to answer the K–12 education community's questions (and/or e-mail or other Internet tools)? What are the hardware requirements to conduct this service?	lankes>>What policies or decision making procedures do you have in place for modifying your existing services or creating new ones? janes>>"Policies"? None really; we've not been that organized/hierarchical till now. It's typically been a general recognition that something had to be done or a student project . . . janes>>we typically work with students/groups to help them shape and think about what they want to do, then let them go do it (making mistakes along the way), now more
Rules	Resource Types (people)	What are the skills of the people who build and maintain this service? Do the people processing the questions have high technical skills? Do they have library backgrounds?	Are there different roles in your process? Do different people do different things? Do you make a division between those who process the questions (intermediaries) and those who answer the questions (the collection)?	lankes>>What resources do you use to do all of this in terms of people, policies, computing. janes>>A lot of blood, sweat and tears and very little money. A budget of about $90K this year (down from $250 last year), 2 FTE staff (from 5) plus me, 32 students ranging . . . janes>>from administrator of Reference to people who've never worked in libraries before. Policies—some up (off the About page) about reconsideration, logs, etc., collection . . .
Rules	Effector Tie-Ins	What policies or decision making structures do you have in place for modifying your existing services or creating new services?	Does the new service have to match a given stakeholders expectation (such as users or funders)?	lankes>>How does your question/answer activity fit into these services? janes>>Also, more specialized services under Youth (Ask the Author, etc.), Exhibits (design and layout experimentation, also curatorial exploration), Especially for Librarians . . . janes>>Web Searching, etc.

Conceptual Framework Section	Sub-Section	Sample Question	Probes	Example Responses from Pre-Test[31]
Effectors	Technical	What types of Internet tools are used to deliver information to the K–12 community?	Do you have a Web site? Do you have a Gopher site? Do you have an FTP site?	lankes>>Are there other delivery technologies involved besides the Web and e-mail? janes>>We had a MOO, with many interesting ideas, but I think it's petering out, tho we had quite a vocal and supportive group in there for a long while. That's it.
Effectors	Other	What other types of services do you offer to the K–12 community?	Do you find the need to have an 800 number? Have you established multiple Web sites? Do you do workshops or conferences?	lankes>>You mentioned POTUS and A+, would you describe the service or services you presently offer. janes>>In Collections: Ready Reference, Online Texts (largest such collection in the world), Newspapers, Serials, Teen, Youth, Associations on the Net, POTUS (Presidents of the janes>>United States), Stately Knowledge, Native American Authors database, A+ Research and Writing for High School/College Students. All available off the Reference main page.

These basic question areas created a picture of an agent's (organization's) performance system (Holland, 1995). The elite then confirmed that the description matched his or her understanding. This review process was done using a combination of the World Wide Web, e-mail, and telephone. Descriptions were placed on a Web site, and the elite was contacted via e-mail. The majority of feedback and corrections to the descriptions occurred via a follow-up telephone interview (the researcher saved interview tapes).

Interview data and member checks (as described above) were used in conjunction with secondary information sources (as described below) to insure trustworthy data. By triangulating (Patton, 1990) data from interviews and the secondary information sources, the researcher could "reduce systematic bias in the data via a process by which the research can guard against the accusation that a study's findings are simply an artifact of a single method, a single source, or a single investigator's biases." (Patton, 1990, p. 470). Further methods used to ensure data quality are discussed below.

Once the performance system of the K–12 digital reference service was created, it was added to a body of service descriptions (the descriptions of the other K–12 digital reference services already created). The researcher then looked across the body of service descriptions (segmented by detectors, rules, and effectors) to seek patterns and commonalties. The researcher looked for commonly used detector types, such as World Wide Web usage logs or anecdotal evidence from users' e-mail input. This search for meta-descriptions occurred using an inductive approach. In this approach, the researcher continually "looked through" the data (in this case the K–12 reference service descriptions and the empirical evidence that those descriptions are based upon) looking for repeated terms, phrases, and concepts (Bogdan & Biklen, 1992). The researcher developed a set of working definitions and hypotheses. These were checked against the empirical data for exceptions and reinforcement. Figure 3-1 demonstrates a meta-description

created by the researcher and Lynn Bry from the MAD Scientist Network to represent the question answering procedures used at both AskERIC and the MAD Scientist Network. This figure is presented as an example, not as a working hypothesis explored in this research.

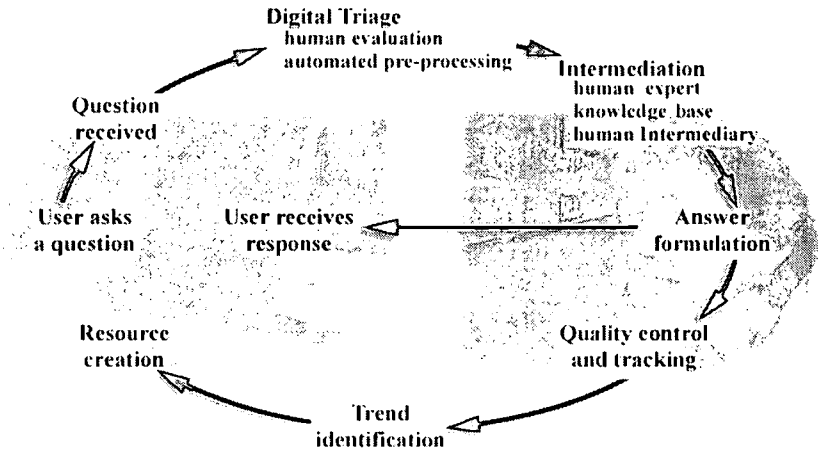


Figure 3-1 Meta-Description Example: In this example of a meta-description, a question answer process is outlined from a user question to the eventual answer and quality control process.

Venues for Interviewing

Two media were used to conduct interviews: WebCT chat rooms and phone interviews. The goal of the data gathering was to create descriptions based on the conceptual frame (of an agent's performance system). These descriptions were verified by the elite being interviewed. The media used to gather that description was deemed less important by the researcher than in a controlled environment. Figure 3-2 represents the overall method for this study.

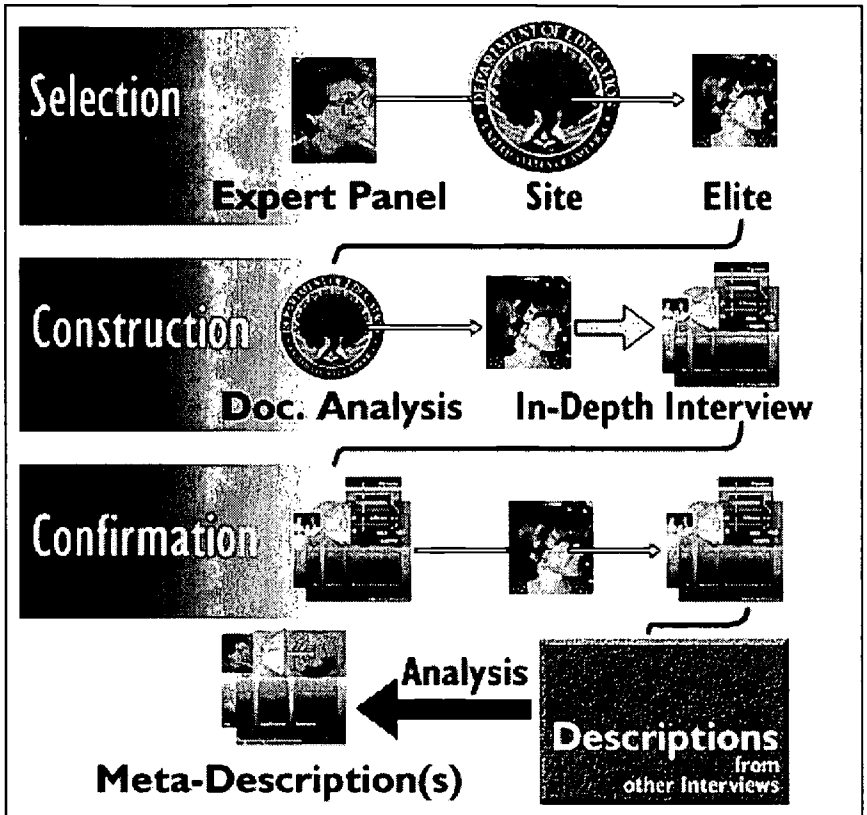


Figure 3-2 Overview of Method: The process moves from site selection to building models and then to an attempt to aggregate those models.

Use of Secondary Information Sources

Secondary sources of information supplemented the primary interview data. Figure 3-3 represents the primary and secondary means of data gathering. In this figure, the interviews produced the largest, richest, and most important data set. Interview data was in the form of HTML transcripts. Secondary sources were in multiple electronic forms (pictures, animation, text, video, etc.).

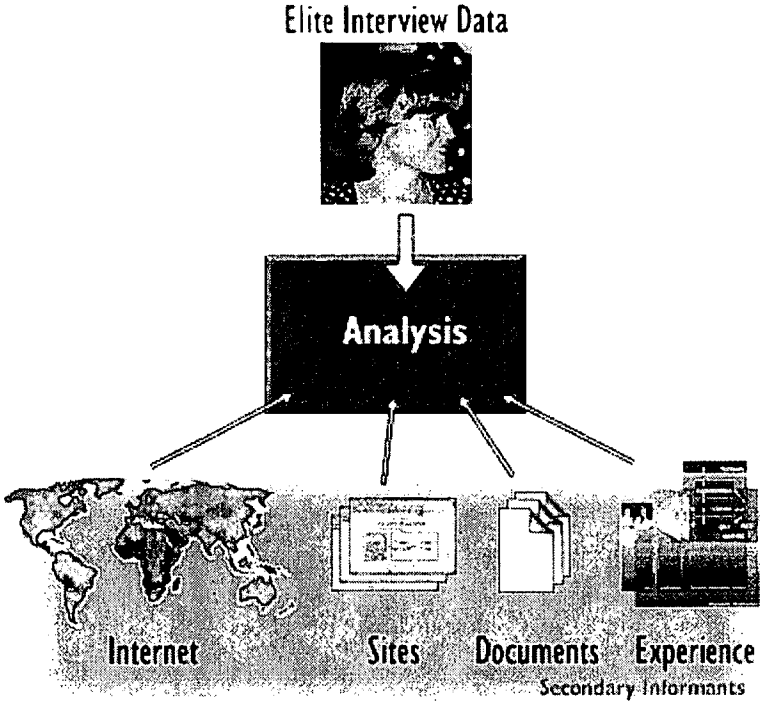


Figure 3-3 Primary and Secondary Sources of Data: Elite interviews provide the primary data for the study (description development). Several secondary sources of information assist the researcher in identifying salient elements of the final meta-description.

Other types of information were used to either enrich the data set, or to account for the researcher's experience. They were:

- The Internet
- Sites
- Documents
- Researcher Experience.

These information types are discussed below.

The Internet

The researcher constantly scanned the Internet for new developments that might be important to builders and maintainers of K–12 digital reference services. As the associate director of a K–12 digital reference service, this type of scanning is part of the researcher's daily activities. This "peripheral scanning" (done with such devices as mailing lists, newsgroups, and the World Wide Web) was useful in keeping the researcher informed of technology developments that elite interviewees might discuss. The more knowledgeable the researcher was about Internet trends and developments, the better equipped the researcher was to communicate with elites.

Sites

The sites created by the K–12 digital reference services are online "evidence" (Buckland, 1991) provided by organizations under investigation. These included primarily World Wide Web accessible documents as a means of disseminating organizational information to end users. Sites were a sub-class of documents in document analysis. These documents were meant for a diverse and public audience.

Internal Documents

The researcher attempted to obtain any relevant organizational documents such as planning guides, internal policy statements, or internal documentation. The study used this information to clarify concepts from interviews and allow a greater understanding of the organization itself. These internal documents are a sub-class of documents used in document analysis. These documents are meant for members of the organization and may not be readily available to the public.

Experience

The last factor in the analysis process was the researcher's experience, particularly the AskERIC project as described in Appendix C. In qualitative work, the researcher is the primary data-gathering instrument (Creswell, 1994). All data are "filtered" through the experiences of the person gathering the data. Human filtering is an assumption of the naturalist; that is, human beings provide the greatest ability to understand social phenomena:

> The naturalist prefers humans as instruments, for reasons such as greater insightfulness, flexibility, and responsiveness, the fact that they are able to take a holistic view, are able to utilize their tacit knowledge, and are able simultaneously to acquire and process information (Guba & Lincoln, 1986 p. 83).

Indeed, it is the ability of the human instrument to rephrase and reinterpret information in situ that makes qualitative data so rich and potentially powerful; this is unlike a survey, which does not allow for probing or restating if the respondent does not understand a question. The ability of the human instrument to be flexible is vital in dealing with the virtually unexplored Internet information service environment. There must always be some negotiation of meaning (Blumer, 1969).

A central issue in interview research is the "expert" interviewer or researcher. Should the investigator be a novice to prevent bias or an expert to understand the content area? In this study, expertise of the researcher aided in the investigation. Expertise and experience of the researcher acted as a filter. An example may illustrate the point. If a person walks into a foreign country where he or she does not speak the language and listens to a conversation, that person at best might be able to pick up social cues and some vocabulary. The person might, for example, note that voices get raised in what seems like anger or the repetition of certain words. He or she might even be able to associate certain words with certain responses (such and such a word makes people uncomfortable). One is restricted to obvious social interactions and patterns without pre-knowledge of the vocabulary and, by extension, the social norms.

On the other hand, if the person knows the language or has experience in the foreign country, that person can concentrate on the content of the conversations although he or she might

miss certain social aspects of the conversation. The central deciding factor between the expert and novice views is the information sought. If one seeks the social interactions, a novice view is logical. On the other hand, if the content is the focus of the study, expertise is appropriate.

In the case of this study, the researcher sought content information. This research de-emphasized social interactions and "surface" patterns in favor of a deeper understanding of the elites' world views. Compare the following two examples:

> 1. I used a Cisco router, well actually these days they're using switches, to set up my TCP/IP network. I liked Cisco because it not only gave me T3 with no problem; it allowed me to do SNMP and proxy to my firewall.
>
> 2. I hooked up the Internet using a high bandwidth line. I liked the person I bought the connecting hardware from because I could get good security features and run it from my desk.

These two examples say roughly the same thing (namely the hardware used to connect to the Internet and the features of that hardware), but the first, if you know the vocabulary, is much richer. Also, if you understand the first, you can understand the second. The first example indicates a different level of expertise and outlook on the Internet than the second example.

Data Description

The data gathered through the primary and secondary data gathering activities were rich natural language documents. These documents were primarily text (such as the interview transcripts) and were stored online. Two sets of data were stored online: the raw data in a secure area and a set of data available to the expert panel and the general public.

The researcher then coded the data set with ATLAS ti, a qualitative analysis software package. The coding process was to generate a series of descriptions of organizations. A series of coded transcripts (Bogdan & Biklen, 1992, Chapter 5) formed the basis for the descriptive process. Table 3-6 shows the researcher's coding scheme. This scheme was derived from the conceptual framework presented in Chapter 2 and the application of this framework to the AskERIC project. These codes were from a preliminary coding scheme and the data gathered. New codes were formed when data from documents and interviews did not "fit" into any of the initial codes.

Table 3-6: Final Coding Scheme

Conceptual Framework Section	Sub-section	Description
Detector	Internet Agent Type (Users)	Mechanisms that gather input directly from users. Examples: usage statistics, e-mail messages, focus groups.
Detector	Internet Agent Type (Information Services)	Mechanisms that gather input directly from other information services. Examples: Internet surfing, resource guide creation, competitive analysis, research and development groups.
Detector	Internet Agent Type (Application Builders)	Mechanisms that gather input directly from application builders, organizations that create Internet software. Examples: subscribing to a software vendor announcement mailing list, reading trade magazines, forming vendor agreements, creating a systems evaluation group.

Conceptual Framework Section	Sub-section	Description
Detectors	Internet Agent Type (Infrastructure Providers)	Mechanisms that gather input directly from infrastructure providers or networking hardware manufacturers. Examples: attending seminars conducted by hardware vendors, participating in the Internet Engineering Taskforce, receiving regular briefings from Internet service providers.
Detectors	Internal Influences	Mechanisms that gather input directly from staff of the K–12 digital reference service. Examples: brainstorming sessions, retreats, internal briefings and training sessions, conference reports.
Detectors	External Influences	Mechanisms that gather input directly from stakeholders and influences beyond the Internet agent types and the organization. Examples: deliverables set by a funder, policy statements by government entities (such as the Telecommunications Reform Act).
Rules	Detector Information Processing	Processes for prioritizing and deciphering input from detectors. Examples: mission statements, decision policies.
Rules	Process	Descriptions of day-to-day methods of conducting digital reference. Examples: processes for distributing questions to experts, processes for building a knowledge base of questions and answers, flow charts.
Rules	Resource Types (Technical)	Descriptions of the hardware and software used to meet the information needs of the K–12 community. Examples: World Wide Web servers and computer workstations.
Rules	Resource Types (People)	Descriptions of the individuals used by an organization and their functions. This can include background as well as roles played in processing user questions.
Rules	Resource Types (Policy Instrument)	Documentation used to formalize and transfer rules and processes. Examples include manuals.
Rules	Resource Types (Information Resources)	Static sources of information used in answer formulation. Examples include dictionaries and encyclopedias.
Rules	Effector Tie-Ins	Procedures for determining changes to existing services or creation of new ones. Examples: strategic plans, grant writing activities.
Effectors	Technical	Mechanisms used to interface with other Internet agent types. Examples: World Wide Web sites, e-mail addresses, mailing lists.
Effectors	Other	Mechanisms used to interface with other Internet agent types beyond the Internet itself. Examples: toll free numbers, conference presentations, paper publications.
Other	Background	History of the service.
Other	Permission	Statements by the elite allowing the researcher to do certain things like sharing the transcript.
Other	SetUp	Non-content statements discussing the process of the interview (for example, how to use the chat software).

An iterative coding process was used initially on documents obtained and then the elite interview transcripts. The researcher then constructed a meta-description based on patterns found across the K–12 digital reference services as found in the coded data. The elite's data empirically grounded any larger descriptions or patterns identified by the researcher. This grounding was accomplished by matching every part of the meta-description to specific evidence in documentation or transcript data.

Data Quality

It was essential to insure the quality of the study's data and the results based on the data acquired by the researcher. There have been many terms put forward to discuss ensuring data quality in research. Brinberg and McGrath (1985) referred to the process of ensuring quality of data as validity and stated "validity has to do with truth, strength, and value" (p. 13). They proposed an entire system of ensuring validity called the Validity Network Schema (Brinberg & McGrath, 1985, p. 14). Yet they cautioned:

> Validity is not a commodity that can be purchased with techniques. Validity, as we will treat it, is a concept designating an ideal state—to be pursued, but not to be attained (p. 13).

In the qualitative paradigm, the concept of insuring quality data is most often referred to as "trustworthiness" (Marshall & Rossman, 1995, p. 143). Marshall and Rossman stated the following in regards to data quality:

> All research must respond to canons that stand as criteria against which the trustworthiness of the project can be evaluated. These canons can be phrased as questions to which all research must respond (Lincoln & Guba, 1985). First, how credible are the particular findings of the study? By what criteria can we judge them? Second, how transferable and applicable are those findings to another setting or group of people? Third, how can we be reasonably sure that the findings would be replicated if the study were conducted with the same participants in the same context? And, fourth, how can we be sure that the findings are reflective of the subjects and the inquiry itself rather than a creation of the researcher's biases or prejudices? (p. 143).

There are four tests of trustworthiness, and therefore, data quality put forth in this quote:

1. Criteria for judging credibility
2. Transferability of findings
3. The ability to replicate findings
4. Accountability for researcher bias.

The researcher developed several techniques to attempt to meet these tests (keeping in mind Brinberg and McGrath's point that these tests can never be fully met).

Use of Criteria

Much of the method used in this study involved some form of selection. Whether in selecting participating sites or elites or even coding categories, the researcher was constantly called upon to select. By making explicit criteria for selection the researcher attempted to both make explicit assumptions (thus noting potential researcher bias) and ensure the ability of others to replicate decisions. Throughout this chapter, where possible, selection criteria have been made explicit. For example, the discussion of elites includes selection criteria used to identify individual AskA services.

Use of Conceptual Framework

Another way to ensure trustworthiness is to use theory and literature (Brinberg & McGrath, 1985). In this study, theory, literature and previous research are represented by the conceptual framework. By basing coding categories and the initial interview schedule on the conceptual framework, the research reduced the chance of missing data. The conceptual framework outlined the initial areas of investigation and therefore outlined the data expected. The use of open-ended interviews, on the other hand, allowed for new data to emerge that was not anticipated by the framework.

The conceptual framework will also be useful in transferring results from K–12 digital reference services to other domains. The conceptual framework is "context free" in its description of Internet information services. The conceptual framework should be valuable in the study of any Internet information service. It also creates a structured way to look across organizations regardless of their contexts (by comparing detectors, rules, and effectors for example).

Use of an Audit Trail

Qualitative research is about making decisions in the midst of the data collection and coding. The creation of working hypothesis (Bogdan & Biklen, 1992), additional coding categories and decision points in the creation of both K–12 digital reference descriptions and the meta-description involved decisions by the researcher. These decisions were both unavoidable, and the strength of qualitative research (as discussed above). However, in order to ensure trustworthiness, particularly in questions of replications and attention to researcher bias, these decisions must be made explicit. By noting these decisions, reviewers of the study can judge the credibility of the researcher and the findings of the research.

The mechanism used to document decisions was an audit trail. This audit trail was created through several techniques. First, transcripts and notes of all interchanges with others (elites, K–12 digital reference services, and the expert panel) were kept. Secondly, the researcher created memos at decision points in coding data and in adjusting both the initial interview schedule and initial coding scheme. These memos document the thinking process of the researcher and allow reviewers to analyze decision points for potential biases.

Use of Member Checks

At several points in the process, data and analysis were confirmed by either the elite interviewed or the expert panel. These confirmations are known as "member checks." In these checks the researcher "take[s] the categories or themes back to the informants [the elites or expert panel] and ask[s] whether the conclusions are accurate" (Creswell, 1994, p. 158). This is based on the precept of qualitative research that the distance between the researcher and the informants is minimized (Guba & Lincoln, 1988).

Use of the AskERIC Example

The researcher applied the concepts and methods of this study to the AskERIC project (see Appendix C). This was done both as a pre-test of the method and conceptual framework as well as to make the researcher's past work explicit. Descriptions and the meta-description can be compared to this initial model to identify potential bias.

Summary of Data Quality

Table 3-7 represents the overall method of this study with specific data quality mechanisms used at each step.

Table 3-7: Data Quality Mechanisms in Methodology

Step in Method		Data Quality Mechanisms
1	Analysis of K–12 digital reference services list for criteria match	Use of selection criteria: • Digital reference services presently in operation • Explicitly state their mission as serving the K–12 population
2	Expert panel Criteria development (see Appendix B)	Use of panel selection criteria: • Member of AskERIC digital reference service • Member of the MAD Scientist Network • Member of digital reference service • Have been involved with digital reference for over one year
3	Expert panel site selection	Use of expert panel and their site selection criteria (see Appendix B)
4	Site contact for elite	Criteria for elite • Manager • Knowledgeable about implementation issues • Knowledgeable about mission and vision of the organization • Able to represent the organization
5	Elites contacted for participation	Transcript of contact through e-mail
6	Document analysis against conceptual framework	Criteria for detector identification • A detector is a thing. It is a person (or group of people), software and/or hardware that gather information. Ultimately detectors are mechanisms that you can "point" to. Criteria for rules identification • A rule is a process. Rules are purely abstract and need resources to transform information. They are structures and either implicit in action or made explicit through documentation. Criteria for resource identification • A resource is a thing. It is a person (or group of people), technology, money, or documented policy that as dictated by rules transform information. Criteria for effector identification • An effector is a service or set of information with which an agent other than the organization under study can interact. Examples of effectors include a Web page and an e-mail service.
7	Elite interview	Interview schedule derived from conceptual framework Interview transcript

	Step in Method	Data Quality Mechanisms
8	Interview coding	Use of initial coding scheme derived from conceptual framework. Criteria for detector, rule, resource, and effector identification (see step 6) Memos
9	Elite contacted for clarification (if necessary)	Interchange transcript
10	Description creation	Coding scheme Use of document analysis as a check
11	Description verification (see Appendix E)	Member check Transcript of exchanges Memos
12	Cross description analysis	Conceptual framework guidance Coding scheme Clarifications from elites (transcript of member check) Review by expert panel (transcript of member check)

Pre-tests

There were two different types of pre-tests used in this study. The first was a pre-test of the interview schedule with Dr. Joe Janes of the Internet Public Library. This pre-test served two purposes:

- To test the initial interview schedule for completeness
- To test the Internet as a means for elite interviewing.

The transcript of the in-depth interview can be seen in Appendix A.

A second type of pre-test was used with AskERIC (see Appendix C). This pre-test served three purposes:

1. Test of the conceptual framework: While not a traditional pre-test, this section of the study demonstrated the use of the conceptual framework developed for the study and the ability to gather the data needed for further descriptions.
2. Concrete example of descriptions: The AskERIC example allowed the reviewer to anticipate the means used to represent the descriptions created by the researcher.
3. Data quality measure: By making the researcher's previous work explicit in the form of this empirical description, the description can be compared to those created in Chapter 4. The AskERIC example served as a sort of narrative control.

This description has two parts. The first is a narrative of AskERIC's purpose and background. The second is a direct application of the conceptual framework. The initial narrative is more extensive than those in succeeding descriptions generated by the study. This additional length and depth served as a replacement for empirical data in the form of interview transcripts and document analysis.

Method Summary

This study used a series of qualitative methods (primarily elite interviews and secondarily document analysis) to elicit the performance systems of K–12 digital reference services. Six sites were selected by a panel of experts. These sites represented exemplary Internet information services. Elite interviews and document analysis based upon the conceptual framework presented in Chapter 2 were used to construct descriptions of these digital reference services. These descriptions represent the elites' views on how their organizations build and maintain their Internet information services. These descriptions were used to search for overlap, commonalties and patterns across organizations.

This methodology was used to fulfill the purpose of the study—using K–12 digital reference services as a starting point to better understand the process of building and maintaining Internet information services. The methodology did this by accomplishing the three following study objectives. Specifically, the research:

- Applied the conceptual framework based upon complexity research, literature, and the researcher's experience (as seen in the AskERIC example)
- Used this conceptual framework to empirically describe how organizations, specifically K–12 digital reference services, build and maintain services in the dynamic Internet environment (through the development of the initial interview schedule and coding scheme), and
- Sought commonalties across these descriptions by creating a single meta-description.

The researcher used the method to fulfill the goals of this study by answering the following research questions:

1. What are exemplary K–12 digital reference services' detectors (i.e., inputs) for Internet agent types, internal inputs, and influences external to both the Internet and the organization?
2. What are exemplary K–12 digital reference services' rules for processing the input from detectors and, through resources, build and maintain effectors (i.e., services)?
3. What are exemplary K–12 digital reference services' effectors (i.e., outputs) used to meet users' information needs?

By better understanding the building and maintaining processes in exemplary K–12 digital reference services, the researcher can begin to better understand the processes at work in Internet information services in general.

Chapter 4: Results

Simply put, a question is received through the Web or e-mail . . . A process determines the best expert to answer the question . . . Once an appropriate expert has been identified, that expert formulates an answer . . . The answer is sent to the user via e-mail . . . After an answer has been created a tracking process occurs.

Introduction

The previous chapters outlined the scope of this study, the relationship of the investigation to existing research, the conceptual framework used in this work, and a research design and methodology. This chapter reports on the results of the research. It presents the data of the investigation in answer to the research questions:

- What are agents' detectors for Internet agent types (users, other information services, application builders, and infrastructure providers), internal inputs and external influences?
- What are agents' rules for processing detector input and, through resources, building and maintaining effectors?
- What are agents' effectors used to meet users' information needs?

The answers to these questions satisfy the study's three specific objectives: (1) to build and apply a conceptual framework based on complexity research, literature and the researcher's experience; (2) to use this conceptual framework to empirically describe how organizations, specifically K–12 digital reference services, build and maintain services in the dynamic Internet environment; and (3) to seek commonalties across these descriptions. Ultimately this data addresses the problem of Internet information services having to meet the increasing information demands of users in the dynamic Internet environment.

This chapter is organized into four parts: general results, a series of service descriptions that are structured empirical descriptions of K–12 digital reference services, a discussion of commonalties among these services, and a meta-description.

Results of Data Gathering

Data gathering consisted of an initial review of each service's Internet presence and documentation, in-depth interview and then a follow-up member check interview (see Chapter 3 for more details). The results of this process could have taken one of three forms:

1. Agreement: the description presented to the elite matched his/her perception of service operations with minor revisions.
2. Agreement with Revisions: the description presented did not meet the perceptions of the elite, and through discussions, a new description was created that matched both the elite's and researcher's views of the service.
3. Disagreement: the description did not match the elite's view, nor did the elite's perception match the data collected by the researcher.

In all six cases (one for each service examined) there was agreement between the description generated and the elite's view. While each service made changes to its initial description, these changes did not represent significant departures from the initial description. Most changes

concerned terminology and detectors. Appendix E specifies the results of data gathering for each service as well as changes made in the service descriptions as a result of follow-up interviews.

The overall agreement on the blueprints reviewed (see below) suggests the success of the data gathering and data description methods used in this study. The format of the results and the conceptual framework itself were novel to all the services, and yet all services found the resulting blueprints accurately represented their individual systems.

The Blueprint Metaphor

Chapter 2 outlined a conceptual framework based on complexity research, current literature and experience. This framework was operationalized via the methodology described in Chapter 3. The result of this method applied to a given Internet information service is a blueprint. The conceptual framework acts as a lens organizing the rich qualitative data of elite interviews and document analysis into transferable sets of detectors, rules, resources, and effectors. Just as an architect's blueprint can describe a rich multidimensional, multimedia construction of a building in a transferable way, the blueprints created in this study captured the multifaceted digital reference service into a succinct, transferable description (see Figure 4-1).

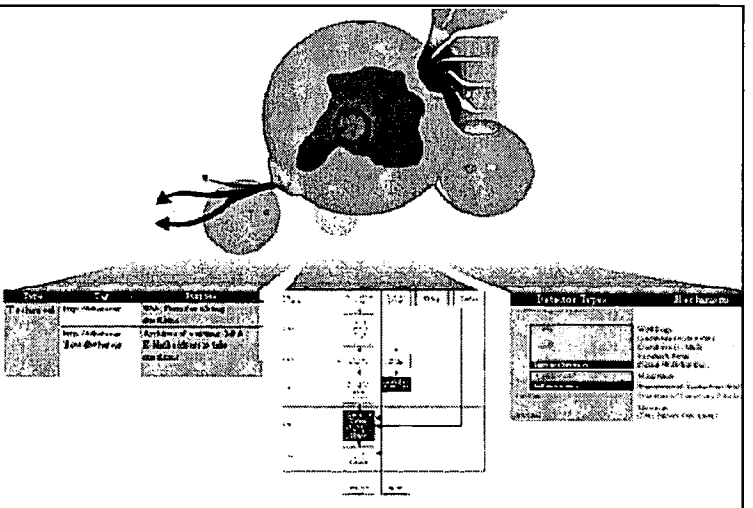


Figure 4-1 Blueprints: The conceptual framework and the methodology of this study creates descriptions in the style of "blueprints," transferable descriptions of a multifaceted situation.

However, as with architectural blueprints there are limitations to these empirically based descriptions. These service blueprints identify that a feature (descriptor, rule, effector) is present, but not why it is present. Further these descriptions do not capture the dynamic nature of the service development process in the sense that they do not show how rules, detectors, and effectors came into being or change over time. They do indicate any iterative functions that exist in the service as presently structured. These limitations will be discussed in Chapter 5.

How to Read the Service Descriptions

All of the service descriptions follow one basic format. They begin with an overview of the service in the form of a GEM[32] record and a brief narrative description. GEM records (see Table 4-1) are the basis of the Locator built for this study (see Chapter 3). These records give a concise description of the service and its key attributes.

Table 4-1: Structure of GEM Catalog Record

Element	Description
Publisher	The online provider of the resource being cataloged
E-mail	E-mail address of the contact
Contact	Person to contact for additional information on the service (the elite, for the purposes of this study)
HomePage	Web home page of the publisher
Subject	The subject of topic of the resource being cataloged
Grade	The grade or grade range of the intended audience for the resource being cataloged
Audience	The intended audience of the resource being cataloged
Description	A textual narrative describing the resource
Answer Policy	Turnaround time and type of response given
Keywords	Keywords that describe the content of the resource being cataloged
Language	The language in which the resource is written

The next section of the service description is the blueprint of the service generated by the researcher and confirmed by the elite. This central figure represents detectors, rules, resources, and effectors in a single information flow diagram[33]. The blueprint can be read left to right, with the left most column listing detector information. These detectors are segmented vertically by agent types from the conceptual framework (users, information services, application builders, infrastructure providers, internal, and external). An agent type will not be listed if it is not used (for example in single-person services such as "How Things Work" there are no internal detectors). Certain detectors are marked as "Key Detectors." These are detectors upon which the elite relies as the most important information sources when building and maintaining his/her service. Certain detectors are connected to processes in place at the service. These are the rules used to process detector information and produce effectors. Effectors are marked in black with white type. Each component of the blueprint (detector, rule component, effector) can have one or more resources associated with it. Resources are physical mechanisms or component mechanisms used at a certain point in the process. Figure 4-2 graphically depicts the structure of the blueprint.

[32] GEM (http://www.geminfo.org/) is a meta-data project creating vocabularies and standards for finding educational material on the Internet.

[33] Blueprint figures may be seen in full size at URL: http://ericir.syr.edu/ithome/bmiis

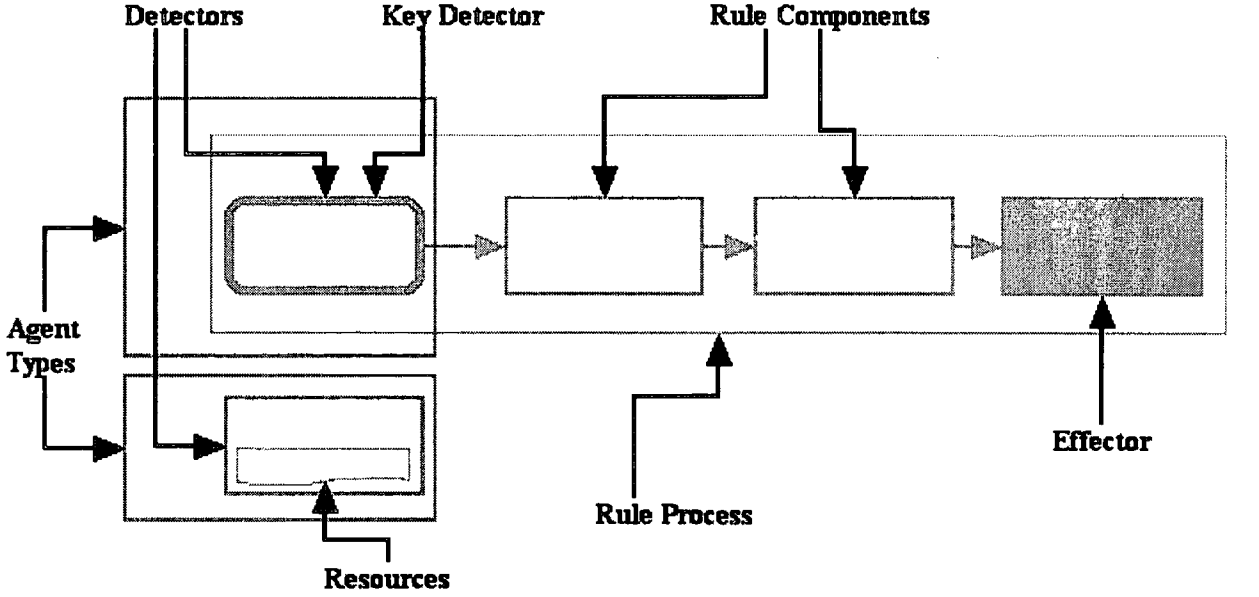


Figure 4-2 Structure of Blueprints: The overall structure of a blueprint.

Following each service's blueprint is a set of tables listing the detectors, rules, resources, and effectors that link the blueprint to the conceptual framework by explicitly listing the components of the blueprint as Holland's performance system. An associated narrative ends each service description. The narrative describes the rule process(es) and adds detail to the overall blueprint. For example, the narrative may show actual screenshots or policy instruments referred to in the blueprint.

Purpose of Service Descriptions and Blueprints

The service descriptions and blueprints represent the answer to the research questions posed in this study. The tables and diagrams illustrate the detectors, rules and effectors used by exemplary K–12 digital reference services to build and maintain Internet information services. They are the result of building and applying a conceptual framework based on complexity research, literature and the researcher's experience. Further, these descriptions lay the foundation for seeking commonalties across these exemplary services.

"'How hot is lava' comes in every day!"
-Jamie Dronen

Service 1: Ask A Volcanologist

Publisher: University of North Dakota
Contact: Jamie Dronen
HomePage: http://volcano.und.nodak.edu/vwdocs/ask_a.html
Subject: Science - Careers | Science - Earth Science | Science - Geology
Grade: Pre-kindergarten | Kindergarten | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Post Secondary
Audience: Students | Teachers | Parents
Description: Ask a Volcanologist is a question-answering and referral service staffed by three professional volcanologists. The site also features a keyword-searchable FAQ of commonly-asked questions on volcanoes, and lesson plans for teachers, lessons and activities for students, and links to sources of other information about volcanoes through its link to Volcano World.
Answer Policy: Tries to answer 100% of all questions received within 1–3 days.
Keywords: Education | K–12 | Science | Volcanoes | Eruptions | Environment | Digital reference services | Question and answer services
Language: English
Relations: Ask A Volcanologist is part of Volcano World, an online resource of the University of North Dakota, and sponsored by NASA's (http://www.nasa.gov) program Public Use of Earth and Space Science Data Over the Internet.

Record Created: 8/13/1997
Cataloged by: Joann M. Wasik, Virtual Reference Desk
E-mail: vrd@vrd.org
HomePage: http://www.vrd.org

Introduction

Jamie Dronen and Volcano World have a mission:

> Our original goal was to have more information than anyone else about volcanoes in one place. This provides us with a lifetime supply of work . . . For example, someone might write in a question about a volcano they live by, and if we do not have information already online on this volcano, we will make it a point to put it on the list of 'things to do.'

Part of this mission is to answer people's question about volcanoes and volcanology. This is done through their Ask A Volcanologist service:

> **Dronen**>>Ask-A-Volcanologist is one section of the VolcanoWorld Web site . . . [Ask A Volcanologist and VolcanoWorld] are the same thing, funded from the same grant. VolcanoWorld existed first, and Ask A [Volcanologist] was developed to provide users with a better connection to the scientists studying volcanoes.

