

Internet Portal For the Environmental Industry

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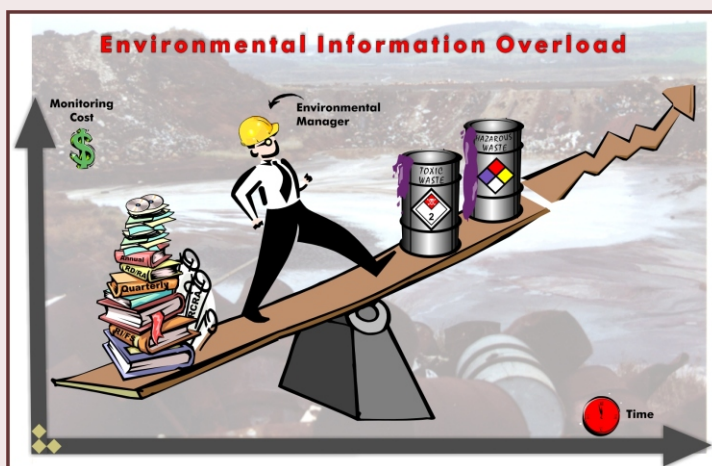
Abstract

The Internet revolution has swept the world like no other communication technology before it. Not only has it provided a completely new method of delivering information and services with unprecedented speed, but it also has significantly reduced the importance of distance as a factor in the ability of various parties to collaborate and to exchange and share information with one other. Locus Technologies has attempted to capitalize on this explosion of interest in the Internet and on the advances in tools and technologies in this arena by building a suite of Internet-based applications. This suite, named LocusFocusSM, includes modules for:

(1) operating and controlling groundwater treatment and recovery facilities from a web-based browser; (2) managing environmental data; (3) uploading field data into, and retrieving such data from a centralized database using hand-held, wireless devices; (4) storing and retrieving project documents; and (5) collaborating on-line. LocusFocusSM is the first comprehensive multi-channel dynamic web portal environmental industry.

LocusFocus'sSM remote control and automation module includes the capability to monitor water levels, flow rates, pressures, and other operational statistics of groundwater and other contaminated media recovery and treatment plants; open and close valves; and perform system resets and diagnostic work, all over the Internet without a costly site visit. Installation and usage of this module can save a company 30 to 70 percent over the traditional method of periodically sending technicians to a site. Other benefits of this technology include improved treatment efficiency, reduced use of consumables, less system downtime, better data collection and reporting, and earlier attainment of cleanup goals.

Locus's Environmental Information Management module (EIMTM) offers the capability of planning and scheduling sampling events, inputting field data, uploading analytical data transmitted via electronic files, producing downloadable reports and mail files, performing statistical analyses, and creating XY plots through the Internet. EIMTM eliminates many of the installation and maintenance problems associated with traditional client-server systems. Most importantly, an individual with the proper authorization can access the system from any computer at any location, provided only that the user has a connection to the Internet and that a web browser is installed on the computer. LocusFocus'sSM applications for hand-held, wireless devices greatly reduce the costs of data entry for sampling and other field activities. They also enable information on the status of the work to be delivered more quickly to managers and other personnel.



LocusFocus'sSM document management and project communication tools are intended to reduce costs and project delays, streamline interactions; and improve communications among the myriad participants in a typical environmental project. By storing information and documents electronically, and then making these data and documents available over the web to all who require access to them, LocusFocusSM is able to deliver information in a more timely and cost-effective manner and speed up the routing and approval of documents. By providing role-based access to a common source of information and opportunities for secure, on-line collaboration, LocusFocusSM reduces the need for costly meetings and promotes better and more informed decision-making.

