Using Information Technology Resources to Share Engineering Knowledge in the Information Age

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Abstract

Sharing engineering knowledge is not limited to the classroom setting; it takes place under many different circumstances and settings. Conferences are a good example of one of these settings. Thus, in an effort to foster the knowledge sharing in engineering education, the American Society of Engineering Education - Southeast Section (ASEE-SE) hosts a peer-reviewed conference every year. The review process for the conference requires a great amount of communication among the conference organizers, authors and reviewers. As of today, the communication is mainly done through e-mails, which in most cases need to be compiled, processed, and re-distributed manually to the different parties involved. This paper describes the first attempt made by the ASEE-SE to develop and implement a web-based system to enhance the review process of the papers submitted to the conference. This system partially automates some of the most common tasks performed by the conference organizers. Thus, it is anticipated that this system will decrease the repetitive workload of the conference organizers and allow more effective and efficient system of sharing knowledge. It is also expected that the system will allow the storage of valuable conference submission information in a centralized location and it will serve as the asis for future enhancements of the review process. Therefore, the project described in this paper has the potential to directly benefit the educational engineering community associated with the ASEE-SE and also indirectly benefit the overall educational engineering community.

Background of Knowledge Sharing in Engineering

Engineering knowledge sharing is fundamental to promote best practices, create new knowledge and achieve academic and professional excellence [Lee 2003]. Thus, the analysis of knowledge sharing deserves particular attention from both academics and professionals. Engineering knowledge sharing could be analyzed from a variety of perspectives. One perspective for analysis is the characterization of knowledge based on its source. Nanoka and Takeuchi portray this characterization by classifying knowledge as tacit and explicit [Nanoka and Takeuchi 1995]. Tacit knowledge is personal, experiential, and context specific while explicit knowledge is codified, articulated, and published in some way. Another perspective for analyzing knowledge sharing is the setting in which it occurs. These settings are very diverse and include classrooms, laboratories, field trips, peer-discussions, seminars and conferences among others. With the advent of new information technology resources, these settings are changing, thereby impacting the way in which knowledge is shared.

According to a 2003 study by the University of California, Berkeley, the amount of data stored in 2002 totaled five exabytes, a staggering volume that could fill roughly half a million libraries full of sharable knowledge. The vast majority of this data was stored on magnetic media such as hard disks. As if this figure were not impressive enough, the study also concluded that this amount is growing at a rate of about 30 percent a year [Gross, 2003]. This study and others like it beg the question of how such large quantities of information are processed and shared in usable form to promote academic and professional excellence. As the amount of knowledge grows, processes by which we share such knowledge must necessarily become more powerful and efficient in order to keep pace. If

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knowledge cannot be collected and converted into a meaningful format, then it loses its potential value. Therefore, it is imperative for academia and industry - which both depend on knowledge for excellence - to constantly optimize the processes by which knowledge is made available.

Academia and industry have traditionally relied on technological advances to optimize the sharing of engineering knowledge. As the spread of information technology becomes more ubiquitous, however, their "off the shelf" strategic value lessens, and the importance of deploying and using them effectively becomes of higher importance [Carr, 2003]. Thus, academia and industry attention is shifting from buying the latest and greatest tech gadgets toward solutions that maximize the benefits and extend the capabilities of existing technologies through more efficient processes. An excellent example of this trend is seen through the current challenges in knowledge sharing and knowledge management strategies.

Conferences As A Means To Share Engineering Knowledge

The challenge of knowledge sharing is especially felt in the academic environment, where the collection and dissemination of knowledge is of foremost importance. As modern technology and information sharing techniques expand, academia is having an increasingly difficult time staying on par with the corporate environment into which its students are sent. Widespread budget cuts within the university and lightening fast turnover rates for new technologies often make investments difficult to justify. A current survey of information and communication technologies (ICT) usage within universities would reveal a wide range in the level of saturation and implementation. Many universities, especially ones with well-known names and large corporate backing are extremely "cutting edge," while others are not so well equipped. In many instances, techniques that are common in industry are slow to emerge in academia. Moreover, the field of information technology, which has been incorporated into virtually every discipline, is no longer a small and easily manageable body of knowledge. This fact is multiplied when one considers the typical university professor already stretched with teaching, research, and service responsibilities.