And answer questions they do. According to Dronen, Ask A Volcanologist expects

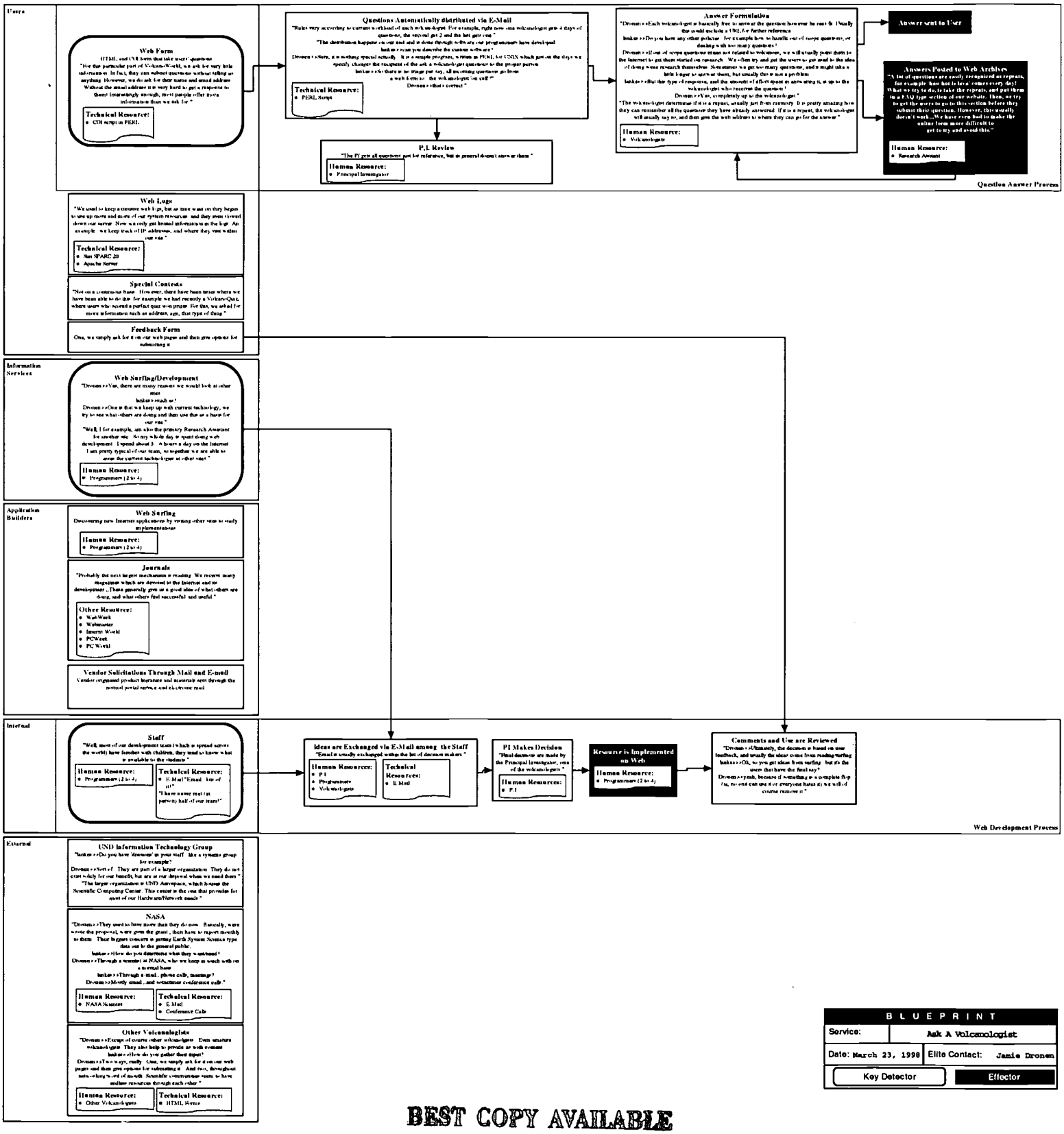
> to have 1 million visitors this year. This is not hits. We get about 6 million hits a month.

In addition the service answers 25 questions a day.

Ask A Volcanologist is an interesting combination of expertise and programming experience. There is no human evaluation process for questions, and there is no attempt to include the users directly into the Web development process. Instead, the service works as a gestalt of expertise, personal experience, and the talents within the organization. Certainly there is an interest in the user, but this information is used after the fact. This is clear when Dronen discussed an upcoming service:

> **Dronen**>>Soon, we want to start a new service. This will be the LIVE ask a volcanologist. We will allow users to ask question via chat similar to this, then stream the volcanologists voice out live over the internet.
>
> **Iankes**>>How do you decide to offer this service?
>
> **Dronen**>>We wanted to offer something else for our users. Something that made them feel closer to the scientists working with the data. This is a good way to do that.
>
> **Iankes**>>So the idea came from within the project . . . you knew the capability was there from surfing the Web, and you checked that your users could access the information?
>
> **Dronen**>>Yes, from within. One of the other projects I work on works with live audio on a daily basis. I think the idea came from there.

However, while the ideas may come from sources other than users, the service is being used. From the comments on the Web site, it is apparent that these users are satisfied. Ask A Volcanologist demonstrates the potential power of the expert service. The ability of a small number of experts to answer a large number of questions and continue to push forward with new services and new technology.



BLUEPRINT	
Service:	Ask A Volcanologist
Date: March 23, 1998	Elite Contact: Jamie Dronen
Key Detector	Effector

Detectors

Detectors are the organization's mechanisms for acquiring information on the environment. These mechanisms may actually be a combination of several resources. Some detectors were deemed more important than others in making decisions about building and maintaining activities. These are called "key detectors" and are highlighted in Table 4-2.1.

Table 4-2.1: Detectors Used by Ask A Volcanologist (key detectors are highlighted)

Agent Type	Detector	Purpose
User	Web Form	To take in user questions
	Web Logs	To determine where users are coming from
	Special Contests	To promote the site and gain additional user information
	Feedback Form	To gather user comments on the VolcanoWorld Web site
Information Services	Web Surfing	Looking for interface ideas and features at other Web sites
Application Builders	Web Surfing	Looking for specific software and software implementation
	Journals	Reading about new software options and features
	Vendor Solicitations Through Mail and E-mail	Software companies send information on new products through the postal mail and electronic mail
Internal	Staff	Ideas of how to improve the VolcanoWorld Web site and the Ask A Volcanologist service
External	UND Information Technology Group	The information technology folks at the University of North Dakota are responsible for wiring and infrastructure support for VolcanoWorld.
	NASA	NASA is the funder of VolcanoWorld, and helps set objectives for the VolcanoWorld site.
	Other Volcanologists	The volcanologist community helps build and improve the VolcanoWorld Web site with their suggestions.

Effectors

Effectors are the output of the service. Ask A Volcanologist has three effectors.

Table 4-2.2: Ask A Volcanologist Effectors

Effector	Description
Answer Sent to User	Answer is e-mailed to the user.
Answer Posted to Web Archives	Answers are also posted to the Ask A Volcanologist portion of the VolcanoWorld Web site.
Resource Implemented on the Web	Ideas from internal detectors lead to a Web-based resource that is made available on the VolcanoWorld Web site.

Rules

Rules represent the abstract flow and transformation of information within an organization. Table 4-2.3 represents the two primary information processes in regards to their digital reference activities for Ask A Volcanologist (see the Blueprint narrative for more information on these processes).

Table 4-2.3: Ask A Volcanologist Rule Processes

Process Name	Description
Question Answer Process	The process whereby an incoming question is answered and tracked
Web Development Process	The process that creates new Web resources on the VolcanoWorld Web site.

Resources

Resources are the means by which rules are implemented. Resources include people, tools, and policies an organization uses to implement a process. Table 4-2.4 lists the resources used in both Ask A Volcanologist processes.

Table 4-2.4: Resources used by Ask A Volcanologist

Resource Type	Resource	Description
Human	NASA Scientist	Contract officer assigned to the volcanologist service by NASA
	Other volcanologists	Professional and amateur volcano experts
	Principal Investigator	"Charles A. Wood is a volcanologist with 25 years of experience using remote sensing and other techniques to study volcanoes. His PhD is in Planetary Science (Brown University, 1979). In addition to having published 180 professional papers and abstracts on volcanoes and other geologic topics he is a member of the NASA EOS Interdisciplinary Team on Volcanology and a volcano P.I. on the SIR-C Shuttle radar mission. Chuck has previously pioneered a variety of techniques in volcanological outreach including founding the first volcanic computer bulletin board system (1986), publishing Volcano News, a quarterly newsletter, and scripting a Hypercard stack on Kilauea volcano. He has also applied more traditional methods such as contributing the Volcanoes entry to the 1995 edition of New Book of Knowledge Encyclopedia, compiling (with Jurgen Kienle) Volcanoes of North America, and he is currently writing a children's book on vo lcanoes entitled America's Volcanoes. Chuck will manage the team's work, and contribute to its overall design and the content of many modules. E-mail: cwood@badlands.nodak.edu" http://volcano.und.nodak.edu/vwdocs/vwteam/cwood.html
	Programmers	Staff members of the service that write PERL and HTML code. Jamie Dronen, Research Asst./Programmer, U. of North Dakota Jeremy Gibbens, Programmer, U. of North Dakota Lee Hulteng, Graphic Artist, GF Herald Chris Schweiss, Content, U. of North Dakota Jeremy Williams, Programmer, U. of North Dakota
	Research Assistant	"Jamie Dronen is currently a graduate student in Space Studies at the University of North Dakota focusing on space policy. Expected date of graduation is May 1998. He has a B.S. in Computer Science and minors in Math and Space Studies. He also studied at Moscow State University in Russia for one semester." http://volcano.und.nodak.edu/vwdocs/vwteam/jdronen.html
	Volcanologists	Scott Rowland, U. of Hawaii Steve Mattox, U. of North Dakota John Dvork, Hawaii volcanologist.
Other	Journals	Application/software oriented trade publications
Technical	Apache Server	A popular, freely available World Wide Web server for UNIX servers.
	CGI and PERL	PERL is a high-level programming language. Common Gateway Interface (CGI) is a software mechanism used to expand the capabilities of a Web server.
	Conference Call	Telephone calls
	E-mail	Internet-based electronic mail

Blueprint Narrative

"Ask A Volcanologist" demonstrates the power of expertise. Three volcanologists handle all questions with no pre-processing or special hardware. "Ask A Volcanologist" also demonstrates a nearly dichotomous relationship between answering questions and creating a Web site. There are two processes described. The "Question Answer Process" describes how incoming questions are answered, and the "Web Development Process" describes how Web resources (other than the archives of questions and answers) are put online. The two processes have very little to do with each other. This is a stark contrast with "How Things Work" where the Web site is the output of the question answer process.

Question Answer Process

A question is submitted by a user through a Web form (see Figure 4-3.1). It is not necessarily that easy to find this form, however:

> What we try to do, is take the repeats, and put them in a FAQ type section of our Web site. Then, we try to get the users to go to this section before they submit their question. However, this usually doesn't work.

Once a question is received, it is automatically distributed via a PERL script to one of three volcanologists and the principal investigator of the VolcanoWorld project. The process is very simple:

> **Dronen>>** Rules vary according to current workload of each volcanologist. For example, right now one volcanologist gets 4 days of questions, the second get 2 and the last gets one . . . The PI [the forth volcanologist] gets all questions just for reference, but in general doesn't answer them.
>
> **lankes>>**Oh, do you have software to gather and distribute the questions, or is all of this done in off-the-shelf e-mail software?
>
> **Dronen>>**Each volcanologist can use whatever email software they want. The distribution happens on our end and is done through software our programmers have developed.
>
> **lankes>>**Can you describe the custom software?
>
> **Dronen>>**Sure, it is nothing special actually. It is a simple program, written in PERL for UNIX which just on the days we specify changes the recipient of the ask a volcanologist questions to the proper person.
>
> **lankes>>**So there is no triage per say, all incoming questions go from a Web form to the PI (who generally doesn't answer) and the volcanologist 'on call'?
>
> **Dronen>>**That's correct.

The volcanologist is then free to answer questions as he or she sees fit. The volcanologists are paid for their work:

> **lankes>>**Are they [the volcanologists] all paid?
>
> **Dronen>>**Currently they are, but there have been times when they donated months of their time.

An answered question is then sent to the user (if an e-mail address was provided with the original question) and placed in a Web archive by Dronen.

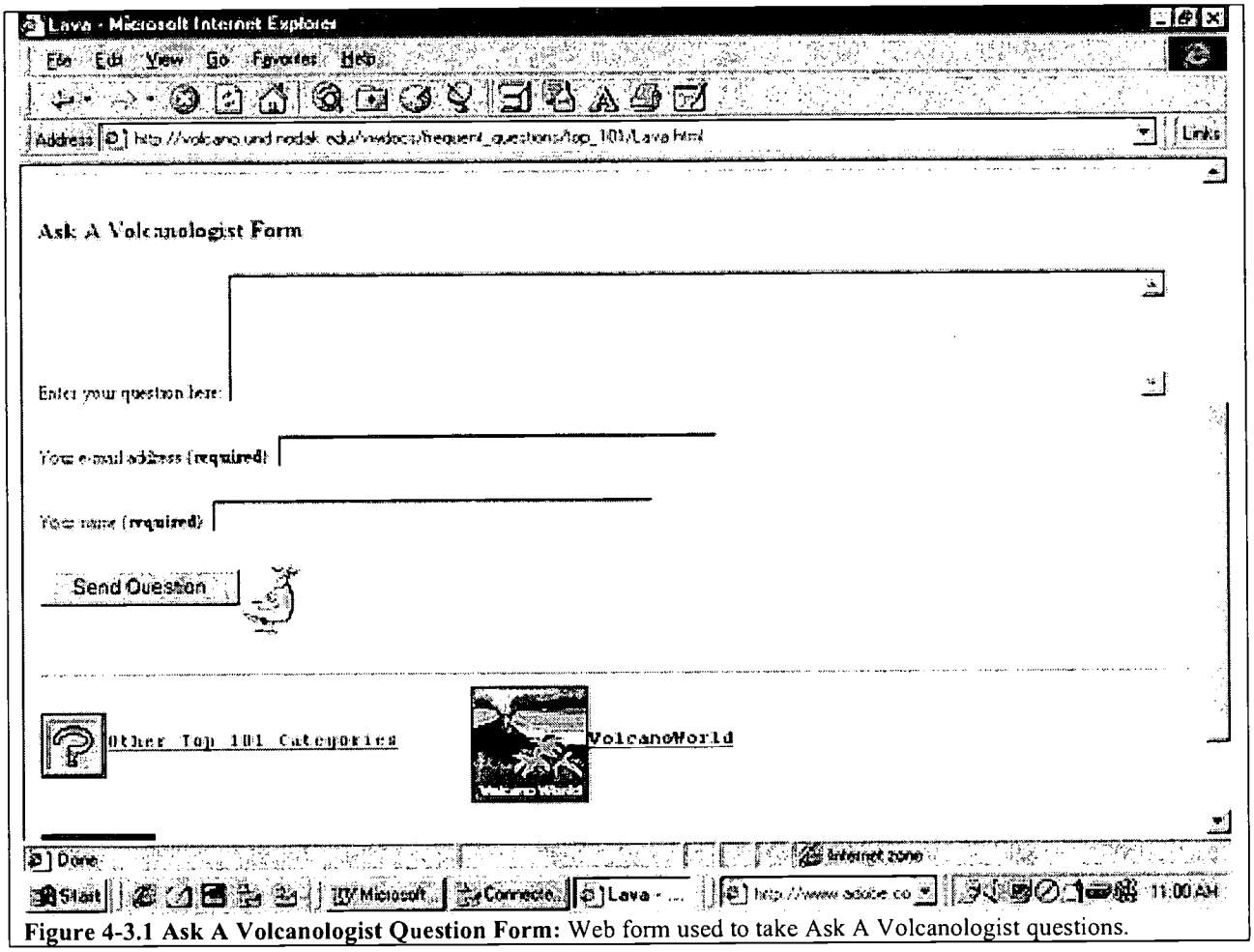


Figure 4-3.1 Ask A Volcanologist Question Form: Web form used to take Ask A Volcanologist questions.

Web Development Process

The "Web Development Process" represents a somewhat informal means of expanding the services and information on the VolcanoWorld Web site. As mentioned earlier, there is very little connection between this process and the question/answer process above. While the question/answer process above does result in Web archives, these archives and the questions they are based on do not inform the larger Web development effort for VolcanoWorld. Instead, the staff develops ideas among themselves for the Web site. These ideas either come from e-mail discussions, or from other projects with which the staff is involved. Once an idea is generated it is shared among the VolcanoWorld staff. The Principal Investigator makes a final decision, and a

resource is developed. User input is sought after resource creation. This input is in the form of usage statistics and comments received from a Web feedback form (see Figure 4-3.2).

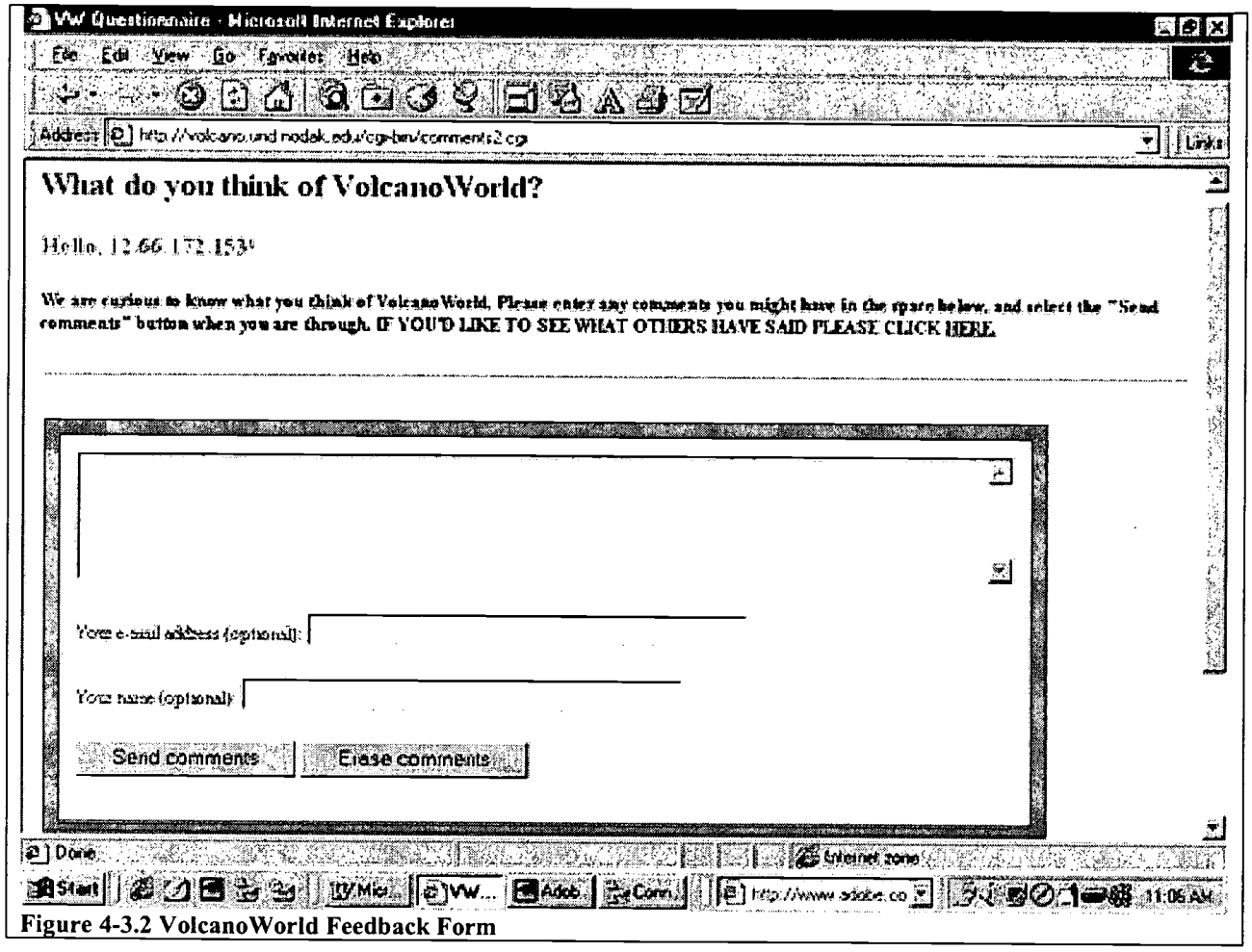


Figure 4-3.2 VolcanoWorld Feedback Form

Ask Shamu

"Kids like animals and they want to work with animals."
-Pamala Wilson

Service 2: Ask Shamu

Publisher: Sea World, Inc. and Busch Entertainment Corp.
Email: shamu@seaworld.org
Contact: Pamala Wilson
HomePage: http://www.seaworld.org/ask_shamu/asintro.html
Subject: Science - Biological and life sciences | Science - Biology | Science - Oceanography
Grade: Pre-kindergarten | Kindergarten | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Post Secondary | Adult
Audience: Students | Teachers | Parents
Description: Ask Shamu is a question and answer service for questions about the ocean and marine animals. An 800-number (1-800-23SHAMU) is provided for students to submit questions by telephone and for teachers to request curriculum materials. The site also features an FAQ, instructions on subscribing to the Ask Shamu listserv, teachers' curriculum guides, and more.
Answer Policy: Answers are short and factual with minimal references.
Keywords: Education | K–12 | Higher education | Science | Biology | Marine science | Oceanography | Digital reference services | Question and answer services
Language: English
Relations: Ask Shamu is a service of Busch Entertainment Corporation (http://www.buschgardens.org).

Record Created: 8/13/1997
Cataloged by: Joann M. Wasik, Virtual Reference Desk
E-mail: vrd@vrd.org
HomePage: http://www.vrd.org

Introduction

Shamu is a whale. A killer whale to be precise. Ask Shamu, on the other hand, is part of Sea World's Animal Information Database.

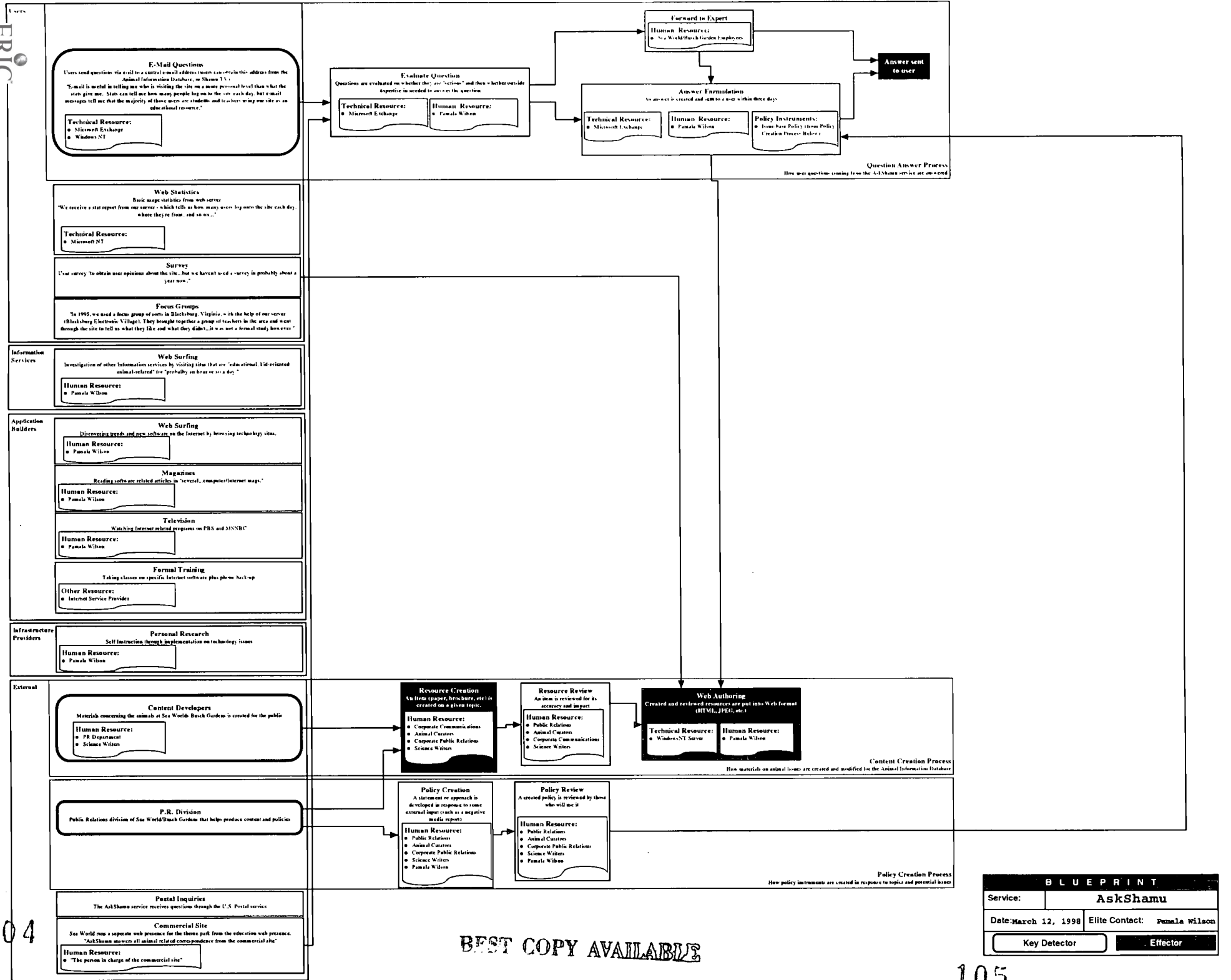
> 'Ask Shamu' is a small section of a rather large animal information Web site. Ask Shamu originally was a newspaper article in San Diego, California [where] children would write in with animal questions and a Sea World animal expert would respond. We used past questions and answers to begin a section of our Web site to encourage students to send us animal questions electronically.

And yet that small part of the Animal Information Web site answers "200–250+ [questions] a week . . . sometimes more, and sometimes less."

Ask Shamu answers questions related to ocean and marine animals. It uses the expertise of the employees of Sea World/Busch Gardens, and is coordinated by Pamala Wilson. Wilson also answers questions from the larger Sea World commercial site and prepares all the information (mark-up, editing, etc.) for the entire Animal Information Database. Consequently, Ask Shamu and its processes are very much tied to the maintenance of the Animal Information Database and the larger Sea World/Busch Gardens organization.

Ask Shamu and the Animal Information Database will continue to evolve. Even though it remains a one-person operation, it is far from becoming overwhelmed and stagnant. Wilson has ambitious plans for the future:

> I think the seaworld.org Web site will continue to grow and remain one of the largest animal resources on the Internet. I would like for the site to become more kid-friendly, fun and still remain educational. We hope to add chat rooms, scheduled live Internet events, a kids' club, and offer more interactive opportunities for students . . . Kids like animals and they want to work with animals—we receive many requests from students for live chats, bulletin boards, that sort of thing. Also, as the Internet becomes more used in the household, I think the software will become more accessible and easier to use for everyone.



BLUEPRINT

Service:	AskShamu
Date: March 12, 1998	Elite Contact: Pamala Wilson

Key Detector | Effector

Detectors

Detectors are the organization's mechanisms for acquiring information on the environment. These mechanisms may actually be a combination of several resources. Some detectors were deemed more important than others in making, building, and maintaining decisions. These are called "key detectors" and are highlighted in Table 4-3.1.

Table 4-3.1: Detectors used by Ask Shamu (key detectors are highlighted)

Agent Type	Detector	Purpose
User	E-mail Questions	E-mail address and server that takes questions from users
	Web Statistics	Usage logs created by the Web server
	Survey	Results of an old survey used to determine user reactions to the Animal Information Database
	Focus Groups	Results from an old informal focus group on the Animal Information Database
Information Services	Web Surfing	Informal surfing to education, animal, and kid-oriented sites
Application Builders	Web Surfing	Information from looking at technology sites for new software and capabilities
	Magazines	Information from reading about new software options and features
	Television	Information from watching computer related programming to learn about new software options on the Internet
	Formal Training	Training classes on software applications provided by a local Internet Service Provider
Infrastructure Providers	Personal Research	Results from self instruction on hardware and infrastructure issues
External	Content Developers	Products from product authors in the public relations and science writing departments
	Public Relations Division	Notices and briefings from the SeaWorld/Busch Gardens public relations department
	Postal Inquiries	Questions sent through the postal service
	Commercial Site	Briefings, discussions and questions from the larger Sea World commercial Web site

Effectors

Effectors are the output of the service. Ask Shamu has three effectors related to digital reference.

Table 4-3.2: Ask Shamu Effectors

Effector	Description
Answer Sent to User	Answer is e-mailed to the user
Resource Creation	Non-Internet based information items on a given topic
Web Authoring	The Animal Information Database

Rules

Rules represent the abstract flow and transformation of information within an organization. Table 4-3.3 represents the three primary information processes in regards to their digital reference activities for Ask Shamu (see the Blueprint narrative for more information on these processes).

Table 4-3.3: Ask Shamu Rule Processes

Process Name	Description
Question Answer Process	The process whereby an incoming question is answered and tracked
Content Creation	The process that creates new Web resources on the Animal Information Database
Policy Creation Process	How policy instruments are created in response to topical and political issues

Resources

Resources are the means by which rules are implemented. Resources include people, tools, and policies an organization uses to implement a process. Table 4-3.4 lists the resources used in all Ask Shamu processes.

Table 4-3.4: Resources used by Ask Shamu

Resource Type	Resource	Description
Human	Animal Curators	Experts in charge of care and feeding of animals at the theme parks
	Corporate Public Relations	Employees of Sea World/Busch Gardens organization whose job is to promote and manage Sea World/Busch Gardens to the general public. "Corporate PR would be (of course) at the corporate level and ultimately responsible for the whole deal."
	Pamala Wilson	"I've been at SeaWorld for seven years, so I've learned a lot of animal information. I have a B.A. in Mass Communications and English."
	Public Relations	Employees of Sea World/Busch Gardens organization whose job is to promote and manage Sea World to the general public on a local level. Each park has a Public Relations Department.
	Science Writers	Experts in oceanography, zoology and biology
	Sea World/Busch Gardens Employees	Various animal curators, science writers and animal experts employed at the various Sea World and Busch Garden theme parks.
	The Person in Charge of the Commercial Site	Director of the Sea World/Busch Gardens Web sites. "Sheila Sullivan, Environment Communications Manager of Busch Entertainment Corporation is responsible ultimately for the seaworld.com and seaworld.org sites."
Other	Internet Service Provider	External organization that provides the Internet connection and training for Sea World Florida
Policy	Issue-Based Policy	Topically oriented information guides on a given topic developed by the Sea World/Busch Gardens organization.
Technical	Microsoft Exchange	Microsoft client/server messaging software that includes e-mail handling
	Windows NT	Microsoft's Server software

Blueprint Narrative

Ask Shamu has three processes that affect its digital reference services: the "Question Answer Process," "Content Creation Process," and the "Policy Creation Process." As a single-person operation, all of the processes are simple and straightforward, with little documentation. However, they represent a holistic reference process, from information referral to reference collection building. Also as a result of the single-person nature of the service, all of the processes are tightly integrated.

Question Answer Process

A question is sent to the Ask Shamu service through e-mail. They might get this address from the Animal Information Database Web site or "Shamu TV [which] advertises the Web site and e-mail address for students to use for additional information."

After the question is received, it is evaluated. This evaluation consists of determining if Wilson can answer it herself, or if she needs to forward it to another expert from within Sea World/Busch Gardens:

> **Wilson**>>If I can't answer the question, I will forward it to the person I know can.
>
> **Iankes**>>A person within the organization (Sea World)?
>
> **Wilson**>>Sea World/Busch Gardens—yes.

It also involves determining if a question is real and should receive a response at all:

> [I] respond to all real questions . . . [I] respond personally to just about everyone . . . Of course, sometimes people send messages that are meant to be jokes and I may not respond to those.

Questions forwarded to experts are either sent directly to the user by the expert or sent back to Wilson:

> Some folks are comfortable in responding directly themselves. Others prefer that I respond for them.

When Wilson answers a question she relies on her own expertise and the help of "Issue-Based Policies" from the policy creation processes described below. Once she has either created an answer or reviewed answers created by others she e-mails a response back to the user who asked the question.

Content Creation Process

In addition to Ask Shamu, Wilson is also responsible for building and maintaining "a rather large" Animal Information Database. The Animal Information Database is Sea World's education Web site:

> We currently have a Web site [including] over 1,000 pages, 2,500 photographs of animal information. This site is updated almost on a daily basis. We have sections of the site that are used to post newsworthy events that must be updated on a weekly basis, and educational program information that is updated when needed (usually several times a year), new animal resources are always being developed and added to the site, and new ideas (like live animal cams throughout the parks) are being created and added to the site.

While she is responsible for putting resources on the Web site, she is not responsible for creating them:

> My job is to take the already developed resources and turn them into online resources.

However, she uses her discretion based partly on user feedback to decide which existing resource is put on the Web:

> **Wilson**>>I try to determine what would be the most fun, educational, and appealing to users [of] our site.
> **Iankes**>>And how do you determine that . . . from the questions they ask, the hits on the Web site . . . software availability?

Wilson>>All of the above. I have learned, for example, through e-mail and survey responses that users of our site like to see lots of photographs. So, with each animal resource, I try to include as many photos and illustrations as possible.

The process begins with the "Content Developers." These are primarily employees in the Public Relations department and science writers on staff at Sea World/Busch Gardens who identify topics for new resources. These topics are then used to create non-Web materials by Corporate Communications (a division of Sea World/Busch Gardens), animal curators, Corporate & Public Relations (a division of Sea World/Busch Gardens) and science writers. These materials are reviewed and then forwarded to Pamala Wilson for preparation for the Web.

Policy Creation Process

Animal issues are important to an amusement park that uses a captive whale for a logo. Large corporations such as Sea World/Busch Gardens are particularly sensitive to animal activists and the media. Oftentimes it is important to create policy documents and materials that present a unified position to the outside world. This is the purpose of the "Policy Creation Process." The policies created in this process are used in both the Animal Information Database Web site and the Ask Shamu Question Answer Process:

Wilson>>As far as the guidelines—these are created if necessary. For example, if we know that a certain animal-issue is going to be brought to the public attention, then we will formulate answers to what are sure to be the most popular questions.

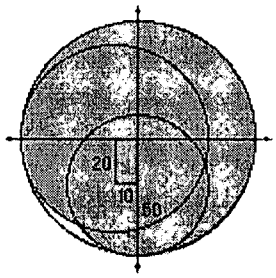
lankes>>And those issues are identified how?

Wilson>>By people on our staff—for example, recently we were presented in a somewhat questionable light on a television show. We knew that the show was going to be aired and were prepared with statements to make on our behalf.

lankes>>These people are primarily in Public Relations?

Wilson>>Public Relations, Animal Curators, Corporate Public Relations, Science Writers—it is determined by the subject matter.

This process begins with the Public Relations Division of Sea World/Busch Gardens. A policy is created in response to some external event, or in anticipation of some external event. Members of the Sea World/Busch Gardens staff review this policy document. This document can then be used as a resource in the question answer process.



"One thing we think we provide is a different perspective from the one students get in school—more of a mathematician's perspective."
-Ken Williams

Service 3: Dr. Math

Publisher: The Math Forum
Email: dr.math@forum.swarthmore.edu
Contact: Ken Williams
HomePage: http://forum.swarthmore.edu/dr.math/
Subject: Mathematics - Algebra | Mathematics - Applied mathematics | Mathematics - Arithmetic | Mathematics - Calculus | Mathematics - Discrete mathematics | Mathematics - Functions | Mathematics - Geometry | Mathematics - Measurement | Mathematics - Number sense | Mathematics - Number theory | Mathematics - Patterns | Mathematics - Probability | Mathematics - Statistics | Mathematics - Trigonometry | Digital reference services | Question and answer services
Grade: 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Post Secondary | Adult
Audience: Students | Teachers
Description: Ask Dr. Math is a question-and-answer service for K–12 math students and their teachers. The service provides archives that are searchable by grade level and topic, and includes such features as Frequently Asked Questions (FAQ), puzzle archives, links to other math sites, and an online mathematics dictionary.
Keywords: Education | K–12 | Higher education | Mathematics | Math | Geometry | Algebra |
Language: English
Relations: Ask Dr. Math is funded by the National Science Foundation (http://www.nsf.gov/) and operates under the auspices of the Math Forum at Swarthmore College (http://forum.swarthmore.edu/)

Record Created: 8/11/1997
Cataloged by: R. David Lankes, Virtual Reference Desk
E-mail: rdlankes@vrd.org
HomePage: http://www.vrd.org

Introduction

Ken Williams, the head of Dr. Math, states clearly that his service is not homework help:

> We don't like to be called a homework help service because we can't answer questions fast enough for people to use our help for the next days' homework, and because we don't possess the resources to answer all the questions we receive . . .

In fact, out of an estimated 54 questions received in a day, only about 23 are answered[34]. Instead, Dr. Math is:

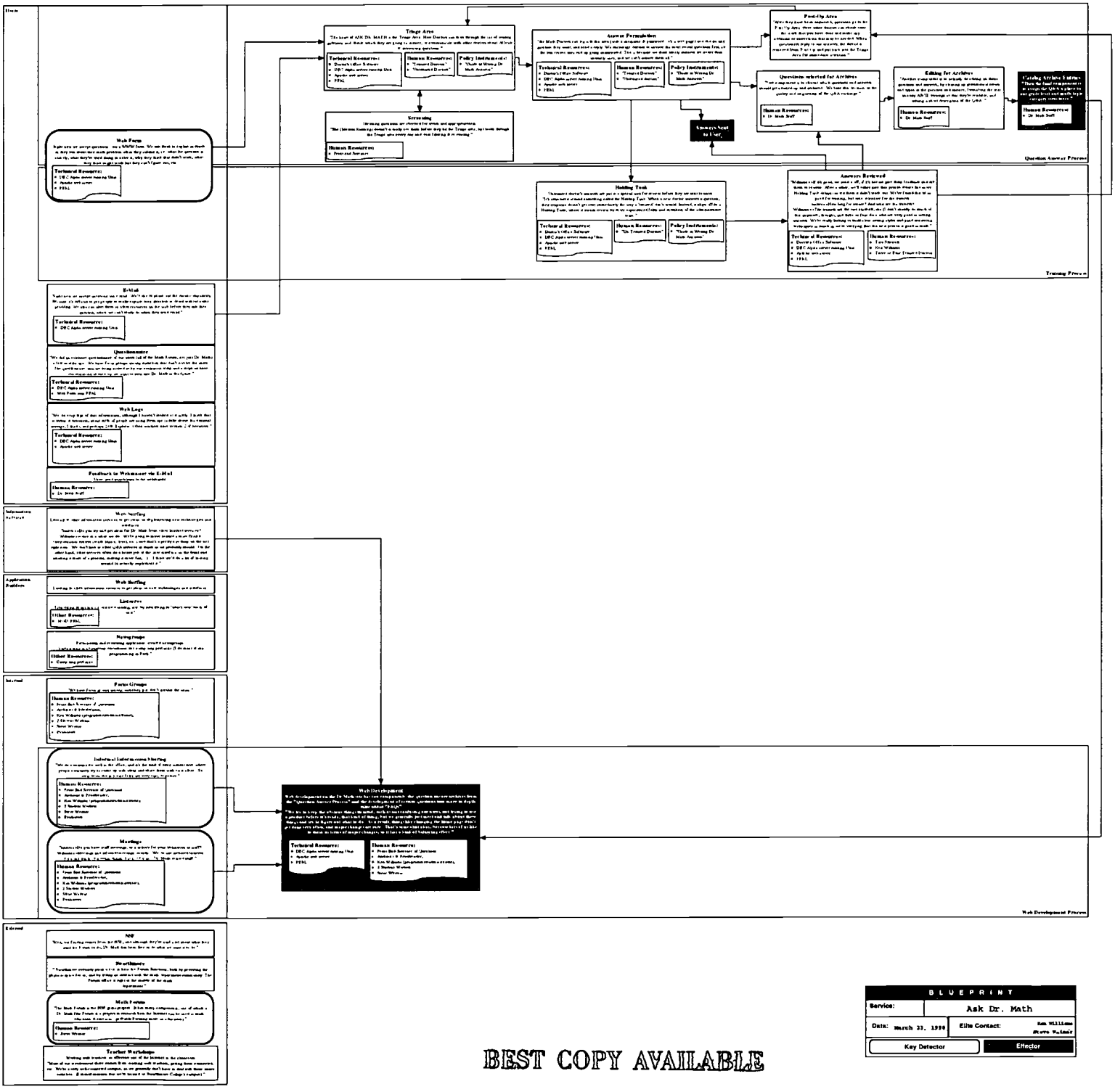
> 'An ask-an-expert service for mathematics.' The long version is something like this: We provide students in kindergarten through 12th grade (or the international equivalent) with help from mathematicians. These mathematicians might be college professors, researchers, high school math teachers, undergraduates, retired teachers, etc . . .