Introduction

The first sentence of the abstract above was written in early September of the year 2000. At the time, the NASDAQ composite index was at 4143, down somewhat from its 1999 high (5132), but significantly above the low it was to hit on Dec 21 of 2288. The share price of CMGI, an Internet development and holding company, was just under \$50 in early September. Today (January 18, 2001), it is \$7.03. Up until October of 2000, the first author of this paper was able to shop for his groceries over the Internet and have them delivered to his house on Wednesday of every week. Today, the company that provided this service in the Boston area (Streamline) is out of business, as is one its competitors, ShopLink. At the end of the year 2000, more than 200 Internet companies had closed their doors, including Furniture.com, MotherNature.com, Garden.com, and Pets.com. Yet another sign of the changed environment are the daily announcements of layoffs from some of even the most prominent e-businesses. This dramatic downturn in the fates and fortunes of Internet companies would suggest that much of the talk of a revolution has been nothing but hype, and that the potential of the Internet to change how we conduct business and how we communicate and exchange information with one another is unlikely ever to be realized. With the benefit of hindsight, it seems clear that many e-businesses were overvalued and/or based on questionable business models that were unlikely ever to generate profits. Still, despite the current gloom that pervades this sector of our economy, the authors of this paper continue to believe that the Internet will bring about extraordinary changes in our society and, in particular, the environmental sector where we are employed. In some ways, Locus is no different from many other companies that are involved in environmental investigations, assessments, and cleanups. Our employees are called upon to prepare sampling plans; collect samples; take field measurements; process and review laboratory analytical data; prepare reports; evaluate remedial alternatives; make recommendations regarding technically feasible and cost-effective cleanup solutions, and then implement these solutions; and/or work with clients and regulators. In large part, Locus, and companies like it, are in the information collection, analysis, and delivery business. While we may take samples, drill boreholes, and install wells, these are only a means of gathering information on the environmental conditions at a site, including the nature and extent of air, water, and/or soil contamination. When we are done with our fieldwork, we must submit the results of our investigations to our clients and to the appropriate regulating agencies. Many times, we must work side by side with other environmental firms, and share whatever we learn about the site with them.

Beginning several years ago, Locus recognized that the Internet, and the ever-increasing number of tools to develop web-based applications, offered an unparalleled opportunity for changing how we go about our work and meet our clients' needs while, at the same time, reducing both their and our costs. In the intervening years, Locus has developed a suite of applications, named LocusFocusSM, that can be accessed over the Internet through an Application Service Provider (ASP) model. This suite includes modules for operating and controlling groundwater and wastewater treatment and recovery facilities; inputting, managing, and downloading environmental data; uploading and viewing field data using hand-held, wireless devices; storing and retrieving project documents; and collaborating with project participants on-line. The remaining sections of this paper are organized as follows. First, an overview of the architecture of LocusFocusSM, the tools that were used to build it, and other aspects of the system is presented. Next, more detailed information is presented on the different modules that comprise the application. Particular attention is given to how these modules have helped Locus better serve the needs of its clients while at the same time lowering costs. The final section of this paper discusses the additional services and capabilities that will be added to LocusFocusSM in the coming months.

Overview

LocusFocusSM uses SQLServer as its "back-end" database. Most of the application was developed using Active Server Pages and Cold Fusion. Except for those components of the remote control and automation module that must reside at a treatment plant, the entire application resides on a set of SQLServers and redundant, load-balanced web servers at a data facility managed by Intel Online Services (IOS). Each web and SQLServer has two and four processors, respectively. The bandwidth into each is 2 Mbs, but can be expanded, based on demand, to 10 Mbs. IOS guarantees 24-hour, 7-days-a-week, 365-days-a-year access to the system. These guarantees and redundancy of server system were very important for Locus and its client. Access into the system is controlled through the use of user IDs and passwords.

Remote Control and Automation Module

Several years ago, at a Union Pacific Railroad (UPRR) Company site in a remote area of the Sierra Nevada Mountains diesel fuel leaked into the soil when a hose became disconnected during a transfer operation. This site is only accessible by vehicle for six months of the year. To clean up the spill and prevent any further spread of the contamination, UPRR installed a groundwater treatment and recovery system. In the first few years of operation, UPRR's only recourse was to send technicians, some from as far away as 90 miles, to periodically monitor site operations and make needed

repairs and adjustments. UPRR realized that this was not an efficient way to operate this site. Seeking a more cost-effective approach, managers at the company turned to Locus's engineers, who had many years of experience designing and installing remote control and automation systems in the Silicon Valley and had recently developed a web interface to such systems. UPRR was impressed with Locus's technology and applied it to a number of its sites.

