

Liner leaks - using the internet to prevent them

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ABSTRACT: As geomembrane usage increases, liner problems are a growing concern throughout the geosynthetics community worldwide. Even though the level of knowledge at the forefront of the technology is advancing, the rapidly increasing number of newcomers working with geosynthetics may be lowering the average level of experience with geosynthetics products. In order to improve the quality of design, application and implementation of geosynthetics it is necessary to provide easy-to-access, cost-effective educational resources to these newcomers. The internet provides the platform to develop educational and informational tools which surpass the traditional methods in timeliness, speed, usefulness, accessibility, availability, and cost.

1 INTRODUCTION

While the success rate of installed linings systems, as assessed by manufacturer/installer call-back rates, exceeds 98%, the total number of installations is increasing so rapidly that the number of failures within the 2% of call-backs is, of course, rising proportionately. In May of 1999 the second author had 11 active consulting projects of which 6 (55%) were failures. In May 2000 these figures were 24 and 16 (67%) respectively. Of the failures, in the opinion of the author, approximately 60% were due to inadequate design features, about 20% due to poor installation, and 20% due to inadequate materials and other reasons. As the perception of geomembrane materials becomes that of a commodity rather than specialty materials design, testing, and CQA services are contracted on the basis of lowest cost only. The number of problems that exist as a result of inappropriate or insufficient information continues to increase, costing time, money and damaging industry reputation.

There is no question that, within a small group, the knowledge of geomembrane technology is increasing, but with the increasing number of newcomers to the industry, the average level of knowledge may, in fact, be decreasing. The general level of knowledge must be increased rapidly to fuel an upward trend in product success and an increase in the financial value associated with geosynthetics products. The resources that are presently available; universities, conferences, institutes, trade associations, professional societies, and workshops - are evidently not meeting the demand. So what needs to be done?

Although much effort is made to attract contractors and novice engineers to conferences, there has generally been moderate success. In many instances, the commodity philosophy has become so pervasive that novice engineers believe that no special effort is required to successfully install a plastic liner and owners believe that no special knowledge is required to perform effective construction quality assurance. Consequently these people see no special need to expend effort or funds to become educated. Therefore it becomes necessary to take the required information to them in a way that they can use it with little effort and at little cost. In taking this information to them it might just be possible to initiate a respect for geomembranes and to identify the differences

between commodity type applications (golf course ponds, MSW landfills) and specialty applications such as hazardous waste containment, lining steep quarry walls, and underwater installation.

All members of the geosynthetics community as well as owners, engineers and project managers are paying the price for the lack of interest and education;

- Manufacturers' products are often not being used as intended, resulting in failures often inappropriately assigned by others as being caused by defective products.
- Project Managers are faced with novice designers. Limited time and financial resources prevent the acquisition of the necessary education.
- Designers are presented projects with no budget for research. Very few are willing to pay for the learning curve on the front end of a project. These are the people who will cause us all to pay for the learning curve at the back end
- Installers, although qualified, are provided materials and methods and directed to perform within the specifications set forth for them. If the specified materials and methods are not correct the installers, despite their knowledge can rarely correct or change products or methods. The result, will most certainly be unacceptable and the installer may bear the brunt of errors for which they are not responsible.
- Owners end up with improperly constructed sites eventually resulting in costly repair and possibly fines.

The obvious solution to these growing pains is simple..... Get more education to the appropriate people and get them to invest more money in the beginning to save money in the end.

If it is so simple why isn't it happening? What are the constraints? It is the opinion of the authors that if the first item is properly addressed the second will follow.

Get more education to the appropriate people. We live in a society which respects knowledge and embraces technology, so why is it that "they" are not absorbing all of the information required to properly design and implement geosynthetic structures? Where does the existing system, and its members, fall short. To answer these questions we need to examine closely both the information and process of providing it. This includes the volume of information, quality of information, accessibility to information and other non-information based constraints including time and money.

2 VOLUME OF INFORMATION

If we examine the geosynthetics industry we will discover a broad range of associations, institutes, organizations, symposia, workshops, conferences and courses offered as a resource to those who want to attend. In the 2000 Geosynthetica calendar are listed no less than 56 significant - geosynthetics related events averaging 5 events per month internationally. Certainly there is not a lack of information volume.

3 QUALITY

Geosynthetics technical information is generated by manufacturers, academics and members of the community. Manufacturers will only benefit from producing top level information to facilitate the highest level of customer satisfaction with their products. Academic groups by definition focus primarily on quality. Members of the community are interested in the evolution and growth of geosynthetics and therefore provide and invest in the information to the best of their ability. There is always room for improvement but quality is not a major short coming in the process. As with planning and construction, there should be quality control systems in place for information. Standards committees ASTM, ISO, and CEN provide checks and balances from within the community.