Due to the several challenges faced by academia, educators and researchers must work together to collect and disseminate the vast amounts of new ideas and knowledge as it is made available. Conferences are one of the primary settings by which the academic community has approached the sharing of engineering knowledge. Although conferences are an effective means of sharing knowledge, they are nevertheless subject to the same trends described above in ICTs and data processing. If conferences are to be used as a solution to the growing disparity between new data and usable knowledge, then conferences themselves must be made efficient. Conference procedures and techniques, i.e. organization, communication, paper sharing and reviewing, etc, must be updated to reflect approaches employed in modern solutions. The task of organizing and conducting academic conferences can be a daunting process, especially when approached with outdated methods. In addition to this, conference responsibilities usually fall on a university professor who receives no extra pay or time allotment to manage the conference. If conferencing procedures are not updated for efficiency, they can quickly become a burden for everyone involved and reverse the advantage of their usefulness. Thus, this paper describes the first initiative taken by the American Society of Engineering Education - Southeast Section (ASEE-SE) to propose the use of information technology resources to share engineering knowledge in the information age. More specifically, this paper describes the ASEE-SE conference process and its transformation to make use of information technology resources to enhance the annual review process of papers submitted to conference.

The use of information technology resources to assist in conference management is becoming increasingly more sophisticated as new methods utilizing the advantages of ICTs are introduced. Many are highly automated, transferring the burden of time-consuming and repetitive tasks such as emailing, storing, and categorizing papers from volunteer professors to computers. In an excellent 1999 summary of conference management software, Snodgrass [1999] lists capabilities inherent within these systems, including:

- Submission of papers
- Assignment to reviewers
- Mailings to appropriate members
- Submissions of reviews
- Reviewer thread comments

- Distributed meetings
- Letters to authors
- Conference registration
- Handling of associated workshops
- Handling different tracks of submissions

At the time of this summary, very few of the 20 systems examined included all of these capabilities, but clearly, even a system incorporating a portion of them would introduce large timesavings to those currently managing conferences without such tools.

It should be noted that some of these systems offer customization and the ability to work in other conference settings, but this is oftentimes difficult to do because conference procedures and formats vary widely. However, the systems themselves are not extremely difficult to create, even for non-professional programmers because web-based conference management systems are created using rather common techniques and languages such as Perl, CGI, Python, Java, and simple HTML. In light of this, the question must be asked as to why most conferences today are not using such systems, but rather depend on email, "snail-mail," and phone calls to accomplish the tasks listed above. Most likely, there are numerous answers to this question, but the fundamental restrictions of up-front development time and the lack of awareness of new methods are obvious. For a better understanding of why there is a need for developing a conference management system for ASEE-SE, it is important to first discuss the current methods used for this process.

ASEE-SE Conference Management

The ASEE-SE initiates the conference organization by selecting both the host institution and theme of the conference. The organizing team then disseminates the "Call for Peer Review Papers" through flyers, web site, e-mail and regular mail. The current process has the following deadlines:

- First week of September –Abstracts submitted for consideration
- First week of October – Authors notified regarding acceptance
- Second week of November – Manuscript due from authors for review
- First week of January – Reviewed manuscripts returned to authors
- First week of February – Final manuscript and extended abstract due from authors

Throughout the complete conference management cycle, constant communication is required among all the members of the organizing team. Figure 1 presents a schematic diagram highlighting the main communication among the organizers and authors prior to the submission of the manuscript, which occurs on the second week of November.