Included in the remote control and automation module is the capability to monitor water levels, flow rates, pressures, and other operational statistics of groundwater recovery and treatment plants; open and close valves; and perform system resets and diagnostic work, all over the Internet without a costly site visit. Setting up this module for a client involves more than just installing software. It also requires on-site installation of special automated valves and sensors to transmit data from the site to a web server via the Internet. Depending on the location of the site, the Internet link is made via telephone, DSL, or T-1 line; cable modem; or satellite. Some of the examples of the specific benefits that can be gained from using Locus's remote control and automation technologies are listed below:

1. **Treatment Precision:** Unlike a human operator, the Programmable Logic Controllers (PLCs) that are part of the system monitor and adjust system parameters several times every second rather than hourly, daily, or weekly. This precision means that the treatment technologies are always running at peak efficiency, and the system is vigilantly monitored for alarm conditions, which is critical for regulatory compliance.
2. **Consumables Expenditures:** The PLCs can also continually monitor the chemical residual in the effluent water of the air stripper and automatically increase or decrease the amount of the chemical injected upstream to attain the desired level. The system automatically and immediately compensates for changes in flow rates and injection pump variations so that no wasteful overdosing occurs.
3. **Waste Removal Expenditures:** The system monitors the condition of the water filters and sends an e-mail or a page when a filter is at the end of its useful life span. This eliminates the practice of replacing them, regardless of condition, on periodic visits because of the length of time between visits.
4. **System downtime:** PLCs can be programmed to respond to alarm conditions in a way that keeps the system running. In addition, when an

alarm condition occurs, the PLC can immediately notify an off-site operator of the condition. The operator can make an informed trip to the site or he can remotely access the system from a personal computer, make an adjustment, and restart the system without a site visit.

5. **Data collection:** LocusFocusSM system software can be programmed to collect and store process data as often as once per second. Water levels can be recorded hourly, rather than during monthly site visits, providing more useful information. Daily summary reports can be generated in a word processing or spreadsheet format. This automatic data collection, when combined with preformatted documents that make real-time inquiries to the database, can dramatically reduce the time needed to generate routine monthly, quarterly and annual reports and can increase the quality and accuracy of the information contained in the reports. Because the systems can be monitored and adjusted at any time or at any desired interval from a desktop computer with virtually no increase in cost, system reliability and environmental compliance improve dramatically. This is especially significant if stiff penalties are handed down for permit violations.
6. **Early Shutdown:** Perhaps the most compelling benefit of Locus's remote control and automation module is that it provides the opportunity to shut down the treatment system early. All groundwater and soil vapor extraction systems approach the cleanup goal asymptotically, or with a greater reduction in contaminant levels early in the process. The high efficiency and reliability of Locus's automated systems mean that they achieve cleanup more rapidly than other systems, thus providing an opportunity to stop treatment earlier. Overall, installation and usage of Locus's remote control and automation systems can save a client 30 to 70 percent over the traditional method of periodically sending technicians to a site. How significant are such savings? Construction of a \$1 million groundwater treatment plant operated for 30 years or more typically would be preceded by several years of consulting, regulatory negotiation and engineering costs. These initial costs would total about \$300,000. After construction, the O&M phase might continue for 30 years. If the initial O&M cost is \$40,000 per year and the inflation rate is 3 percent, the true future cost of O&M would be just over \$1,900,000. A reduction in 30 percent of these

costs would yield savings of \$570,000.

Environmental Information Management Module

Since the late 1980s, many environmental firms and software vendors have developed electronic database management systems to store the data collected at contaminated facilities and sites. Some are stand-alone systems that reside on a single individual's computer. The drawback of these is that only one individual can work with the data at a time. Much more common are client-server systems that use a commercial database as the "back-end" for data storage. In addition, each offers a customized "front-end" that allows users to interact with the data through a series of forms, menus, and interfaces to third-party products. The various components of the system that make up the "front-end" either reside on each user's machine or are pulled down from the central server, as needed. Access to the "back-end" database typically occurs over a corporate Intranet.