Dr. Math is an ambitious service with over 200 volunteers. It is part of the Math Forum, an NSF sponsored project that seeks to "build an online community of teachers, students, researchers, parents, educators, and citizens at all levels who have an interest in math and math education." They do this through the following:

- Encouraging communication throughout the mathematical community
- Making math-related web resources more accessible
- Providing quality math and math education content.

[34] Self reported statistics by Ken Williams.

112



BLUEPRINT

Service:	Ask Dr. Math
Date: March 23, 1999	Elite Contact: Ken Williams, Steve Weimar
Key Detector	Effector

Detectors

Detectors are the organization's mechanisms for acquiring information on the environment. These mechanisms may actually be a combination of several resources. Some detectors were deemed more important than others in making decisions regarding building and maintaining the service. These are called "key detectors" and are highlighted in Table 4-4.1.

Table 4-4.1: Detectors used by Dr.Math (key detectors are highlighted)

Agent Type	Detector	Purpose
User	Web Form	Takes in user question
	E-mail	Takes questions from user via e-mail
	Questionnaire	Web-based questionnaire solicits user feedback
	Web logs	Automatically generates usage logs
	Feedback to Webmaster via E-mail	E-mail suggestions and comments geared towards the Web site
Information Services	Web Surfing	Looks for interface ideas and features at other Web sites
Application Builders	Web Surfing	Looks for specific software and software implementation
	Listservs	Topically-oriented e-mail based discussion groups
	Newsgroups	Technology oriented bulletin boards
Internal	Focus Groups	Internal discussions on how to build and improve the Dr. Math service
	Internal Information Sharing	Informal office discussions among staff
	Meetings	Scheduled meetings to discuss operational issues
External	NSF	The National Science Foundation funds the Math Forum
	Swathmore	Interactions with Swarthmore faculty and staff in the Math Department
	Math Forum	Works with Steve Weimar, the head of the Math Forum, the parent organization for the Dr. Math service
	Teacher Workshops	Math Forum activities to teach teachers how to better use the Internet in the classroom

Effectors

Effectors are the output of the service. Dr. Math has three effectors.

Table 4-4.2: Dr. Math Effectors

Effector	Description
Answer Sent to User	Answer is e-mailed to the user
Catalog Archive Entries	Cataloged question/answer sets are posted to the Dr. Math Web site
Web Development	FAQ's and more global Web pages (such as the homepage) are developed and put on the Dr. Math Web site

Rules

Rules represent the abstract flow and transformation of information within an organization. Table 4-4.3 represents the three primary information processes in regards to their digital reference activities for Dr. Math (see the Blueprint narrative for more information on these processes).

Table 4-4.3: Dr. Math's Rule Processes

Process Name	Description
Question Answer Process	The process whereby an incoming question is answered and tracked
Training Process	Process parallel to the "Question Answer Process" that trains volunteers how to create answers
Web Development Process	The process that creates new Web resources on the Dr. Math Web site.

Resources

Resources are the means by which rules are implemented. Resources include people, tools, and policies an organization uses to implement a process. Table 4-4.4 lists the resources used in the three Dr. Math processes.

Table 4-4.4: Resources used by Dr. Math

Resource Type	Resource	Description
Human	Archivist & proofreader	Dr. Math staff who edit and catalog question/answer sets
	Dr. Math staff	Dr. Math staff, including coordinator
	Front-end screener	Dr. Math employee who reads through incoming questions
	Ken Williams	B.A. in Mathematics from Swarthmore
	Steve Weimar	Education consultant and former middle and high school math teacher. "I started working at the Math Forum back when it was still the Geometry Forum and we figured out that 'they' don't come just because you build it . . . My professional life began with teaching math to middle and high school students. I left to write curricula but was soon diverted by coming into contact with an energetic, brilliant, and compassionate group of teachers thinking about what education had to do with the state of affairs in the world, particularly with the nuclear arms race between the U.S. and Soviet Union. I worked for seven years helping to build Educators for Social Responsibility, both nationally and in the Philadelphia area." - http://forum.swarthmore.edu/~steve/me.html
	Tenured doctors	199 volunteers who answer questions without review
	Untenured doctors	New Dr. Math volunteers in training
Other	Comp.lang.perl.misc	Newsgroup dedicated to discussing PERL programming
	Mod_PERL	Listserv discussing PERL's use with Webservers
Policy	Guide to Writing Dr. Math Answers	A training guide stressing clear writing style and the basics of the "Doctor's Office" software
Technical	Apache	A popular, freely available World Wide Web server for UNIX servers.
	DEC Alpha Server	A UNIX workstation/server produced by the Digital Corporation
	Doctor's Office Software	A set of PERL scripts that manage the question/answering process and create interfaces for the "doctors" to use
	PERL	A high-level programming language used with Common Gateway Interface (CGI), a software mechanism used to expand the capabilities of a Web server.
	Web Form	An HTML form with a PERL-based CGI script

Blueprint Narrative

Dr. Math has three processes. Two processes, the "Question Answer Process" and the "Training Process," are tied tightly together. The third, "Web Development Process," is tied into question answering, but is much less formal.

Question Answer Process

A question is received via the Web (see Figure 4-4.1) and placed via a PERL script into the "Triage Area."

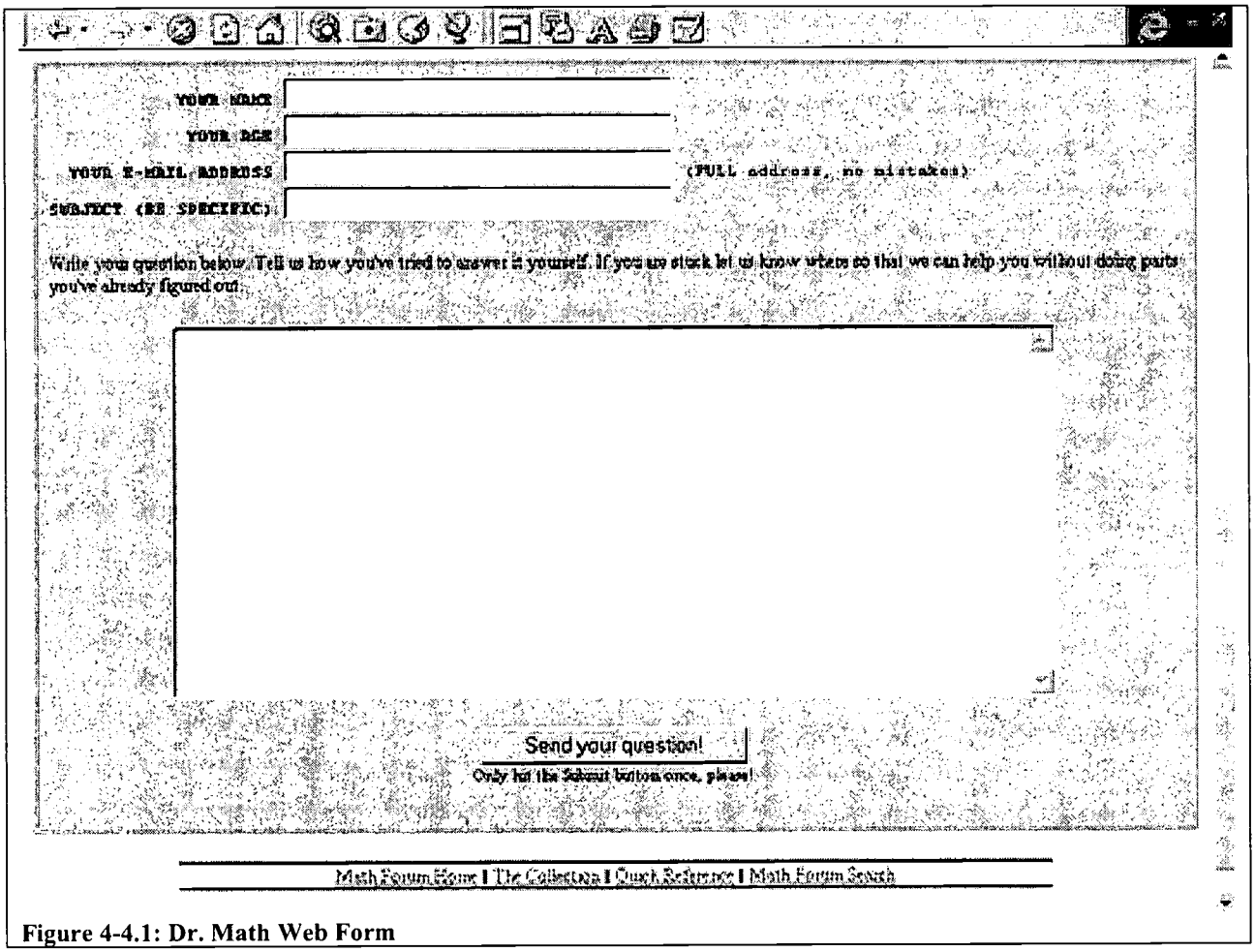


Figure 4-4.1: Dr. Math Web Form

Questions received via e-mail are manually marked-up and placed into the triage area. Questions are listed in reverse chronological order in the triage area. Once in this area, a "front-end screener" regularly examines questions for technical errors:

lankes>>Is there someone who reads all incoming questions before they are put in the triage area?

Williams>>Yes—we talked about this a lot before we actually created the job, but for about 9 months we've had such a person. She (Melissa Running) doesn't actually see them before they hit the Triage area, but looks through the Triage area every day and does filtering & re-routing.

Doctors (volunteers who answer questions) can then select the questions they want to answer by logging into the triage Web interface (see Figure 4-4.2). The doctors are encouraged to answer the most recent questions first. Doctors are also encouraged to use a clear writing style in composing their answers.

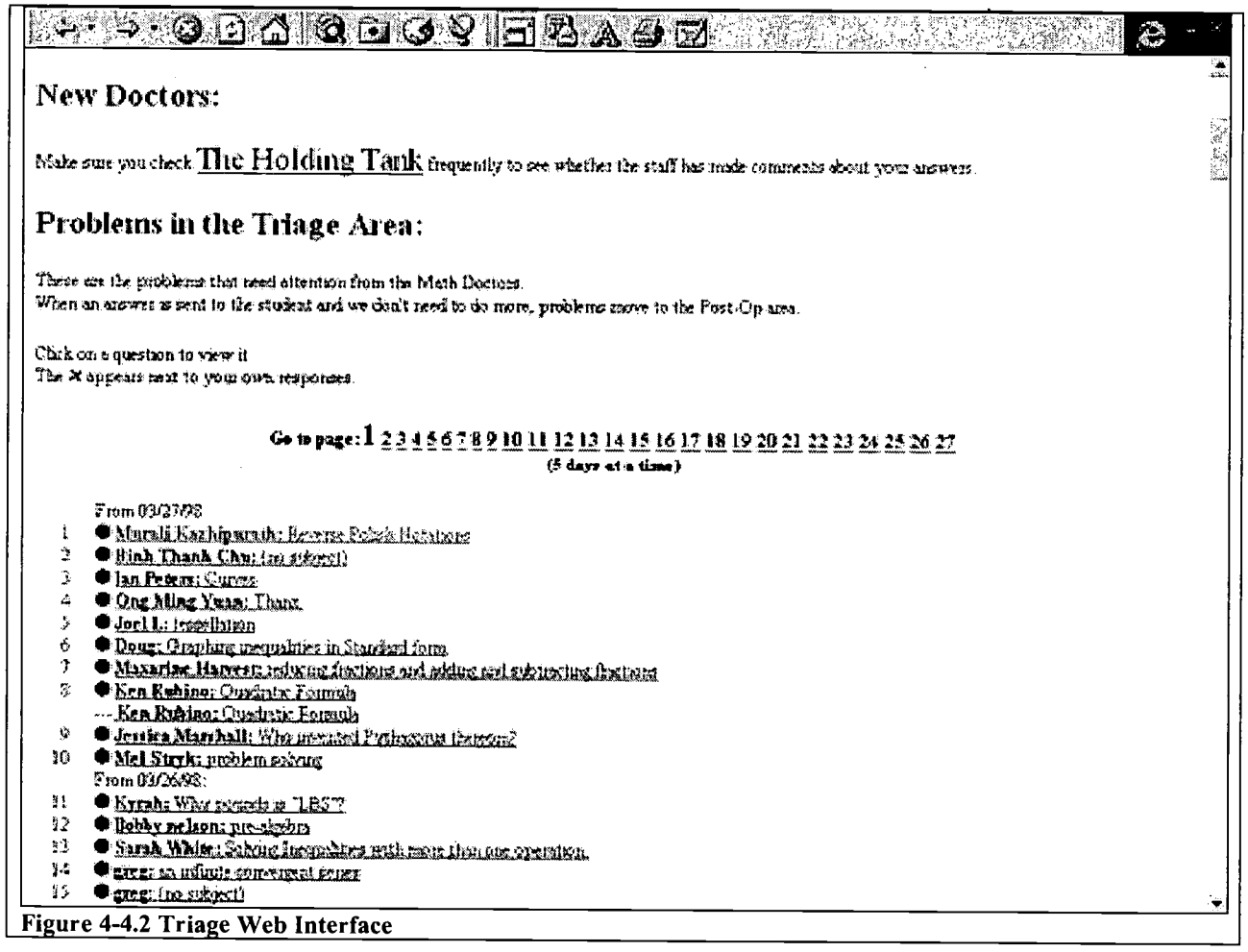


Figure 4-4.2 Triage Web Interface

Doctors who have been "tenured" then send answers to the user via e-mail, and move question/answer sets to the "Post-Op Area." In "Post-Op" other doctors can comment and expand on answers. Certain answers are selected for inclusion in the Dr. Math Archive:

One thing that we've found absolutely invaluable about our service is our archive of Q&A's. I can't stress that enough. To have a real, useable archive (searchable, browsable, well-organized) is something that's very important to us and something we always strive for. That's something we often don't see in other services. On the other hand, other services often do a better job of the user interface on the front end (making it more of a process, making it more fun, . . .). That's

> something we want to work on. We're thinking of something like: when a student submits a question, they categorize it themselves and get a list of Q&A's in our archive that look like they might be apropos to their question. We haven't made this a reality yet.

Questions selected for the archive are edited, cataloged and put on the Dr. Math Web site (see Figure 4-4.3 for the Dr. Math archive). This work is done by proof-readers and archivists:

> The archivist & proofreader job is done by a couple of people, and there are several separable components to the job. One component is to choose which questions and answers should get cleaned up and archived. We base this decision on the quality and uniqueness of the Q&A exchange. Another component is to actually do editing on these questions and answers, by cleaning up grammatical errors and typos in the question and answer, formatting the text and any ASCII drawings so that they're readable, and writing a short description of the Q&A. Then the final component is to assign the Q&A a place in our grade-level and math-topic category structures.

If a user responds to a Dr. Math answer for additional clarification or questions, a question/answer set is moved out of the "Post-Op Area" and back into the "Triage Area."

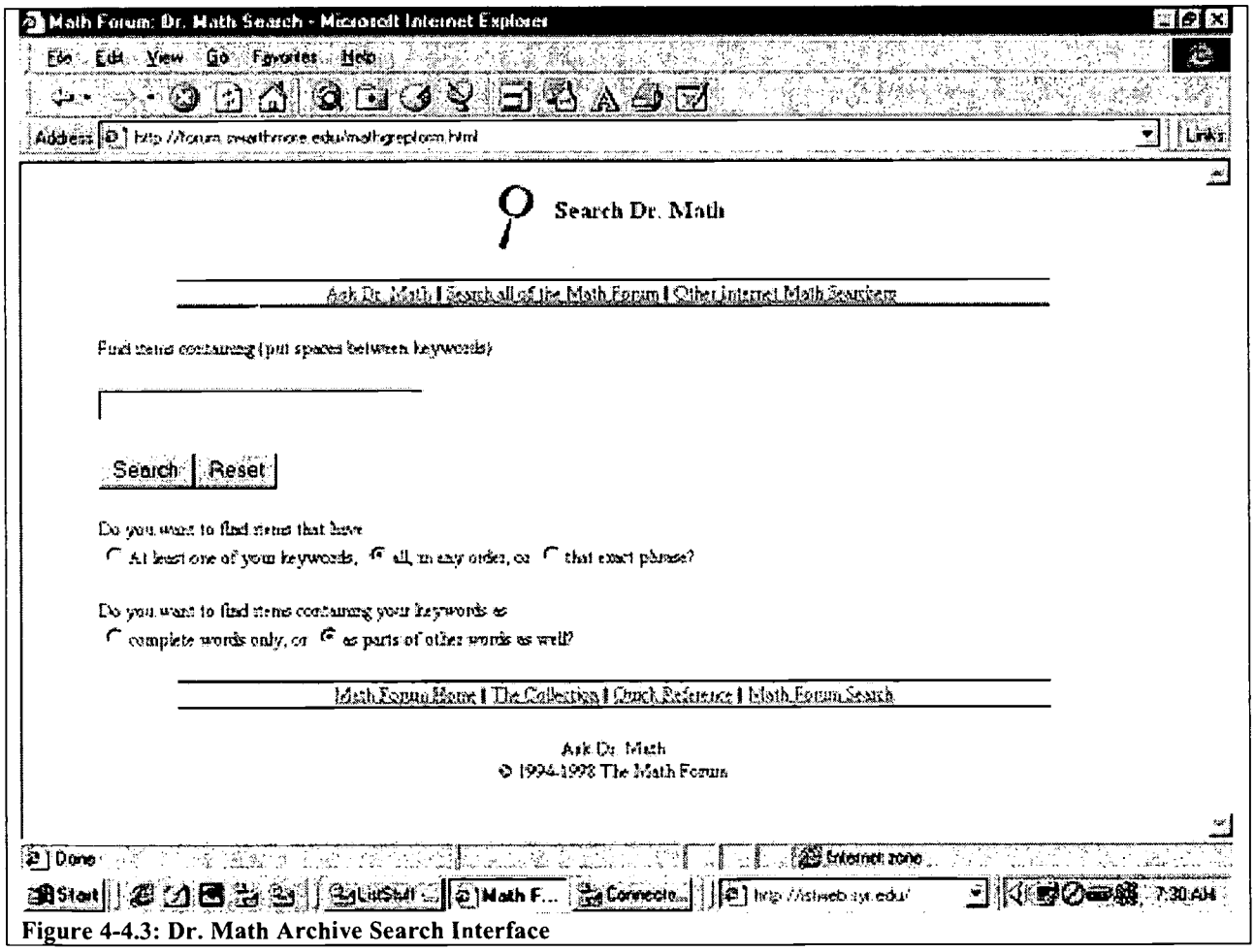


Figure 4-4.3: Dr. Math Archive Search Interface

Training Process

"Untenured" doctors are volunteers in training. These "doctors" log into the same triage Web site, and select questions just as tenured doctors would. However, all untenured doctors' answers are sent to a "Holding Tank" before being sent out. Once in the holding tank, answers are reviewed and corrected/edited before being sent to the user, moving the question/answer set to "Post-Op" and entering the answer into the archiving process:

> **Williams>>**Okay. It's [the training process] structured around something called the Holding Tank. When a new doctor answers a question, their response doesn't get sent immediately the way a "tenured" doc's would. Instead, it ships off to a Holding Tank, where it awaits review by more experienced folks and members of the administrative team. If it's good, we send it off, if it's not we give them feedback and ask them to rewrite. After a while, we'll either give that person tenure (no more Holding Tank delays) or tell them it didn't work out. We've found this to be good for training, but time-intensive for the trainers.
>
> **lankes>>**How long for tenure? And who are the trainers?
>
> **Williams>>**The trainers are the two students, me (I don't usually do much of this anymore, though), and three or four docs who are very good at writing answers. We're really looking to build clear writing styles and good answering techniques as much as we're verifying that this new person is good at math.

These volunteers come from a variety of sources:

> One way is to send a message to some math-oriented newsgroups like geometry.pre-college or sci.math. Another way is to wait for people to stumble upon our Web recruitment form (which is not well-publicized, or else we'd be flooded by applications!). And a certain portion of our volunteers have come to us by recommendation of other volunteers.

Web Development Process

There are three types of Web development done by Dr. Math. The two types that are formalized are the creation of answer archives from the "Question Answer Process" and the development of FAQ's:

> One of our newest features is our FAQ—it's different from most Web FAQs, in that most FAQs really mean 'if you're asking a question on these topics, people will get mad at you, because the answers are right here!' Our FAQ is more an attempt to give relatively complete or basic treatments of topics that we get asked about fairly often. It's also useful to our doctors when they answer questions, because they can refer students to basic information and move on to the subtle points of the math.

The third type of development is more informal:

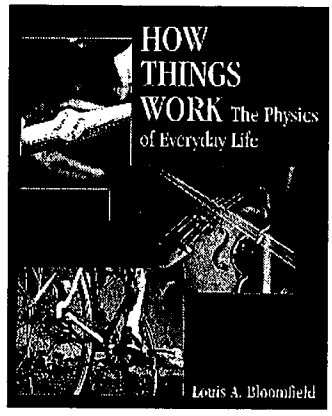
> **lankes>>**Switching the topic for a moment, do you have any policies (formal or otherwise) that help you in deciding when to make a change in a service . . . like implementing TACO[35] or

[35] TACO is an updated version of the "Doctor's Office" software currently in use.

changing the home page?

Williams>>Not really—we try to keep the obvious things in mind, such as not confusing our users, not trying to use a product before it's ready, that kind of thing, but we generally just meet and talk about these things and try to figure out what to do. As a result, things like changing the home page don't get done very often, and major changes are rare. That's somewhat okay, because lots of us like to think in terms of major changes, so it has a kind of balancing effect.

So while the majority of information on the Dr. Math Web site is user driven and user-derived, there are more global changes that have little in the way of direct user influence.



"Because I'm the only person working on the site, the word 'service' is a little problematic."
-Louis A. Bloomfield

Service 4: How Things Work

Publisher: Louis A. Bloomfield
Email: lab3e@virginia.edu
Contact: Louis A. Bloomfield
HomePage:
http://landau1.phys.virginia.edu/Education/Teaching/HowThingsWork/home.html
Subject: Science - Physics
Grade: Kindergarten | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Post Secondary | Adult
Audience: Students | Teachers | Parents
Description: How Things Work is a question and answer service for physics information and why things around us are the way they are. The site also features a searchable index of previously-answered questions, a recent questions list, and links to other "how things work" resources.
Keywords: Education | K–12 | Higher education | Science | Physics | Digital reference services | Question and answer services
Language: English
Relations: How Things Work is a volunteer effort of Louis A. Bloomfield, a professor of physics at the University of Virginia.

Record Created: 8/15/1997
Cataloged by: Joann M. Wasik, Virtual Reference Desk
E-mail: vrd@vrd.org
HomePage: http://www.vrd.org

Introduction

Lou Bloomfield began How Things Work as an activity to enrich his physics class:

> The service grew out of my class. At the end of each class, I have students drop paper questions in a box. I've done this for the past 3 or so years. At first, I simply responded to the questions in class the next day. But I soon began posting answers on the Web. I then added a form to the Web page so that students could ask me questions online as well as in class. And, surprise, most of the questions I received from that form were from outside the university. I began sprucing up the question and answer page once I realized that it was being read by the outside world and its readership gradually expanded from a hundred or so a week to something like 6000 a week.

How Things Work today is a one-person operation answering physics questions for the Internet community. While Bloomfield is still answering questions, he is getting substantially overwhelmed. As of this writing Bloomfield has nearly 4,442 questions unanswered. This fact is not lost on Bloomfield:

> **Bloomfield>>**Because I'm the only person working on the site, the word 'service' is a little problematic. I'm so far behind in answering questions that the site has lost its 'service' aspect.
>
> **lankes>>**How so?
>
> **Bloomfield>>**What I have always intended the "service" to do is to answer people's questions about science in the everyday world. Most of the questions I get are appropriate and the kind that I can answer. However, I am now something like 2,700 questions behind.

And yet, in the face of this backlog, How Things Work still retains a reputation of quality.

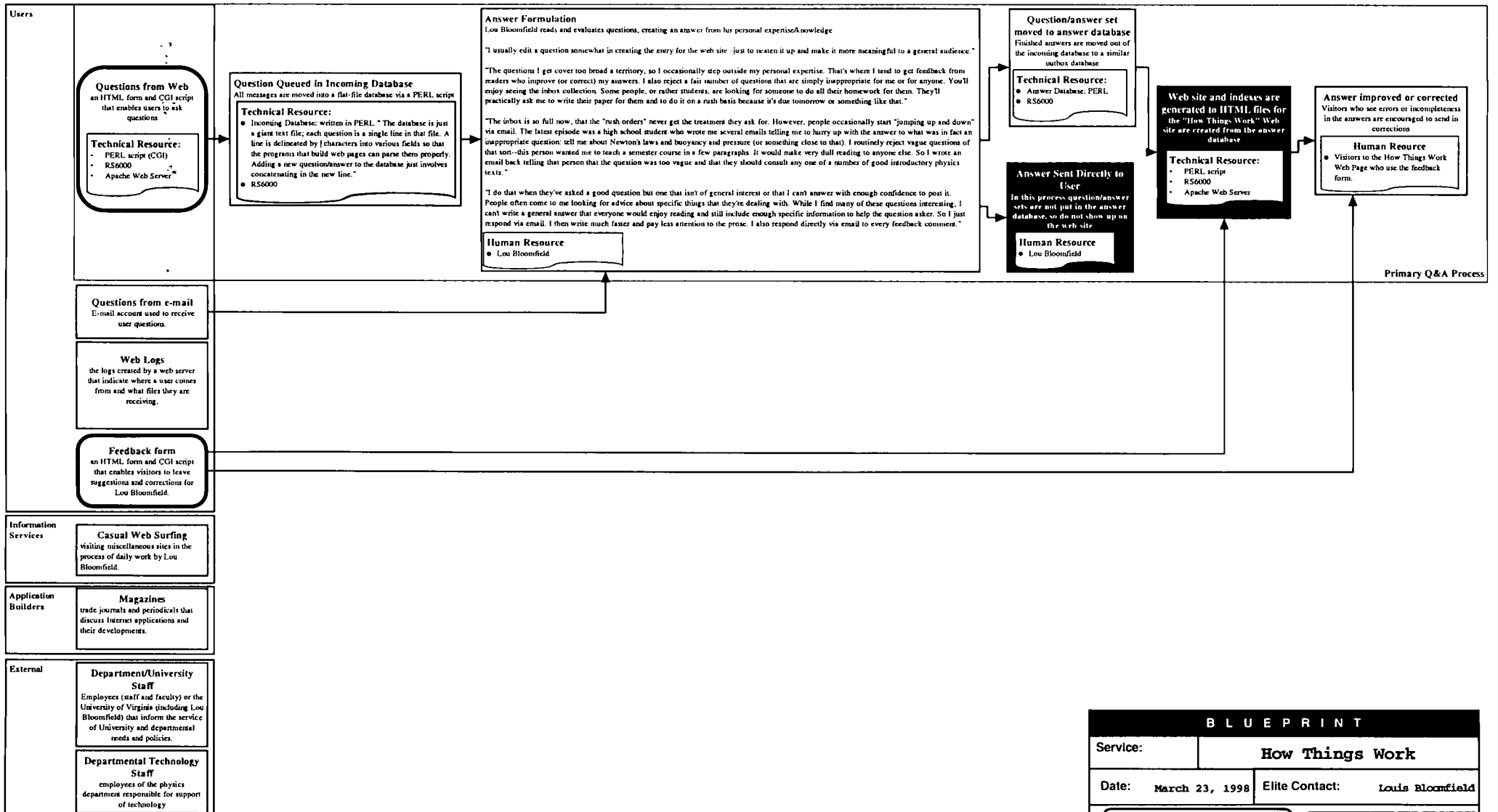
Bloomfield's How Things Work is an example of a user-driven service. The entire service (either through the e-mail effectors or the Web site) is guided from user input in the form of questions. Question/answer sets constitute the vast majority of the information on the Web site. Features such as searching archives, and method of presenting the information is driven by user feedback:

> I have responded to a number of suggestions from the people out in Web land. For example, people asked often for some search mechanism, so I wrote one. That required a redesign of the whole Web site; a shift from hand-written Web pages to a database driven site. It was an important change and I'm very pleased to have done it. I might never have gone that route without outside influence.

However, this kind of responsiveness is starting to take its toll and Bloomfield considers options for sharing some of the responsibilities:

> I'm on leave from UVA this semester, but when I return I think that I'll begin looking into 'giving' the site to the department. I'm so behind that I really need help. Our new chairman is very interested in maintaing a good Web presence and I plan to talk to him about letting others help me with the site. I'd like to see all of the appropriate questions answered in a timely fashion and that requires other people. I don't want the site to become a commercial operation (no advertising!), but I'm about ready to give up the sole ownership arrangement. It has been exciting . . .

How Things Work is the simplest service described in this study. It has few detectors and only one process. Yet, it demonstrates that a site does not have to be large or well staffed to gain a good reputation.



BLUEPRINT			
Service:	How Things Work		
Date:	March 23, 1998	Elite Contact:	Louis Bloomfield
Key Detector		Effector	

Detectors

Detectors are the organization's mechanisms for acquiring information on the environment. These mechanisms may actually be a combination of several resources. Some detectors were deemed more important than others in making building and maintaining decisions. These are called "key detectors" and are highlighted in Table 4-5.1.

Table 4-5.1: Detectors used by How Things Work (key detectors are highlighted)

Agent Type	Detector	Purpose
User	Questions from the Web	Questions submitted by users to a Web form on the How Things Work Web site
	Questions from E-mail	User questions sent directly to Lou Bloomfield's personal e-mail account
	Web Logs	Usage logs generated by the Apache Web server
	Feedback Form	User comments received via an HTML form (see Figure 4-5.2)
Information Services	Casual Web Surfing	Surfing the Web as part of Lou Bloomfield's daily work
Application Builders	Magazines	Information from reading about new software options and features
External	Department/University Staff	Faculty and staff of the University of Virginia
	Department Technology Staff	Systems staff for the Physics department

Effectors

Effectors are the output of the service. How Things Work has three effectors related to digital reference.

Table 4-5.2: How Things Work Effectors

Effector	Description
Answer Sent Directly to User	An e-mail answer that does not have wide appeal or is urgent
Web Site Indexes Are Generated to HTML Files	HTML archive available on the Web site

Rules

Rules represent the abstract flow and transformation of information within an organization. Table 4-5.3 represents the primary information process in regards to the digital reference activities for How Things Work (see the Blueprint narrative for more information on these processes).

Table 4-5.3 How Things Work Rule Processes

Process Name	Description
Primary Q&A Process	The process whereby an incoming question is answered and tracked

Resources

Resources are the means by which rules are implemented. Resources include people, tools, and policies an organization uses to implement a process. Table 4-5.4 lists the resources used in the How Things Work process.

Table 4-5.4: Resources Used by How Things Work

Resource Type	Resource	Description
Human	Lou Bloomfield	"Louis A. Bloomfield (lab3e@virginia.edu) is Professor of Physics at the University of Virginia. He received his Ph.D. from Stanford in 1983 and was a postdoctoral fellow at AT&T Bell Laboratories before arriving at the University of Virginia in 1985. He is the recipient of numerous awards for his research in atomic, condensed matter, and optical physics, including the Apker Award of the American Physical Society, a Presidential Young Investigator Award of the National Science Foundation, a Young Investigator Award of the Office of Naval Research, and an Alfred P. Sloan Fellowship, and he is a Fellow of the American Physical Society. Bloomfield has also been widely recognized for his teaching of physics and science to thousands of non-science students at the University of Virginia. He is the author of more than 70 scientific publications in the fields of atomic clusters, autoionizing states, high-resolution laser spectroscopy, nonlinear optics, and computer science, and of a recent introductory textbook titled *How Things Work: The Physics of Everyday Life* (Wiley, New York, 1997)." http://landau1.phys.virginia.edu/Education/Teaching/HowThingsWork/biography.html
	Visitors to the How Things Work Web site	Users of How Things Work that can expand and correct answers in the Web archive
Technical	Answer Database	A PERL-based flatfile text database similar to the incoming database
	Apache Web Server	A popular free UNIX-based World Wide Web server
	Incoming Database	"The database is just a giant text file; each question is a single line in that file. A line is delineated by | characters into various fields so that the programs that build Web pages can parse them properly. Adding a new question/answer to the database just involves concatenating in the new line."
	PERL script	A PERL script that takes information in an HTML form and puts it into the incoming database
	RS6000	An IBM manufactured UNIX computer

Blueprint Narrative

How Things Work is by far the simplest service studied. It is not only a one-person operation, but a one-person volunteer effort. Bloomfield only does one thing; he answers questions. This is reflected in the single process employed at the site, the "Primary Q&A Process."

Primary Q&A Process

A question is entered via a Web form on the "How Things Work" site (see Figure 4-5.1).

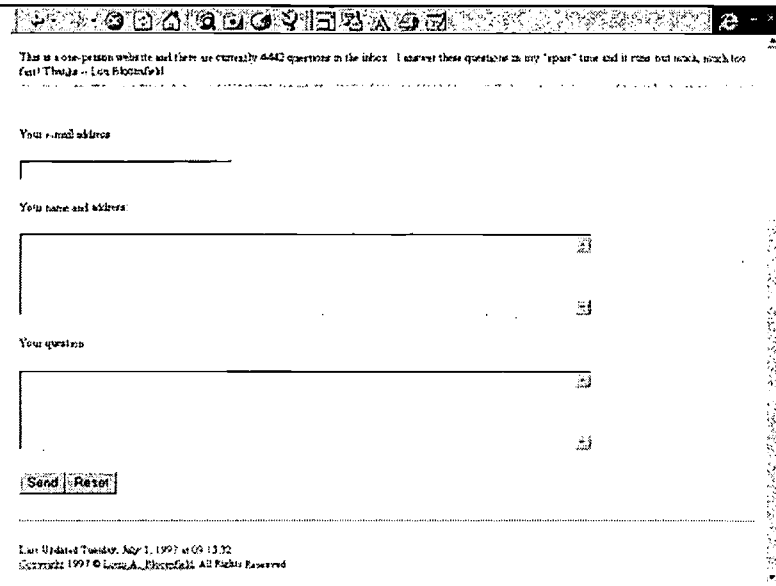


Figure 4-5.1 How Things Work Web Form: Web form used by How Things Work users when submitting a question.

A PERL script (running as a CGI script within an Apache server on a RS6000 machine) takes the question and places it as a single line of text in the incoming database. Dr. Bloomfield then reads and evaluates the questions and answers them from his personal knowledge or deems them as "inappropriate." Answered questions are then moved from the incoming database to the "answer database." Some answers, however, are sent directly to the users without being moved to the answer database:

> However, I do occasionally respond directly to peoples' questions via email. I do that when they've asked a good question but one that isn't of general interest or that I can't answer with enough confidence to post it. People often come to me looking for advice about specific things that they're dealing with. While I find many of these questions interesting, I can't write a general answer that everyone would enjoy reading and still include enough specific information to help the question asker. So I just respond via email. I then write much faster and pay less attention to the prose. I also respond directly via email to every feedback comment.

On a regular schedule a PERL script transforms the answer database into HTML pages that are placed on the How Things Work Web server. Once on the server, users of the service can suggest additions or corrections to answers through an online feedback form (see Figure 4-5.2).

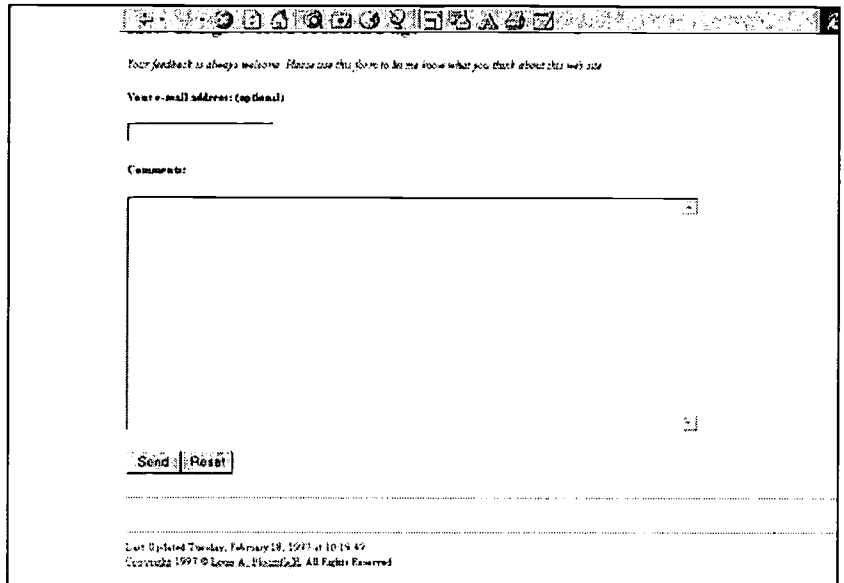


Figure 4-5.2 How Things Work Feedback Form

"When we are looking to add functionality [it] is always: try and make the system as efficient as possible and as user friendly as possible and make it accessible."

-Joe Simpson

Service 5: MAD Scientist Network

Publisher: Washington University Medical School
Email: madsci@madsci.wustl.edu
Contact: Joe Simpson
HomePage: http://madsci.wustl.edu/
Subject: Science - Agriculture | Science - Astronomy | Science - Biological and life sciences | Science - Botony | Science - Chemistry | Science - Technology | Science - Earth science | Science - General science | Science - Physics | Science - History
Grade: Pre-kindergarten | Kindergarten | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Post Secondary | Adult
Audience: Teachers | Students | Parents
Description: Welcome to the MAD Scientist Network. We are a collective crania of scientists answering questions in many areas. The "network" provides a forum in which people can learn more about the world around them. Our site has three primary divisions . . .