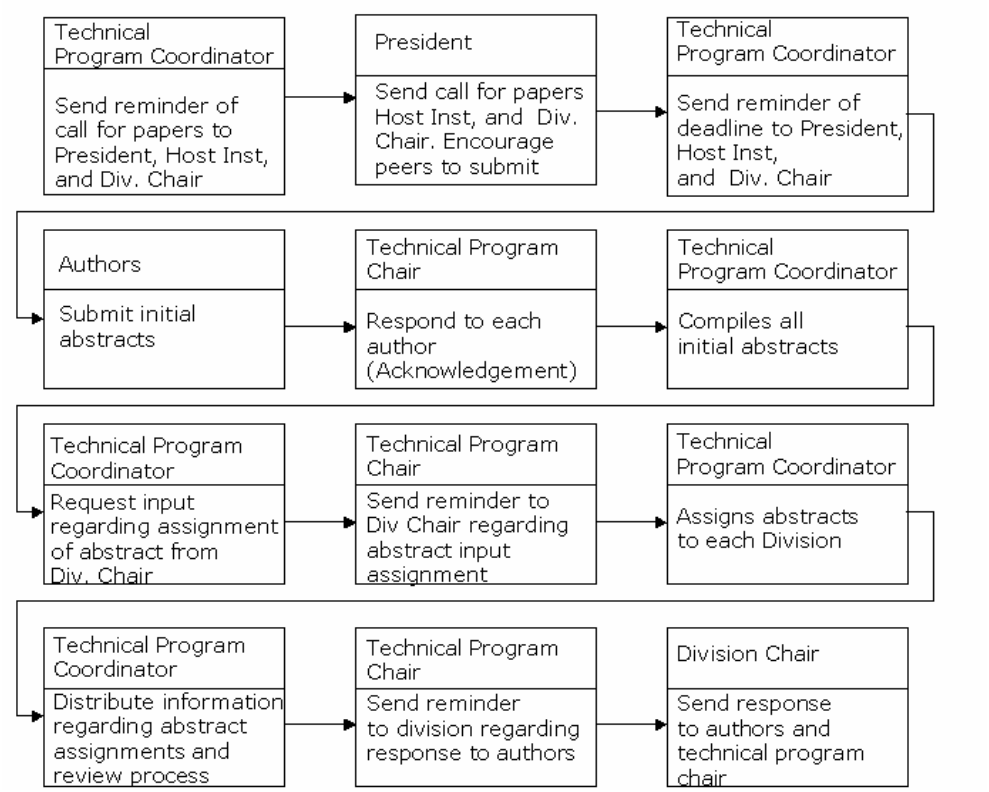

Figure 1. ASEE-SE Conference Communication Prior to Manuscript Submission

After the manuscripts (Paper and Extended Abstract) have been submitted, communication among organizers, reviewers, and authors continues. Figure 2 shows a schematic of the communication after the manuscript has been submitted and prior to sending the review results to the authors (first week of January).

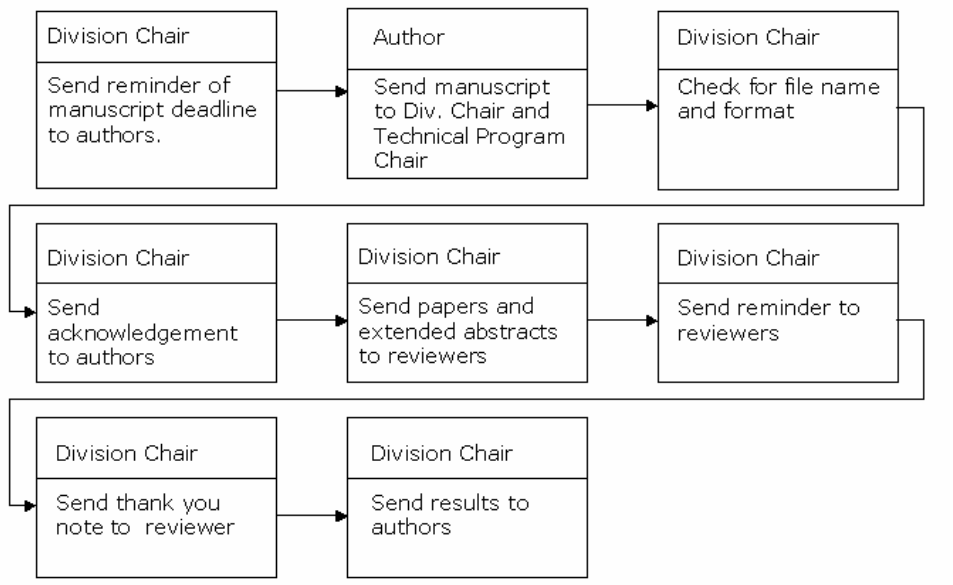

Figure 2. ASEE-SE Conference Communication between Manuscript Submission and Review Results returned to authors

The last stage of communication among organizers and authors is mainly directed towards the final products that will be presented in the conference. Figure 3 shows a schematic of the communication in the last stage of the review process of the papers.