4 ACCESSIBILITY

Information is disseminated to whom and how? Sources of information include: print, (journals, proceedings), workshops, conferences, phone calls, and consultants. To evaluate the strengths and weaknesses of each of these items we can use some very basic criteria:

- Availability: how easy is it to acquire the information?
- Timeliness: how dated is the information - is there anything available that supersedes it?
- Ease of use: how effectively can the information presented be used?
- Thoroughness: does the information presented meet all of the requirements, and is any further documentation typically required?
- Cost: what is the cost of acquiring the information?
- Time: how much time must be invested to find and use the materials?

Each information source has its own advantages and disadvantages as illustrated in the comparison Table 1. This comparison assumes that the quality of the information is always the best that it can be. As would be anticipated, the sources which have the lowest cost also require the highest time investment, the high priced items such as consulting require the least effort and time by those seeking the information.

Where can we find a resource which provides the best cost benefit ratio and effectively accomplishes the educational goals? We propose internet technology, as *the* method of information delivery. In the effort to create a geosynthetics portal site, geosynthetica.net, we have discovered strong evidence to support the use of internet technology, quite surprisingly we have found no argument to the contrary! However, as with any solution it is just not that simple. In order to use the technology to its maximum capacity, and to fulfill our goals, there must be planning and provisions must be made for the new set of challenges which will certainly evolve. First we needed to confirm that the internet could satisfy the existing criteria;

Availability. Web sites are “on” 24 hours a day 7 days per week. Regardless of time zone access to a web site is always available. On the geosynthetica.net site our statistical data illustrates 24 hour use of the site with traceable visitors from over 30 countries including Iran, Australia and China. In fact we have found roughly half of our users to be other than American, surprising considering we are an American based company.

Forethought is not required when using the internet. Unlike most other information sources it is not a requirement to acquire the information source prior to its being needed (to order periodicals, or to take a course before it is found to be needed etc.).

The exception to “always available” comes if the much needed site is suddenly “down”. Measures can and should be taken to make sure that sites do not regularly go down. One basic and cost effective way for an information service to provide insurance against crashing is to use mirrored servers. Mirrored servers are two separate computers which contain the same or nearly the same information. As updates and changes are made to one of the computers the second computer will remain unchanged. Should the first system “crash” while being adjusted the second system with the uncorrupted information will take over, leaving the opportunity for the first system to be repaired with no interruption of service. Mirrored servers provide a live back-up system. A mirrored server system has been used on the geosynthetics site for 10 months with 100% effectiveness.

With the technology available and the always “on” delivery of the internet this system ranks the highest in availability.

Timeliness. The internet medium is by far the most malleable system created to date. With a few key strokes, in just minutes, information can be updated and broadcast to the entire world. Nothing must be reprinted, no courses must be re-written, and it can be attached to the previously current information in such a way that the user can understand the evolution of technology and application.. The internet provides an opportunity to broadcast technology instantly. There is not a more timely way to provide information to the world.

Thoroughness. Because there are no space or time constraints within a web site the ability of a web site to be thorough is only limited by the information available and the people managing the site. Not only can the information on the site be extensive but through the process of linking resources, back-up, contact information, computer models and related topics can be made simultaneously available. The internet has the potential to be a one-stop-shop for information and education. Perhaps the single concern with thoroughness is not lack of information but the surplus. In order to present information which is thorough and streamlined the geosynthetic.net site will have a technical advisory board comprised of non-underwriter, well established technical experts to review the site contents and submissions.

Cost. Cost to the user can vary dependant upon existing computer equipment, software and internet access. The majority of professionals worldwide posses the mechanical ability to use the internet. The subscription cost of accessing the internet via an ISP (Internet Service Provider) ranges from about US\$10 to US\$30 per month. The investment in internet capability is already being made by the bulk of engineering companies. In this case there is virtually no additional cost for use of the internet as a research tool. The cost of using the internet is significantly lower than most of the other information sources and is certainly not prohibitive

Ease of use. Most professionals are using a computer and a good number of them are using the internet. Statistical information identifies that millions worldwide begin using the internet every week and almost as many sites are being added to the web weekly. Web site providers range from highly technical trained web site designers to the person who drew the short straw in the office pool. Sites vary from a single page of rudimentary company information to elaborate sites with labyrinths of cross referenced, multi-linked, documents, pictures, video, audio, forms, passwords, membership sections, calendars, news, technical information and more. The method in which the "ease of use" criterion evolves will be a determining factor in the success of internet technology with our target group.