The popularity of client-server systems arises from the fact that multiple users can access the database at the same time. In many cases, these systems are fully capable of meeting all project, site, or facility requirements relative to data access, storage, and reporting. Their limitations become apparent, however, when data pertaining to a site must be shared with multiple parties or when one is on the road and requires access to the database.

It is our experience that most companies with environmental problems choose not to store their own site data but, instead, rely on consultants for this service. Client-server systems typically do not allow outside access; as such, whenever questions arise about a piece of data, these questions must be referred back to the consultant's office. There, someone must query the database and then phone or email the answer. These issues of access are not just a problem for company employees. Consultants, too, encounter these same difficulties whenever they are away from their offices.

There is yet one more drawback of client-server systems that should be mentioned. Most require that some specialized software be installed on one's computer. Anyone who has been involved in this task knows that it can be both a frustrating and costly effort, especially when users have different versions of other software that the system interfaces with, and different operating systems.

Those companies with large, complex or multiple sites are often reticent about "putting all their eggs in one basket" and opt instead to apportioning their environmental work among multiple contractors. Rarely do all contractors use the same environmental database management system, and, equally rare, is the

customer who insists on this. The end result is that the company's environmental data is stored in different stand-alone or client-server systems at different locales. If another consultant is hired to do some specialized work, such as risk assessment, the data must usually be downloaded into files, then uploaded, after much "massaging," into the new consultant's system. Both parties involved in this transfer charge their client for this work.

Companies that do not manage their own data often find themselves "paying twice" for the same data for other reasons as well. It is not uncommon for a company to switch environmental consultants after a period of time, due to dissatisfaction with the work product, merger or acquisitions, a change in management, or as part of an effort to reduce costs. When this occurs, the entire database must be moved from the old to the new consultant. The cost of such work can vary from the low five figures to a half million dollars or more, depending upon the amount of the data, its condition, and its compatibility with the new consultant's data management system.

An Internet-based environmental database management system eliminates most of the problems mentioned in the above paragraphs. First, such a system accessible from any locale, provided one has a web browser and can connect to the Internet. Second, access to the database is not limited to the members of one's own company or firm. Anyone with a valid user ID and password is able to gain access to and use the data. Third, no specialized software would be required, except perhaps for some applets, ActiveX controls, or plug-ins that would be able to be downloaded from the web site itself. Last, there is no need to transfer data from one party to another, because all interested parties are able to query and, as needed, download information from the database.

Foreseeing the benefits and advantages of an Internet-based system, three years ago, Locus undertook the task of building one. The system, named EIM™, part of LocusFocusSM multi-channel dynamic web portal, was completed and deployed in the spring of 2000. Since then, it has been continually improved and expanded. Today, EIM™ is used by Locus's engineers, geologists, and managers, as well as by clients and other consultants. Its features include the capability of:

- Setting and customizing certain features and components of the database, including lists of valid values, parameters, analytical methods, and action and QC limits "
- Planning and scheduling sampling events
- Inputting field data using forms, including sample collection information, field measurements,

analytical results, well construction details, borehole information, and lithology data

- Uploading field and/or analytical data transmitted via electronic files
- Viewing analytical, sampling, water level, and other information stored in the database with a browser
- Producing downloadable reports and flat files
- Importing data into Excel spreadsheets
- Performing statistical and trend analyses
- Displaying boring logs and well construction diagrams
- Creating XY plots of analyte concentrations versus time and groundwater elevations versus time

eWell, A Wireless-Based Internet Application

In November of 2000, Locus Technologies released the environmental industry's first wireless Internet application for recording water level data in the field. This application, called eWell, uses the popular Palm® operating system. It can be operated either as an independent wireless application or as a module within LocusFocusSM and EIMTM.

