# An Adaptive Hypermedia System for Improving an Organization's Customer Support

**Timothy R. Schmoyer & Bernard J. Jansen**

*For organizations that provide services directly to customers, there is a requirement for involvement with customers along with organizational tracking of customer support performance. Examples of such support requirements are maintenance service orders for buildings, merchandise return or repair, and status reports of actions or accounts. The degree to which an organization successfully accomplishes this customer support has a direct impact on the overall perception of the organization's efficiency, customer satisfaction, and organization's bottom-line. Some functional issues to consider are completeness, accuracy, and timeliness of the provided support. Not only must an organization effectively and efficiently address these issues, but the organization must also accomplish them in a manner that the customer perceives as personal. These factors became the design criteria in the development of our online system.*

Timothy R. Schmoyer and Bernard J. Jansen, Department of Electrical Engineering and Computer Science, United States Military Academy, West Point, NY

E-mail: timothy.schmoyer@ieee.org
E-mail: jjansen@acm.org

We were able to combine adaptive hypermedia in the form of dynamic web pages, usability aspects of computer interface design, and the connectivity of the World Wide Web (the Web) to develop a paradigm that delivers the high level of organizational support that many customers desire and expect. The system implementation resulted in improved customer support and automatic record keeping of valuable knowledge for improved management of the organization.

We designed and developed an adaptive hypermedia customer support system that accepts, checks, submits, and confirms maintenance requests for the tenants of a large governmental building. The system accomplishes this, and ensures continued customer use, by recognizing and adapting the information presented to a particular customer, including name recognition, contact information, automatic e-mail dialogue, presentation of historical data, and error checking of customer submissions. The result is a more satisfied customer base, better knowledge management by the organization, and most importantly, an improved state of maintenance for the building. The system structure is flexible enough to be easily adapted for other organizations and situations.

## REVIEW OF LITERATURE

Adaptivity is an aspect of hypermedia that can use a variety of methods for flexible delivery of information, especially through a web-based interface.

(Eklund & Brusilovsky, 1998). Adaptive hypermedia has the potential to overcome the limitations of traditional computer systems by tailoring applications to meet specific user needs and requirements. Adaptive hypermedia has been used in various aspects, including interfaces (Nielsen, 1993a) and education (Schneider, 1994). An excellent review of adaptive systems is contained in Brusilovsky, 1996. Adaptive pages are now appearing on the Web. An example is Excite's (http://www.excite.com) personalized search page, which receives an average of five times as much traffic per user relative to a normal Web page (Basse, 1999).

Adaptive systems attempt to anticipate the needs and desires the users. To do this effectively, the application design must be based on a model of the user (Knott, Mellish, Oberlander, & O'Donnell, 1996; Milosavljevic, Tulloch, & Dale, 1996). Some systems develop this model using the user's previous actions. Other adaptive system may also gather information by monitoring what the user is doing, or the system may ask questions of the user. For example, some intelligent tutoring systems build a user model based on what reading material a user accepts, and validates the model by means of multiple-choice questionnaires.

A user model can be represented by a set of pairs (*c, v*) where *c* is a *concept* and *v* is a *value* (Eklund & Brusilovsky, 1998). A concept is an idea, subject, preference, submission, or topic (i.e., a noun). A value is a measure that associates the user to that concept. The value is typically a descriptive term to represent the degree to which a user knows about a particular concept (i.e., beginner, novice, or expert), or a number representation of varying degrees defined in the meta data of the system. Concept-value pairs are often represented using numeric data types. Greater granularity is obtained by offering a range of many values, for instance, a value between 0 and 100. An adaptive system could also use only a few numeric values-1 through 5 for example-if less granularity is required. Or, a system could simply use Boolean values, that is true and false. In the system we developed, we opted for using Boolean values. With this implementation, the concept-value pair is a straightforward way to represent a particular user.

## THE ADAPTIVE HYPERMEDIA CUSTOMER SUPPORT SYSTEM

We developed an adaptive hypermedia system to process the maintenance service requests from the building's tenants. The system resulted in dramatic, positive improvement in the processing of customer service requests, the management of these service requests, and most importantly, improved the maintenance support of the building.

### *Background*

Prior to the development of this system, the submission of service orders was a laborious, inefficient, and in the view of many tenants, a fruitless process. The building in question was built in the 1930s as a riding stable. It was needed for the training of college students who would be future military officers. At the time, it was the largest riding stable in the world. Now it provides several thousand square feet of usable space.