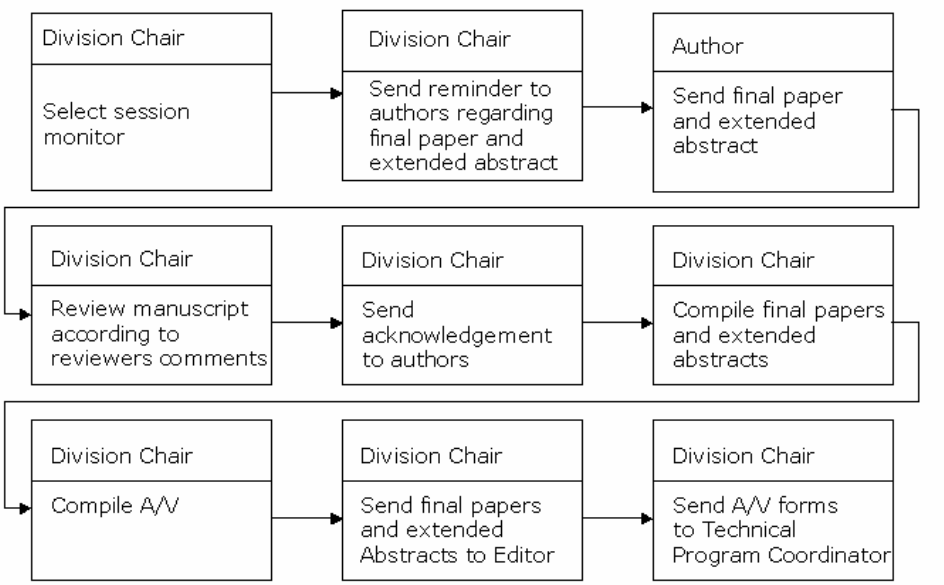

Figure 3. ASEE-SE Conference Communication before compiling final papers and extended abstracts

It should be obvious that the process detailed above requires a significant investment of time and effort on the part of coordinators and chairs. As an example, in the 2004 ASEE-SE conference, 140 abstracts were received for consideration. The process of (1) transferring the files from the form of an email attachment to a directory, (2) archiving the e-mail in to a folder, and (3) sending a follow-up e-mail to the authors acknowledging their submissions took between 3 and 5 minutes for each paper. For 140 abstracts, this translates to between 7 and 11 hours of work for a faculty member. After this process was completed, (1) the main information (such as: title, author, contact information, etc) of all abstracts was compiled, (2) the files were converted to PDF, and (3) the files were renamed and assigned a preliminary reference number. This process took between 4 and 6 minutes for each paper, requiring a time investment of between 9 and 14 hours. This was followed by linking the PDF files with a list of papers to be posted on the web to give access to the division chairs. This took approximately 2 to 4 hours. The division chairs were notified and provided input regarding the appropriate division assignment of the papers. This was manually processed and papers were assigned to a division, requiring approximately 2 to 4 hours.

Proposed Web-Based System For ASEE-SE Conference

The development of a web-based conference management system is an excellent opportunity for blending information techniques with engineering knowledge sharing. The diverse set of skills depicted in ASEE-SE's divisions presents the perfect platform for collaboration among educators to create such as system that would benefit everyone involved. Realizing this potential, a small group of professors and students was formed at the University of Southern Mississippi in the spring of 2003 for the purpose of proposing a web-based paper review system to be used by ASEE-SE. The proposed system would automate much of the current process described above and centralize all events involved in submitting, reviewing and judging papers for ASEE-SE conferences.

In beginning this task, the scope of the project had to be defined and individual processes identified that should be included in the system. Emphasis has been placed on replacing as much of the current conference management processes with automated phases that require minimal manual oversight. Where possible, advantages presented by a central web-based system were exploited, necessitating changes in the current methods.