1.Ask-A-Scientist: Includes the online archive of questions and answers, and "Ask-A-Scientist" Section.

2.MAD Labs: More about having fun with science.

3.MadSci Library: Locate science sites and resources on the WWW. Includes links to other Ask-A-Scientist sites, and information about careers in science.

Answer Policy: Answers given are brief and factual with no references to resources. Attempts to answer questions within 2 weeks, but can take up to 3 months.
Keywords: Science | Digital reference services | Question and answer services
Language: English

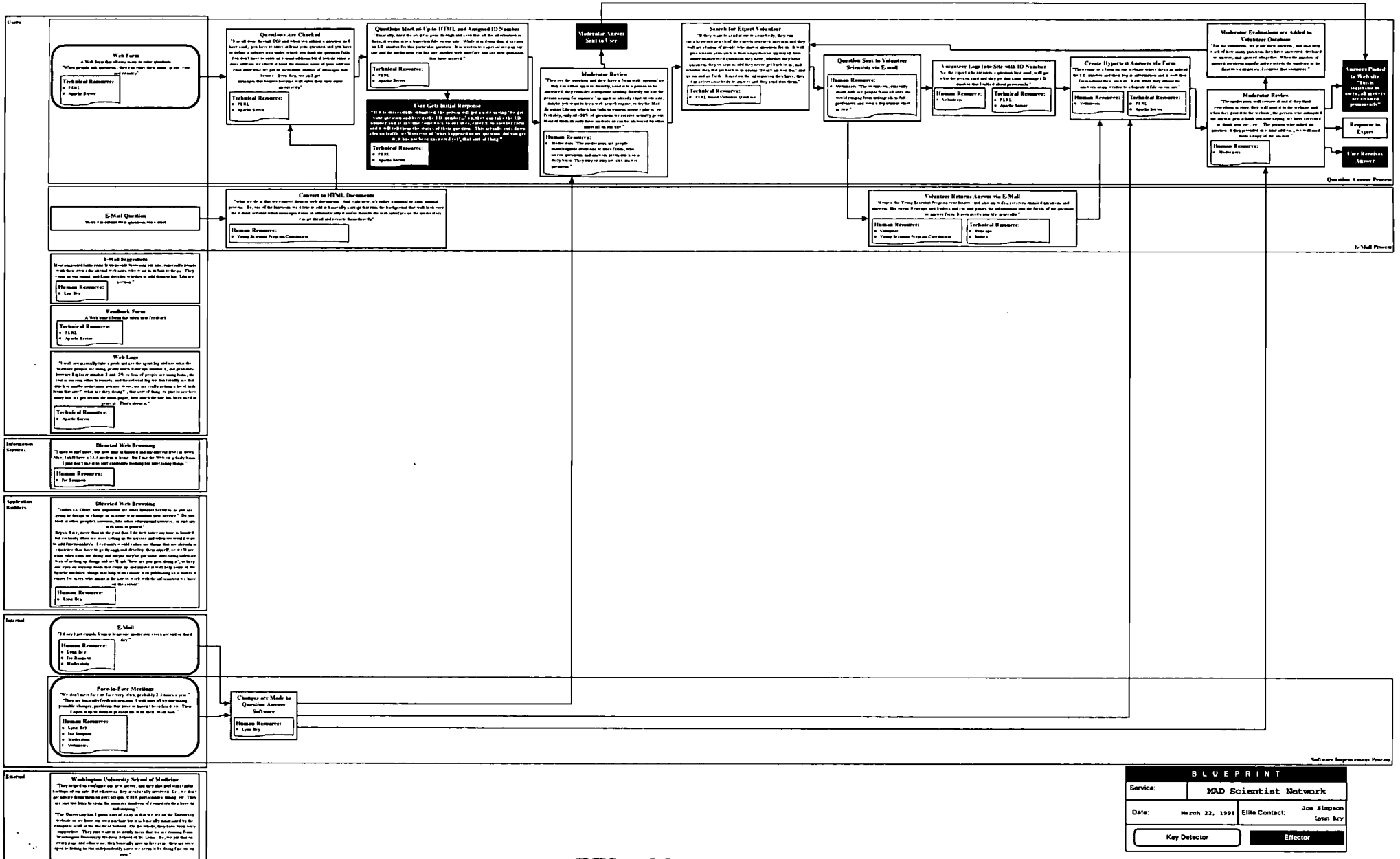
Record Created 8/8/1997
Cataloged by: R. David Lankes
E-mail: rdlankes@vrd.org
HomePage: http://www.vrd.org

Introduction

Lynn Bry created the MAD Scientist Network in 1995 just as the Web was beginning its tremendous growth. The timing shows. While e-mail plays a role in the question/answer process, the Web provides the glue that allows the service to utilize the talent of 400 volunteers. From taking in questions, to creating answers, to tracking volunteers, the Web is at the center of the MAD Scientist Network.

The MAD Scientist Network was built on the Web. It uses PERL and CGI extensively to process questions and coordinate 400 volunteers in creating answers. Questions are received via the Web, answers are posted via the Web, and in-between are a plethora of PERL scripts and Web server extensions. Lynn Bry created and maintains all the scripting for the service, even though she doesn't run the service on a daily basis any more. Lynn hopes that in the future, this trend of decreased "one person" reliance will continue:

> Well, we've been around for two (2) years and as far as I see it is pretty stable. I would like it to be a group effort, a group run effort. I don't intend to be the one person managing the Mad Scientist Network or the one person solely involved for what it does. Certainly, by getting our own Web site, it is now possible to make access to Web space and other elements of the site. Make it available basically to people outside of the University. So certainly, in the future, I think the hope would be to make it more of a group or maybe even a global effort as to how it is runs and what it does.



BLUEPRINT			
Service:	MAD Scientist Network		
Date:	March 22, 1998	Elite Contact:	Joe Simpson Lynn Bry
Key Detector		Effector	

Detectors

Detectors are the organization's mechanisms for acquiring information on the environment. These mechanisms may actually be a combination of several resources. Some detectors were deemed more important than others in making building and maintaining decisions. These are called "key detectors" and are highlighted in Table 4-6.1.

Table 4-6.1: Detectors used by the MAD Scientist Network (key detectors are highlighted)

Agent Type	Detector	Purpose
User	Web Form	To take in user question
	E-mail Questions	Questions sent via electronic mail
	E-mail Suggestions	Comments and suggestions sent by users via e-mail
	Feedback Form	To gather user comments on the MAD Scientist Web site
	Web Logs	Usage statistics generated by a Web server
Information Services	Directed Web Browsing	Looking for interface ideas and features at other Web sites as well as using the Web for daily work purposes
Application Builders	Directed Web Browsing	Looking for specific software and software implementation
Internal	E-mail	Suggestions for improving software and interfaces from moderators and volunteers
	Face-to-Face Meetings	Moderator and volunteer meetings held 2–3 times a year
External	Washington University School of Medicine	The public relations department of the university

Effectors

Effectors are the output of the service. The MSD Scientist Network has four effectors.

Table 4-6.2: MAD Scientist Effectors

Effector	Description
User Gets Initial Response	Confirmation and ID number sent to user with some basic instructions on how to track a question (if user submitted valid e-mail address)
Moderator Answer Sent to User	Answers created by the moderator are sent to user via e-mail (if user submitted valid e-mail address)
Answer Posted to Web site	Answers are posted to topical answer areas in a Web searchable archive
User Receives Answer	Answers created by the volunteers and checked by a moderator are sent to user via e-mail (if user submitted valid e-mail address)

Rules

Rules represent the abstract flow and transformation of information within an organization. Table 4-6.3 represents the three primary information process in regards to the digital reference activities for the MAD Scientist Network (see the Blueprint narrative for more information on these processes).

Table 4-6.3: MAD Scientist Rule Processes

Process Name	Description
Question Answer Process	The process whereby an incoming question is answered and tracked
E-mail Process	How questions and answers transmitted via e-mail are brought into the "Question Answer Process"
Software Improvement Process	The process whereby volunteer input is incorporated into the software used in the "Question Answer Process"

Resources

Resources are the means of implementing rules. They are the form the abstract rules take when implemented. Table 4-6.4 lists the resources used by MAD Scientist.

Table 4-6.4: Resources used by MAD Scientist

Resource Type	Resource	Description
Human	Moderators	Topic specialists who answer questions, route questions to volunteers, and evaluate responses
	Volunteers	400 volunteers from a variety of backgrounds who answer questions
	Young Scientist Program Coordinator	Monica Simpson
	Lynn Bry	MD/PhD students, Washington University Medical School
	Joe Simpson	MD/PhD Student, Neuroscience, Washington University Medical School Areas: Neuroscience, Computer Science, Science History

Resource Type	Resource	Description
Technical	PERL and CGI	"Perl is an interpreted language optimized for scanning arbitrary text files, extracting information from those text files, and printing reports based on that information. It's also a good language for many system management tasks. The language is intended to be practical (easy to use, efficient, complete) rather than beautiful (tiny, elegant, minimal). It combines (in the author's opinion, anyway) some of the best features of C, sed, awk, and sh, so people familiar with those languages should have little difficulty with it. (Language historians will also note some vestiges of csh, Pascal, and even BASIC-PLUS.) Expression syntax corresponds quite closely to C expression syntax. Unlike most Unix utilities, Perl does not arbitrarily limit the size of your data—if you've got the memory, Perl can slurp in your whole file as a single string. Recursion is of unlimited depth. And the hash tables used by associative arrays grow as necessary to prevent degraded performance. Perl uses sophisticated pattern matching techniques to scan large amounts of data very quickly. Although optimized for scanning text, Perl can also deal with binary data, and can make dbm files look like associative arrays (where dbm is available). Setuid Perl scripts are safer than C programs through a dataflow tracing mechanism which prevents many stupid security holes. If you have a problem that would ordinarily use sed or awk or sh, but it exceeds their capabilities or must run a little faster, and you don't want to write the silly thing in C, then Perl may be for you. There are also translators to turn your sed and awk scripts into Perl scripts." - http://language.perl.com/info/synopsis.html
	Apache	"We have also tried NCSA's httpd_1.5, and Netscape's Enterprise Server. While the Enterprise server has the niftiest WWW/user interface for administration, we have found Apache to be faster and more adaptable to the ever rising needs of our site. The mod_perl module for Apache has also proved useful in term of speeding the performance of some of our CGI scripts." - http://madsci.wustl.edu/info/how.html
	Volunteer Database	PERL-based database that keeps track of volunteer information and their associated evaluations
	Netscape	Netscape Communicator and Navigator and World Wide Web browsers to access HTML documents (in this case forms)
	Eudora	E-mail client to receive, send, and manipulate electronic mail messages

Blueprint Narrative

There are three tightly tied processes in MAD Scientist related to question answering. Two processes involve producing answers while the third improves the software used to process questions. The system is remarkably simple considering the 400 volunteers that participate. It is also innovative in that, while there is no formal training, quality and training are built into almost every question answering interaction by having moderators check and evaluate every volunteer answer.

Question Answer Process

A question is received via an HTML Web form (see Figure 4-6.1). Users are asked to categorize their questions via MAD Scientist's areas of expertise. Questions are then checked by an automated PERL script to make sure the correct information is entered, and that an entered e-mail address (optional) at least has a legitimate domain name.

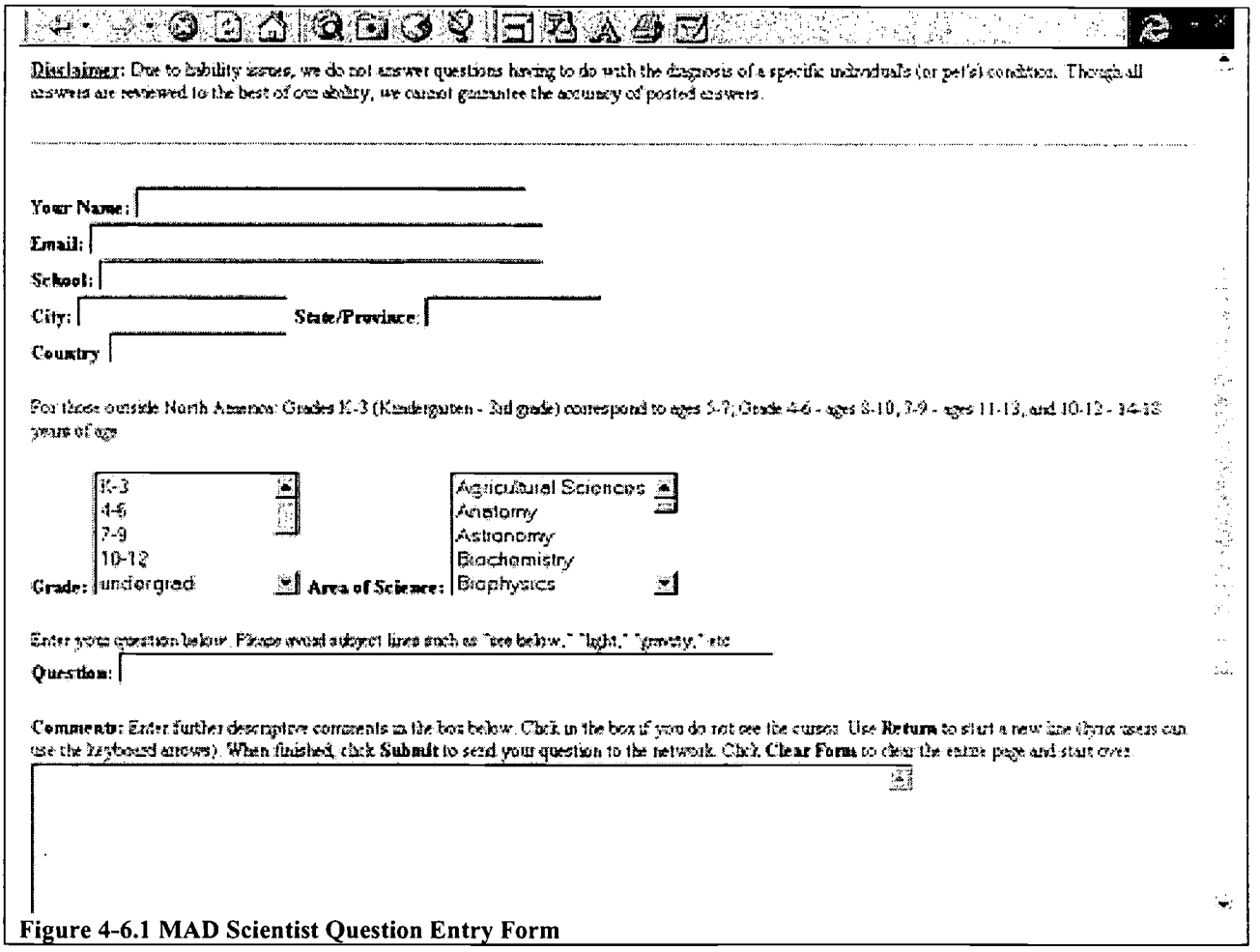


Figure 4-6.1 MAD Scientist Question Entry Form

Once this check is completed, the questions are automatically marked-up in HTML via a PERL script and assigned an ID number. This ID number is a unique identifier for the question and is used by users when inquiring about the status of a question, or a volunteer when creating an answer to a question. Once the question is marked-up and an ID number assigned, a user receives a response via e-mail (if one was entered) with the ID number (that can be used to check on the status of a question via the form seen in Figure 4-6.2).

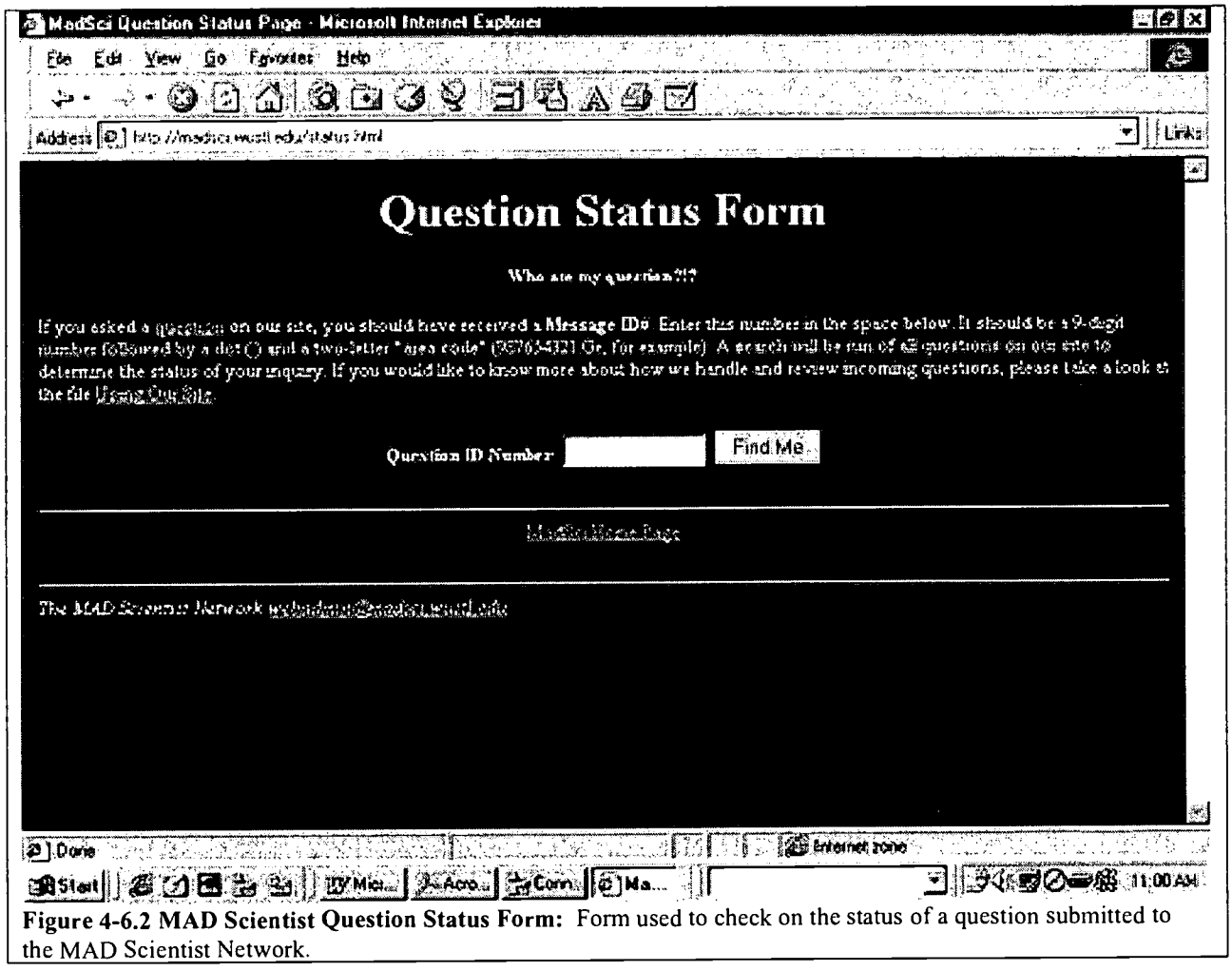


Figure 4-6.2 MAD Scientist Question Status Form: Form used to check on the status of a question submitted to the MAD Scientist Network.

Moderators then review each question in their area (the area a question fits into is based on the user's initial category assignment) that passed the initial automated checks. Moderators are:

> The moderators are people knowledgeable about one or more fields, who screen questions and answers pretty much on a daily basis. They may or may not also answer questions.

These moderators check over questions, answering some of them, and referring others to volunteers:

> Each question is read by the moderator covering that area. About 50% are not sent on to a scientist. Usually this is because the question has already been answered on our site, but there are

> other reasons ranging from "homework question," to medical diagnosis, to the moderator's belief that he can't understand what the question is about and no one else is likely to either. The other half of the questions are passed on to a volunteer scientist.

If the moderator answers the question these answers are sent directly to users. These answers are also archived.

If a moderator decides to send off the question he consults a database of volunteers. Volunteers are:

> The volunteers, currently about 400, are people from all over the world ranging from undergrads to full professors and even a department chief or two. These people receive questions from the moderators via email on an irregular basis—sometimes one every couple of months, other times more like once a week. The volunteers can also look through the overdue questions— questions that were sent to a scientist but not answered for over 20 days.

The database contains information on the volunteers, as well as evaluations of a volunteer's performance:

> We have more extensive info on the people who answer questions such as their degrees, fields of interest, etc . . . For the volunteers, we grade their answers, and also keep track of how many questions they have answered, declined to answer, and ignored altogether. When the number of ignored questions greatly significantly exceeds the numbers in the first two categories, I remove that volunteer.

Once a volunteer is selected the question and its associated ID are sent to the volunteer. These volunteers can then log into the site and enter an answer into a Web form or return the answer via e-mail (see the "E-mail Process" below). Once a hypertext answer is created via the Web form a moderator reviews the answer, assigns a grade, and sends the question out. Question/answer sets are archived in subject categories via a Web searchable archive (see Figure 4-6.3). The user receives an answer via e-mail (if an e-mail address was provided) and the volunteer who answered the question receives an e-mail thank you:

> So for example when a question has been answered and the moderator decides it is satisfactory, he or she does three things with a few clicks: 1) move the answer to where it will be visible on the Web, 2) send an automated thank-you email to the person who answered the question, and 3) send an automated email notification to the person who asked the question that their question has been answered. These emails can also be added to by the moderator.

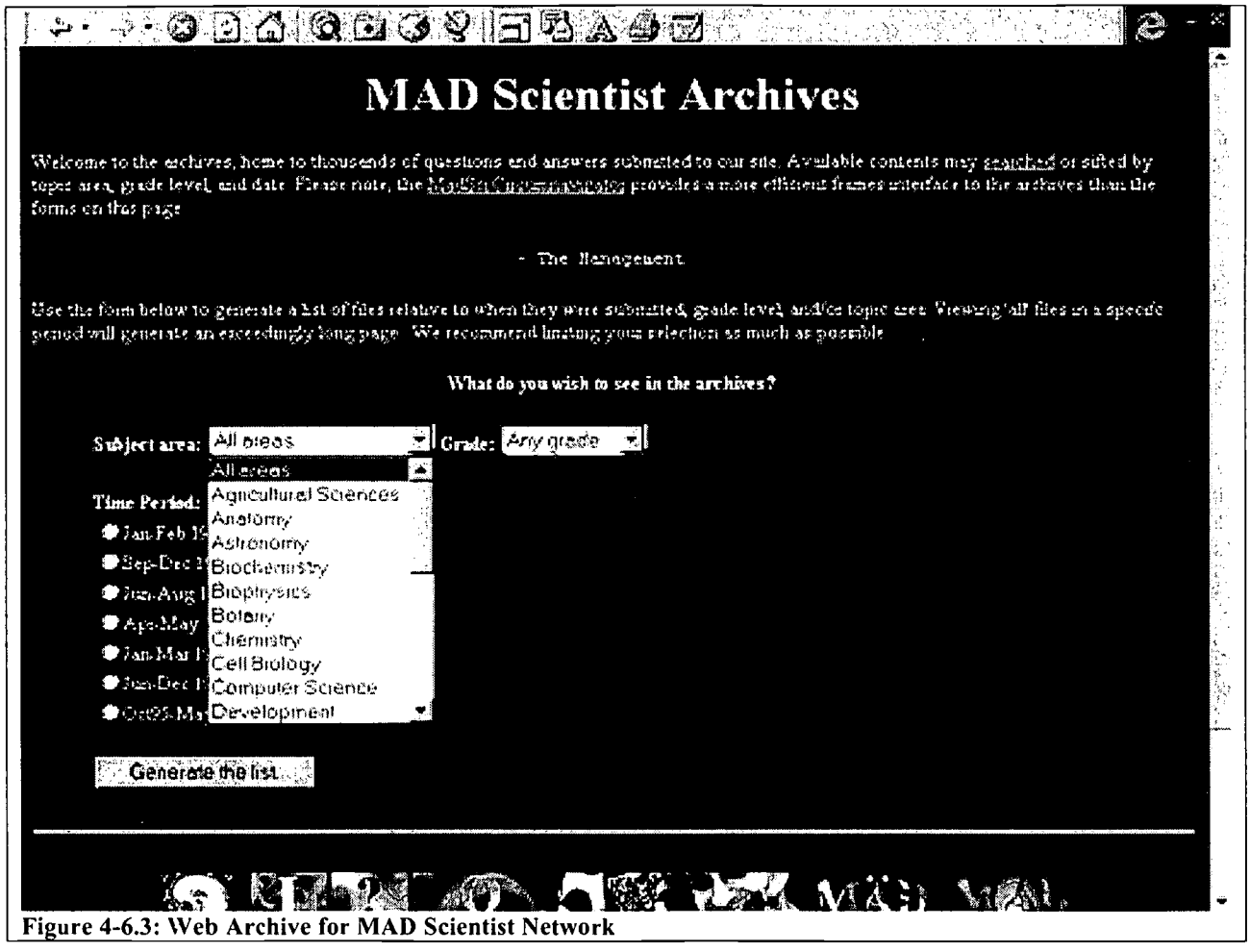


Figure 4-6.3: Web Archive for MAD Scientist Network

E-Mail Process

Questions can also be received and answered via e-mail. Question sent to MAD Scientist are manually entered into the Web form. Answers sent to MAD Scientist by volunteers are manually entered (via cut and paste) into the Web form used to format hypertext answers.

Software Improvement Process

Moderators and volunteers who use the MAD Scientist software (*Moderator*) make suggestions via e-mail and in face-to-face meetings:

> **Simpson>>**I'd say I get emails from at least one moderator every second or third day. We don't meet face-to-face very often, probably 2–3 times a year.
>
> **lankes>>**Do you seek ideas from these folks on running the service?
>
> **Simpson>>**Absolutely . . . we want their jobs to be as user-friendly as possible and to minimize the load on them.
>
> **lankes>>**How do you gather these ideas . . . e-mail, Web forms, more than those two face-to-face meetings? How about gathering ideas from Lynn?
>
> **Simpson>>**Mostly via the face-to-face meetings, but also through email. I don't usually gather ideas from Lynn— if she wants to do something she goes ahead and does it. And sometimes she does things that I suggest ;-)

Lynn Bry takes these suggestions and makes corrections to the *Moderator* software used by MAD Scientist.

"I've long hired reference librarians...and I've found that the best reference librarians are those with broad subject interests and good searching skills."
-Joan Stahl

Service 6: National Museum of American Art Reference Desk

Publisher: National Museum of American Art
Email: jstahl@nmaa.si.edu
Contact: Joan Stahl
HomePage: http://nmaa-ryder.si.edu/referencedesk/
Subject: Arts - Visual arts | Arts - History
Grade: Pre-kindergarten | Kindergarten | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Post Secondary | Adult
Audience: Teachers | Students | Parents
Description: Do you have a question about American Art and don't know how to find the answer? Art information specialists at the National Museum of American Art, using print and electronic resources, will help you get started. Generally, you will receive an e-mail response within 5 working days (depending upon the question); if you have asked a specific question you will get a brief factual answer and if your query was broadly described, you will be directed to sources that will help you with your research.
Answer Policy: Attempts to answer all questions within 5 working days.
Keywords: American Art | Smithsonian | Question and answer services | National Museum of American Art | Digital reference services
Language: English
Relations: A service of the National Museum of American Art (http://www.nmaa.si.edu/)

Record Created: 8/11/1997
Cataloged by: R. David Lankes, Virtual Reference Desk
E-mail: rdlankes@vrd.org
HomePage: http://www.vrd.org

Introduction

Joan Stahl is a busy woman:

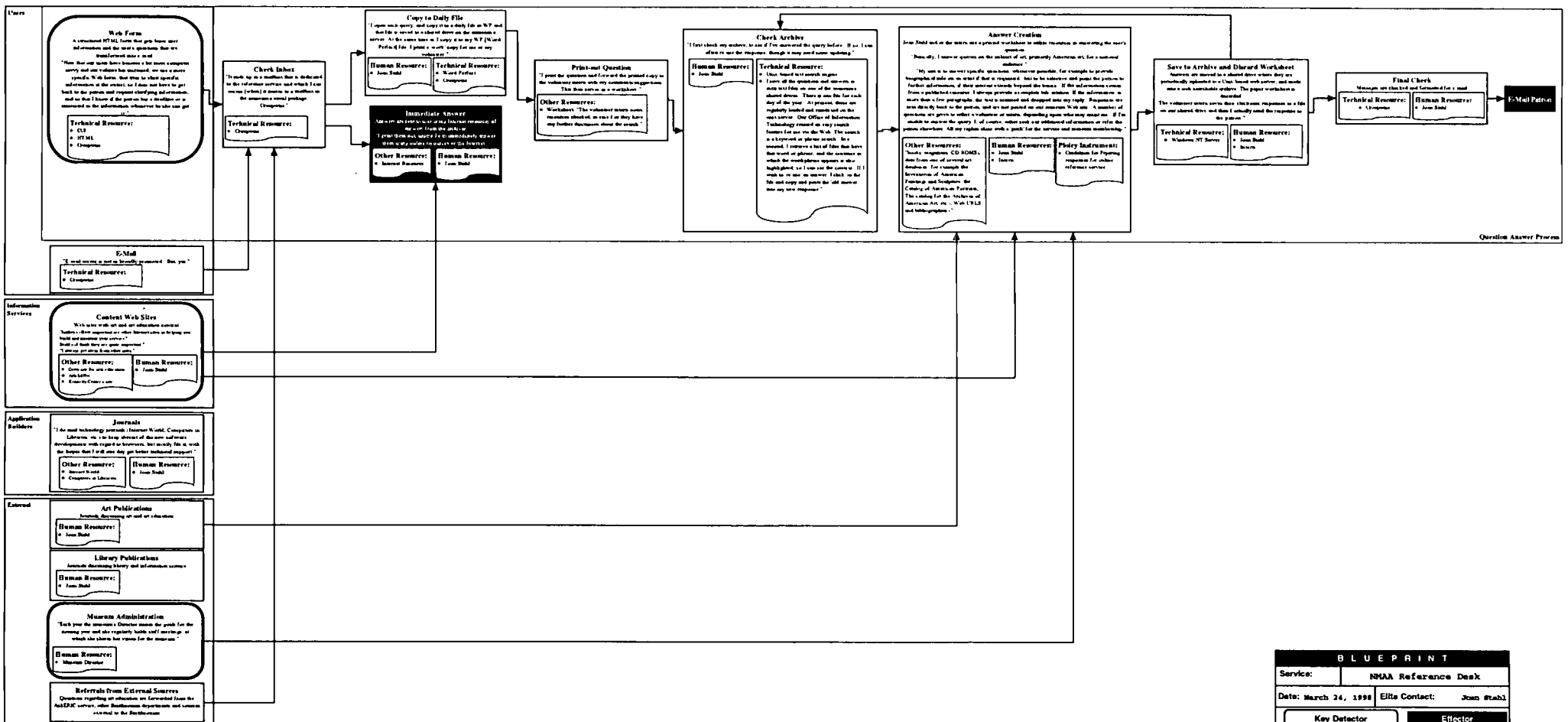
> My job responsibilities include: overseeing a Slide & Photo Archives of approximately 1/2 million images, overseeing the CD-ROM resources for the museum's library, and running the museum's digital art reference service, which I began 4 years ago. I have other responsibilities, but these are the primary ones.

She is also the only elite in this sample with formal library training, "My background is in art and library science and what technical background I have, I have gained on-the-job." As a result, while there is a single process that is overseen by a single person working with a single library intern, that process is well documented and regimented. Compare this blueprint with "How Things Work," where there is no formal documentation or process. This background is also evident in the resources used to answer questions (traditional paper and electronic information resources such as Inventories of American Paintings and Sculpture, the Catalog of American Portraits, and the Catalog for the Archives of American Art).

Stahl continues to try and improve her service, as well as grow it.

> I'd like to see the service become more technically efficient, gain more staff/funding, and better advertise it. It's a constant lobbying effort on my part. That's why my participation in your project is helpful—as well as the conferences at which I speak (Computers in Libraries is upcoming), the articles that I write—all help to make the service more visible and draw further support from the museum administration. Most immediately—I think in the next few months—the museum will have their newly re-designed Web site that gives much greater visibility to the digital reference service, At the same time, we have a better location/link on AOL that also gives better visibility. And I will continue to do the best I can to provide accurate and timely information in a friendly manner.

Stahl's service, in its documentation, worksheets, and use of traditional resources, demonstrates her strong library background and commitment to service.



BLUEPRINT

Service:	NMAA Reference Desk
Date: March 24, 1998	Elite Contact: Joan Stahl
Key Detector	Effector

Detectors

Detectors are the organization's mechanisms for acquiring information on the environment. These mechanisms may actually be a combination of several resources. Some detectors were deemed more important than others in making building and maintaining decisions. These are called "key detectors" and are highlighted in Table 4-7.1.

Table 4-7.1: Detectors Used by the National Museum of American Art Reference Desk (key detectors are highlighted)

Agent Type	Detector	Purpose
User	Web Form	To take in user question
	E-mail	Questions sent directly to Stahl's personal e-mail account
Information Services	Content Web Sites	Information from art and art education Web sites.
Application Builders	Journals	Information from reading about new software options and features
External	Art Publications	Information from reading the art literature
	Library Publications	Ideas and information from literature in the library and information science field
	Museum Administration	Briefings and information from the museum administration on exhibits and art trends
	Referrals from External Sources	Questions from other Smithsonian units and external sources like the AskERIC service

Effectors

Effectors are the output of the service. The National Museum of American Art Reference Desk has two effectors.

Table 4-7.2: Effectors of the National Museum of American Art Reference Desk

Effector	Description
Immediate Answer	An e-mail response sent to a user
E-mail Patron	An e-mail response sent to a user that may include bibliographic citations, full-text information resource excerpts, and Internet sources

Rules

Rules represent the abstract flow and transformation of information within an organization. Table 4-7.3 represents the primary information process in regards to the digital reference activities for the National Museum of American Art Reference Desk (see the Blueprint narrative for more information on these processes).

Table 4-7.3: National Museum of American Art Reference Desk Rule Processes

Process Name	Description
Question Answer Process	The process whereby an incoming question is answered and tracked

Resources

Resources are the means of implementing rules. They are the form the abstract rules take when implemented. Table 4-7.4 lists the resources used in the National Museum of American Art Reference Desk question answering process.

Table 4-7.4: Resources used by the National Museum of American Art Reference Desk

Resource Type	Resource	Description
Human	Intern/volunteer	"My volunteers/interns all are graduate students in library science programs with an interest in the arts, and a strong liberal art background. I've long hired reference librarians (I used to head the fine arts and recreation depart in Baltimore's Enoch Pratt Free Library) and I've found that the best reference librarians are those with broad subject interests and good searching skills. I have, for example, found that the museum's interns in graduate art programs are not good assistants with the service, because their knowledge/interests are too focused."
	Joan Stahl	Professional Librarian with "20+ years as an arts librarian." She also worked in a public library setting.
	Museum Director	Head of the National Museum of American Art
Other	Internet resources	Other Internet services including Getty site for arts education, ArtsEdNet and Kennedy Center's site.
	Journals	Technical journals as well as art and library literature
	Traditional art reference sources	"books, magazines, CD-ROMS, data from one of several art databases (for example the Inventories of American Paintings and Sculpture, the Catalog of American Portraits, the Catalog for the Archives of American Art, etc.)."
	Work sheet	A paper form used to keep track of a user's question and the process used to answer that question
Policy	Guidelines for preparing responses for online reference service	Policy document that aids interns/volunteers in composing answers (see Figure 4-7.1)

Technical	CGI and HTML	A Common Gateway Interface (CGI) script that takes information from an HTML form and creates a Groupwise e-mail message
	GroupWise	"GroupWise 5.2 is platform independent, supporting Windows 3.x, Windows 95 and Windows NT clients, Macintosh, PowerMac, and UNIX clients. In addition, GroupWise also supports industry-standard communication protocols such as NetBEUI, NetBIOS, SMTP, TCP/IP, x.400 and POP3. GroupWise 5.2 is a fifth-generation client/server messaging solution that shares the networking heritage and expertise of the networking leader, Novell." http://www.novell.com/groupwise/html/gw5.2.html
	Unix-based text search engine	A Web-based flat-file database that allows Stahl to use keywords to search for existing answers
	Windows NT server	Microsoft 32 bit server operating system
	Word Perfect	Word processing software

Blueprint Narrative

The National Museum of American Art has a single process. The "Question Answer Process" takes a question and uses a variety of resources to answer it.

Question Answer Process

A question is received from a Web form which is transferred to a Groupwise[36] e-mail account (questions are also received from "External" services and sometimes in her personal e-mail account). Stahl regularly checks this e-mail inbox and determines what to do with the questions there. If she can immediately answer a question with an Internet resource or archived answer, she does so and responds to the user via e-mail. If she cannot answer the question with a known resource she copies the question to a daily file.

Questions are printed in the form of a worksheet. This worksheet documents ideas for answering questions, the resources used in answering a question and the question itself. The first place checked for an answer is an archive of existing questions and answers. This is a Web-accessible keyword database. If an answer does not exist in the archive, or if an answer needs to be updated Stahl or her intern utilize the larger resources available at the Smithsonian's Museum of American Art:

> My aim is to answer specific questions, whenever possible for example to provide biographical info on an artist if that is requested—but to be selective and point the person to further information, if their interest extends beyond the basics. If the information comes from a published resource, I always provide a complete bib. citation. If the information is more than a few paragraphs, the text is scanned and dropped into my reply. Responses are sent directly back to the patron, and are not posted on our museum Web site. A number of questions are given to either a volunteer or intern, depending upon who may assist me. If I'm unable to answer the query, I, of course, either seek out additional information or refer the patron elsewhere. All my replies close with a 'pitch' for the service and museum membership.

[36] Groupwise is a groupware software package that handles e-mail.