5 USING THE INTERNET

The user must first decide to use the internet as their information resource. Then it is up to the user to define the topic they are looking for, and identify that to a search engine. While writing this paper searches on "*geosynthetics*", "*geosynthetic liner leak rates*" and "*geosynthetics technical information*" were performed - the results were amazing! Search results ranged from 6,100 to as high as 80 million matches. The quality of the results were in some cases equally as daunting, items with no relevance to the geosynthetics industry often found their way into the top 10 search results. Additionally search engines produce sub-sets of information which can provide more detailed results or more confusion contingent upon presentation and level of user knowledge. Microsoft, in order to keep the customers attention and provide product satisfaction prescribes to the "**Soft-Boiled Egg Rule**." - the principle that software should be simple enough that a user can do most transitions in less than 3 minutes, or about the time it takes to soft-boil an egg". When presented with excessive, and sometimes unassociated search results users will give up, and likely will not come back.

If we are to make proper use of the technology it is paramount that the ease of use be properly managed. What steps can be taken? Certainly we can not control the way that the 25 top search engines operate, nor can we control how items and keywords are submitted to those search engines, especially if we consider that millions of sites are created weekly. If we are able to provide an alternative to using the "major search engines" as the tool to query a select group of high quality geosynthetics sources and resources we can ensure ease of use. Many industries are forming alliances, Web Rings, Web Hubs or Portal sites to centralize and streamline information, increasing the ease of use. According to NetLingo, Inc. an on-line dictionary of internet reference terms, these systems are defined as follows:

- Web Rings are an internet service concept which links together a group of sites that have the same theme. In each Web Ring member web sites have banded together to form their sites into

linked circles. Their purpose: to allow more visitors to reach them quickly and easily. Sites connected to a particular web ring are usually considered by the Ring Master to be of superior quality.

- Portals are web sites that serve as starting points to other destinations or activities on the web. Initially thought of as a “home base” type of web page, portals attempt to provide “all of your internet needs in one location”. Portals commonly provide service such as e-mail, online chat forums, shopping, searching, content, news feeds and practically everything else under the sun.

- A web “hub” is one of the initial names for what is now known as a portal. It came from the creative idea of predicting a web site which would contain many different “portal spots” ... This content combined with Internet technology, made this idea a milestone in the development and appearance of Web sites, primarily due to the ability to display a lot of useful content and store one’s preferred information on a secured server...

By isolating focused resources, standards, specifications, and technical information in one easy to navigate location a cost effective, time sensitive method of education can be made available to the engineering / designing public. The internet has the power to meet and surpass the criteria outlined for delivering a successful educational source.

6 BENEFITS NOT SUPPLIED WITH OTHER EDUCATIONAL SOURCES

Additionally the internet provides a vehicle to deliver information in new interesting and explicit formats. 360° virtual tours of construction site successes and failures can be made available. Engineers can virtually tour physical job sites, viewing how specific technologies are working and not working. Discussion groups provide a forum for members of the community to discuss, query and compare experience. Listserv such as Geosyn post monitored notices around the world that can be customized and delivered for review at the users convenience. Because the lag time of printing, mailing or even faxing is eliminated the internet provides a forum which works in real time. This means that educational information can be retrieved and applied before it becomes obsolete in a project. Technology combines simultaneous web site and personal phone contact through one connection is available. If an engineer has a question while viewing a web page that engineer will be able to click an icon on the screen and be connected verbally or by video to a person who can provide assistance. Customizing features provide the user with the information they have specified. By utilizing database technology “dynamic” sites can generate customized delivery of information for each individual user. This technology has allowed us to provide a search engine which will deliver: news, standards, specifications, workshop information, technical documents (including CQA plans), abstracts, industry contacts and more based on single subjects, dates, and various other criteria, as defined by the user.

The internet is not a one way communication tool. Not only can the engineers and designers be provided the ability to increase education, the manufacturers, installers, fabricators, academics and consultants will also be provided that opportunity. By interfacing with the end-users, the geosynthetics professionals will be able to get and track: success, failure, requests, comments and concerns regarding the industry. As well the internet can be a dream tool for research and development as well as marketing departments.

As stated by Jack Welch, Chairman, of General Electric “An organization’s ability to learn, and translate that learning in to action rapidly, is the ultimate competitive advantage”.

Geosynthetics have rapidly evolved during the course of the last 20 years and still are evolving. Information technology, if used properly will provide the tools to increase the rate of development of geosynthetics, decrease the rate of failures and improve the overall standing of the geosynthetics market worldwide.