In the 1950s, the building was refurbished and converted into college classrooms, offices, laboratories, shops, an indoor ballistics range, and commercial retail space. Over the years, there were numerous renovations, modifications, and additions to the building. One of the modifications was to wire the building with a local area network (LAN). Therefore, most occupants and all agencies in the building had access to the LAN. At the time our system was implemented, more than 200 individuals from 17 separate agencies were tenants in the building, along with thousands of temporary users of the building. The responsibility for the upkeep and overall building maintenance, as well as customer service support to the tenants of the building belong to a building supervisor known as the Building Commandant. The resources available to the Commandant included a small janitorial staff and external maintenance support provided by a agency known as the Department of Housing and Public Works (DHPW). DHPW was responsible for all maintenance, repair, and utilities at the location. This maintenance situation parallels many other governmental and non-governmental building arrangements where the upkeep is outsourced.

**The system resulted in dramatic, positive improvement in the processing of customer service requests, the management of these service requests, and most importantly, improved the maintenance support of the building**

When a tenant had a maintenance issue, the tenant would call or e-mail the Commandant, who then recorded the service request and reported the issue by telephone to a service clerk at DHPW. The service clerk entered the request into a database, assigning it to the appropriate shop and provided a tracking number to the Commandant. Upon receiving the request, the DHPW shop dispatched maintenance teams to address the request, responding within a few hours for emergencies and within a few weeks for routine requests. The Commandant was responsible for monitoring the progress of these requests and acting as a liaison with DHPW to ensure that the work was completed.

There were several deficiencies with this arrangement. First, the information that the tenants provided to the Commandant was often vague. Second, by communicating first with the Commandant, there was a built-in delay in addressing the request. The Commandant may not be available to answer the telephone or his e-mail for a period of time. This caused a delay in the request getting to the maintenance organization. Third, some tenants, realizing the delay caused by communicating with the Commandant, would bypass the Commandant and call the maintenance organization directly. Unfortunately, the Commandant would then lose oversight of these requests and lose historical information that, with the proper analysis, could be the harbinger of future, larger problems. Additionally, since the DHPW service clerk received calls for every building within the locality, customers were often placed on hold and received no feedback on their requests once submitted. Because of these issues and despite the hard work of all involved, the building fell into disrepair while building use increased.

**Using this web-based system, a tenant could submit a maintenance request containing all the necessary information directly to the Commandant and the service organization, simultaneously**

### *Purpose*

To address these issues, we designed and implemented an adaptive hypermedia system to handle the submission of maintenance requests. We decided to use the adaptive hypermedia paradigm to design the system because we believed it provided the opportunity to realize both the functionality requirements the organization needed and the usability aspects that would ensure the tenants used the new system. Using this web-based system, a tenant could submit a maintenance request containing all the necessary information directly to the Commandant and the service organization, simultaneously. The system would also provide feedback on the success of the submission and a mechanism for the customer to monitor the status of the service request.

### *Design*

Since all tenants had access to the LAN, we decided to take advantage of this infrastructure. We wanted an adaptive, hypermedia-based system, with the central functionality being the submission of service requests. However the system would also provide a conduit for the receipt and posting of important building and tenant information. First, we reviewed dozens of Web systems, both well and poorly designed. Many of these web sites were reviewed in Kahn, 1998. This is the first step in usability and system design methodology advocated by Nielson (1993b), which is to conduct a field study of comparable systems and isolate well and poorly designed features.

During the design of our system, we incorporated other features of Nielson's (1993) methodology. For example we use a common interface design platform as a starting point, defining measurable usability attributes, realizing the "less is more" functionality features and acceptance of an iterative design process. This last point was critical to our system as we rolled out three major versions and several minor changes in less than six months. However, the interface layout remained basically the same, and the actual URL for access to the system never changed. So, the customers were cushioned from the frustration associated with successive system changes.

Based on the needed functionality aspects of the system, the concept-value pair of adaptive hypermedia systems, and our usability design methodology, we set forth the following design characteristics of our system.

- A hypermedia system that permits the submission of new service requests, along with the ability to check the status of previously submitted service requests.
- Immediate confirmation to the customer, and notification to the Commandant and maintenance organization of a new service request.
- The ability for the Commandant to track the requests in four categories: awaiting acceptance by DHPW, accepted but not completed, accepted but not completed within 30 days (DHPW's goal for completion of routine requests) and completed service requests.
- The ability for DHPW to communicate simultaneously with the customer and the Commandant.
- The providing of a personalized service for users.
- The interface and functionality of a system that is straightforward in design and clear in purpose to ensure customer usage.