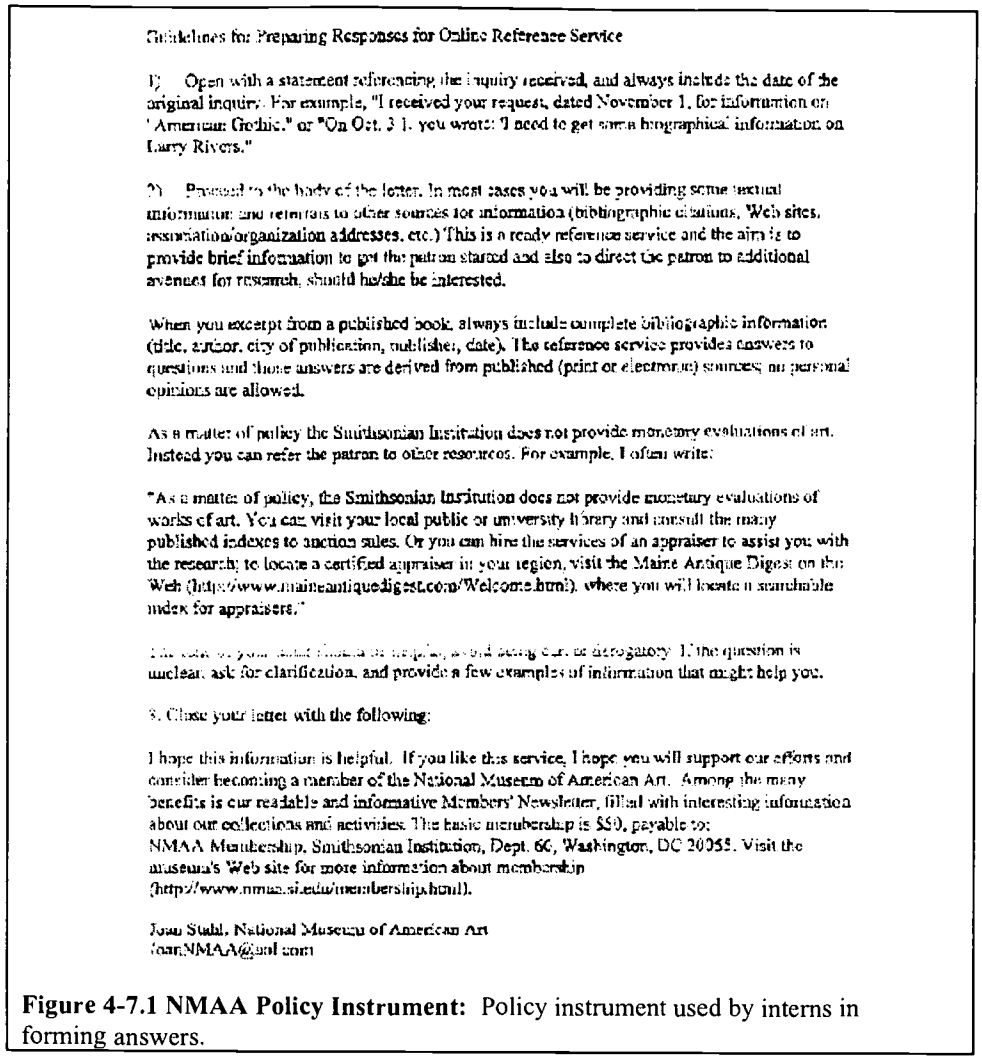
The answer is formulated either by Stahl, who has more than 20 years as an arts librarian, or an intern:

> My volunteers/interns all are graduate students in library science programs with an interest in the arts, and a strong liberal art background. I've long hired reference librarians (I used to head the fine arts and recreation depart in Baltimore's Enoch Pratt Free Library) and I've found that the best reference librarians are those with broad subject interests and good searching skills. I have, for example, found that the museum's interns in graduate art programs are not good assistants with the service, because their knowledge/interests are too focused.

Stahl has created a set of guidelines to aid in the creation of answers (see Figure 4-7.1). She also provides volunteers with some initial training:

> I give them an extensive orientation to arts resources (not often covered in library school programs). Additionally, I suggest resources for checking when I route queries and we discuss queries that stump them.

The library administration also provides information on current museum exhibits that may be used in the answering process.



Guidelines for Preparing Responses for Online Reference Service

1) Open with a statement referencing the inquiry received, and always include the date of the original inquiry. For example, "I received your request, dated November 1, for information on 'American Gothic," or "On Oct. 3 1, you wrote: 'I need to get some biographical information on Larry Rivers."

2) Proceed to the body of the letter. In most cases you will be providing some textual information and referrals to other sources for information (bibliographic citations, Web sites, association/organization addresses, etc.) This is a ready reference service and the aim is to provide brief information to get the patron started and also to direct the patron to additional avenues for research, should he/she be interested.

When you excerpt from a published book, always include complete bibliographic information (title, author, city of publication, publisher, date). The reference service provides answers to questions and those answers are derived from published (print or electronic) sources; no personal opinions are allowed.

As a matter of policy the Smithsonian Institution does not provide monetary evaluations of art. Instead you can refer the patron to other resources. For example, I often write:

"As a matter of policy, the Smithsonian Institution does not provide monetary evaluations of works of art. You can visit your local public or university library and consult the many published indexes to auction sales. Or you can hire the services of an appraiser to assist you with the research; to locate a certified appraiser in your region, visit the Maine Antique Digest on the Web (http://www.maineantiquedigest.com/Welcome.html), where you will locate a searchable index for appraisers."

[illegible] inquiry is not helpful, avoid being curt or derogatory. If the question is unclear, ask for clarification, and provide a few examples of information that might help you.

3. Close your letter with the following:

I hope this information is helpful. If you like this service, I hope you will support our efforts and consider becoming a member of the National Museum of American Art. Among the many benefits is our readable and informative Members' Newsletter, filled with interesting information about our collections and activities. The basic membership is $50, payable to: NMAA Membership, Smithsonian Institution, Dept. 6C, Washington, DC 20055. Visit the museum's Web site for more information about membership (http://www.nmaa.si.edu/membership.html).

Joan Stahl, National Museum of American Art
JoanNMAA@aol.com

Figure 4-7.1 NMAA Policy Instrument: Policy instrument used by interns in forming answers.

Once an answer is created (which may be an existing archive answer, a revised archive answer, or a new answer), it is saved to a shared drive and the paper worksheet is discarded. On a regular schedule, the answers are saved to this shared drive, uploaded to the Unix server, and entered into the archive. Stahl performs a final check on the answers and they are sent to the user who asked the question.

Towards a Meta-Description

The preceding service descriptions and blueprints presented empirical descriptions of the six exemplary services selected for this study. The third objective of this study was to look across these descriptions to find commonalties. This search provided the basis of a meta-description of K–12 digital reference services.

As stated in Chapter 2, the conceptual framework will be utilized in comparing services. The conceptual framework provided for an agent's (a K–12 digital reference service's) performance system. This system is composed of detectors, rules, and effectors. The following tables compare detectors, resources, and effectors across services. These sections also answer the specific research questions:
Table 4-8 lists the abbreviations used in the following cross-service comparisons.

1. What are exemplary K–12 digital reference services' detectors (i.e. inputs) for Internet agent types, internal inputs, and influences external to both the Internet and the organization?
2. What are exemplary K–12 digital reference services' rules for processing the input from detectors and, through resources, building and maintaining effectors (i.e. services)?
3. What are exemplary K–12 digital reference services' effectors (i.e. outputs) used to meet users' information needs?

Table 4-8: Service Name Abbreviations

Service Name	Short Name for Tables
Ask A Volcanologist	Volcano
Ask Shamu	Shamu
Dr. Math	Math
How Things Work	Work
MAD Scientist Network	MAD
National Museum of American Art	Art

Looking Across Detectors

Table 4-9 lists the different detectors used by the exemplary digital reference services. Detectors are the mechanisms used by the six exemplary K–12 digital reference services to gather information from their environment.

Table 4-9: Aggregation of Detectors

Type	Detector	Volcano	Shamu	Math	Work	MAD	Art	Sum
User	Web Form	■		■	■	■	■	5
	Web Logs	■	■	■	■	■		5
	Other[37]	■	■	■				3
	Feedback	■		■	■	■		4
	E-mail Questions		■	■	■	■	■	5
Information Services	Web Surfing	■	■	■	■	■	■	6
Application Builders	Web Surfing	■	■	■		■		4
	Journals	■	■		■		■	4
	Vendor Solicitation	■						1
	Television		■					1
	Listservs			■				1
	Formal Training		■					1
	Newsgroups			■				1
Infrastructure Providers	Personal Research		■					1
Internal	Information Sharing	■		■				2
	Focus Groups			■				1
	Meetings			■		■		2
External	Funders	■		■				2
	Field of Experts	■					■	2
	Content Developers		■					1
	Postal Questions		■					1
	Commercial Site		■					1
	Parent Organization	■	■	■	■	■	■	6
Sum	23	12	13	14	7	8	6	

The summations in the rows and columns are not meant to represent quantitative conclusions or assertions, but rather aid the reader in detecting patterns. The researcher notes the density of agreement among services in user and information service detectors. This may indicate a limited number of methods for gathering user information on the Internet. It also indicates an evolution away from older Internet technologies such as telnet, FTP, and Gopher. None of these services have a gopher site for example.

When looking across information service detectors "Web Surfing" is an obvious commonality on the surface. However, looking deeper into the data, services such as MAD Scientist and Ask A Volcanologist use other information services to gain ideas about software, organization and interfaces. Other services such as the National Museum of American Art Reference Desk and Ask Shamu use the Web to find content to supplement their personal knowledge in question answering. So while Web surfing is a common detector, the underlying information gathered is different.

Services demonstrated the importance of seeking information on application builders not for content, but software development. Four of the six services used the Web to find information on software capabilities. The other finding of note is the extensive use of non-Internet sources for learning about Internet application builders. Four of the six services stressed journals and magazines as important sources of information. Dronen, of Ask A Volcanologist, indicates this in the following response:

[37] Other detectors mentioned were contests and focus groups.

> **Iankes>>**Aside from looking at other Internet sites, are there other mechanisms or mediums you use to determine trends or new capabilities in Internet applications?
>
> **Dronen>>**Yes. Probably the next largest mechanism is reading. We receive many magazines which are devoted to the Internet and its development. These generally give us a good idea of what others are doing, and what others find successful and useful.

Another interesting result in looking across the services relates to infrastructure detectors. When considering information technology support from the parent organization as external detector types there are no true infrastructure detectors in these services. The one exception is Pamala Wilson's "personal research" in the Ask Shamu service. It seems that all but one service feels comfortable building and maintaining their services without consideration for infrastructure.

The internal detectors are not very useful mechanism for comparing commonalties. Three of the six services (Ask Shamu, How Things Work, and the National Museum of American Art Reference Desk) have no internal detectors because they run themselves as single-person operations. However, even when factoring these services out, there are few commonalties among the remaining services in terms of internal detectors.

Lastly, the role of the parent organization becomes obvious when looking at external detectors. This role is varied in that it tends to include technology support as well as financial and content support. However, it is equally striking that all of these services have parent organizations. None of the services claims to "stand on its own" as a commercial or non-profit organization. Four of the services are located at universities, one at a corporation (Ask Shamu is part of Sea World Florida) and one at a government institution (The National Museum of American Art is part of the Smithsonian).

Looking Across Effectors

The range of effectors used by the six exemplary services is limited. As will be expanded in Chapter 5, the services studied in this research were selected according to their effectors, therefore reducing variance. One trend becomes obvious, however; e-mail remains the common currency of the Internet. All services, no matter how Web-based, sent results when possible via electronic mail. Even if questions were not accepted via e-mail (as in the case of Ask A Volcanologist) answers were still sent out via e-mail.

If you consider "Answers Posted to Web Archives" and "Web Resources Created" collapsible categories[38] then almost all services also had the creation of Web resources related with their question answering service. The only exception is the National Museum of American Art that has a very limited Web presence, but does at least have links to other Web sites of interest. Figure 4-10 compares effectors across services.

[38] These categories were not collapsed. Archive creation is the end result of the question answer process while "Web Resource Created" represents other Web development not directly tied to an answer generation process.

Table 4-10: Aggregation of Effectors

Effector	Volcano	Shamu	Math	Work	MAD	Art
Answer E-Mailed to User						
Answer Posted to Web Archive						
Web Resource Created						
Non-Internet Effector						
Automated Response						

Looking Across Resources

Table 4-11 summarizes the resources used by the six exemplary services. Some resources were added to this table after the creation of the final blueprints. This was done by going back to the original data and finding an empirical basis for their use. Since the descriptions were created separately there was no attempt to normalize the terms and resources listed in the blueprints. So while e-mail was not listed as a resource in the How Things Work service, for example, it was obviously in use from such effectors as "Answers Sent Directly to User."

Table 4-11: Aggregation of Resources

Service	Technical	Human	Policy	Other
Volcano	PERL Scripting Apache Server E-mail Forms Conference Calls	NASA Scientist Other Volcanologists Principal Investigator Programmers Elite Volcanologists		Journals
Shamu	Microsoft Exchange WindowsNT	Animal Curators Corporate Public Relations Elite Public Relations Science Writers Sea World/Busch Gardens Employees Director Commercial Site	Issue-Based Policy	Internet Service Provider, Journals
Math	Apache DEC Alpha Server PERL Doctor's Office Software Web Form E-mail	Archivist & Proofreader Front-end screener Elite Steve Weimar Tenured Doctors Untenured Doctors	Guide to Writing Dr. Math Answers	Newsgroups, Listservs
Work	Answer Database Apache Server Incoming Database PERL RS6000 E-mail	Elite Visitors Parent Organization		Journals
MAD	PERL CGI Apache Volunteer Database Netscape Eudora	Moderators Volunteers Young Scientist Program Coordinator Lynn Bry Elite Parent Organization	Guidelines for moderating	Journals

Service	Technical	Human	Policy	Other
Art	CGI HTML GroupWise UNIX-based text search Windows NT Word Perfect	Intern/Volunteer Elite Museum Director	Guidelines for Preparing Responses for Online Reference Services	Internet resources, Journals, Traditional art reference resources, Worksheet
Common	Web Server [Apache, Windows NT] E-mail [Exchange, Eudora, GroupWise]	Funder or Parent Organization Elite		Software-related publications [either electronic or print]

There was little agreement in resources used by the exemplary services. Some services relied heavily on policy instruments, while others had none. The difference was not based on size. The National Museum of American Art Reference Desk, for example, had established guidelines for creating answers in a service with one employee and an intern/volunteer. In contrast, Ask A Volcanologist, with a staff of four different volcanologists and two to three programmers, had no guidelines.

The only commonalties that could be found in technical resources were the use of Web servers (either Apache on Unix or WindowsNT) and electronic mail.

The lack of commonality in human resources is more interesting than the similarities among those resources that were shared. All services (as was previously mentioned) have some link to a parent organization (either for technical support, policy support, or content support), and obviously each service has an elite that was interviewed for this study. However, each elite is different. The elite backgrounds varied from a librarian (National Museum of American Art Reference Desk) to an English major (Ask Shamu) to a M.D./Ph.D. student (MAD Scientist Network). Their technical and educational backgrounds, their titles, and their roles all varied. Some services used 400 volunteers to answer 25 questions a day (MAD Scientist) while some used only one staff member to answer 60 questions a day (Ask Shamu).

The "Other" category also demonstrated the need to incorporate non-Internet related information sources into the conceptual framework. Journals and traditional reference resources played a major role in the building and maintenance of these services.

Looking Across Rules

Looking across rules is more difficult than looking across detectors or effectors. Table 4-12 looks across major processes. As would be expected, all services shared a "Question Answer" process (once again because that was part of the selection process). Web development was also shared by several services.

Table 4-12: Major Processes across Services

Process	Volcano	Shamu	Math	Work	MAD	Art
Question Answer						
Web Development						
Policy Development						
Training						
Software Improvement						

Attempting to add specificity, each service has some rule (or sets of rules) to take a question from a user and get that question to a single person for an answer. In all cases the person creating an answer had some expertise related to the question. All service had rules for sending respondents answers and all of these rules involved electronic mail. All services had some mechanism for tracking or archiving the answers, though in the case of Ask Shamu this process was very informal.

Meta-Description

The commonalties mentioned in the previous sections (Specifically the discussion "Looking Across Rules") form the foundation for the meta-description. Figure 4-8 represents the meta-description of K–12 digital reference services.

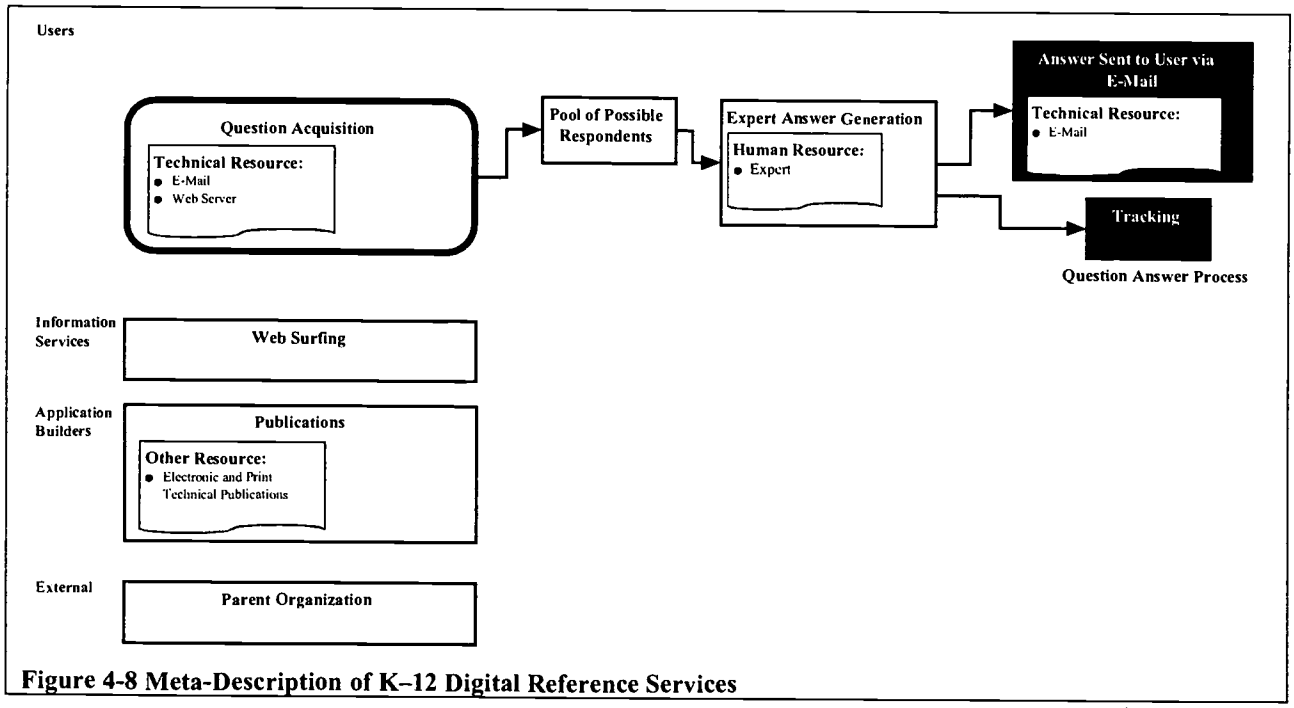


Figure 4-8 Meta-Description of K–12 Digital Reference Services

This simple process covers the range of possible activities related to question/answering processes; this does not represent Web development activities, as they were not common across the exemplary services. It also incorporates common resources and detectors from the exemplary services. Table 4-13 defines the steps in the "Question Answer Process" of the meta-description.

Table 4-13: Components of the Meta-Description Question Answer Process

Step	Description
Question Acquisition	An e-mail address or Web form is used to allow a user to enter a question. This may require the user to determine a topic for the question. Some automated pre-processing may occur to put the question in HTML or assign some sort of tracking identification.
Pool of Possible Respondents	A message is queued and prepared for expert response. In services with multiple experts available, some triage process occurs (for example in Ask A Volcanologist a PERL script simply sends questions to experts based on the days of the week, while MAD Scientist Network uses moderators to select experts). In single person operations, messages are simply queued for the single expert.
Expert Answer is Generated	An expert generates an answer. In some services this is done in accordance with a policy document. In some services these answers come from Internet resources, and in all cases the expert has personal knowledge of the topic.
Answer Sent to User via E-mail	Once an answer is generated, it is sent to the user via e-mail (if possible).
Tracking	Trends and subjects from questions are tracked and used. In some cases the trends are used in Web development. Tracking can consist of Web-based archives, private archives, or simply informal information.

Simply put, a question is received through the Web or e-mail. A process determines the best expert to answer the question. In the case of How Things Work, the only choice is Lou Bloomfield. In Ask Shamu it is either Pamala Wilson or another expert at Sea World/Busch Gardens. Once an appropriate expert has been identified, that expert formulates an answer. The answer is sent to the user via e-mail. After an answer has been created, a tracking process occurs. In the case of services such as Ask A Volcanologist, Dr. Math, How Things Work, or MAD Scientist, this involves the creation of a public Web-searchable archive. The National Museum of American Art Reference Desk uses a private archive. In Ask Shamu, a more informal tracking process is used to inform the creation of Web resources. Table 4-14 links steps in the blueprints to this meta-description. This table grounds the meta-description to the empirical data of the exemplary services.

Table 4-14: Rules From Descriptions as They Relate to the Meta-Description

Service	Question Acquisition	Pool of Possible Respondents	Expert Answer Generation	Answer Sent to User via E-Mail	Tracking
Volcano	Web Form	Question Automatically Distributed via E-mail P.I. Review	Answer Formulation	Answer Sent to User	Answer Posted to Web Archives
Shamu	E-mail Questions	Evaluate Question	Forward to Expert Answer Formulation	Answer Sent to User	Web Authoring
Math	Web Form E-mail	Triage Area Screening	Answer Formulation	Answer Sent to User	Post-Op Area Question Selected for Archives Editing for Archives Catalog Archive Entries
Work	Question from Web Question from E-mail	Question Queued in Incoming Database	Answer Formulation	Answer Sent Directly to User	Question/Answer Set Moved to Answer Database Web Site and Indexes are Generated to HTML Files Answers Improved or Corrected
MAD	Web Form E-mail Question Questions are Checked Convert to HTML Documents Questions Marked-up in HTML and Assigned ID Number User Gets Initial Response	Moderator Review Search for Volunteer	Question Sent to Volunteer Scientist via E-mail Volunteer Returns Answer via E-mail Volunteer Logs into Site with ID Number Create Hypertext Answer via Form	Moderator Review Moderator Evaluations are Added to Volunteer Database Answers Posted to Web site	Moderator Answer Sent to User User Receives Answer
Art	Web Form E-mail Check Inbox	Copy to Daily File Print-Out Question	Check archives Answer Creation	Save to Archive and Discard Worksheet Final Check	E-mail Patron

The meta-description does highlight an interesting finding of the study: these services appear to treat users simply as questions. The meta-description is articulated at the question level. There is little attempt to treat the user's information need beyond a single interaction. This is particularly interesting in relation to librarianship's notion of the reference interview and question negotiation. The implication of this finding is further discussed in Chapter 5's conclusions related to the meta-description.

Chapter Summary

This chapter presented two types of results. The first type, in the form of six service descriptions, is the results of applying the conceptual framework to a single service. The second type of results, in the form of the meta-description, looked across these descriptions towards commonalties and dissimilarities. The service descriptions and associated blueprints can stand on their own as case studies. The meta-description demonstrates the common elements of the service descriptions and blueprints.

Aside from these two types of results, there were a series of findings that emerged in both creating the service descriptions and the meta-description. Table 4-15 outlines findings beyond the service description and meta-description.

Table 4-15: Other Findings

Finding	Description
The Conceptual Framework was successful	The conceptual framework constructed in Chapter 2 was essential in creating service descriptions. It allowed the analysis of data and increased the ability of the researcher to transfer the results of the study. The elites quickly understood the conceptual framework (discussed during the follow-up interviews) and saw its utility.
The methodology was successful	The methodology outlined in Chapter 3, including the use of the Internet to gather and transmit data successfully elicited detectors, rules, resources, and effectors from elites.
User detector types were limited in number and shared among most services	While resources and rules varied widely among services, and effectors were limited by sample, user detectors where limited and shared by many services. While there is unanimity on only question acquisition (once again due to sample selection), nearly every service used Web logs and feedback forms to some extent. There was much less commonality in other detector types.
E-mail is still an essential Internet tool	Unlike the AskERIC pre-test, all services either abandoned or ignored older Internet applications such as Gopher, FTP, telnet. However, even with the growth and universal adoption of the World Wide Web, all services incorporated electronic mail. All services sent out answers via e-mail and most accepted e-mail questions.
Services treated users as questions	The meta-description and the blueprints in general were predominately linear and tended to treat users simply as questions with little regard for the potential iterative nature of reference inquiries.
Services operated with little concern for infrastructure issues	With the exception of Ask Shamu, no services had infrastructure detectors. Even Ask Shamu did not use information from infrastructure detectors to build or maintain Internet hardware on a daily basis. All services left infrastructure maintenance to their parent organizations.
Elites had varied backgrounds	While this study labeled these services as "digital reference," there was little formal training in library style reference present in the pool of elites. In fact, only Joan Stahl of the National Museum of American Art Reference Desk had a library background. Knowledge of Internet applications or content area appeared to be more important than knowledge of reference and information seeking.
Services depended on human expertise not automation	In all cases, once a human asked a question, a human expert answered that question. While in some cases archives of previous question/answer sets were used, these archives were searched by human experts. There was no pre-processing of questions that involved automation. The only pre-processing of questions either blindly distributed them (Ask A Volcanologist), or checked their origin and assigning an ID (MAD Scientist and Dr. Math).

Conclusions, implications, and limitations of the service descriptions, the meta-description, and the other findings will be discussed further in Chapter 5.

Chapter 5: Conclusions, Limitations, and Future Research

One aspect of K–12 digital reference services that is not immediately apparent from the results of the study is the burden on these services to create software.

Introduction

The preceding chapters presented the problem under investigation, a conceptual framework for examining this problem, a methodology for empirically describing how Internet information service organizations build and maintain their services, and finally the results of that methodology. This chapter draws conclusions from the results, discusses limitations of the results, explores benefits of the current research, proposes areas for future studies, and offers a specific application of the research that could have a major impact on K–12 digital reference services and beyond.

Conclusions

This study's purpose was to investigate the building and maintaining of Internet information services using exemplary K–12 digital reference services. Three objectives were stated in regards to this purpose: (1) to build and apply a conceptual framework based on complexity research, literature, and the researcher's experience; (2) to use this conceptual framework to empirically describe how organizations, specifically K–12 digital reference services, build and maintain services in the dynamic Internet environment; and (3) to seek commonalties across these descriptions. Three research questions were posed in order to meet these objectives:

1. What are exemplary K–12 digital reference services' detectors (i.e. inputs) for Internet agent types, internal inputs and influences external to both the Internet and the organization?
2. What are exemplary K–12 digital reference services' rules for processing the input from detectors and, through resources, build and maintain effectors (i.e. services)?
3. What are exemplary K–12 digital reference services' effectors (i.e. outputs) used to meet users' information needs?

These research questions take on a different meaning in the light of each objective. For example, in light of the first objective (building a conceptual framework) the questions can be restated as: "what are detectors, rules, and effectors?" Whereas in the context of the second objective (description building) the questions can be restated as: "what are the detectors, rules, and effectors of service X?" Lastly, in the context of the third, meta-description objective, the questions become broad: "what are the detectors, rules, and effectors of K–12 digital reference services in general?" Figure 5-1 represents this contextual difference where the context for objective 1 is semantic (dealing with meaning), the context for objective 2 is descriptive, and the context for objective 3 is analytic (analyzing commonalties across descriptions).

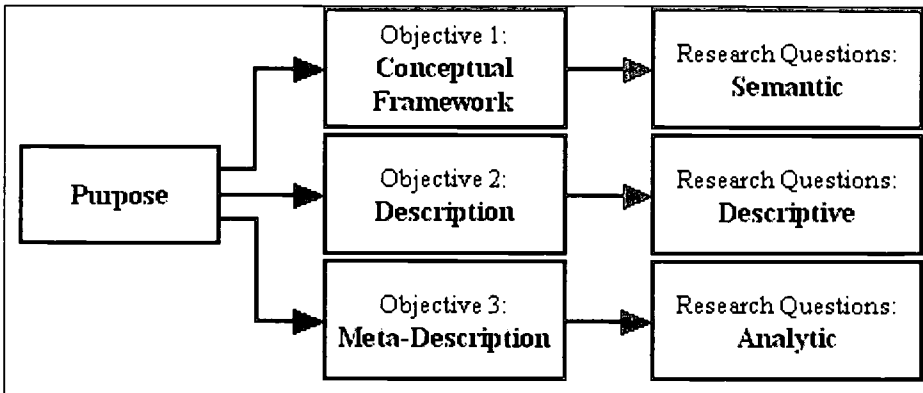


Figure 5-1 Context of Research Questions to Objectives: The interpretation of the research questions is dependent upon the objective being discussed.

The research questions within the context of each objective form the basis for the chapter's conclusions. The research questions are addressed in each context exploring implications and application of the study and its results.

Conclusion 1: Conceptual Framework

The research questions in light of the first objective (building a conceptual framework) are semantic in nature. That is they seek definition and meaning. What are detectors, rules, and effectors? These definitions came in large part from the literature, particularly Holland's performance system (1995) as discussed in Chapter 2. The broad definitions provided as part of Holland's performance system along with the specificity in Internet agent types added by the Lankes/Eisenberg Architecture, were quite successful in eliciting the structure of the exemplary K–12 digital reference services studied. The conceptual framework was sufficient and effective in building empirical descriptions of a "messy" Internet information service. There was agreement between the generated descriptions and the elites' views of their services.

The conceptual framework and resulting descriptions are, however, skewed. There is a great deal of information and specificity in detectors, with little diversity in effectors. This is due, in large part, to the fact that the selection of sites was based on very limited effector sets (question answering services). By choosing K–12 digital reference as the starting point of a larger investigation of Internet information services, an effector (e.g., reference service) became a delimiter of the sample. Had another means of sampling been used, say random sampling, effectors might have been more varied.

In addition the "un-tuned" conceptual framework is more precise in detectors than in rules. This is due to the black box effect discussed by Still and Campbell (1993) in Chapter 2. Detector types were knowable and predicted by the literature before data was gathered. This foreknowledge lead to more precision in interviewing and analysis. In the interviewing process respondents were asked to walk through each detector type, whereas they were simply asked to describe their rule processes with little structure or guidance.

This apparent skew has implications for the use of complexity research in the Internet. Holland's performance system captures generalities of an Internet information system, but it is a blunt instrument. While the generic performance system still provides more interpretive power than General Systems Theory (particularly in the addition of resources in a performance system),

it is insufficient to capture the complexity of an Internet information service. Internet agent types are important, and provide additional analytic power.

Revised Conceptual Framework

Since the conceptual framework has yet to be tested on Internet information services other than K–12 digital reference services it would be difficult to revise the framework substantially without potentially biasing it towards a single type of Internet information service. Further, the conceptual framework was successful in eliciting descriptions for this study so the general conceptual framework functions well with no revision. However, the conceptual framework can be "tuned" for K–12 digital reference services. These refinements drawn for the meta-description (discussed in Chapter 4 and below) are the following:

- "External Detectors" can be refined from the results into external detectors and "Parent Organization" detectors
- "Information Resources" can be added as a resource type
- "Web Surfing" can be assumed as a specific detector for "Information Services"
- "Question Answering Process" is an assumed process in all services that involves:
  - Question Acquisition
  - Pool of Possible Respondents
  - Expert Answer Generation
  - Answer Sent to User via E-mail
  - Tracking
- Inclusion of "E-mail" and "Web server" as technology resources
- Inclusion of "Publications" as a specific detector type for Application Builders.

This "tuned" conceptual framework (see Figure 5-2) adds a level of precision concerning K–12 digital reference services. Also, this tuned framework could be further refined by specific study of K–12 digital reference service's Web development process. A meta-description of Web development in these services could be fit into the rules and meta-description discussed below.

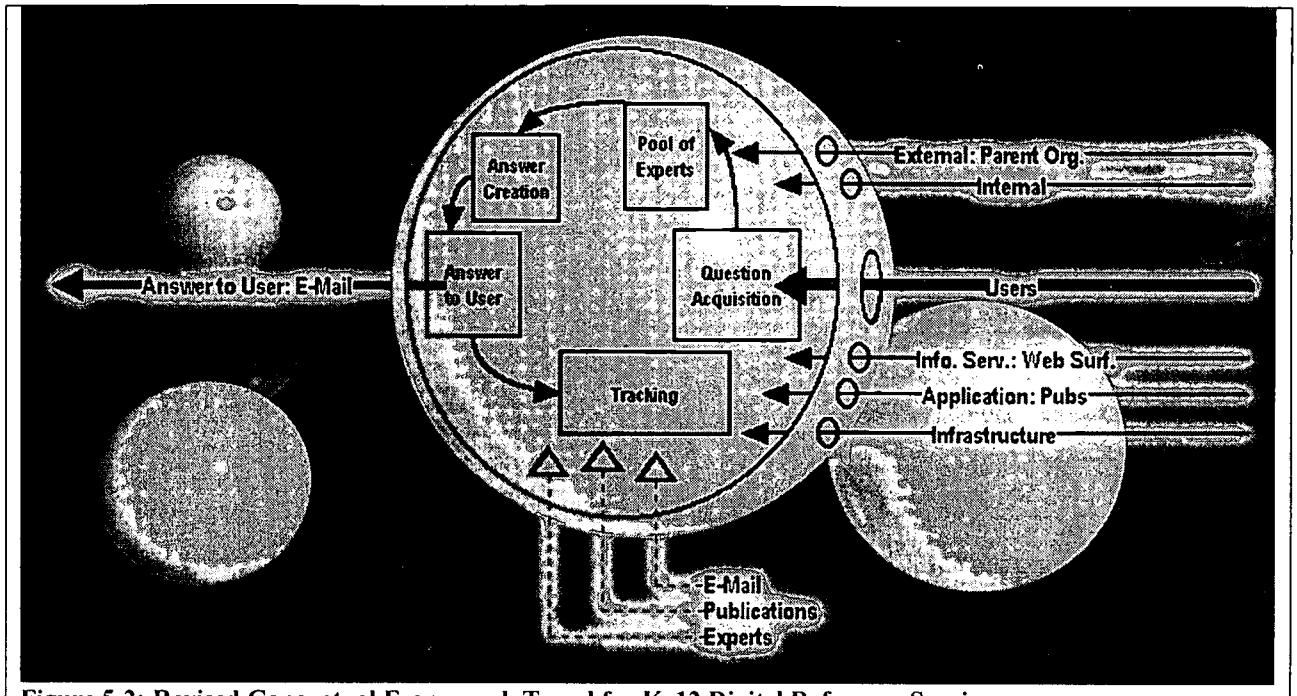


Figure 5-2: Revised Conceptual Framework Tuned for K–12 Digital Reference Services

Finally, it is assumed that tuned versions of the conceptual framework could be created for different types of Internet information services. Since each version would share a common "root" framework they could be compared and combined forming a general refined conceptual framework for Internet information services.

Implications of the Conceptual Framework

As stated in Chapter 1, the study of how Internet information services function is at a very early stage. The conceptual framework provides a tool to builders and maintainers of Internet information services. This tool can be used to both plan for services, as well as analyze existing services (as was done in this study). By using a common complexity framework, organizations can learn from each other and begin to add descriptive and analytic power to Internet projects. In Internet services where there is virtually no control and little knowledge (see the discussion in Chapter 2 of knowledge and control), looking at a service as a self-contained structure makes a great deal of sense. Understanding structures in place that detect and adapt to change is essential. With the conceptual framework, organizations can be made more aware of how they gather information, react to input and how these mechanisms and processes relate to other Internet information services.

Conclusion 2: Description

The second objective of this study was the following:

> to use this conceptual framework to empirically describe how organizations, specifically K–12 digital reference services, build and maintain services in the dynamic Internet environment.

In the light of this objective the research questions take on a specific descriptive function. That

is, they ask "what are the detectors, rules, and effectors of a specific service?" These research questions studied through the methodology outlined in Chapter 3 lead directly to the service descriptions in Chapter 4. Conclusions on this objective fit into two basic areas: those related to the method of generating descriptions (answering the research questions for a given service) and the findings related to the service descriptions themselves.

Methodological Conclusions and Implications

In traditional qualitative studies, introduction, literature, and method are small parts of the study and results and conclusions are large sections; however this qualitative study is just the reverse. A great deal of time was spent in building the conceptual framework and positioning the study, followed by concise, almost terse, results. This relates to the basic nature of the study: to build a sophisticated lens to focus on a complex subject at a given time. For that time, the complex item becomes simple; it is the dynamic nature of the agent over time that makes it complex. In such a case, it is the instrument used to reduce complexity that needs explanation and grounding, while the results are simplified. It is like attempting to study a butterfly: observed in nature, the insect is fast moving and hard to define. However, pin the butterfly to a board and it is a simple matter to examine it.

Another finding of the study relates to the extensive use of the Internet to gather and report data. Of particular note was the use of synchronous chat software to perform elite interviews. The use of chat had several advantages. First, there was an instantaneous transcript of the interview. Second, this transcript included nearly the entire interview data including environmental data. With the exception of time, all aspects of the interview were captured. There were no unspoken cues or garbled speech. However, chat provided some unexpected results. The transcripts were very terse. Three-hour interviews became eight page transcripts. In contrast the single phone interview conducted that lasted twenty minutes created a six-page transcript. Possibly the text-based environment gave respondents more time to compose and answer. Perhaps respondents were more concise to save the effort of typing. The researcher offers no explanation for this other than to point out that the data gathered was sufficiently rich to create the descriptions in Chapter 4.

The use of blueprints as a tool for analysis and reporting in the descriptions was also a contribution of the study. The blueprint format was not specifically delineated in Chapter 3 rather it was a result of the data analysis process. Blueprints allow a succinct method to present an overall picture of an Internet information service while empirically grounding the description and emphasizing key features. The use of quotations in the diagram worked well to ground representation in actual data. The use of "key detectors" effectively highlighted important features without sacrificing completeness. The next steps in refining the blueprint method is to weight linkages between rule components, showing how strong a relationship different components have in relation to each other. Also there needs to be a way to represent organizational emphasis on different processes. For example, in organizations with both question answering and Web development processes, does the organization provide equal attention/resources to both processes?

Other Findings from the Service Descriptions

The application of the research questions to description building in Chapter 4 generated a series of findings related to the Lankes/Eisenberg Architecture and the role of the elites themselves. These findings did not necessarily answer the research questions, but were a product of the investigation.

User Internet Agent Types

The user detectors were limited in number and shared among most of the services. They include Web forms, Web logs, feedback forms and e-mail (see Table 4-9 for a complete list). However, all the detectors used were limited in their ability to gather rich user information. In all cases, the majority of user information that was gathered by builders and maintainers of services came in the questions these users asked; however, there was no obligation on the user to volunteer contextual information. Web logs, while utilized, were not seen as a key detector in any service. Also, while feedback played a role in some services, it was voluntary, and little user information was sought.

These findings relate directly to the second assumption listed in Chapter 1: "understanding users does not equate to understanding information services." There was little attempt by these services to understand the information-seeking behavior of users. There were few focus groups or demographic studies used (and those used were considered "unscientific" or outdated as seen in the Ask Shamu service description). The results of this study indicate that K–12 digital reference services treat the user as simply a question. For these services use was sufficient for continued user input. Services were able to succeed without user gathering mechanisms outside of service functions.

Application Internet Agent Types

While services have evolved away from older technologies, e-mail is still an essential tool. None of the exemplary sites had a gopher site; none of the services mentioned an FTP effector or a telnet interface. All of the services have embraced the World Wide Web. This could be a matter of timing; i.e., these services began when the Web was the dominant means of information dissemination on the Internet. However the fact that e-mail is still used throughout the process is telling. It means that all of these services believe that text is sufficient to answer questions in their respective domains.[39] If the Web's multimedia capabilities were fully utilized it was only after the reference transaction. Dr. Math for example, chose certain key questions to expand into multimedia resources, but only long after the original question was answered.

It is assumed that this lack of multimedia usage is the result of the uneven technological implementation in the user base. Services do not implement software capabilities they do not feel users will be able to access. There are few technologies other than e-mail that these services can take for granted. Even if multimedia-authoring tools were sufficiently easy for these services to implement, there is no way to assume a user could access animations, graphics, or video. An alternate explanation for the lack of multimedia usage is a lack of expertise and authoring capabilities on the part of the service providers. The experts within the services themselves may

[39] While e-mail can handle multimedia documents, there were indications from the services that they were still using text as their primary representation of information.

be unable or unwilling to invest the time and effort needed to learn the tools needed to compose multimedia answers. However, there was insufficient data gathered to explain the lack of multimedia answers.