The water levels that field personnel record using eWell are immediately uploaded into a central database (EIMTM), where they can be immediately viewed and used by engineers and geologists. The application is not limited to just data entry. Technicians in the field can use it to determine the next well they are supposed to visit. Once at that well, they can pull down the historic high and low water level readings, as well as the last one, from the central database. After the current reading has been entered, the system issues a warning if the value is outside the historic range. The technician must then confirm that the value is correct before it is processed further.

The benefits of the eWell application include less data entry and transcription, simplified QA/QC, better access to key information, a reduction in the time required to upload field-generated records into a project or site database, and ultimately, reduced monitoring and sampling costs.

Document Management and Project Communication Module

The environmental industry has traditionally been process-bound and paper-intensive. Projects are often slowed by regulatory and legal issues, the need for public

input in the process, and the difficulty of managing and interpreting the vast quantities of information that are generated by monitoring studies and site investigations.

Larger companies often have not one, but, sometimes, dozens of contaminated sites. Moreover, the work on a given site may be broken into a number of distinct projects. These projects may run concurrently or overlap, with the entire cleanup taking months or more realistically, years. Most significantly, multiple contractors and consultants are often involved. Enormous numbers of documents are generated by these projects, from technical drawings and legal contracts to purchase orders, permits, requests for information (RFIs) and project schedules.

While the environmental industry has benefited tremendously from the development of CAD systems, it has been less successful in adopting electronic technologies for other aspects of its business. Many companies, for example, still routinely write up purchase orders and change requests that are then either faxed, mailed, or delivered in person. Requests for even seemingly minor changes in a project can take weeks to wind through the approval process, if all stakeholders (contractors, engineers, regulators, etc.) must sequentially add their approval to a single sheet of paper.

Even if all the firms working on a project store their documents and data electronically, files can often not be readily shared and exchanged, due to differences in the hardware, operating systems, and software applications used by the various participants. Performing data conversions and developing workarounds take time and impact the overall project budget.

The amount of information and numbers of documents generated during an environmental project only add to the underlying difficulty of coordinating and scheduling the activities of all the parties involved. In fact, some have likened the process of managing an environmental project to that of making a movie. In the case of the latter, there are producers, a director, the director's assistants, actors and actresses, costume designers, carpenters, painters, electricians, makeup artists, set decorators, cameramen, stuntmen, publicists, hair stylists, editors, and so forth. Few of these individuals are involved from start to finish, and often much of the action takes place at locations away from the studio.

Similarly, managing an environmental project involves coordinating with and scheduling the activities of sampling technicians, health and safety personnel, engineers, scientists, construction personnel, secretarial staff, analytical laboratories, subcontractors (drillers), other construction firms, other consultants, lawyers, real estate professionals, facilities personnel,

clients, and agency personnel. As with making a movie, few of these individuals or parties are involved in the project for its entire duration, and much of the work (sampling, construction) takes place away from the managing firm's main offices. Miscommunication among these various parties and poor coordination of their activities can dramatically increase the budget of the project.

LocusFocus'sSM document management and project communications module is a complete and integrated work environment that is designed to be used by and support all participants throughout the entire lifecycle of an environmental project—from project initiation and investigation to assessment, design, construction, and operation and maintenance. By storing information and documents electronically, and then making these data and documents available over the web to all who require access to them, the module is designed to streamline interactions and improve communications among the myriad participants in a typical environmental project. Some of its specific features include:

- Documents can be posted to a website and files exchanged with other team members.
- Team members are automatically notified via e-mail when new information or drawings are uploaded.
- Project files can be viewed or directly updated through a web browser. A new version is automatically created when a file is updated, so team members can compare the current document to any earlier version.
- Project drawings can be viewed in Adobe PDF, AutoCAD, or other popular formats.
- Threaded discussions are supported. Team members can track decisions resulting from such discussions, add new comments, or reply to an ongoing discussion thread.
- The process of setting up new users, connecting team members, and posting project information is fully automated. Moreover, the application is customizable, so you can set up the site for your project, based on your specific needs.
- The administrator for each project has complete control over user access privileges and can easily designate the files and folders each team member is permitted to view, access, or edit.