“Build it and they will come” - Unfortunately this concept is not a reality. The internet can be a source of great information *if* the people looking for the information decide to come to the internet and find it. Once a cohesive site or series of sites has been developed it is necessary to make the end-user aware of the site. By definition this target group has not demonstrated the will to be pro-

active about their own education. It has already been ascertained that the volume and quality of information is available and this group has not had the inclination or resources to search it out.

As we develop an on-line geosynthetics community it is imperative that every contact, email, phone call, and discussion reinforce the need to expand knowledge. All industry professionals must pro-actively encourage engineers, designers and regulators to utilize internet based resources as they evolve. Not only should geosynthetics users receive on-going exposure to information, but information on geosynthetics resources should be presented to engineers and regulators attending non-geosynthetics events. Non-geosynthetics conferences who's participants are potential geosynthetics users must be attended by our professionals. Universities training civil engineers should be provided geosynthetics resources and information at no charge.

Bill Gates of Microsoft provided public schools with computers and software from his company, those children became accustomed to using Microsoft products. Those children went home to parents, on to college, and have entered the work force, they are all asking for Microsoft applications because that is what they know. Microsoft continues to change and evolve their products they are anything but stagnant, and it is said that they have the highest consumer base in the world. If we bring engineering students along the same geosynthetics path it is possible that they too will go out into the work force and demand proper use of specialized geosynthetics products.

7 CONCLUSIONS

The internet offers a major opportunity for educating the largest percentage of the engineering community about geosynthetics applications, their performance, and how they are best used. However, this requires the development of a comprehensive technical resource, making the engineering community aware of the availability of the resource, making the resource easily navigable, and providing the information in a form in which it can be easily used.

The www.geosynthetica.net portal site, supported by an international cross-section of the geosynthetics industry, has been initiated and is being developed with these parameters in mind. It has generated interactive communications on a 24 hour per day, 7 days a week basis with engineers, students, and regulators in over 30 countries.

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Table 1. Comparison of Educational Information Sources.

Source	Availability	Ease of use	Cost	Completeness of information	Time investment
Periodicals / Proceedings / Print media.	Significantly available – delivered to your door or post-box. This requires forethought, the novice must identify the need for materials ahead of requiring and subscribe in order to have materials on hand when needed.	Moderate Not always cross-referenced. May have to review multiple indexes to find specific topic desired.	Moderate, most subscriptions are reasonably priced	Moderate, may articles reference other materials, specifications, standards etc. or may represent only part of a paper or more complete body of work. In order to ask questions of the author some homework may be required to find and speak with the author.	Significant, obtain periodicals, search index(s) to find topic of interest, review and potentially find back up or cross referenced info. (more time) – clarification or additional information may require a significant time investment.
Workshops/ Symposium/ Course/ Conferences etc.	Moderate, although there are many what is the timeliness of the next symposium addressing the educational needs – This is a pro-active method of education. The attendee must, in most cases anticipate the need for education in the future – If our target group were this proactive many of the issues identified earlier would not be issues.	Significant –Selecting segments of workshops from descriptions provided is quite simple. Exact topics of interest may not be highlighted and the need to attend a course in an associated topic may be the only option.	High. Enrolment fees, hotel, travel and food expenses along with time away from the office translate into \$100s or thousands of dollars per opportunity.	High, quite often presenter's or hosts will provide the supporting documentation during the class. Questions may be asked and answered right on the spot.	Moderate to Significant depending upon travel distance and length of the course. More often than not there is a significant time investment

Phone Calls	Highly available, everyone we have come in contact with this year has a phone.	Significant level of difficulty here in most cases. Particularly for the novice geosynthetic user. With lack of experience most likely comes lack of contacts. This means a telephone game.	Slight, with few exceptions most phone calls are of manageable cost. This may vary when long international calling is required.	Slight, relying often on people providing information out of their heads the information may be vague or inaccurate. No information provided in writing. Experts may be hesitant to provide information verbally and at no charge.	Significant. Often through a series of phone calls the correct person must be identified and then contacted. Frequently this can involve the time consuming game of "phone tag" and potentially not achieve the desired result.
Consulting	Highly available	Significant.	High – consultants are potentially the most expensive method of gaining information. Hourly rates, expenses and travel costs may be included when using a consultant.	High – paid professionals in their field are most often reliable. Consultants rarely pass on a complete education. More often than not providing a solution to the symptom not the problem, lack of education.	Slight – the time required to review industry directory and find a specialist, request a resume and file a contract is low.