Infrastructure Internet Agent Types

All of these services operated in isolation from infrastructure providers. Infrastructure providers are defined in the Lankes/Eisenberg Architecture as "agents that build and maintain hardware and software used to move bits from one place to another on the Internet." Even in the case of Ask Shamu, the one service that had infrastructure detectors, Internet hardware and information transport standards were considered the responsibility of parent organizations. One might conclude that information service provision can be built and maintained without regard to underlying network infrastructure. This should not be considered universal as the AskERIC pre-test (Appendix C) shows a "systems" component; however, it demonstrates an evolution in Internet information systems. With growing implementation of the Internet in organizations, the growing number of packaged Internet software solutions, and the content-less nature of the underlying Internet infrastructure, content, and service creators appear to be able to operate successfully without deep knowledge of infrastructure (and in large part application) concerns.

Nature of Elites

The fact that service elites and experts are able to operate in Internet information services without regard to infrastructure issues has direct implications for authors mentioned in the discussion in Chapter 2 of changing roles of reference librarians. The exemplary services in this research demonstrated an ability to shelter experts from the "type and rate of change that will accompany the networked environment" (McClure, Moen & Ryan, 1994). Volunteers in MAD Scientist and Dr. Math do not have to be current on Internet technologies and trends. They need only have basic network literacy (i.e., to log onto a Web site) and strong subject skills. Even when the elite was intimately involved with technical aspects of information services, as in the case of MAD Scientist, his or her role was either in some way isolated from infrastructure issues, or his/her role was to isolate experts from such issues.

This ability to isolate human intermediaries from underlying technical issues was also seen in the lack of automation. All services had a human expert compose all answers. Once again, this fact can be seen as a result of selecting digital reference services. Yet none of the services utilized automated searching of archives, for example, to attempt to create automated answering. Once a question was asked, a human expert would perform some evaluation and have final say in composing an answer. This demonstrates the need for human intermediation in the selected services. In complexity theory, if such a system of human intermediated answering was not effective it would have either been changed, or the entire organization would have ceased operation. All of these services have evolved to put a human expert at the core of their processes.

Conclusion 3: Meta-Description

When interpreting the research questions in the context of the third objective of the study (seeking commonalties among the descriptions) the questions become more generalized. The research questions can be restated as: what are the detectors, rules and effectors of exemplary digital reference services in general? The answer to this generalized question was presented in Chapter 4 as the meta-description. While the meta-description is broad, it is significant in two ways: it demonstrates a level of convergence in the complex Internet environment, and it has utility to builders and maintainers of digital reference services.

At the outset of this research, there were three broad possible outcomes from the study's third objective:

1. Generation of a single meta-description: a single description accounting for the specifics of all services studied
2. Generation of several meta-descriptions: a series of two or three descriptions accounting for all the services studied, but segmented by some variable (such as size or subject domain), or
3. An inability to create any meta-description: no useful level of abstraction could describe all services or the meta-description was the conceptual framework itself which indicated a structure was imposed by the framework, not exposed by it.

In complexity terms, each of these results would have different implications. For example an inability to generate any generalizations would lead the researcher to question whether the Internet was indeed a complex system at all, or a chaotic one with no regularity. Being able to build a single meta-description among six varied services, as was done in this study, implies the utility of the complexity approach. With this approach, aggregation of service descriptions on a wider scale is possible and ultimately a model of how such services interact can be created and studied.

The utility of the description is that it works with single person services and 400 person services. It is a simple set of rules that covers a broad set of cases. The meta-description acts as a simple rule from which complex systems can be derived. While broad, the commonalties identified are more specific than the model of detectors, rules, and effectors used to gather the data. It can also be used as a mechanism for planning a digital reference service. For example, a series of planning questions can be drawn from the meta-description:

- What are your rules for acquiring a question? Will you use e-mail? The Web? What kind of automatic processing will you use with that question? Assign an ID number? Put it into a database?
- How will you manage your pool of possible respondents? Will you have a database of volunteers? Will you have multiple volunteers answering questions, or paid staff?
- How will your experts generate their answers? What technology will they use? What policies will there be to help them? What information resources will you make available to them?
- How will you e-mail answers to users? Will you use template responses?
- How will you track trends and answers? Will you use a Web-based archive? Will you make question/answer sets publicly available?

As discussed in the section on future application research, this meta-description can be invaluable in building and maintaining new digital reference services.

Users of the meta-description should be cautioned, however, that it is linear and may oversimplify the process (as discussed in "Surface Descriptions" in the following limitations). The meta-description, as was stated in Chapter 4, is centered on a single question. Traditional library reference, on the other hand, centers on the user and their problem:

> In all but the most simple transactions, the steps might be more adequately described as opening the interview (the initial encounter of the parties and the presentation of the user's question or problem); searching for appropriate information in response to the problem (which usually involves a number of questions and interchanges rather than simply locating "the answer" to "the question") and closure of the interview, which should be based on a mutual understanding that, for the time being at least, an adequate amount of information has been communicated, or that it is most productive or necessary to close the interview. Thus, the interview process can be viewed as a problem-centered rather than question-centered process (Sutton & Holt, 1995, p. 37).

This is not to say that a linear, or question centered approach is by definition incomplete. Grogan found that "most of the library users who put questions to the librarian know exactly what they need and ask for it clearly." (1991, p. 63) Further "Mary Jo Lynch found in her 1977 study of public library reference service that fewer than half of the observed reference transactions involved interviews . . . and that only 13 percent of these interviews substantially altered the initial query." (Sutton, E. & Holt, 1995, p. 37). This discussion is not presented, therefore, to dissuade builders and maintainers from using the meta-description, or challenge the findings of the study, but rather to caution users of the study and highlight the need for future research on this topic.

Limitations of Study and Findings

This section discusses limitations of the study as well as a discussion of transferability of the study's findings to other Internet information services. The limitations of the study are:

1. The absence of dynamic aspects of building and maintaining Internet information services in general, and exemplary K–12 digital reference services specifically
2. An inability to determine effectiveness and efficiency in the building and maintaining process, and
3. The "surface" nature of the descriptions generated.

These three limitations are not meant to be exhaustive, but rather serve as cautions in the use of the study's results. They are detailed below.

Dynamism in Building and Maintaining

Complex adaptive systems are dynamic. They shift and change over time. Rules, detectors, and effectors are all transformed by the morphing landscape within which they exist. From the outset of the study, the researcher made clear that not all of complexity research was utilized within this study. The performance system of an agent is the static portion of that agent at any given moment in time. Said performance system is what was captured during this

research. What is missing in the service descriptions is the accounting for change mechanisms of the organizations. The question of how these services evolve in the face of a shifting landscape remains largely unanswered. The blueprints that form the heart of Chapter 4 tell no history. They do not show what did not work. Rather these descriptions are a picture of a moment in time. Only with follow-up studies looking at services longitudinally can the evolving nature of these services and associated mechanisms be exposed.

Efficiency and Effectiveness

The K–12 digital reference services examined in this study are exemplary. That was operationalized as the consensus opinion of an expert panel that these services were worthy of imitation. They had good reputations and recognition. However, these services were not chosen because they answered their questions most effectively (from a user perspective) or created answers in the most efficient process. At the time of selection, the expert panel did not know the effectiveness or efficiency of the process used by selected services. Further, this study's purpose was to describe the current state and structure of these services. There was no attempt to benchmark how well these services functioned. There is nothing in the descriptive process, or the descriptions themselves, that indicates how a process could improve.

However, part of the utility in complexity research is that of punctuated evolution. That is to say that complexity research holds that the structure of these services has evolved in response to their environments. Complexity research would state that inefficient services would either change in response to external stimuli (through their detectors) or eventually cease operation. With this in mind, while the researcher cannot state that a given process is "best," "good," "efficient," or "effective," the researcher can state that it is sufficient for continued operation and generation of good reputation.

Surface Descriptions

There are a variety of resolutions in description. With these services, further detail could have been added. For example, Dr. Math, How Things Work, Ask A Volcanologist and MAD Scientist Network rely on PERL scripts for their information processing. Inclusion of these scripts would precisely describe how questions are manipulated. HTML source code would concisely describe how Web pages are composed. Yet, the researcher determined that this was too much detail for generation of meta-description and determining detectors, rules, and effectors to answer the research questions.

There is another question about resolution, however. While each elite was given ample opportunity to add detail and challenge descriptions, the researcher still feels what was captured was the "norm." That is to say that the majority of questions are processed according to the blueprints, but the exceptions are not captured. This sense comes from both the researcher's experience and discussions with members of the expert panel. Another methodology, such as participant observation, might have better elicited the exceptions, and undocumented processes. Such a method would also capture different perspectives on the services. With services such as Ask Shamu, How Things Work, and the National Museum of American Art Reference Desk, the elite's view can be seen as holistic because these services are largely single-person operations. In the other services, however, more perspectives might add another level of detail. These limitations are also discussed in Chapter 1.

Transferability of Descriptions and Meta-Description

Marshall and Rossman discuss transferability as a construct that both relates to the trustworthiness of a study and in applicability of a study's findings to other situations.

> The second construct Lincoln and Guba propose is transferability, in which the burden of demonstrating the applicability of one set of findings to another context rests more with the investigator who would make that transfer than with the original investigator. That is, the first decision span allows the researcher to generalize the findings about a particular sample to the population from which that sample was drawn (assuming adequate population specification and random selection of the sample). The second decision span occurs when an investigator wants to apply the findings about the population of interest to a second population believed or presumed sufficiently similar to the first to warrant that application. This second decision span entails the judgement about the relevancy of the first study to the second setting (Marshall & Rossman 1995, p. 142–143).

While there was no use of random selection in sampling and therefore no possibility of generalization, there can be some indication of "presumed" populations to which these findings would relate.

First, the researcher assumes that the findings are most transferable to other K–12 digital reference services. The descriptions and meta-descriptions in this study describe six K–12 digital reference services. These six sites (eight with pre-tests) represent a significant portion of the seventy services identified for the AskA Locator discussed in Chapter 3. The services investigated in this study were selected to be "exemplary," that is, worthy of imitation. This selection was done by experts in the field of digital reference and K–12 digital reference. The sample itself covered the range of services, including small operations and large ones. With the pre-tests, the sample also included organizations that used paid staff and volunteers. The subject domains of the services under investigation also varied (science, art, mathematics, etc.). Therefore K–12 digital reference services should be able to utilize the meta-description, and tuned conceptual framework with little translation or change.

Second, transfer to the library world (i.e., reference services at public, research, special, and school library institutions) is also warranted. While the population of library-based digital reference services is not as coherent or as easily identifiable as K–12 AskAs[40] the information and referral mission and existing methods are similar. While certainly more rigorous and studied, the reference interview can be seen as a form of question acquisition in the meta-description. The researcher also has anecdotal and experiential support for this assumption.

Beyond these specialized reference populations there is much less confidence in the ability to transfer specific findings. However, the conceptual framework, as has been discussed, is transferable to any Internet information service. It was built as a generalized model of these services.

Future Research

The purpose of this research, as stated in Chapter 1, was as a starting point for a larger investigation into the building and maintaining of Internet information services. The starting

[40] For an overview of digital reference efforts on the Internet see Wasik, 1998.

point is now done, and future research to continue this larger investigation must be outlined. Table 5-1 outlines future areas of investigation based on the conclusions in this chapter.

Table 5-1: Future Research

Related To	Research Study
Conclusion 1: Conceptual Framework	Conceptual Framework in Non-Reference Settings
	Conceptual Framework in Library and Information Center Settings
	Balancing the Conceptual Framework
	Developing the Dynamic Nature of the Conceptual Framework
Conclusion 2: Description	A Longitudinal Study of K–12 Digital Reference Services
	Development of Efficiency and Effectiveness Benchmarks for Digital Reference Services
	Developing a Streamlined Elicitation Process for Internet Information Services' Performance Systems
Conclusion 3: Meta-Description	Enrichment of Meta-Description with Additional Processes
	Expansion of the Meta-Description to Consider Threaded Discussions and Iterative Processes

These research areas delineate direct scholarly follow-ups to the current study. They would both deepen the current understanding of digital reference services and expand the understanding of Internet information services in general. Each area is explored briefly below.

Future Research Related to the Conceptual Framework

As was discussed in the previous conclusions, the conceptual framework was successful, but could be tuned for different situations. Future research related to the framework would have two threads: refining the framework itself, and applying the framework to different Internet information service types.

Refining the Framework

The framework, while currently effective, lacks dynamism and equal resolution in the investigation of Internet information services. Two proposed studies could address these problems.

Developing the Dynamic Nature of the Conceptual Framework

As stated in Chapter 2, there are large parts of complexity research not utilized in this study. Future research could look at the dynamic nature of K–12 digital reference services (or Internet information services in general) using the dynamic aspects of complexity research. How do these organizations change their performance systems over time? Internal models and credit assignment algorithms (Holland, 1995) can serve as the first step in attempting to incorporate dynamism into the conceptual framework. Once the dynamic nature of Internet information services is explored, a model of how these services interact in the Internet as a Complex Adaptive System can be built and tested.

Balancing the Conceptual Framework

Another refinement needed in the conceptual framework is leveling the degree of specificity and precision among detectors, rules, resources, and effectors. Detectors, effectors,

and resources are well defined as a result of this research, and literature leading to this work. However, rules remain elusive. Certainly the meta-description built in Chapter 4 is helpful for K–12 digital reference services. Yet there needs to be a considerable amount of work done in refining the concept of rules, or it will remain an ad hoc, case-by-case determination and will be difficult to generalize or compare across domains.

Applying the Framework to Different Settings

One of the strengths of using complexity research as a base for the conceptual framework was the ability to look at Internet information services regardless of context. This allows for a cross-context review and comparison of services. In order to truly realize this analytic power the framework must be applied to multiple settings.

Conceptual Framework in Library and Information Center Settings

The first choice of the researcher would be to have the framework applied to other digital reference services. It would be interesting to see the comparison of K–12 digital reference services with little library linkages (with the exception of the National Museum of American Art Reference Desk) to traditional reference centers and activities.

As libraries wrestle with the migration from Sutton's (1996) traditional and automated libraries to hybrid and digital libraries, they face a changing reference world. Serious questions exist about the role of the librarian as being unbiased and complete in a world with thousands of relevant documents. Serious questions abound as libraries face local support and global reach. Research into how libraries (public, school, academic, public) transition reference services from synchronous face-to-face reference interviews to asynchronous, often linear reference processes is essential.

Conceptual Framework in Non-Reference Settings

As was previously stated, reference settings constitute a small number of Internet information services. Using the conceptual framework one could examine Internet information services other than K–12 digital reference services. These studies could create a set of "tuned" frameworks that could be compared. This comparison would then refine the root conceptual framework. Refinement of the root framework could only be done across settings and Internet information service types.

Future Research Related to Descriptions

There are three studies needed to enhance both the existing service descriptions and future descriptions.

A Longitudinal Study of K–12 Digital Reference Services

Future research related to the descriptions created by this study includes the creation of new descriptions sometime in the future to gain a more longitudinal view of the services. This work is needed to discover the dynamic mechanisms discussed in Conclusion 1 above. Another

study might take a more in-depth look at a single service. Such a study could find if these descriptions did indeed miss a level of detail, or if there is significant variance between the view of an elite and the view of an external observer.

Added depth and longitudinal views would aid in both the discovery of the dynamic aspects of building and maintaining Internet information services as well as enhancing understanding of digital reference in general. Help desk vendors, libraries, and organizations providing human intermediated services on the Internet must have in-depth information to avoid overloaded services and dissatisfied users.

Development of Efficiency and Effectiveness Benchmarks for Digital Reference Services

As was stated in the discussion of limitations in Chapter 5, this study did not develop or utilize existing metrics of efficiency and effectiveness. While complexity research implies efficiency and effectiveness by evolution, this does not exclude the development of benchmarking standards that could be applied to new and existing digital reference services.

Benchmarking is essential in the evolving field of digital reference and digital libraries in general. As organizations, including the federal government, begin large-scale investment into providing information and service electronically they are looking for measures to demonstrate the value of such services. In cases like the federal government where effective and efficient implementation of service is not only important in return on investment, but legally actionable, metrics will determine the extent of implementation of digital reference services.

Developing Streamlined Elicitation Process for Internet Information Services' Performance Systems

A more structured method could be developed to streamline the description construction process. A site builder would be asked to first list detectors (broken down by category [i.e., user, application builders, etc.) then break down the rules related to those detectors (with effectors), then describe the resources used at each point in the rules. This is very similar to the method used in the member checks. The qualitative method used by this study, however, was still essential in refining the conceptual framework that would be used in this more streamlined approach.

One could develop an online automated interview process that stepped an elite through the blueprint process. Such a piece of software could be customized as both an analysis tool and a planning device. Blueprints would allow both internal mapping of services as well as generating transferable models of an organization's workflow process (see Future Applications of Research below).

Future Research Related to Meta-Description

There are two follow-up studies suggested by the researcher in relation to the meta-description. The first is an expansion of the existing meta-description with non-question/answer processes. The second is an expansion of the existing meta-description question/answer processes to accommodate threaded discussions and greater interactivity if such detail exists in the current K–12 digital reference services.

Enrichment of Meta-Description with Additional Processes

The meta-description developed in this study captures a single process of digital reference. In traditional library terms, this process might be referred to as information and referral. There is another process evident in most of the services studied, that of collection building. Many services link their question answer processes to Web site building. They determine what resources to develop and how to structure and organize these resources from user input in the form of questions and feedback. Just as traditional reference refers to the information and referral process as well as the reference collection, so too can the meta-description be expanded to incorporate Web building, training, and other processes.

Expansion of the Meta-Description to Consider Threaded Discussions and Iterative Processes

This study would have two parts: to discover if K–12 digital reference services do use iterative, problem-based processes in their question answering processes; and to represent these iterative interactions if they exist in the current meta-description.

Summary of Future Research

There are many avenues of research that can follow this study. Several of the threads interact and complement one another. For example the creation of a streamlined process for eliciting a service's structure would lead to faster creation of tuned conceptual frameworks. Future research will either add to a deeper understanding of digital reference services, or the conceptual framework. One set of studies will require a greater understanding of the library world, while another set of studies will require a more general approach. All of these studies will further the understanding of complexity research and its impacts on Internet information services. The next section details a follow-up study based upon application as opposed to discovery.

Applications of Research

The above research studies focus on explorations beyond K–12 digital reference services. There are also development activities that can have a direct and immediate impact on K–12 digital reference services and K–12 education in general. The following section outlines a more applied agenda derived from this study. It is explored in depth as an answer to the rhetorical question "how can this study be put into use?"

A main impetus behind this study was to assist the emerging digital reference field. The conceptual framework provides assistance via a means of describing and analyzing Internet information services. The results provide a basic structure and specific examples that new digital reference services as well as existing services can use when planning and expanding their services. In this section a more applied approach is used to delineate future research to aid these services.

One aspect of K–12 digital reference services that is not immediately apparent from the results of the study is the burden on these services to create software. Dr. Math created a set of inter-operating PERL scripts called the Doctor's Office that implements their question answering process. The MAD Scientist Network created and maintains MODERATOR. Ask A

Volcanologist wrote the scripts that automate their services as did How Things Work. An easy to install and maintain software package based on meta-description and the blueprints of Chapter 4 would be a significant aid to the K–12 digital reference community and would have larger implications for the help desk software industry and the growth of digital reference in general. Removing the barrier of software development from digital reference services may well stimulate growth of such services just as the National Center for Supercomputing Applications' release of an easy to install and modify World Wide Web client (Mosaic) and server (NCSA's HTTP Daemon) prompted the growth of the Web by removing the software development burden from Internet information service providers.

This digital reference software would be a set of Web-based customizable modules that was easy to install and maintain, and that allowed maximum flexibility in implementation. At its heart would be the meta-description from Chapter 4, and it would take advantage of the exemplary service descriptions. Such software could also link into a system that allowed these services to inter-operate, creating a means of building cooperative reference services via the Internet. Table 5-2 represents the meta-description from Chapter 4 with some minor variations, without the common detectors and resources.

Table 5-2: Components of the Meta-Description Question Answer Process

Step	Description
Question Acquisition	An e-mail address or Web form is used to allow a user to enter a question. During this process a user may be prompted to identify a topic for their question. Some automated pre-processing may occur to put the question in HTML or assign some sort of tracking identification.
Pool of Possible Respondents	A message is queued and prepared for expert response. In services with multiple experts available, some triage process occurs (for example in Ask A Volcanologist a PERL script simply sends questions to on-call experts based on the days of the week, while MAD Scientist Network uses human moderators to decide which experts to use based upon their expertise). In single person operations, messages are simply queued for the single expert.
Expert Answer Generation	An expert generates an answer. In some services this is in accordance with a policy document. In some services these answers come from Internet resources, but in all cases an expert utilizes personal knowledge of a topic in answer generation. Answers may be factual or referrals to appropriate resources.
Answer Sent	Once an answer is generated it is sent to the user. The answer may be sent via e-mail if possible, or posted to a Web site.
Tracking	Trends and subjects from questions are tracked and used. In some cases the trends are used in Web development. Tracking can consist of Web-based archives, private archives, or simply informal information.

The meta-description would constitute the core of the system. This core would manage the information flow within a digital reference service and provide basic system services (i.e., assigning tracking data to questions, managing a database of possible expert respondents, sending out responses to users). In essence, the core would be a database that provided the basic workflow process and related functions in digital reference services. However, this core would be insufficient to capture all the complexity of a service's digital reference process. The meta-description core is instead a skeleton to which the detail of routine question answering must be attached. Table 5-3 describes specific functions and software that would be available through the core.

Table 5-3: Functions and Software Controlled by the Meta-Description Core

Component of Core	Function/Software	Description
Question Acquisition	Parser	None of the current AskA services examined incorporate automated pre-processing. It is hoped that by building a lightweight Parser to aid in the analysis and assignment of questions, these services can increase capacity of questions answered.
Pool of Possible Respondents	Volunteer Database	A searchable database of volunteers. The database would include volunteer profiles that track performance evaluations, unique expertise, and number of questions that a volunteer is able to answer. This database would strongly resemble the Locator discussed in the Meta-Triage function.
Expert Answer is Generated	Knowledge Base	All of the current AskA services examined incorporate some sort of archive to help answer questions. However, there is no standard way of building (or sharing) these FAQ's and archives. Further, the present state of technology used to build these systems varies widely (many are simply Web pages in classified directories). A common knowledge base component would ease integration into the larger knowledge base and improve efficiency in answering questions.
Answers Sent to User	E-mail Engine	Software to distribute e-mail in batch.
Tracking	Tracking Database	Tracking and resource allocation is essential if these services are to grow and handle the potential overwhelming volume of questions from a fully connected K–12 community.

The details needed in any given service could be added through the blueprints created in Chapter 4, as well as the blueprint creation process (a streamlined version of the method in Chapter 3). The researcher calls this second layer of detail the *Blueprint Manager*. This manager would link major service functions provided by the meta-description core to a specific detail process created by an organization. So while the core provides a database of possible expert respondents, the *Blueprint Manager* would dictate the process a service coordinator (or moderator) would use to select from the possible respondents. Does the coordinator pick the next person available? the highest rated? by seniority? These blueprints would need to be represented in a standard format. This format would be a machine-readable set of processes that could be loaded dynamically to extend the basic functionality of the meta-description core.

Once a standard way of representing blueprints in digital form is created, the blueprints from exemplary services could be distributed in this format. New digital reference services could in essence load processes put in place and tested by existing exemplary services such as Dr. Math or MAD Scientist. Because these blueprints are tied directly into portions of the meta-description, organizations could pick and choose parts of these blueprints to implement. A service could be quickly assembled by using the MAD Scientist Network's question acquisition processes, Ask A Volcanologist's question distribution process, and How Things Work's tracking methods for example.

A standard for templates would allow services to quickly build processes as well as customize and improve them. Improved processes could then be quickly disseminated and

implemented. A new advance in answer formulation could be exported from one service and quickly applied in a new service without extensive customization or programming. No programming would be needed as the underlying core functionality (and related software) would remain unchanged by applying a different blueprint. Likewise an improvement in the underlying software of the meta-description core could be added to a service without disruption to the templates.

While the *Blueprint Manager* would allow customization of process, another interface layer would be needed. The *Interface Manager* would create, modify, and present human/computer interfaces where needed by the *Blueprint Manager*. The *Interface Manager* creates the Web question interface for example, or the answer creation process required by Dr. Math's template. The Interface Manager would also allow a service's administrator to modify interfaces based on context (everything from changing names on forms, to requesting additional information from users when they ask a question).

Creating a common core for handling questions, and creating a standard means of implementing blueprints also implies a standard way of representing questions. This standard means of representing user questions is necessary in building the meta-description core. Once this question representation standard is created, however, it is just as easy to exchange questions as it is to exchange blueprints. Services can easily transfer questions to other AskA services.

This four layer architecture of a meta-description core, a *Blueprint Manager*, an *Interface Manager* and a standard representing questions is presented in Figure 5-3.

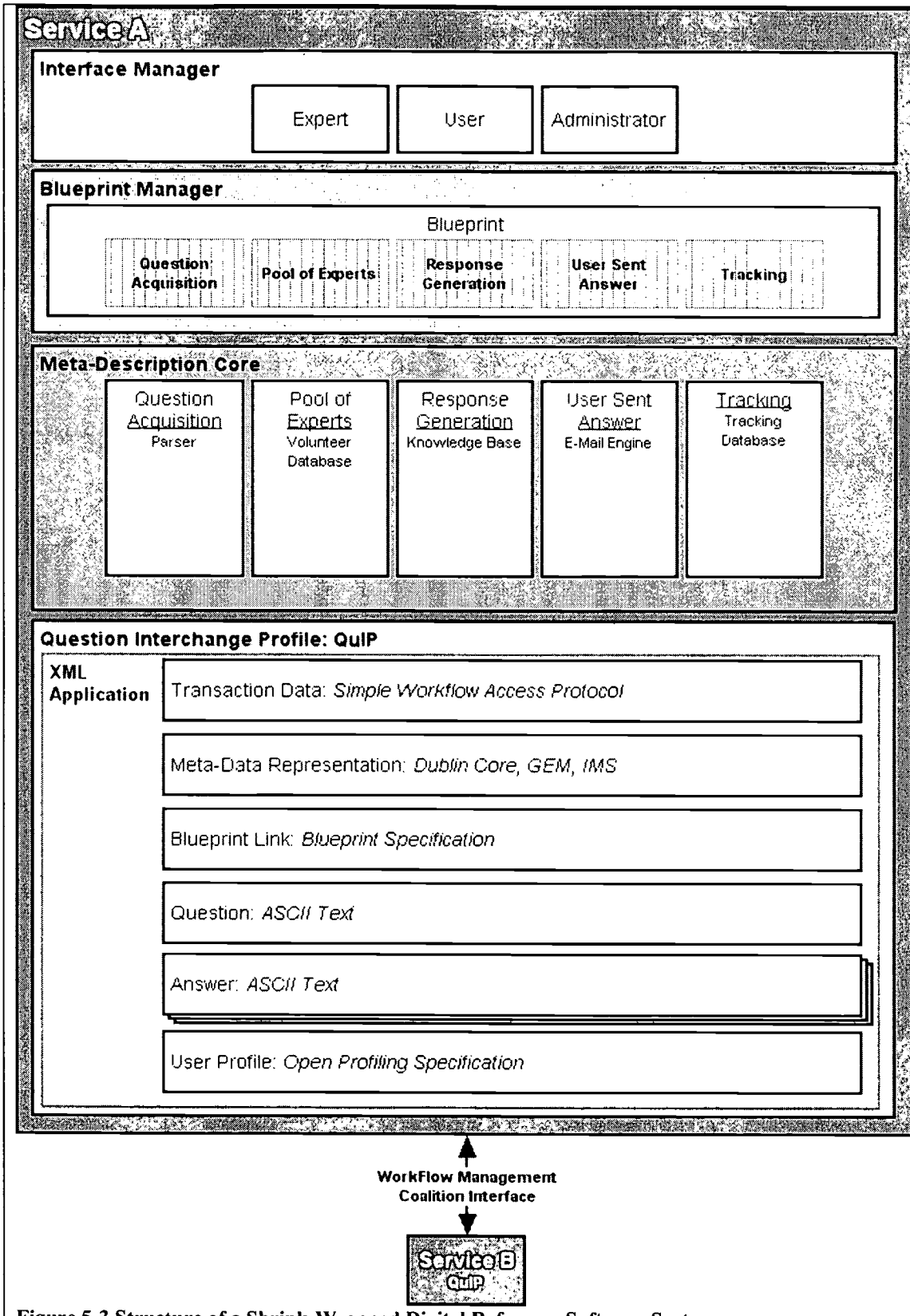


Figure 5-3 Structure of a Shrink-Wrapped Digital Reference Software System

A Common Answer Format: QuIP

Creating a standard means of representing questions has implications far beyond a single system for K–12 digital reference services. Once a question can be represented outside of a given service, powerful exchanges are possible. The first problem is how to represent the question in a context-less manner. Table 5-4 is the first attempt to define the structure of a standard format for questions. The researcher calls this standard structure the Question Interchange Profile (QuIP).

Table 5-4: QuIP Components

Component	Description
Transaction Wrapper	Additional information added to a question answer set that defines how the information can be used and if there is any money or bartering that occurs (buy question with money or in-kind capacity). This layer would handle all automated negotiation information such as certification requirements, time restrictions and all restrictions imposed by the service that originated the question.
Metadata Representation	A structured representation of the question used for improved retrieval and selection. It is assumed that the metadata standard will vary by domain. However, the researcher assumes at least use of the Dublin Core and proposes for the purposes of K–12 digital reference the use of the GEM element set.
Blueprint Module	Defines a pointer to a portion of a blueprint template. This information can be used to determine how to interact with other modules in other AskAs (i.e., return this question with an answer to this module. Here is how to submit a question to this triage process).
Question	A full-text representation of the user's question.
Answer	A full-text representation of an expert's response to the user's question. This element is assumed to be repeatable.
User Profile	Contextual information on the user that can be used by an expert in constructing answers.

QuIP Components

QuIP, as the name states, is a profile. A profile differs from traditional standards and protocols in that it is a means of implementation. It specifies either a single protocol or, as in the case of QuIP, multiple protocols. In the case of defining standards, a profile dictates which options in the general standard are requirements in a given implementation. A profile also adds needed details to general protocols and standards. For example, while the WorkFlow Management Coalition has defined standards for exchanging data between help-desk type software, it has not specified values and formats for a specific "question" entity. A profile also allows multiple delivery mechanisms to be specified if they do not directly affect the data being transferred. In the case of QuIP this means that data interchange according to the QuIP profile can occur between services via e-mail, the Web (HTTP), FTP or even more "advanced" database protocols such as Z39.50 or some future protocol.

Because QuIP is a structured data format for interchange, it would be represented in XML (Light, 1997). XML is an emerging Internet standard based upon SGML[41] (in fact XML is an SGML profile and XML documents are valid SGML documents). QuIP would most likely be implemented as a publicly available XML application. It would have a defined and public Document Type Definition (DTD) that would allow digital reference services to parse and utilize

[41] SGML stands for Standard Generalized Markup Language and is an international standard (ISO 8879:1986) for representing the content and structure of a document (Light, 1998, p. 6).

QuIP's structure. It is anticipated there will be a large number of XML tools available that will allow services with existing software to take advantage of QuIP for transferring questions. The following sections provide additional details on the Question Interchange Profile and tie-ins to existing standards efforts.

Transaction Wrapper

A standard for representing questions allows services to go beyond their own resources in creating an answer. K–12 digital reference services could exchange questions based on load and scope balancing. In order to facilitate this, some sort of transaction record must be kept, and constraints of the transaction must be defined in advance. For example, will a given digital reference service pay to have a question answered? Does a service require a certain level of expertise in order to answer a question? Is there a time frame limitation in answering the question? The transaction wrapper would contain the data needed to negotiate the details of exchanging questions. It is assumed that the majority of these negotiations would be automated.

This wrapper would also have to include provisions for digital signatures to ensure certification and identity. It would have to include provisions for privacy such as the P3P (World Wide Web Consortium, 1998). Since QuIP is presently a self-contained object, no specific transmission protocol has yet been defined, but use of the WorkFlow Management Coalition's interface standards (Lawrence, 1997) is presently assumed for service-to-service interchange requirements.

Metadata Representation

Free-form text is often insufficient to facilitate automated interchange of data. Database fields and service restrictions must be made explicit. In the Internet domain, specifically the World Wide Web, the mechanism used to create structured and controlled representation of documents is metadata. Metadata is either implemented in specific HTML tags, or with recent developments, in XML Document Type Definitions.

Over the past two years there has been extensive development of metadata sets that create basic, standard ways of representing information about items (in this case questions). In the K–12 domain, the Gateway to Educational Materials (GEM) has created a standard way of representing educational materials such as lesson plans and Web resources. It describes an item's subject, grade level appropriateness, publishers, and more in a standard way. GEM itself is a superset of the Dublin Core. The Dublin Core is a set of metadata elements that can describe any Internet resource. The inclusion of metadata in QuIP facilitates automated means of capturing or transmitting questions. A service could, for example, build a service profile that either automatically accepts or rejects questions from other services based on topic, grade range, or audience.

Blueprint Module

This portion of QuIP contains a pointer to some point in a question/answer process (as encoded in blueprints). Such information would be used by the Meta-Description Core to determine where a question is in the overall process. For example a pointer would determine if a question has been answered or not. This pointer would also allow an exchange between specific

functions of services. For example, when a question is exchanged between services a pointer could tell the remote service to return an answer to a review process or simply send the response directly to the user. This pointer could be used by a service to ensure that every outsourced question will not appear as a new question coming into a central receiving area.

Question

This portion of QuIP contains the full-text user question. It can be edited by a service for format or clarity. Questions would be stored as ASCII text.

Answer

This portion of QuIP contains the full-text answer or answers created by an expert or experts. It can be edited by a service for format or clarity. It is also assumed to be a repeatable element so multiple answers can be associated with a single question. Answers would be stored as ASCII text.

User Profile

A user profile is an optional element of QuIP. It is a slot provided for a service to add contextual details about a user who asked a question. The format of the profile and extent of detail are dependent on the service where the question originated (though a third party "profiling service" could add it). It is assumed that this profile would conform to emerging standards such as the Open Profiling Specification (Haeberli, 1997). This standard defines a profile as "a hierarchical collection of personal profile information, the features and corresponding values describing an end user" (Hensley et al., 1997).

Implications of a Common Answer Format: A Question/Answer Electronic Marketplace

There are larger implications in the creation of a standard way of encoding and distributing questions. In essence, QuIP creates an object. That object has certain attributes (a metadata representation, a blueprint pointer, a profile) and certain functions (transaction mechanisms) inherent in the object and separate from the process that created it. The object-oriented nature of the QuIP allows for a transaction space that goes beyond the meta-triage system discussed above. QuIP would allow the creation of a question/answer marketplace in which question objects could be exchanged and bid upon.

For example, an organization could outsource a question, paying some fee to a third-party "answering organization." This third-party organization could subsist solely by answering questions without a direct user interface. Organizations could use the QuIP concept as a foundation for cooperative support and reference services. Originating services (those that first receive the questions) could include minimum requirements for answering questions and a maximum amount they are willing to pay for each answer. Third-party answering agencies could "bid" on the question allowing a sort of supply and demand economy to develop. This bidding could be either automated or human-controlled. Money doesn't have to be the only resource exchanged. A barter economy (e.g., "I'll answer one of yours if you answer one of mine") could

develop. Such a system of either resource swapping or fee exchange is essential in the development of cooperative reference services.

In today's public and research libraries there is a debate over how to support digital reference efforts that extend beyond a geographic area. How does a public library in New York get reimbursed when it answers a question from California? What is the library's incentive to offer such services? This becomes particularly problematic when it is nearly impossible to determine a question's point of origin. With the use of QuIP, electronic IOUs or actual dollars can provide an incentive to these libraries not only to answer the occasional question, but also to seek out questions.

This marketplace of objects is only one example of the uses of QuIP. Imagine a large computer company that establishes blanket support contracts with its largest customers. In such an agreement the customer has paid the computer manufacturer to answer any and all questions. If the customer asks a question on a piece of third-party software, the company can use QuIP to forward the question to the third party and pay the third party to answer that question. By utilizing the blueprint standard discussed above, this entire transaction can be customized so that the computer company's request gets high priority in the third party's question/answer process. Further, using the structure inherent in QuIP the computer manufacturer can make the entire transaction seamless to the customer. One can imagine intermediaries creating value-added support services that broker question/answer services.

Facilitating a Question/Answer Electronic Marketplace for K–12 Digital Reference

While QuIP may allow for the creation of a marketplace of objects, the K–12 community provides unique challenges and opportunities. Creation of such a marketplace must allow for the public nature of education, build on volunteerism, and ensure all questions get answered even in the absence of economic incentives. Such a system would need to facilitate communication between K–12 digital reference services in such a way as not to overburden these services. This would mean that the object marketplace discussed above would need to have intelligence to determine appropriate services in terms of both load and scope. It would need to utilize automation to facilitate the work of human intermediaries and reduce the burdens of volunteerism while ensuring quality.

Such a system could be a scaled up version of the "shrink-wrapped" software discussed previously. Questions could come through some interface from either an end user or a K–12 digital reference service. The question could then be used in an automated search of existing answers and available K–12 digital reference services. The results of these searches could be checked and modified by a human intermediary (assumedly a trained information professional as discussed in Chapter 2 by He & Knee [1995] and Mardikian & Keselman [1995]). Once the search results are checked and/or corrected, the human intermediary could either generate an answer from existing knowledge (existing answers or personal knowledge) or assign it to a K–12 digital reference service.

Study Summary

This study started with the problem of organizations having to build and maintain services in the complex Internet environment. K–12 digital reference services were used to both illustrate the potential problems of working in the Internet, and serve as a starting point in examining other service types. A conceptual framework was created from the literature, theory, and the researcher's experience. This conceptual framework served as the foundation for a method to elicit the structure of K–12 digital reference services. The methodology created a series of six blueprints and a meta-description. The study ended with a series of conclusions based on the study's objectives, a discussion of limitations in the findings, and future research opportunities.

The study was successful in creating empirical descriptions and a conceptual framework that can be used in studying other Internet information services. The study successfully created a meta-description of K–12 digital reference services. The study lays the foundation for a national cooperative digital reference service based on best practice and human expertise.

References

Abdal Haqq, I. (1995). ERIC as a resource for the teacher researcher (ERIC Digest). Washington, DC: ERIC Clearinghouse on Teaching and Teacher Education. (ERIC Document Reproduction Service No. ED 381 530).

Allen, P. (1994). Coherence, chaos and evolution in the social context. Futures, 26, 583–597.

Ancona, D., Kochran, T., Scully, M., Maanen, J. van, & Westney, D. E. (1996). The "New" organization. In Managing for the future (Module I). Cincinnati, OH: South-Western College Publishing.

Anderson, C. (1996). The Accidental Superhighway. In The Economist. (Online). Available: http://www.economist.com/surveys/internet/intro.html [1997, April 1].