Locus's document management and communications module has the potential to eliminate the many inefficiencies and incompatible technologies that afflict

the environmental industry and to bring the benefits of Internet technology to its members. These benefits include the capability of providing role-based access to a common source of information; allowing secure, real-time collaboration among all interested parties, including clients, environmental compliance specialists, general contractors, subcontractors, design consultants, and suppliers; and delivering information in a timely and cost-effective manner.

Future Direction

The following subsections discuss the changes that will be coming to LocusFocusSM in the coming months. Remote Control and Automation

Locus intends to expand its remote control and automation services to include both private and municipal wastewater and drinking water treatment plants. Many of the same technologies and applications that Locus has used to automate and remote controlled groundwater treatment and recovery systems are also applicable to treatment plants. The benefits to be realized from implementing these technologies at such plants are the same as with groundwater treatment and recovery systems, namely, lower costs, better and more timely information, and improved system control. Locus is also in the process of developing real-time air monitoring channel for the LocusFocusSM portal. The new air emissions control-Tier II Clean Air Act-is estimated to generate \$3 to 5 billion in business just for refineries upgrades.

Locus also plans to develop a series of parallel Internet applications for various vertical markets, with primary focus on energy industry and other industries where applications are relevant, such as water, power plants, chemicals, mining, crude oil, petroleum refining, pipelines, railroads, utilities, and waste management. The underlying web portal and Internet-based automation technology for each of these markets is very similar and easily scaleable. The solution will be delivered to customers as an ASP model available through the Internet, wireless devices, and microcomputers. Expansion possibilities for the portal are limitless.

EIMTM

The task of identifying, investigating, and cleaning up sites with contaminated soils, surface waters, and/or groundwater is an ongoing one that will be with us for many years to come. And, with it, a continual need for systems, such as Locus's EIMTM. Although the size of the market for such systems is large and will continue to grow, an even bigger market exists for analytical data management systems and tools. This is the market for the Internet-based monitoring, data collection, and storage of information pertaining to wastewater

discharges, drinking water quality, and air emissions at manufacturing and production facilities, and private and municipal drinking water and wastewater treatment plants. Various federal laws, such as the Clean Water Act, the Clean Air Act, and the Safe Drinking Water Act, require such monitoring to take place. Some of it is real-time. Data from these monitoring devices must be stored, analyzed, and reported to the appropriate agencies. To serve this market, Locus intends to expand and integrate EIM™ with its remote control and automation tools, thus creating a single system that has the capability of capturing and storing monitoring data and then making these data available for reporting and assessment purposes.

eWell-A Wireless Based Internet Application

Additional wireless applications are being developed for the field. One of these will allow a sampler to retrieve information on what locations must be sampled next, including the numbers and types of sample containers needed, and the manner in which each sample is to be preserved. The sampler will then be able to enter information on each sample using his or her wireless device. As with the eWell application, this information will be uploaded directly into a central database after the user's entries have passed any needed "sanity" checks. In addition, Locus is retooling its web portal to allow downloads and displays of key information into the wireless devices.

Final Thoughts

Many of the failures that have occurred among Internet companies have involved firms that tried to market a product that was already being sold by a "bricks and mortar" business. These companies found it difficult to attract customers, establish the required infrastructure, and sell their products at a cost at which they could generate a profit. In reality, all most of these companies offered was a different way to shop for products that were priced slightly less than one could find in local retail stores. The potential of the Internet extends far beyond that of an alternative means to market products. Its ready availability and ease of access enable it to serve as an unparalleled vehicle for the delivery and exchange of information. It is this aspect of the Internet that Locus finds so compelling and the reason it has put so much effort into building LocusFocusSM. The driving force behind each module in the application has been the same, that is, to enable companies to manage their environmental projects more effectively and to give them greater access and more control over the vast quantities of data that they must collect and store each year while, at the same time, lowering the costs of monitoring, remediation, and cleanup programs. These same goals will continue to drive the development of the system in the years ahead as we, hopefully, expand into other areas, such as environmental compliance management, hazardous waste management, and health and safety issues.

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