## *Development*

The system had two major components, the interface and the backend. The backend was an integration of a *Microsoft Access* and an *Oracle* database. The two databases were linked via Visual Basic code and embedded standard query language (SQL). The *Access* database was used for tracking by the Commandant and as the data source for customer queries on the status of service requests. The *Oracle* database was used by DHPW for their internal management of service requests. The duplicative storage of information-seemingly a waste of space and effort-actually was a boon for the care and upkeep of the building. With access to an independent local database, the Commandant had a record of submitted service requests that DHPW's *Oracle* database should mirror. This allowed for the identification of lost or improperly terminated service requests. This also minimized concerns by DHPW of providing access and suffering possible disruption to DHPW's database. Plus, a local database permitted the storing of building and customer-specific information that the outside maintenance organization did not care about or have the need to track. This specific customer information also permitted the development of the adaptive aspects of the system.

Cold Fusion was used as the development application program interface (API) for the system's interface. Cold Fusion provides a standard mechanism for developing both dynamic web pages and the database-query mechanism. The resulting system interface is displayed in the customer's browser as HTML and Javascript. These are all standard platforms for the development of web interfaces. Using the concept that "less is more," when customers requested the URL for the customer support system, they had a limited number of options or concept-value pairs. The primary pair was to submit a service order or not. The concept was the service order. The value was a Boolean data type, stating that the customer did or did not want to submit a service request.

If the customer desired to submit a request and had never submitted one before, the system queried the user for some personal information (e.g., name, office number, e-mail address, etc.). This information was utilized to identify the customer on subsequent visits. This allows the system to tailor or adapt the information provided to that customer, and also provided the Commandant necessary information to conduct customer relations. So, the system uses the approach of questioning the customer to develop a portion of the user model.

For a particular service request, the essential field or concept was location, and the value was that a location already had a service order request submitted or it did not. When a customer submitted a request, the system first addressed the customer by name, and then queried the customer for the location of that request. This personal addressing, along with personalized e-mail responses, seemed to humanize the system in the minds of the customers. In a six-month sample of 1,003 exchanges from the customers to the systems, we identified 126 entries (12.6 percent) that indicated the customers were personifying the system. These queries contained terms or phrases that one would expect in a conversation, such as "thank you," "please", and "I would appreciate." The percentage would be higher if entries from the Commandant and DHPW technicians-people who know how the system works-were removed from the six-month sample.

Once the customer entered the location-usually a room number-the system displayed a list of all open (i.e., not completed) requests for that location to the customer. The customer could then scan the list to see if someone else had already submitted the request. This feature, in itself, was a significant productive boon, resulting in significantly fewer duplicate service requests being submitted.

If a request was not on the already submitted list, the customer could proceed, and the system would prompt the customer for the necessary information. If the customer did not submit all the correct information, the system would prompt the customer for the missing information. Only when all the information was correctly entered would the system submit the service order to the maintenance organization. The system would also e-mail a confirmation message to the customer, the Commandant, and a point of contact at DHPW. Figure 1 shows a typical service request web screen.

The system also handled many other functions needed for building maintenance, such as checking the status of previously submitted requests and tracking all requests submitted by a particular customer. Using the system, the Commandant could track trends in service requests to isolate problem locations and customers experiencing recurring problems. The system also offered FAQ lists, direct e-mail contact to points of contact within the building for many of the major tenant organizations, and e-mail contact to the Commandant. In these features, we used previous actions of the user in order to implement the adaptive aspects of the system.

The first version of system debuted within one week of setting forth the design considerations. The second version debuted one month later. The final version debuted two months after conception of the system. There have been numerous but relatively minor changes since that time. Overall, the system appears robust and enthusiastically endorsed by the customers, based on the high volume of use.

Several design considerations went into the system. To address "location in hyperspace," the first image that a customer sees on accessing the system's URL is a picture of the building. This reaffirmed, visually, for the customer that they were in the correct location. We intentionally designed a site that focused exclusively on the building maintenance, so the choices for the customer are narrow by design. This keeps the cognitive load on the customer to a minimum. Figure 2 shows the initial page to the Web system.