Arms, C. (1990). Using the national networks: BITNET and the Internet. Online, 14 (5), 24–29.

Balas, J. (1995). The Internet and reference services. Computers in Libraries, 15 (6), 39–41.

Belkin, N. J. (1980). Anomalous states of knowledge as a basis for information retrieval. Canadian Journal of Information Science, 5, 133–143.

Benjamin, R. I., & Wigand, R. (1995). Electronic markets and virtual value chains on the Information Superhighway. Sloan Management Review, 36 (2), 62–67.

Bertalanffy, L. (1968). General system theory: Foundations, development, applications. New York: Braziller.

Bloomfield, L. (1996). How things work: The physics of everyday life. New York: John Wiley & Sons.

Blumer, H. (1969). Symbolic interaction: Perspective and method. Englewood Cliffs, NJ: Prentice-Hall.

Bobp, M. E., Kratzert, M., & Richey, D. (1993). The Emergence of systemwide electronic access to information sources: The Experience of two California State University libraries. The Reference Librarian, 39, 111–130.

Bogdan, R., & Biklen, S. (1992). Qualitative research for education: An Introduction to theory and methods. Needham Heights, MA: Allyn and Bacon.

Branse, Y. (1993). Internet resources: How not to get tangled up in the net. Bulletin of the Israel Society of Special Libraries and Information Centers, 19 (2), 21–25.

Brinberg, D., & McGrath, J. E. (1985). Validity and the research process. Beverly Hills, CA: Sage Publications.

Buckland, M. (1991). Information and information systems. New York: Praeger.

Callahan, D. R. (1991). The librarian as change agent in the diffusion of technological innovation. The Electronic Library, 9 (1), 13–16.

Callaway, E. (1997). Method from the Madness. PCWeek 14 ,(5), 99.

Carroll, M. L. (1996). CYBERSTRATEGIES: How to build an Internet-based information system. New York: Von Nostrand Reinhold.

Casti, J. (1994). Complexification: Explaining a paradoxical world through the science of surprise. New York: HarperPerennial.

Cerf, V. (1993). How the Internet came to be. In B. Aboba (Ed.), The online user's encyclopedia (pp. 527–534). New York: Addison-Wesley.

Churchman, C. W. (1968). The systems approach. New York: Dell.

Clinton, W. J. (1997). State of the union address. [Online]. Available: http://www.whitehouse.gov/WH/New/other/sotu.html [1997, April 1].

Cohen, J., & Stewart, I. (1994). The collapse of chaos: Discovering simplicity in a complex world. Toronto, Canada: Penguin.

Coveney, P., & Highfield, R. (1995). Frontiers of complexity: The Search for order in a chaotic world. New York: Fawcett Columbine.

Creswell, J. W. (1994). Research design: Qualitative & quantitative approaches. Thousand Oaks, CA: Sage Publications.

Cronin, K. (1995). Doing business on the Internet. New York: Von Nostrand Reinhold.

Davenport, T. H., & Short, J. E. (1994). Information technology and business process redesign. In R. D. Galliers & B. S. H. Baker (Ed.), Strategic information management (pp. 214–240). Butterworth Heinemann.

Dervin, B., & Nilan, M. (1986). Information needs and users. Annual Review of Information Science and Technology, 21, 3–31.

Dr. Math (1997). Ask Dr. Math. [Online] Available: http://forum.swarthmore.edu/dr.math/dr-math.html [1997, April 1].

Eisenberg, M. B., & Berkowitz, R. E. (1990). Information problem solving: The Big Six Skills approach to library and information skills instruction. Norwood, NJ: Ablex.

Eisenberg, M. B., & Ely, D. (1993). Plugging into the "Net." Emergency Librarian, 21 (2), 8–16

Eisenberg, M. B., & Milbury, P. (1994). LM-NET: Helping school library media specialists to shape the networking revolution in the schools. School Library Media Annual, 12, 33–53.

ERIC (1992). Summarizing the recent accomplishments of the educational resources information center. ERIC Annual Report. Washington, DC: Office of Educational Research and Improvement. (ERIC Document Reproduction Service No. ED 359 989).

Executive Office of the President. (1993). The national information infrastructure: Agenda for action. [Online]. Available: http://gopher.cni.org:70/0/cniftp/pub/nii/niiagenda.txt [1997, April 1].

Feeney, A. (1993). Internet applications: STUMPERS-L. Computers in Libraries, 13 (5), 40–42.

Funtowicz, S., & Ravetz, J. (1994). Emergent complex systems. Futures, 26, 568–582.

Gagliardi, G. (1994). Client/server computing: Killing the mainframe dinosaur and slashing runaway MIS costs. Englewood Cliffs, NJ: PTR Prentice Hall.

Gainor, L. & Foster, E. (1993). Usenet and the library. Reference Services Review, 21 (3), 7–22.

Gartner Group. (1995). Gartner Group Interactive [Online]. Available: http://www.gartner.com [1997, April 1].

Green, K. (1996). The national survey of information technology in higher education. [Online]. Available:

http://ericir.syr.edu/Projects/Campus_computing/1996/index.html [1997, April 1].

Grogan, D. (1991). Practical reference work (2nd ed.). London: Library Association.

Guba, E. G., & Lincoln, Y. (1988). Do inquiry paradigms imply inquiry methodologies? In D. M. Fetterman (Ed.), Qualitative approaches to evaluation in education (pp. 89–115). New York: Praeger.

Haar, S. (1997). The Web takes its time. Interactive Week, 4 (2), 74.

Haeberli, M. (1997). Open profiling specification (OPS) submission. [Online]. Available: http://www.w3.org/Submission/1997/6/ [1997, April 1].

Hafner, K., & Lyon, M. (1996). Where wizards stay up late: The Origins of the Internet. New York: Simon & Schuster.

He, P. W., & Knee, M. (1995). The challenge of electronic services librarianship. Reference Services Review, 23 (4), 7–12.

Hensley, P., Metral, M., Shardanand, U., Converse, D., & Myers, M. (1997). Proposal for an open profiling standard. [Online]. Available: http://www.w3.org/TR/NOTE-OPS-FrameWork.html [1997, April 1].

Holland, J. H. (1992). Complex adaptive systems. Daedalus, 121 (1), 17–30.

Holland, J. H. (1995). Hidden order: How adaptation builds complexity. New York: Addison Wesley.

Horgan, J. (1995). From complexity to perplexity. Scientific American, 272 (6), 104–109.

Institute for Information Studies. (1992). A National information network: Changing our lives in the 21st century. Queenstown, MD: The Aspen Institute.

Jacobs, P. (1996). Site management pains: As Internet sites and intranets continue to grown in size and complexity, management needs are outpacing vendor solutions. InfoWorld, 18 (44), 63–64.

Jensen, A., & Sih, J. (1995). Using e-mail and the Internet to teach users at their desktops. Online 19 (5), 82–86.

Kantor, A., & Neubarth, M. (1996). Off the charts: The Internet 1996. Internet World, 7 (12), 44–51.

Kasowitz, A. (1998). Facets of quality for K–12 digital reference services. [Online]. Available: http://www.vrd.org/training/facets.html [1997, April 1].

Kasowitz, A. (1997). Information mentoring: Guidelines for providing reference service to K–12 students. [Online] Available: http://www.vrd.org/training/guide.htm [1997, April 1].

Kast, F., & Rosenzweig, J. (1972). General systems theory: Applications for organization and management. Academy of Management Journal, 15, 447–465.

KidsConnect (1997). KidsConnect. [Online]. Available: http://www.ala.org/ICONN/kidsconn.html [1997, April 1].

Lankes, R. D. (1996). The bread & butter of the Internet: A primer and presentation packet for educators. Syracuse, NY: ERIC Clearinghouse on Information & Technology.

Lankes, R. D. (1995). AskERIC and the virtual library: Lessons for emerging digital libraries. Internet Research, 5 (1), 56–63.

Lankes, R. D. (1994). The Internet model. Information Searcher, 7 (1).

Lankes, R. D., Bry, L., & Whitehead, S. (1996). The Virtual Reference Desk: A proposal to the Department of Education. Unpublished manuscript, ERIC Clearinghouse on Information and Technology, Syracuse University, Syracuse, NY.

Lawrence, P. (Ed.). (1997). Workflow handbook 1997. New York: John Wiley & Sons LTD.

Lewis, D. W. (1995). Traditional reference is dead, now let's move on to important questions. The Journal of Academic Librarianship, 21 (1), 10–12.

Light, R. (1997). Presenting XML. Indianapolis, IN:SAMS.NET

Lincoln, Y., & Guba, E. G. (1985). Naturalistic inquiry. Beverly Hills, CA: Sage Publications.

Liu, C., Peek, J., Jones, R., Buus, B., & Nye, A. (1994). Managing Internet information services. Sebastopol, CA: O'Reilly & Associates, Inc.

Liu, L. G. (1995). The Internet and library and information services: A review, analysis, and annotated bibliography. (Occasional paper). Graduate School of Library and Information Science, University of Illinois at Urbana-Champaign.

Liu, Z. (1996). Dissipative structure theory, synergetics, and their implications for the management of information systems. Journal of the American Society for Information Science, 47 (2), 129–135.

Lynch, C. (1997). Searching the Internet. Scientific American ,276 (3), 52–56.

Machovec, G. (1993). VERONICA: A Gopher navigational tool on the Internet. Online Libraries and Microcomputers, 11 (10), 1–4.

MAD Scientist (1997). The MAD Scientist network: From Washington University's graduate student perspectives. [Online]. Available: http://128.252.223.239/~ysp/MSN/info/intro.html [1997, April 1].

Malone, T. W., Yates, J., & Benjamin, R. I. (1987). Electronic markets and electronic hierarchies. Communications of the ACM, 30 (6), 484–496.

Mardikian, J., & Kesselman, M. (1995). Beyond the desk: Enhanced reference staffing for the electronic library. Reference Services Review, 23 (1), 21–28.

Marshall, C. & Rossman, G. (1995). Designing qualitative research (2nd ed.). Thousand Oaks, CA: Sage Publications.

Mattessich, R. (1982). The Systems approach: Its variety of aspects. Journal of the American Society for Information Science, 2, 197–208.

Mayer-Kress, G., & Barczys, C. (1994). The global brain as an emergent structure from the worldwide computing network, and its implications for modeling. (Tech. Rep. No. CCSR-94-22). Urbana, IL: University of Illinois at Urbana-Champaign, The Beckman Institute and the Physics Department.

McClure, C. R. (1994). User-based data collection techniques and strategies for evaluating networked information services. Library Trends, 42, 591–607.

McClure, C. R., & Lopata, C. (1996). Assessing the academic networked environment: Strategies and options. Washington, DC: Coalition for Networked Information.

McClure, C., Moen, W., & Ryan, J. (1994). Libraries and the Internet/NREN: Perspectives, issues, and challenges. Westport, CT: Mecklermedia.

McKee, M. (1995). A day in the life of a virtual librarian: Helping you zip around the Internet. School Library Journal, 41 (4), 30–33.

Moen, W. (1992). Organizing networked resources for effective use: Classification and other issues in developing navigational tools. Proceedings of the American Society for Information Science Mid-year Meeting, 10–21.

Moen, W. (1998). Understanding information technology standards development: A systems-theoreic conceptual model based on a case study of ANSI/NISO Z39.50. Unpublished Manuscript. Syracuse, NY: Syracuse University.

Moore, J. (1997). The Internet as a complex evolving system. The Internet as Paradigm. Annual Review of the Institute for Information Studies 123–135. Queenstown, MD: Aspen Institute.

Moore, M. (1994). Introducing the Internet. In Morrow, C. (Ed.), The Internet unleashed (pp.3–19).Indianapolis, IN: Sams Publishing.

Morgan, N. A. (1994). An Introduction to Internet resources for K–12 educators. Part I: Information resources. (ERIC Digest). Syracuse, NY:ERIC Clearinghouse on Information and Technology. (ERIC Document Reproduction Service No. ED 372 757).

National Library of Education (1997). Access for all: A new national library for tomorrow's learners. The report of the National Library of Education Advisory Task Force. (WWW Document). Available: http://www.ed.gov/pubs/AccessforAll/title.html [1997, April 1].

Neubarth, M. (1996). A banner year. Internet World 7 (12), 10.

Packard, N. (1988). Adaptation toward the edge of chaos. (Tech. Rep. No. CCSR–88–5). Urbana, IL: University of Illinois, Center for Complex Systems Research.

Parker, R. & Radosevich, L. (1996). Web presence is point. InfoWorld (1996).

Patton, M.Q. (1990). Qualitative evaluation and research methods (2nd ed.) Newbury Park, CA: Sage Publications.

Pitsco Corporation. (1997). Ask an expert (WWW document). Available: http://www.pitsco.com [1997, April 1].

Saffo, P. (1994). It's the context, stupid. Wired, 2 (3), 563–567.

Sarkar, M., Steinfield, C., & Butler, B. (1995). Intermediaries and cybermediaries: A continuing role for mediating players in the electronic marketplace. Journal of Computer-Mediated Communications, 1 (3), Available: http://shum.hujj.ac.il/jcmc/vol1/issue3/sakar.html [1997, April 1].

Sardar, Z. & Ravetz, J. R. (1994). Complexity: Fad or future? Futures, 26, 563–567.

Senge, P. (1990). The fifth discipline: The art and practice of the learning organization. New York: Doubleday.

Silverstein, J. (1997). Information technology and commerce: Attributes of emerging online business. Unpublished doctoral dissertation proposal, Syracuse University, Syracuse, New York.

Smith, P. (1992). Client/server computing: All-in-one reference for total systems development! Carmel, IN: Sams.

Spainhour, S., & Quercia, V. (1996). Webmaster in a nutshell. Sebastopol, CA: O'Reilly & Associates.

Sprague, R., & McNurlin, B. (1993). Information systems management in practice (3rd ed.). Englewood Cliffs, NJ: Prentice-Hall.

Stein, J. (Ed.). (1982). Random House college dictionary (Rev. ed.). New York: Random House.

Still, J., & Campbell, F. (1993). Librarian in a box: The use of electronic mail for reference. Reference Services Review, 21 (1), 15–18.

Strong, G. E. (1996). Toward a virtual future. In K. Low (Ed.), The roles of reference librarians: Today and tomorrow (pp. 153–161). New York: Hawthorn Press.

Stonehill, R., & Brandhorst, T. (1992). The three phases of ERIC. Educational Researcher, 21 (3), 18–21.

Sullivan-Trainor, M. (1996). Webmaster strategies. Foster City, CA: IDG Books Worldwide.

Sutton, E. & Holt, L. (1995). The reference interview. In R. Bopp & L. Smith (Ed.), Reference and information services: An Introduction (2nd ed., pp. 36–54). Englewood, CO: Libraries Unlimited.

Sutton, S. & Oh, S. (1997). GEM: Using metadata to enhance Internet retrieval of educational materials by K–12 teachers. Bulletin of the American Society for Information Science 24 (1), 21–24.

Sutton, S. (1996). Future service models and the convergence of functions: The Reference librarian as technician, author and consultant. In K. Low (Ed.), The roles of reference librarians: Today and tomorrow (pp. 125–143). New York: Hawthorn Press.

Taylor, R. (1968). Question negotiation and information seeking in libraries. College & Research Libraries, 29, 178–194.

Taylor, R. (1986). The value-added process in information systems. Norwood, NJ: Ablex.

Van House, N., Weil, B., & McClure, C. (1990). Measuring academic library performance: A practical approach. Chicago: American Library Association.

Waldrop, M. M. (1992). Complexity: The emerging science at the edge of order and chaos. New York: Touchstone.

Wasik, J. W. (1998). A Report of library-related AskA services. [Online]. Available: http://www.vrd.org/AskA/library.html [1997, April 1].

Weber, M. (1946). Max Weber: Essays in sociology. New York: Oxford University Press.

WebTop Systems (1997). AskERIC Q/A phase 1: System requirements, package assessment, and development estimate. Unpublished manuscript, ERIC Clearinghouse on Information and Technology, Syracuse University, Syracuse, NY.

World Wide Web Consortium (1998). Platform for privacy preferences P3P project [Online]. Available: http://www.w3.org/P3P/ [1997, April 1].

XIWT (1995). An Architectural framework for the national information infrastructure. [Online]. Available: http://www.cnri.reston.va.us:3000/XIWT/documents/arch_doc/title_page.html [1997, April 1].

Yin, R (1989). Case study research: Design & methods. Newbury Park, CA: Sage Publications.

Zakon, R. H. (1995). Hobbes' Internet timeline (Vol. 2.5). [Online]. Available: http://info.isoc.org/guest/zakon/Internet/History/HIT.html [1997, April 1].

Appendix A: Pre-Test Interview Transcript

The following interview occurred on October 10, 1997 via an Internet Chat room. David Lankes (**lankes**), the researcher, interviewed Joe Janes (**janes**), Director of the Internet Public Library, at the School of Information at the University of Michigan. This is the raw transcript. It has not been edited in any way (other than formatting).

**** lankes connected at: Fri Oct 10 97 12:55:40 ****
**** janes connected at: Fri Oct 10 97 12:55:44 ****
lankes>>Joe?

janes>>I'm here

lankes>>How fast is this?

janes>>looks like pretty quick

lankes>>Greetings . . . Please be aware this is being logged.

janes>>Gotcha.

lankes>>The log will be used by me to do some model building, and you can determine how many people aside from me can see the chat.

janes>>Understood.
lankes>>I'm going to be asking you a set of questions about the Internet Public Library . . .

janes>>OK

lankes>>While I have some general areas defined, I'm hoping this will be an interactive, unstructured discussion.

janes>>I'll do my best. This should be fun!

lankes>>Please feel free at anytime to raise issues, corrections, or simply make observations that you feel are important to you.

janes>>OK

lankes>>ok, please identify yourself . . . things like title and the like.

janes>>Sure. I'm Joe Janes, Director of the Internet Public Library, at the School of Information at the University of Michigan.

lankes>>Could you briefily describe the IPL from your perspective and your duties at the IPL.

janes>>What is the IPL? Many different anwsers here. It's a public library, of and for people who "live" on the INternet.
janes>>It's also an educational enterprise, giving students and professionals a place to learn more about librarianship and the Net . . .
janes>>and how they work together (or don't) . . .
janes>>What I do is coordinate the educational aspects of it, provide vision and leadership, hire and manage staff, seek external partners . . .
janes>>and funding, and plan for the future. I also do some occasional work in the library per se, answering reference questions, . . .
janes>>adding material to collections, and so on. Typical administrivia, in an educational environment. <end>

lankes>>Would you say you have a knowledge of both operational as well as "vision" matters at the IPL?

janes>>I try. We're a large and distributed enough enterprise that there are many operational details I'm not that familiar with. In fact, . . .
janes>>I just yesterday learned how to do ref question administration, and have only recently started doing collection work. My primary . . .
janes>>part has been the "vision" and funding/partnership stuff, as well as the educational/curricular piece (teaching classes and workshops, etc.)

lankes>>Would you say you have a large or small role when determing the creation or modification or services (such as new collections or reference activities)?

janes>>I'd characterize it as a facilitative role. Since everything here's been built by students, I always have felt the need to allow them . . .
janes>>the ability & opportunity to explore and try things, so pretty much everything we have is based on somebody (person or group)'s . . .
janes>>desire or obsession, and as long as it fit in the broad framework of an "internet public library", in it went. We've never had . . .
janes>>grand plans at that level. We do have plans for where, say, online texts or the reference collection should go, but I've tried to
janes>>keep as many doors and avenues open to students as I can to keep it an exciting and motivating place for them. Of course, we
janes>>pay for that in overall planning and strategy, but that's been how I've seen best to work. Also suits my style, but I see that starting to change
janes>><end>

lankes>>You mentioned at the start . . .
lankes>>that your users are the people on the Internet, students and professionals . . . is that correct?

janes>>Yep—we think the largest component of our users are students, educators (at all levels) and library/info types. That's maybe 30–40%; the rest is everybody else, a fairly diverse group.

lankes>>How do you figure these percentages out?

janes>>Based on our hit pattern (from .com, .edu, etc.) and a survey done about 18 mos. ago; should be done again but hasn't been yet.

lankes>>So to determine your users you look at logs from your Web server and survey the users?

janes>>The former, regularly; the latter, that one time.

lankes>>Could you describe how you went about the survey?

janes>>Again, a student project; I had an undergrad doing an honors thesis. He and another student drafted the survey, I helped in revision and implementation . . . .
janes>>It appeared on our home page for 2 weeks. We got about 2200 responses, very high quality. Asked primarily demographic questions, how they found us, what they liked best, etc.

lankes>>Do you capture other user information on an ongoing basis?

janes>>We have full logs on everybody, including redirects on most links out of IPL to see what resource links they follow. We capture this data, but are not doing much of anything with it.

lankes>>Do you archive reference questions?

janes>>I do keep an eye on usage; over the last few months, the Youth area is up dramatically, as are hits from SE Asia . . . .
janes>>Yes to ref questions; we have the full record, going all the way back to opening in March 95. Probably getting near 10K qs by now, but not sure exactly how many.

lankes>>Do you track topics, or anything ongoing in these questions (even numbers over time)?

janes>>In bits and pieces; our previous ref administrator kept some stats and tracked questions (by domain, gross topic, etc.); our new staff is still getting their feet under them . . .
janes>>but we now have slightly better automated ways of counting, tracking, searching, etc.

lankes>>But to date, you main user input is in Web logs?

janes>>Yes; we also get email and messages to us from forms (URL suggestions, etc.); not consistent or very heavy but we do hear from people in several ways.

lankes>>I'd like to ask you for a second about what you look at in other sites.
lankes>>Do you surf the Web for ideas in regards to the IPL?

janes>>I wouldn't say I do that actively, but when I do surf I see things I like or don't and think about us in that regard. We redid our front page a few months ago because our . . .
janes>>previous design was looking a bit dowdy, so we jazzed it up a bit. Our basic page design and layout haven't changed since the beginning, and I think it still serves us well . . . .
janes>>I do see things I think we could do, but resource constraints always intrude about there. <sigh>

lankes>>Do you keep track of other digital reference sites? AskERIC, MADScientist and such?

janes>>You mean espionage? :-) Not on a regular basis, but we do certainly use those resources for ref, etc. I'd say when we notice they change we pay attention and see what . . .
janes>>is going on, but most of our ideas and initiatives have come from within.

lankes>>How so?

janes>>Well, I don't think we've ever looked at anybody else's site and said wow that's cool, let's do that. Rather, we sort of know what's going on out there, what we like and don't . . .
janes>>and what's feasible, and when we make changes take all that into account. But we're also blessed by best part of SI here, with a lot of really clever people and an exciting . . .
janes>>environment, so there's always a lot of creative ferment going on. We're an outlet for that for students, and we've benefited from it enormously. But no, we've never . . .
janes>>done a major survey of "other" sites to see what we could differently or better.

lankes>>Do you have "brainstorming sessions"? How do you get a hold of these creative ideas from within the IPL?

janes>>Yeah, that's one of our best ways of working. Brainstorming for us is very effective, because our people are so good and work so well together. We use it a lot and to good effect.\
janes>>We also use class discussion, and individual ideas in projects, etc. from students also.

lankes>>Swithing topics for a moment, how important are new trends or advances in Internet software?

janes>>Less than you might imagine, for a couple of reasons. We don't have any Java applets or vibrating things, (a) because we don't like them and (b) because we feel a responsibility . . .
janes>>to people who use us from low-connectivity connections, abroad, etc. Again, we pay attention to such things from the press, the Web, etc., but only when a technology . . .
janes>>really matures would we include it in the site. We only just started using tables early this year, and we still don't use frames (some of that is a conversion /inertial thing, . . .

janes>>but we also haven't found a truly compelling reason to use it, and there are only now some really good examples of worthwhile and appropriate uses). In many ways, we're very conservative.

lankes>>You say "mature," how do you determine that? DO you look at agent logs or do som einternal testing?

janes>>Not really—more observation and gut feeling.

lankes>>How about changes to the Internet infrastructure itself . . . do you have any mechanisms to look at infrastructure issues like protocol development or things like wiring?

janes>>Our tech people have a pretty good handle on that, again at an observational level. I think we know what's going on, but don't necessarily do anything about it. We also hear things from people at the school, including students.

lankes>>SO you have a technical staff who keep on track of infrastructure issues?

janes>>Yes, at present a .75 permanent staff member, a .25 student/temporary, and my collections guy is very savvy too.

lankes>>Would you say paying attention to browser changes and such also fall in their scope?

janes>>also a working connection with the school's IT folks
janes>>definitely, and we always track that carefully, but we're always very concerned about backwards compatibility. we usually look good in new browsers, but we have to look good in all of them

lankes>>How much influence would say people and organizations outside of the IPL have on how you build and maintain your service?

janes>>Hmmm. Good question. I've never really thought about that. Probably less than there should be—we've thought on several occasions about having an advisory board or . . .
janes>>something to help us, but it's never gotten done. It would have some real benefits, I think, but it's fallen between the cracks (resources again).

lankes>>Does funding influence your service?

janes>>The lack of it does. We could do so much more—almost every really cool idea anybody has here is following immediately by . . . "if we had the money." That's very hard.

lankes>>Do you shift or change what you offer by the money that comes in?

janes>>Sure. The Mellon Fdn grant funded "economic sustainability" enterprises, but we had to keep running the library which exploring those. Consequently, both suffered, because we were underresourced . . .
janes>>Right now, we're doing what we can with very little funding, and very well, but it's still extremelyfrustrating.

lankes>>You are the main mechanism to get funding?

janes>>I guess so; not by any dint of experience or expertise, more by default. Nobody else to do it. I did have a staff member devoted to it fractionally last year, but she knew . . .
janes>>less about it than I did and worked herself sick trying everything we could think of. Unfortunately, to no avail.

lankes>>What influence does the school have on the workings of the IPL and the services it offers?

janes>>Relatively little. We've tried to have the IPL more tightly integrated into the teaching and research enterprise over there, with only minimal success. We seem to be very much . . .

janes>>at arm's length . . . they know we exist but nobody over there (we are now in a different building, across the street, which I try really hard not to take as metaphor) seems to really . . .
janes>>appreciate what we're about or trying to do or help out. Students are quite another matter—they're enthused and exciting, and at least a few have told me that we're part of the reason they came to Michigan.
janes>>Go figure.

lankes>>YOu say you want to align to the teaching and research enterprise of the school . . . how does the IPL determine hat that enterprise is?
lankes>>The students, you?

janes>>Me. I still obviously know everybody over there, go to faculty meetings, etc. and pay attention to what's happening. The new curriculum is very different, still evolving, and doesn't have . . .
janes>>a whole lot to do (at least at present) with librarianship. I think that's part of the reason I have 32 students in the current IPL class which I called "Digital Librarianship" and
janes>>advertised only 2 weeks before the term started.

lankes>>You seem to get quite a bit of input for the IPL, from Web logs, to brainstorming session, etc . . . how have you organizaed yourselves (IPL) to process this . . . you mentioned a tech staff for example..do you have departments?

janes>>Yes, though that's changed when we reorganized last month (i.e., 3 of my 5 staff were let go). It's been somewhat fluid, but has always revolved around 5 major areas:
janes>>Reference, Collections, Young People, Technology, Administration/General/Teaching the Class (this last one mine)

lankes>>Do all of these groups use the same information in determining their services, or do they act somewhat autonomously?

janes>>In between; they work independently, but we're in very small physical quarters, use email a LOT to communicate stuff, and have weekly staff meetings to make sure everybody knows what's goin gon

lankes>>Could you give me a sense on how you work together to answer reference questions . . . how does that process work?

janes>>Sure. We take in questions either via email or a form in the Reference area of the library. They all come into a central repository, using software we developed (called QRC . . .
janes>>Our ref admin staff (formerly 2, now about 10, all students) reviews each question and decides whether to accept or reject (due to quota or scope). Accepted questions . . .
janes>>are posted to a category visible to our students, staff, and volunteers (professionals who help us out) . . . If you're interested in a question after reading it, you can claim it . . .
janes>>so nobody else works on it, compose an answer, send it off to the user, all within QRC. A copy of the entire transaction is preserved; this archive is now minimally searchable.

lankes>>How does this process influence the building of the library Web site?

janes>>[I don't know if you're still receiving, but my window is frozen. I can type but the "Output box" isn't doing anything. Call me 313/764–7321 if need to restart, etc.]

lankes>>joe?

janes>>here
janes>><test>
janes>>ok

lankes>>Ok, could you tell me how your reference process influences your library development?

janes>>Indirectly, and not as much as I'd like. We know from reference sort of "what it's like out there", the nature of good and bad resources, etc., but we don't have a good . . .
janes>>mechanism to get good resources from answered Qs into the collections. Shouldn't be hard (I don't think . . .) but just hasn't been implemented. No opposition from collections . . .
janes>>folks, either, just not done.

lankes>>So they run in parralell?

janes>>Yeah, that's a good way to put it. They should be more tightly integrated, tho.

lankes>>Which of your five departments is responsible for reference and which for library development.

janes>>Reference is responsible for reference question answering, Collections for developing the Ready Reference collection and others. What do you mean by library development—planning, design??

lankes>>Both.

janes>>Both are really overall responsibilities (the kind of thing we do in brainstorming sessions), led by me. Design has bounced around; as it turns out, Dave Carter, who's head . . .
janes>>of collections has de facto design responsibility but based on him not necessarily the fact that it belongs in Collections. (He maintains our Design Dicta document, for example).

lankes>>So, let me take a second to recap to this point . . .
lankes>>You work in five departments, using brainstorming sessions, staff meetings, and a LOT of e-mail. You look at Web logs, some data from reference questions and general trnds from the field to determine your service offerings . . . .
lankes>>YOu work reference and library (Web) develop in parrelell but there is some informal cross-informing accuring. SO far so good?

janes>>Yeah—let me add a couple of things. We've become a great deal more 'hierarchical' in the last few weeks as we've made the transition from the 6 staff who did most . . .
janes>>of the work to a class of 32 doing most of the day-to-day, including some administration, so we've added a layer and so far so good . . . .
janes>>In terms of "determining our service", a lot of that comes from the central question which started the IPL in 95: What does it mean to do librarianship on the Web? . . .
janes>>That question still motivates and informs the work, and as new people (students) come to us, they bring their ideas and perspectives. We've also evolved an "IPL sense"
janes>>of what we do and why, which is now being questioned and challenged (healthily) by the new group of folks. It finally starts to feel like we're on a track here. Right one . . .
janes>>or not we don't know yet, but at least on a track (rather than several or not having one at all, which is how things have felt at times.)
janes>>Otherwise, I think you've got a good handle on it.
janes>><end>

lankes>>What resources do you use to do all of this in terms of people, policies, computing.

janes>>A lot of blood, sweat and tears and very little money. A budget of about $90K this year (down from $250 last year), 2 FTE staff (from 5) plus me, 32 students ranging . . .
janes>>from administrator of Reference to people who've never worked in libraries before. Policies—some up (off the About page) about reconsideration, logs, etc., collection . . .
janes>>development/selection policies in the areas (Reference, Teen, Youth, Serials, AON, etc.); Reference question policies under development. Computing: several desktop machines . . .
janes>>servers: one production, one development, a new one coming, plus an internal server for our databases. We use Institutional File System (IFS) here for storage and backup,
janes>>also other assorted goodies (a cd masterer), and access to SI stuff like scanners, plus UM machines available to students for whatever.

janes>>Also a mirror site at University of Lund in Sweden.

lankes>>IFS is a University service?

janes>>I think started here (? not sure about this), but available at many places. Not SU :-(would have made my life much easier next term.
janes>>servers: 2 physical, at least 4 virtual (QRC is its own, for example)

lankes>>What policies or decision making procedures do you have in place for modifying your existing services or creating new ones?

janes>>"Policies"? None really; we've not been that organized/hierarchical till now. It's typically been a general recognition that something had to be done or a student project . . . .
janes>>we typically work with students/groups to help them shape and think about what they want to do, then let them go do it (making mistakes along the way), now more
janes>>concerned about maintenance, etc., than when we started, but in general people do OK with this. We try to be respectful of student work current and past, but still
janes>>realize that things do have to be changed, pulled, moved, reorganized, added to, etc. No problems so far—knock wood. We've also had some killer stuff come our way via
janes>>this process. (POTUS and A+ currently pointed to off our home page 2 excellent examples of *individual* efforts—amazing both.)

lankes>>You mentioned POTUS and A+, would you describe the service or services you presently offer.

janes>>In Collections: Ready Reference, Online Texts (largest such collection in the world), Newspapers, Serials, Teen, Youth, Associations on the Net, POTUS (Presidents of the
janes>>United States), Stately Knowledge, Native American Authors database, A+ Research and Writing for High School/College Students. All available off the Reference main page.

lankes>>How does your question/answer activity fit into these services?

janes>>Also, more specialized services under Youth (Ask the Author, etc.), Exhibits (design and layout experimentation, also curatorial exploration), Especially for Librarians . . .
janes>>Web Searching, etc.
janes>>re Reference: we do have a specialized form for reference questions from children in Youth. Otherwise, it really runs in parallel. We've always found that reading and . . .
janes>>answering reference questions was valuable for us as one of the few ways we really interact with our users, learning more about who they are, how they perceive us,
janes>>the Web, computing, and information in general, their information needs and so on. Again, no systematic method of capturing this, but we've been a small enough organization
janes>>that all of that gets internalized fairly easily.

lankes>>Are there other parrallel services?

janes>>Young People (Youth and Teen) are to an extent. They are distinct as such services often are in libraries but share much in terms of intent and motivation. Same for
janes>>Exhibits, which just kind of happen again based on individual or group interest but we do have policies about accepting exhibits, intellectual property issues, etc.
janes>>I'd call the whole thing loosely integrated.

lankes>>Are there other delivery technologies involved besides the Web and e-mail?

janes>>We had a MOO, with many interesting ideas, but I think it's petering out, tho we had quite a vocal and supportive group in there for a long while. That's it.

lankes>>Well, I think that exhausts the questions I have, are there any questions I can answer for you?

janes>>Not really. These are very interesting questions, and I'll be intrigued to see what emerges from all this. Who else are you talking to?

lankes>>I have a list of AskA services that I hope to talk to including the MADScientist folks, Ask Dr. Math . . .
lankes>>Ask A Volconologist, the Smithsonian.
lankes>>About 7 total.

janes>>That should be fascinating. A damn sight more than *my* dissertation, I'll tell you. Ugh.

lankes>>Ha! In about a week or two I'll try and reflect this back to you in some sort of process model.

janes>>Cool.

lankes>>Let me call you offline (number again?) Do you mind if I share this interview with others . . . how widely?

janes>>Doesn't bother me; I don't think I've said anything untoward, at least no more untoward than usual. I would ask for my usual 10% fee on movie rights, tho.

lankes>>ok, call you in a sec . . . and thank you very much.

**** janes disconnected at: Fri Oct 10 97 14:49:44 ****

lankes>>bye.

**** lankes disconnected at: Fri Oct 10 97 14:50:16 ****
********** Everyone has logged out **********

Appendix B: Quality Criteria Developed by the Expert Panel

The Virtual Reference Desk expert panel developed a set of quality criteria for K–12 digital reference services. The criteria are intended to serve as a set of standards in building and maintaining K–12 AskA services. Table B-1 presents the criteria divided into two categories: *User Transaction* relates to components that occur during the question answering process and *Service Development and Management* pertains to the organization and management of the service over time. For a more complete discussion see Kasowitz, (1998).

Table B-1: Quality Criteria Used by the Virtual Reference Desk

Applies to:	Facet	Definition
User Transaction	Accessible	K–12 digital reference services should be easily reachable and navigable by any Internet user regardless of equipment sophistication. (Many users connect from school-based computer systems that may not have high bandwidth capabilities.)
	Prompt Turnaround	All questions should be addressed as quickly as possible. Actual turnaround time depends on a service's question/answer policy and available resources (e.g., staffing, funds, etc.).
	Sets User Expectations	Clear communication should occur either before or at the start of every digital reference transaction in order to reduce opportunities for user confusion and inappropriate inquiries.
	Interactive	Digital reference services should provide opportunities for users to communicate necessary information to information specialists and to clarify vague user questions. The more opportunities for interaction, the more effective the transaction.
	Instructive	Digital reference services can play an important role in the learning process of both children and adults by providing access to current information and expertise. Quality digital reference services offer more to users than straight, factual answers; they guide them in subject knowledge as well as the area of information literacy.

Applies to:	Facet	Definition
Service Development and Management	Authoritative	The information specialists of a digital reference service should have the necessary knowledge and/or educational background in the service's given subject area or skill in order to qualify as an expert.
	Trained Information Specialists	Services should offer effective orientation or training processes to prepare information specialists to respond to inquiries using clear and effective language and following service response guidelines. Training of information specialists is one of the most important aspects of planning and operating a digital reference service.
	Private	All communications between users and information specialists should be held in complete privacy.
	Reviewed	Digital reference services should regularly evaluate their processes and services (i.e., responses). Ongoing review and assessment helps ensure quality, efficiency, and reliability of transactions as well as overall user satisfaction.
	Unbiased	Digital reference services should not promote products or personal and/or institutional opinions in such a way that interferes with quality or use of service. This is especially important because adults in the K–12 community (parents, administrators, teachers) may be concerned with children's access to Internet-based information.
	Provides Access to Related Information	Besides offering direct response to user questions, digital reference services should offer access to supporting resources and information.
	Publicized	Services providing information to the K–12 community are responsible for informing potential users of the value that can be gained from participation. The greater the outreach to K–12 communities across the country, the smaller the gap between the "haves" and the "have-nots" in terms of effective learning opportunities.

Appendix C: The AskERIC Pre-Test

This appendix describes the AskERIC service and represents the service as a performance system. This pre-test was used to both test the conceptual framework and aid in the development of a format for the representation of results.

AskERIC Background

The United States federal government formed the Educational Resources Information Center (ERIC) in 1966. The government envisioned ERIC as a national information system designed to provide users with ready access to an extensive body of education-related literature. Today, the Office of Educational Research and Improvement (OERI) within the U.S. Department of Education supports ERIC. One of ERIC's primary products is the ERIC database. This database is the world's largest source of education information. It contains over 800,000 abstracts of documents and journal articles on education research and practice (Abdal Haqq, 1995) and is available in approximately 3,000 locations worldwide as of January, 1995 (ERIC Pocket Guide 1995, Stonehill & Brandhorst, 1992).

AskERIC went online as an Internet-based question answering service in November of 1992 (ERIC, 1992) as a special project of the ERIC Clearinghouse on Information & Technology. The service had a dedicated staff of one with assistance from the ERIC Clearinghouse on Information & Technology and a doctoral student from Syracuse University's School of Information Studies. Within a year, the service had added automated services (FTP, Gopher, WAIS) and increased its staff by three.

As the number of incoming questions doubled, AskERIC's staff increased. When the automated services (primarily Gopher) grew beyond the existing time and effort of the doctoral student, a second coordinator level position was added. AskERIC then expanded from a pilot project of three states (Texas, New York and North Dakota) to the entire country. The system needed to become available twenty-four hours a day, seven days a week. A Research and Development (R&D) team was created with separate resources for experimentation. The goal of R&D was to keep AskERIC current in the constantly changing Internet environment. Also created with the expansion was a separate set of resources for interfacing with state and regional networks originally known as the Virtual Communities group. AskERIC also increased its systems infrastructure with the help of Sun Microsystems. The increase in the technical infrastructure led to the creation of a systems component to AskERIC that operates as a SunSITE[42].