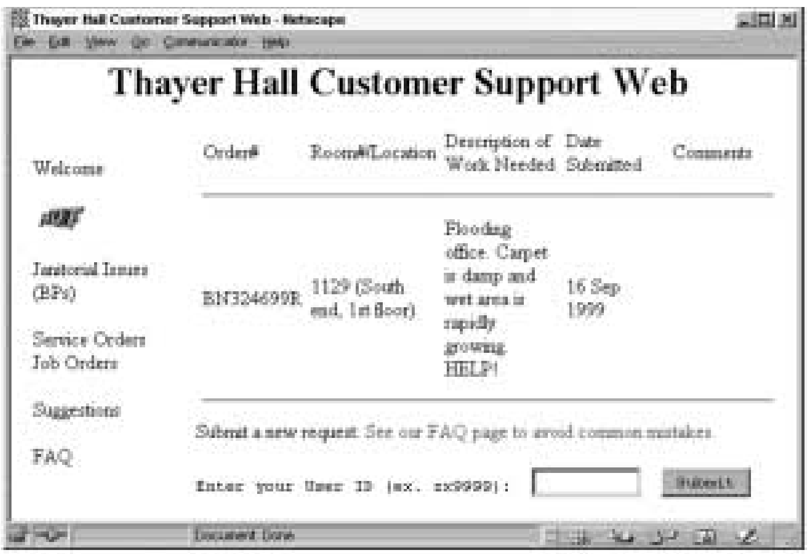


**Figure 1.** Service request entry page showing previous and open service requests

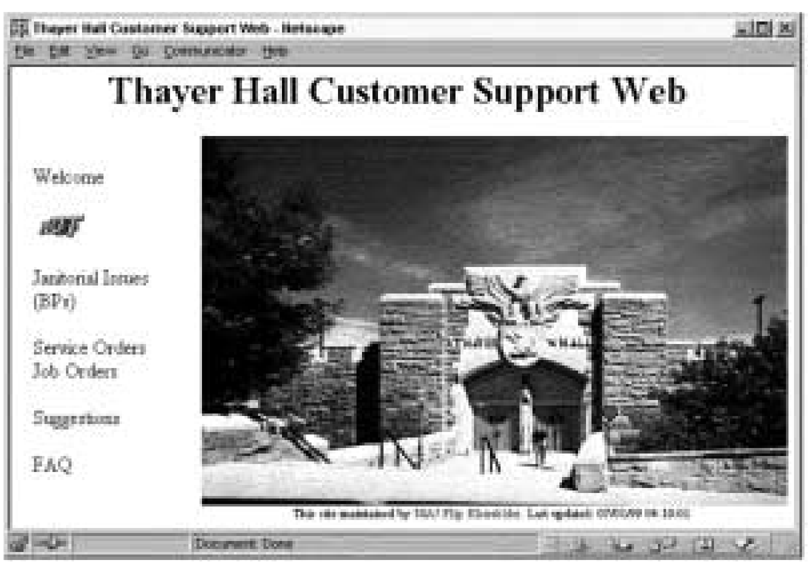


**Figure 2.** Initial page to the Web system with building location

## CONCLUSIONS AND DIRECTIONS FOR FUTURE RESEARCH

The major contribution of the system is the dramatic improvement in the maintenance of the building. From a research and implementation perspective, a significant contribution of the system is the implementation of adaptive hypermedia in a commercial environment. Previously, adaptive hypermedia has been mainly a research area and confined to academic environments or simple, relatively stable "personalizing" of web pages. This research illustrates that adaptive hypermedia systems can be successfully implemented in a commercial setting, with enormous payoff for an organization. Additionally, the system shows that usability design methodologies can be successfully implemented in a commercial setting with little disruption to product-fielding schedules. In fact, this system illustrates that a system design process, incorporating usability factors, can result in a product that is both rapidly taken to market and commercially successful. The system has been so well received that it is currently undergoing expansion to encompass other buildings in the nearby geographical area, with further, nation-wide expansion currently in the planning stages.

We are investigating system improvement in three areas: (a) expanding the system's adaptivity, (b) introducing software agents into the system, and (c) integrating voice technology with the existing web and database components. In the area of adaptivity, we would like the system to prompt (i.e., use push technology) the customer with expanded information on building locations or previous service requests that the customer submitted. We are also investigating having the system assist the user with clarification issues. This clarification would be dependent on the service request and lessons learned from previous but similar service requests. For example, if the request concerns a power outage in a particular room, many times this is simply a tripped circuit that the customer could fix. The system, keying in on the electrical outage problem, would suggest this plan of action to the user before submitting the request. This historical information could be gathered from a variety of sources, including the Commandant and DHPW maintenance teams' reports.