Currently AskERIC is in its fifth year of operation. It provides many types of Internet services (Gopher, FTP, World Wide Web, E-mail). AskERIC is also one of a handful of global SunSITEs. The project has increased its staff and computing power by an order of magnitude. The project has gone from one person in a back room with a NeXT workstation, to staff around the country working on high-end workstations to meet the needs of educators around the country. Throughout that time, the growth has been user-directed: educators and other users have determined the types of services offered and the level of resources allocated.

[42] SunSITEs are university-based projects that use donated equipment from Sun Microsystems.

AskERIC Today

Today AskERIC serves over 70,000 educators a week through its services. It constantly seeks out new partners from education, industry, and government to provide its clients with the best information. As shown in Table C-1 AskERIC has five components:

Table C-1: Functional Components of the AskERIC Service

AskERIC's Question/Answering Service (Q&A)	A set of trained information specialists around the country take educator's questions via e-mail and use a variety of networked and traditional resources (ERIC database, Internet sites, Listservs, etc.) to answer these questions.
AskERIC's Virtual Library (AEVL)	A set of coordinated automated Internet information systems that provide documents on the process of education (including more than 900 lesson plans, subject oriented InfoGuides, and archives of educator discussion groups such as MIDDLE-L, LM_NET (Eisenberg & Milbury, 1994), and EDTECH).
AskERIC's Partnerships (originally Virtual Communities)	AskERIC's outreach services to acquire resources for AskERIC's user services (Q&A and AEVL).
AskERIC Research and Development (R&D)	An effort to investigate the networking tools of today and tomorrow. This group also advocates the position of education in today's high-performance computing and networking effort.
AskERIC Systems/SunSITE (Systems)	Support group that maintains systems (hardware and software), purchases technology and acts as a technical liaison with technology partners such as Sun Microsystems and Personal Library Software.

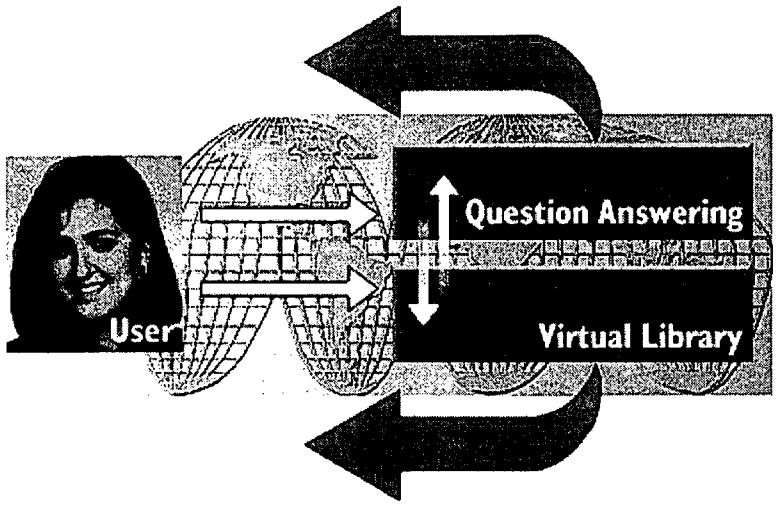
AskERIC will continue to change in the future as educators' needs change and as the network matures. Already several AskERIC initiatives have begun incorporating challenges outlined in the National Information Infrastructure (Executive Office of the President, 1993).

The AskERIC Organization

All five of AskERIC's areas act as detectors, guiding the management of AskERIC's Internet information services. Each area, however, does this in a different manner, and to a different degree. While AskERIC concentrates on user input, it must deal with other forces that seek to create policy. AskERIC *Research & Development*, for example, stresses new technology in vision setting activities. AskERIC *Partnerships* (see below) concentrate on exterior interests in policy setting.

User Services

AskERIC's user services provide the primary method of guiding AskERIC's Internet information services. Of AskERIC's five units, only two are directly accessible to end-users; the *Question Answering Service* (McKee, 1995), and the *Virtual Library* (Morgan, 1994). These services (described above) represent the main user input, and therefore, the primary means of directing the organization. Figure C-1 represents this input.



LEGEND
- Response to User
- User input (e-mail or from client software)
- Formal and Informal Organizational Informing

Figure C-1 AskERIC's User Services: AskERIC uses e-mail to inform (formally and informally) and direct its primary services. The user receives feedback in the form of either an e-mail response or the requested file.

In the question answering service, user questions and comments are the major source of information. Trends in questions and comments represent users' situations and information needs. These trends are communicated to the rest of AskERIC particularly to the Virtual Library. An example of this communication is the development of the InfoGuides—pathfinders to Internet and ERIC resources on given topics. The topics are derived from incoming questions to the Q&A service.

The *Virtual Library*, to a great degree, represents repeated trends in *Question Answering Service*. The Virtual Library also "informs" the *Question Answering Service*. It does this by informing question answerers (Network Information Specialists) what resources are available in the AskERIC Virtual Library and how to access them. It also informs the larger AskERIC organization of "hot" areas on the automated services. This is determined by often-accessed Web pages and Gopher directories.

In combination, then, the *Question/Answering Service* and *Virtual Library* represent not only the interfaces of AskERIC to the user community, but also the primary detectors (gathering data on what users want and how they are satisfying that need). This data forms the direction of the project. The user input forms the primary influence in building and maintaining AskERIC's Internet information services.

Technology Services (Research & Development and Systems/SunSITE)

AskERIC also considers technology in determining the strategy of the organization. However, the technological input is considered secondary to user input. The "Research & Development" effort exists both within the AskERIC organization, and outside it. Not all of the researchers in Research & Development are employees of AskERIC. Many researchers are

students from Syracuse University. One could view Research & Development either as a part of AskERIC, or as a separate research effort working on AskERIC material. Figure C-2 below depicts this relationship.

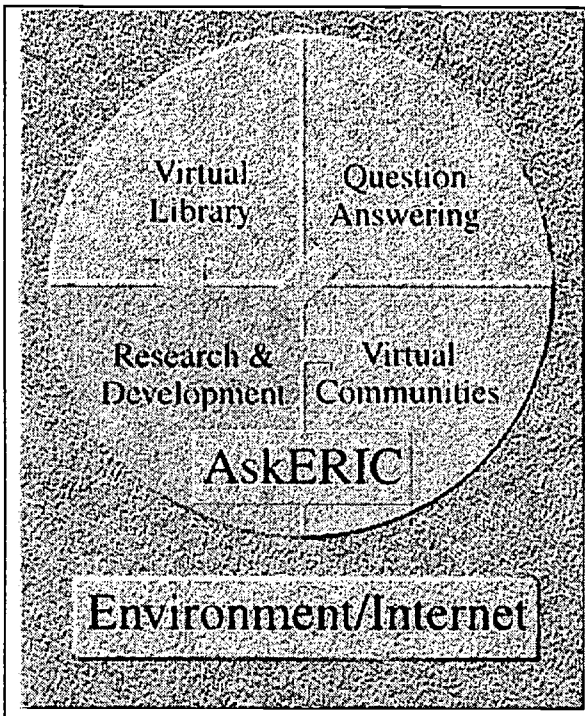


Figure C-2 AskERIC R&D's Relationship to Other AskERIC Components: The figure represents the use of Research and Development efforts to scan the Internet technology environment. Rather than setting direction, Research & Development informs other sections of AskERIC.

The main purpose of Research & Development is to look for future technologies that may be useful to AskERIC and K–12 educators. However, these technologies are not implemented by AskERIC until the user services (Question/Answer Service or the Virtual Library) feel there is broad enough acceptance from the end-user population. AskERIC could not use the World Wide Web, for example, until the user services felt there was enough access for their users. So while Research & Development does help to manage and direct the service, it is always constrained by the needs of the user services.

The "Systems/SunSITE" group of AskERIC serves a different technical purpose. Whereas R&D seeks innovation, Systems seeks stability. It is the responsibility of the Systems Group to ensure all computing and network platforms are available to the other AskERIC components (except for R&D which is mostly self-supporting). Systems also overlaps in responsibility with the Partnership group (described below). Once a relationship is established with a technical organization (such as Sun Microsystems or Personal Library Software) Systems forms a relationship with a technical contact within the partnering organization. This relationship is used to support the technical infrastructure provided by the partner as well as solicit opportunities and feedback from this partner.

Partnerships

Another component of the project that contributes to AskERIC's ongoing activities is the "Partnerships" group. The Partnership group is responsible for soliciting funds, resources, and projects from organizations external to AskERIC. Partnerships also acts as a liaison to external partner organizations (such as state networks, The Federal Department of Education and various organizations). The Partnerships team acts as a liaison between external organizations and AskERIC. This branch of AskERIC, however, does not determine policy or direction. The Virtual Library group assists and directs most efforts of the Partnerships. If the Library does not see a fit between the external organization and AskERIC, then contact is not continued.

The Partnerships team also works with the Systems group and the Research and Development group on a project by project basis. The technology services act as a sort of contractor to provide specifications and technical expertise to the project. These relationships can be seen in Figure C-3.

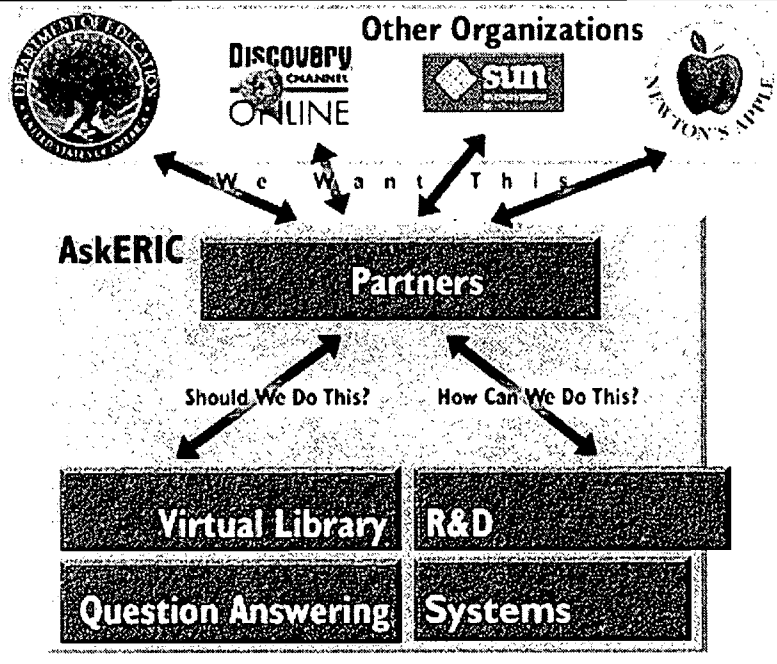


Figure C-3 Relationship of AskERIC Partnerships Group to AskERIC and Other Organizations: The Partnerships area takes input, resources, and projects from outside of AskERIC and coordinates with internal AskERIC sections to determine the usefulness and feasibility of new projects, and adding new resources.

Viewing AskERIC as a Performance System

The above information lays out AskERIC and its services and gives a glimpse into how the five components of AskERIC are used to build and maintain its information services. We can take the above information and recast it into Holland's performance system. For this process the initial coding scheme was used.

Detectors

Detectors are the mechanisms used by an agent to gather information from the environment. From the conceptual framework presented in Chapter 2, detectors can be from other Internet agents (broken down by Internet agent types), from internal sources, or from outside the agent and the Internet (external detectors). Table C-2 below represents a listing of AskERIC detectors. The table lists detectors by their type (Internet agent type, internal or external), the actual mechanism used to gather information from the environment, and a description of the mechanism and the type of information it receives from the environment.

Table C-2: AskERIC Detectors

AskERIC Detectors			
	Detector Type	*Mechanism*	*Description*
Internet Agents			
	Users	Question Answer Statistics	Reports that state the number of users, basic information on where the user is from, and whether the question was answered internally by AskERIC or externally.
		User Questions via e-mail	Actual user queries sent to askeric@ericir.syr.edu. These questions are received by Network Information Specialists who attempt to determine trends in the questions.
		Virtual Library Statistics	Usage logs for the automated services such as the World Wide Web site, telnet, gopher and FTP.
		Virtual Library Comments	Comments sent to the Webmaster of the Virtual Library.
	Information Services	Informal Browsing	Members of the AskERIC project use a listserv to share resources found on the Web through information browsing, or sites found in the performance of non-AskERIC duties.
		Question Answer Resource Creation	Network Information Specialists search for resources used repetitively in answering users e-mail queries. These resources are aggregated and cataloged for use by other Network Information Specialists
		InfoGuides	Library students build pathfinders to "hot topics" identified by the Question Answer service. These pathfinders highlight good Internet sites and services.
	Application Builders	Research and Development	The emphasis of the R&D unit is discovery of new tools and programming ideas from the Internet field. These R&D workers investigate the output of application builders (software) and look for ways to apply these outputs in the AskERIC environment.
		Vendor Agreements: Sun Microsystems	Sun Microsystems sends updates and new product announcements to the System/SunSITE group through a listserv established for SunSITE managers. Sun representatives also work to keep the Systems group up to date on Sun software.
		Vendor Agreements: Personal Library Software	The Systems group works closely with the technical support staff at Personal Library Software in implementing the ERIC database and other search areas on the Virtual Library. Through this working relationship, PLS keeps the Systems staff up to date on PLS software developments.
		Vendor Agreements: Microsoft	The Systems group works closely with the technical support staff at Microsoft in implementing the a related project to AskERIC. Through this working relationship on the other project, the Systems staff up to date on Microsoft software developments.
	Infrastructure Providers	Systems Group Liaison: Syracuse University	Syracuse University provides all of the infrastructure for the AskERIC project. The System group keeps up to date on infrastructure issues by working with the networking staff at SU.
		Systems Group Liaison: Sun Microsystems	Sun Microsystems sends updates and new product announcements to the System/SunSITE group through a listserv established for SunSITE managers. Sun representatives also work to keep the Systems group up to date on Sun hardware.
		Systems Group Research with Trade Publications	The Systems group keeps on top of industry shifts in Internet hardware and standards through a wide variety of weekly trade publications (*InfoWorld, Web Week*, etc).
	Internal	Systems Group Purchasing	The systems group handles all technology purchases for the AskERIC project. As part of this purchasing decision, they often research products and services. This internal research generates ideas of new products and service options.
		Presentations and Conferences	AskERIC staff both attends conferences and gives presentations. These activities generate ideas and options for service development and give first hand evaluations of the service.
		Brainstorming and Retreats	AskERIC has a series of meetings throughout the year to evaluate its services, explore the field of possibilities in information services, and generate ideas for new services.
	External	Partnership: Department of Education	The partnerships group works closely with the U.S. Department of Education to identify new initiatives in education at the national level. This relationship also identifies constraints (such as budgetary) on services.
		Partnership: Syracuse University	The AskERIC staff works closely with Syracuse University to identify constraints in service offering, and determine the needs of AskERIC's parent organization.
		Partnership: School of Information Studies	The AskERIC staff works closely with The School for Information Studies to identify constraints in service offering, and determine the needs of AskERIC's parent organization.
		Questions from users, non-Internet (via phone or face to face)	The AskERIC Question Answer service receives user queries in ways other than the Internet. This information is used in determining service offerings as well.

Rules

According to Holland (1995), aggregation property agents can be seen as aggregates of other agents. This is true of rules as well (i.e., rules can be seen as aggregates of other rules or processes). From the narrative description presented above, it is evident that the "user services" (Q&A and Virtual Library) drive the building and maintenance of the AskERIC service. For this reason, the processes used by the Q&A and Virtual Library components of AskERIC are emphasized in this rules description. Figure C-4 presents a flow chart showing AskERIC processes based upon differing classes of inputs (aggregated from the detectors listed above).

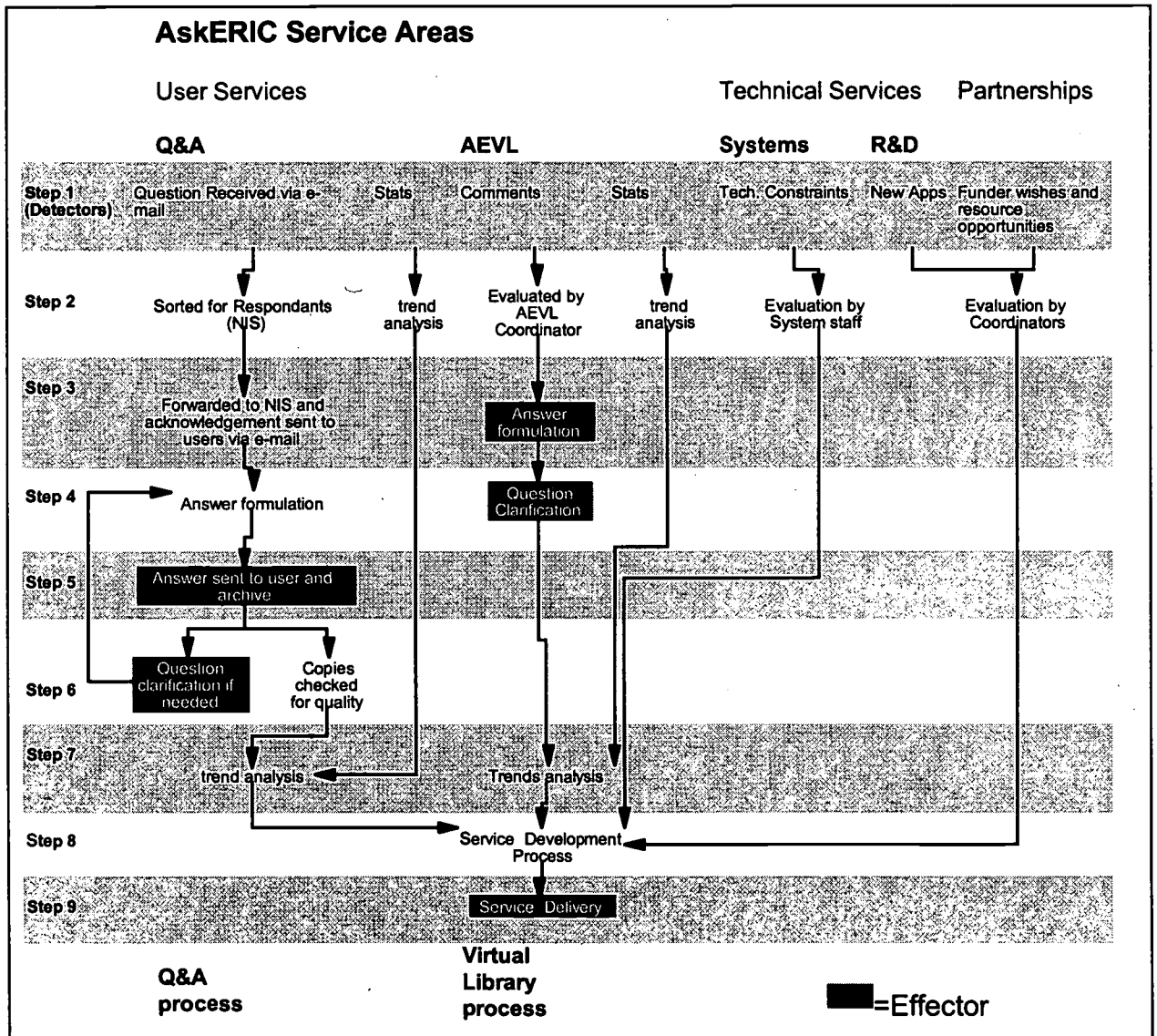


Figure C-4 AskERIC's Rules: AskERIC utilizes differing detectors types (divided by AskERIC components) to build and maintain its services.

The narrative description of AskERIC noted two primary processes involved in building and maintaining AskERIC's Internet information services. These processes are the question

answering service (in Figure C-4 represented by "Q&A process" starting with "Question received via e-mail" in step 1) and the Virtual Library (represented in Figure C-4 by "Virtual Library process" starting with "Comments" in step 1). Figure C-4 also demonstrates how all other detectors become part of these two processes. Tables C-3 and C-4 detail the resources used at each step in each of these processes.

Table C-3: Resources Used for The Question Answer Process

Step	Human Resources	Technology	Policy Instruments
Step 1 (Detectors)		Electronic mail, Unix (Solaris) mail servers for delivery and queuing of messages, and Macintosh machines with Eudora for actual processing of e-mail.	
Step 2	Network Information Specialist (NIS) with special training in sorting and routing user questions.	Eudora on a single sorting platform (Macintosh).	AskERIC Manual stating that all questions should be processed in two working days.
Step 3	Network Information Specialist (NIS) with special training in sorting and routing user questions.	Eudora and specialized AppleScripts on a single sorting platform (Macintosh). Electronic mail.	Letters of agreements limit the number of questions that can be sent to Network Information Specialists.
Step 4	Network Information Specialists, ERIC Clearinghouse staff or content expert.	ERIC database, paper reference resources, Internet tools (Web browsers). In this distributed setting, technologies vary between the person answering the question.	AskERIC Manual specifies a format for responses. Manual also states that Internet resources and full-text resources are preferred.
Step 5	Network Information Specialists, ERIC Clearinghouse staff or content expert.	Electronic mail.	Internal AskERIC manual states that answers should be sent to the archive. All questions should get some answer, even if broad and asking for clarification.
Step 6	Network Information Specialists at Syracuse University checks responses. Network Information Specialists, ERIC Clearinghouse staff, or content expert follows up with a user.	Electronic mail (Eudora for checking answers, various e-mail packages for interacting with users).	The AskERIC manual requires an NIS to always ask for follow-up. Always give pointers to non-full-text responses.
Step 7	Network Information Specialists.	E-mail packages, Excel.	
Step 8			
Step 9			

Table C-4: Resources Used for The Virtual Library Process

Step	Human Resources	Technology	Policy Instruments
Step 1 (Detectors)		E-mail or World Wide Web forms (created with HTML, PERL Scripts with NCSA HTTPD on a Solaris server)	
Step 2	Virtual Library Coordinator	Pine e-mail client on UNIX platform	
Step 3	Virtual Library Coordinator	Pine e-mail client on UNIX platform	
Step 4	Virtual Library Coordinator	Pine e-mail client on UNIX platform	
Step 5			
Step 6			
Step 7	Virtual Library Coordinator	UNIX based log analysis tools and customized PERL log analysis tools developed in-house	
Step 8	Virtual Library Coordinator, Webmaster, graduate project managers, HTML mark-up workers.	Macintosh platforms for HTML mark-up and graphics creation. UNIX utilities, PERL and Personal Library Software for custom software development	Stated policy that no resources will be developed without wide access and appeal for educators. No resources will be created for obvious commercial purposes (Lankes 1995).
Step 9		Sun Enterprise 3000 server running NCSA's HTTPD.	Stated goal of 24 hour per day 365 days a year access for users (Lankes 1995).

The other detector types and processes feed into the Virtual Library and Q&A processes. These detector types are of a lower priority than input from e-mail and comments.

The other major factor in the way AskERIC is built and maintained is internal innovation (represented by the internal detectors as seen in Table C-2). There are no official processes or rules for these detectors (hence they are not represented in Figure C-4). Meetings, informal discussions and exchanges of e-mails can prompt service production, or shifts in service delivery. The innovations tend to come from the directors of the service.

Effectors

Effectors are the tools available to the agent to effect its environment. These effectors were inductively determined from the different K–12 digital reference services. The researcher chose a scheme based on the technology used to interface with users. As was described above in the description of the AskERIC service, there are only two components that directly interface with the users. AskERIC defines its effectors in relationships to users, being a so-called "user-based" service. Table C-5 below outlines the effectors, giving the type of technology used, a tag that uniquely identifies the effector and the perceived purpose (or desired interaction with the environment).

Table C-5: AskERIC Effectors

AskERIC Effectors				
		Type	*Tag*	*Purpose*
	Technical	World Wide Web site	http://ericir.syr.edu/	Repository of static primary resources for educators.
		E-mail	askeric@ericir.syr.edu	One to one asynchronous reference.
		Gopher	gopher://ericir.syr.edu	Repository of static primary resources for educators with low technology access.
		FTP	ftp://ericir.syr.edu	Repository of static primary resources for educators with low technology access.
		Palace	palace://ericir.syr.edu:9998	Synchronous reference and instruction interaction area.
		ERIC Database	http://ericir.syr.edu/Eric/	Repository of education specific reference (bibliographic) resources.
	Other	800 Number	1(800)464-9107	One to one synchronous reference service for individuals without Internet access.
		Publications	AskERIC Cards AskERIC Brochures AskERIC CD	Awareness and training materials.

AskERIC Summary

This section described the AskERIC K–12 digital reference service in detail. This description was in the form of a narrative discussing the project's history, the interrelation of its components, and the application of the conceptual framework created in Chapter 2. AskERIC is the first example of a K–12 digital reference service described by this investigation. This description was refined throughout the research process. The AskERIC example is used to demonstrate to the reader how the conceptual framework was used to describe K–12 digital reference services.

Appendix D: More Information from the Internet

Alta-Vista: http://www.alta-vista.com/
America Online: http://www.aol.com/
Ask Dr. Math: http://forum.swarthmore.edu/dr.math/dr-math.html
AskERIC: http://www.askeric.org
CUSeeME: http://goliath.wpine.com/cu-seeme.html
EdInfo: email message to: listproc@inet.ed.gov Then write SUBSCRIBE EDINFO YOURFIRSTNAME YOURLASTNAME
ERIC: http://www.aspensys.com/eric/index.html
FileMaker Pro: http://www.claris.com/
FTP and telnet: http://ericir.syr.edu/~rdlankes/searcher/Telnet/tel.html
Gopher: gopher://gopher.tc.umn.edu/
InfoGuides: http://ericir.syr.edu/Virtual/InfoGuides/
KidsConnect: http://www.ala.org/ICONN/kidsconn.html
Library of Congress: http://www.loc.gov/
MAD Scientist Network: http://medinfo.wustl.edu/~ysp/MSN/
Microsoft: http://www.microsoft.com/
Mosaic: http://www.ncsa.uiuc.edu/SDG/Software/Mosaic/
National Center for Supercomputing Applications: http://www.ncsa.uiuc.edu/
National Library of Education: http://www.ed.gov/NLE/
Netscape: http://www.netscape.com/
NeXT: http://www.next.com/
Prodigy: http://www.prodigy.com/
Pitsco: http://www.pitsco.com/
RealAudio: http://www.realaudio.com/
Sun Microsystems: http://www.sun.com/
SunSITE: http://www.sun.com/sunsite/
TCP/IP: http://www.ietf.org/
U.S. Department of Education: http://www.ed.gov/
WAIS: http://www.yahoo.com/Computers_and_Internet/Internet/Searching_the_Net/WAIS/
World Wide Web: http://www.w3.org/pub/WWW/
Yahoo: http://www.yahoo.com/
National Museum of American Art Reference Desk: http://nmaa-ryder.si.edu/referencedesk/
How Things Work: http://landau1.phys.virginia.edu/Education/Teaching/HowThingsWork/home.html
Ask Shamu: http://www.seaworld.org/ask_shamu/asintro.html
Ask A Volcanologist: http://volcano.und.nodak.edu/vwdocs/ask_a.html

Appendix E: Synopsis of Data Gathering

Ask A Volcanologist

An initial description of the "Ask A Volcanologist" service was created based upon an in-depth interview with Jamie Dronen, the primary research assistant for the VolcanoWorld Web site. This interview was conducted in an Internet chat room. The researcher also conducted a survey of the Web site in order to clarify, support or refute information from the interview. In the process of creating an initial description, a series of questions were e-mailed to Dronen for clarification, however, no answer was received before the follow-up interview was conducted.

Once the initial description was created, a follow-up phone interview was conducted as a member-check. Dronen reviewed the description via *Adobe Acrobat* on his computer screen while the researcher "walked" him through the blueprint.

There was agreement between the initial description and Dronen's view. There were only two minor changes consisting of the following:

- Adding detail on the type of Web server used by the service
- Adding "Vendor Solicitations via mail and E-mail" to the "Application Builders" detector type.

Dronen was very pleased with the resulting description and stated he would find it useful.

Ask Shamu

An initial description of the Ask Shamu service was created based upon an in-depth interview with Pamala Wilson, Internet Coordinator for the Sea World/Busch Gardens Animal Information Database. This interview was conducted in an Internet chat room. The researcher also conducted a survey of the Web site in order to clarify, support, or refute information from the interview. Since Ask Shamu is exclusively an e-mail based service, there was little Web documentation to augment the interview data. In the process of creating an initial description, a series of questions were e-mailed to Wilson for clarification.

Once the initial description was created, a follow-up phone interview was conducted as a member-check. Wilson reviewed the description via *Adobe Acrobat* on her computer screen while the researcher "walked" her through the blueprint.

There was great agreement between the initial description and Wilson's view. There were only minor changes consisting of the following:

- Eliminating listserv subscriber information as a user detector
- Adding "Formal Training" as an application builder detector
- Linking the "Commercial Site" detector to the "Question Answer Process"
- Adding Wilson as a human resource in "Web Authoring"
- Making minor corrections in terminology.

Wilson was pleased with the resulting description and stated she would find it useful.

Dr. Math

An initial description of the Dr. Math service was created based upon an in-depth interview with Ken Williams, one of the founders of Dr. Math. :

> We don't have many 'official' titles around here, but I think mine is something like 'Programmer and Administrator for Dr. Math.'

This interview was conducted in an Internet chat room. The researcher also conducted a survey of the Web site in order to clarify, support, or refute information from the interview. There was a great deal of information on the Web site regarding the process for answering questions, as well as the policies used in creating answers. In the process of creating an initial description, a series of questions were e-mailed to Williams for clarification.

Once the initial description was created, a follow-up phone interview was conducted as a member-check. Williams reviewed the description via *Adobe Acrobat* on his computer screen while the researcher "walked" him through the blueprint.

There was agreement between the initial description and Williams' view. The changes were oriented around clarifying the relationship between training and question answering, and clarifying the sub-components of "Web Development." Specifically:

- Combining the "Answer Formulation" function used in training as well as normal question answering (they are the same rule)
- Linking the review process in training to all effectors of the Dr. Math service
- Clarifying both the "Workshop Feedback" in function as well as placement as an "External" detector
- Adding "Evaluators" as human resources
- Adding "Feedback to the Webmaster via E-mail" as a "User" detector
- Clarifying the two types of "Web Development" as archives from the "Question Answer Process" and value-added FAQ's.

While these changes were substantial, they did not fundamentally alter the description; instead they clarified and added depth. Williams was pleased with the results and stated that he would find the blueprint useful.

How Things Work

An initial description of the How Things Work service was created based upon an in-depth interview with Louis Bloomfield, the sole operator of the service. This interview was conducted in an Internet chat room. The researcher also conducted a survey of the Web site in order to clarify, support, or refute information from the interview. The How Things Work Web site consist almost exclusively of question/answer archives, so there was little supportive documentation regarding how the service was run. In the process of creating an initial description, a series of questions were e-mailed to Bloomfield for clarification.

Once the initial description was created, a follow-up phone interview was conducted as a member-check. Bloomfield reviewed the description via a large-format printout while the researcher "walked" him through the blueprint.

There was agreement between the initial description and Bloomfield's view. There were only minor changes consisting of:

- Moving the "Answer Sent Directly to User" into the "Primary Q&A Process." This involved the elimination of an "Impromptu Q&A Process." Both the researcher and Bloomfield agreed that there is only a single Q&A process
- The elimination of a linkage between the "Web Logs" detector and the Web production process
- Moving "Departmental Technology Staff" to external detectors (as they are not part of the How Things Work service itself).

Bloomfield agreed that the description captured the structure of the service, while admitting that the service itself was very "informal."

MAD Scientist Network

An initial description of the MAD Scientist Network service was created based upon an in-depth interview with Joe Simpson:

> I'm a 5th year MD/PhD student at Washington University School of Medicine. I volunteered to help Lynn Bry, the founder of the Mad Scientist Network, back in 1995. I've been actively involved on a daily basis ever since.

This interview was conducted in an Internet chat room. The researcher also conducted a survey of the Web site in order to clarify, support, or refute information from the interview. There was a great deal of information on the Web site regarding the process for answering questions, as well as the policies used in creating answers.

During the initial interview, Simpson made it evident that Lynn Bry, founder of the Mad Scientist Network was still involved in daily activities:

> **Simpson>>**I had no input into the original setup of the site. Since that time, I and several of the other volunteer moderators have made suggestions for additions or improvements that Lynn has incorporated. My actual scripting contribution has been pretty small."
>
> **lankes>>**How involved is Lyn in the service at this point?
>
> **Simpson>>**She is still pretty active, although her time is limited because she is in her 3rd year of med school now.

An additional phone interview was conducted with Lynn Bry. In the process of creating an initial description, a series of questions were e-mailed to Simpson for clarification.

Once the initial description was created, a follow-up phone interview was conducted with Simpson as a member-check. Simpson reviewed the description in the form of a large-scale printout while the researcher "walked" him through the blueprint.

There was agreement between the initial description and Simpson's view. The changes involved some terminology changes and the addition of an e-mail answering component. Specifically:

- Adding the "Young Scientist Program Coordinator" to translate e-mail questions and answers into Web documents
- Creating a "Volunteer Returns Answer via E-mail" component in the "E-mail Process" that links into the "Question Answer Process"
- Clarifying terminology
- Adding "Volunteers" as human resources in internal detectors

These changes did not fundamentally alter the description, instead they clarified and added depth.

National Museum of American Art Reference Desk

An initial description of the National Museum of American Art Reference Desk service was created based upon an in-depth interview with Joan Stahl, Coordinator of the Image Collections at the National Museum of American Art, Smithsonian Institution. This interview was conducted in an Internet chat room. The researcher surveyed the Web site and reviewed some documentation provided by Stahl in order to clarify, support, or refute information from the interview. The Web site, however, is only an HTML form for submitting questions and a few links to other art Web sites, therefore, not much information was gathered. In the process of creating an initial description a series of questions were e-mailed to Stahl for clarification.

Once the initial description was created, a follow-up phone interview was conducted as a member-check. Stahl reviewed the description via an *Adobe Acrobat* PDF file on a computer screen while the researcher "walked" her through the blueprint. E-mail clarification was also used after the follow-up interview.

There was great agreement between the initial description and Stahl's view. Minor changes consisted of:

- Adding the use of archives in the "Immediate Answer" stage
- Combining saving files to a shared disk and archiving questions and answers into a single step
- Linking the revised archiving step to the "Answer Formulation" step
- Moving questions from AskERIC to external detectors and expanding this detector to include other services internal and external to the Smithsonian.

Stahl agreed that the description captured the structure of the service and was pleased at the opportunity to see "inside" other digital reference services.

Index

A

B

C

D

E

G

H

I

K

L

M

N

O

P

Q

R

S

T

U

X

Y

U.S. Department of Education
Office of Educational Research and Improvement (OERI)
National Library of Education (NLE)
Educational Resources Information Center (ERIC)

NOTICE

REPRODUCTION BASIS

☐ This document is covered by a signed "Reproduction Release (Blanket) form (on file within the ERIC system), encompassing all or classes of documents from its source organization and, therefore, does not require a "Specific Document" Release form.

☑ This document is Federally-funded, or carries its own permission to reproduce, or is otherwise in the public domain and, therefore, may be reproduced by ERIC without a signed Reproduction Release form (either "Specific Document" or "Blanket").

The Virtual Reference Desk

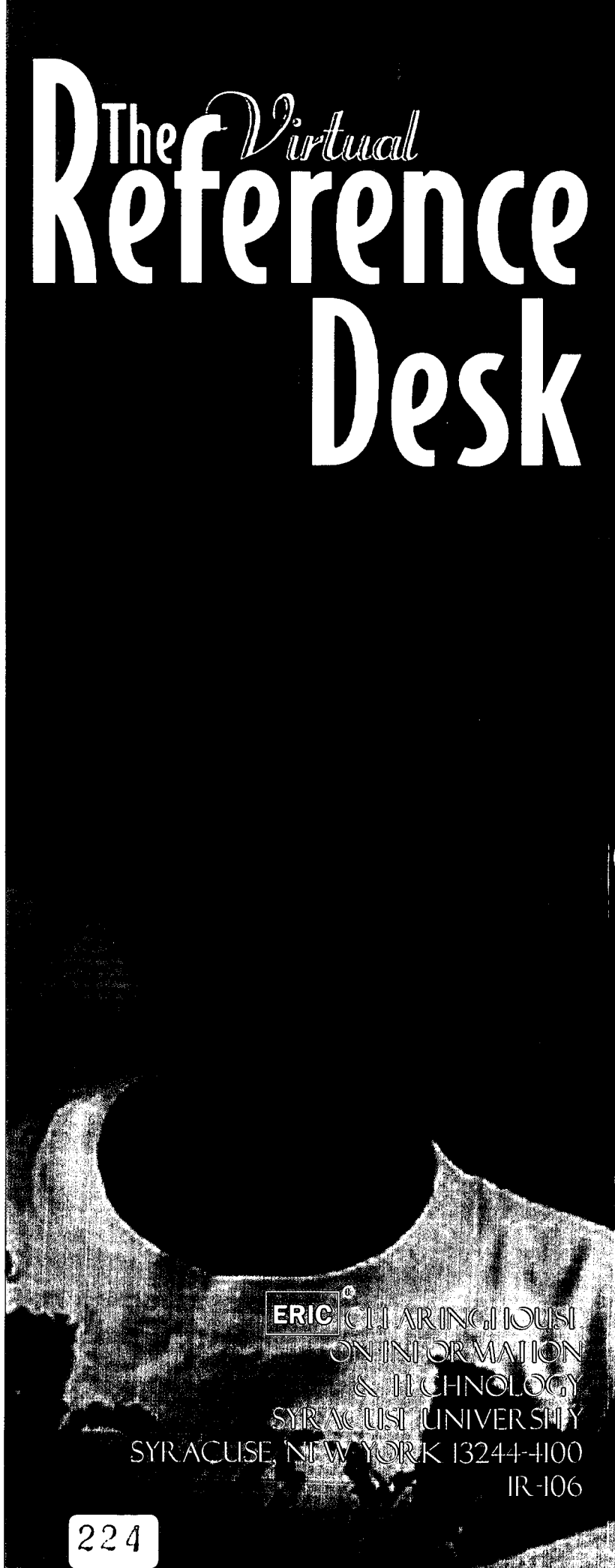
Go behind the scenes of today's exemplary digital reference services.

Ask A Volcanologist
Ask Dr. Math
Ask Shamu
AskERIC
How Things Work
Internet Public Library
MAD Scientist Network
National Museum of American Art Reference Desk

Building & Maintaining Internet Information Services: K-12 Digital Reference Services presents a series of tools to analyze Internet information services. It provides detailed methods to describe services and how they operate in a complex Internet environment. This book looks at how organizations maximize the human elements in an age of disintermediation.

A competent and innovative piece of research that provides a significant contribution to the field. A must read for researchers in digital reference.

- Charles R. McClure, Ph.D.
Distinguished Professor
School of Information Studies
Syracuse University



ERIC CLEARINGHOUSE ON INFORMATION & TECHNOLOGY
SYRACUSE UNIVERSITY
SYRACUSE, NEW YORK 13244-4100
IR-106