Software agents offer numerous potential productivity improvements. Currently we are investigating three: (a) The first is the feasibility of immediately notifying the customer via e-mail on the day a maintenance team is dispatched to work on a service request. One area of productivity that is suffering, under both the old and new system, is that the maintenance teams lose considerable time attempting to locate the customer for room access, and so forth. (b) We are also examining the idea of notifying DHPW, the customer, and the Commandant immediately when an emergency service order has been entered into the system and requires rapid response. Examples of these types are maintenance problems with elevators, plumbing, and safety systems such as fire alarms, exit doors, and sprinkler systems. (c) We are also exploring if software agents could help in the area of long term building upkeep. Software agents could conduct knowledge mining of the database for trends in certain building locations (e.g., a leak in a certain room occurring every summer) or in customers that are having a range of problems (i.e., the same customer entering varied service requests for the same location). The software agent could mine the database and notify the Commandant of these types of maintenance trends for pre-emptive action.

We are also investigating voice technology, specifically computer-telephony integration. In computer-telephony integration, a network server integrates interactive voice response (IVR) with the backend databases. The approach we are taking is to use a small key system unit (KSU) that is IVR capable. We would integrate the KSU with the network server by scripting the system prompts to provide order entry information to the database through the standard SQL, which is the database language. However, we do not want customers to query orders only by telephone.

We also desire our IVR KSU to interact with our customer's web browsers (e.g., see **http://www.peri.com/product/periwbbr.html**). We are investigating putting a link on the system that telephones the maintenance organization's service representative, which is exactly what is needed for emergency service orders. The customer, or a software agent working on the customer's behalf, can "talk" to the service representative using the computer's multimedia sound card and the web browser's Telephony Application Programming Interface (TAPI).

These enhancements will increase the organization's customer support by further addressing the individual customer's needs, improving the long-term management and maintenance upkeep, and increasing the options available for customer support. The adaptive hypermedia system, both currently and with further planned enhancements, is proof that technologies and methods that were only research domains a short time ago, can be implemented and profitably employed in support of an organization's customer support goal.

## REFERENCES


Basse, J. (1999). Retrieved from the World Wide Web on 11 August 1999, [online]. Available: http://www.nielsen-netratings.com/.

Brusilovsky, P. (1996). Methods and techniques of adaptive hypermedia. In: *User modeling and user-adapted interaction, 6*p. 87-129, Kluwer Academic Publishers. [online]. Available: URL: http://www.contr ib.andrew.cmu.edu/~plb/UMUAI.ps

De Bra, P., & Calvi, L. (1998). *AHA: A generic adaptive hypermedia system.* Ninth ACM Conference on Hypertext and Hypermedia Hypertext'98. Pittsburgh, USA.

Eklund, J. & Brusilovsky, P. (1998). *The value of adaptivity in hypermedia learning environments: A short review of empirical evidence*. Ninth ACM Conference on Hypertext and Hypermedia Hypertext'98. Pittsburgh, USA.

Kahn, P. (1998). *Website information architecture*. Presented at Ninth ACM Conference on Hypertext and Hypermedia Hypertext'98. Pittsburgh, USA.

Knott, A., Mellish, C., Oberlander, J., & O'Donnell, M. (1996). Sources of flexibility in dynamic hypertext generation. In *Proceedings of the Eighth International Natural Language Generation Workshop (INLG-96)*, Herstmonceux Castle, Sussex, UK, 151-160.

Milosavljevic, M., Tulloch, A., & Dale, R. (1996). Text generation in a dynamic hypertext environment. In *Proceedings of the 19th Australasian Computer Science Conference*, pp. 229-238. Melbourne, Australia.

Nielsen, J. (1993a). Noncommand user interfaces. *Communications of the ACM 36*, 4, 83-99.

Nielsen, J. (1993b). Usability engineering. London, Academic Press.

Schneider, D. (1994). *Teaching & learning with internet tools a position paper*. Presented at the Workshop on "Teaching & Learning with the Web" at the First International Conference on the World-Wide Web, 1994 at CERN, Geneva.