After a thorough review of the current procedures, it was determined that the optimal web-based solution would tie together organizers, authors and reviewers through 25 separate stages. In order for the system to be successful, it had to allow access to and transition between each of these stages. This process is illustrated in Figure 4.

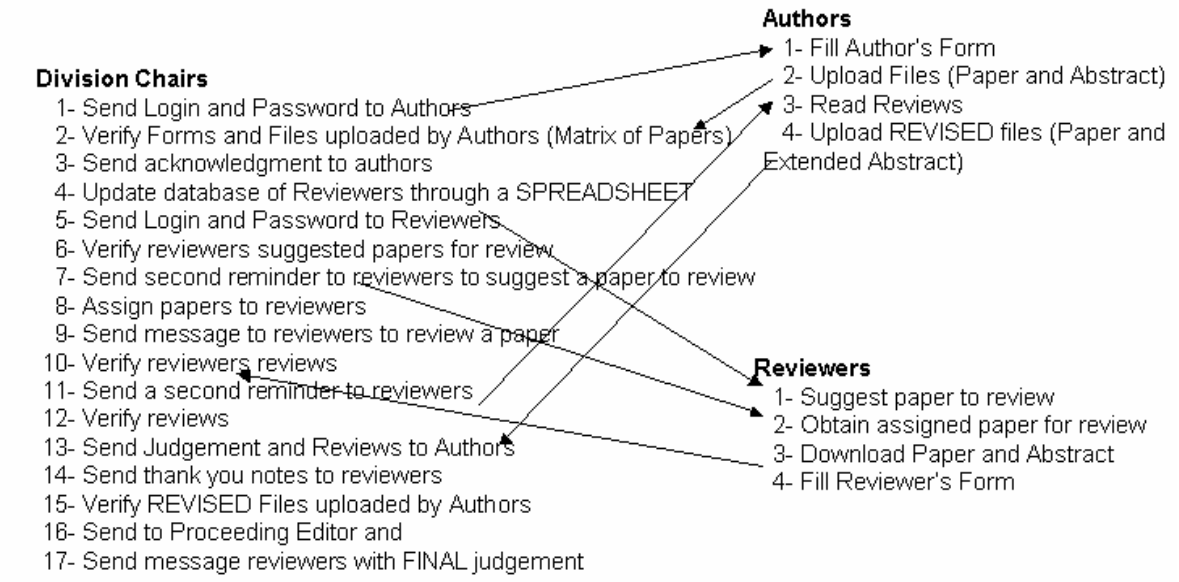

Figure 4. Stages of the web-based solution to tie communication among organizers, authors and reviewers

Secondly, decisions had to be made as to the language, database, supported platforms, etc that were to be used in creating the system. One of the disadvantages to other conference management software is that they tend to have very limited options and cross-platform support. For this reason, it was decided that the system needed to be compatible with Windows and Unix environments and be built with a common language that is portable and expandable. Under these circumstances, it was decided that the system would be coded in PHP and utilize a MySQL database. PHP is a widely used scripting language that is embedded easily into HTML (http://www.php.net). MySQL is the most popular open source database server in the world (http://mysql.com). Both PHP and MySQL work extremely well in combination due to their mutual support. Although originally configured on a Windows 2000 system running the Apache web server, the ASEE-SE conference management system can easily be moved to other popular system configurations with none to minimal coding changes.

Because these technologies are transparent within the ASEE-SE website, they require no learning curve for users already familiar with browsing the Internet. All phases of the paper submission and review process will have a section of the website containing all pertinent functionality. For the purpose of eliminating addressing errors, all required web addresses will be sent automatically from the web server via email and users need simply click the link to access related portions of the site. Upon entering the paper submission website, each user will be required to either enter their login credentials or create a new profile. Using this authentication scheme, users will be linked with all necessary personal information and choices needed for interacting with the system. A screen shot of a beta version of this is given in Figure 5. This also ensures that confidentiality is protected at all points of the process, since access control is implemented based on role and ownership. From this initial page, the user can access help documents, contact the administrator or program chair, upload documents, update profiles, and review submissions in addition to all other required tasks. To illustrate the basic workings of the website, the following scenario of the manuscript submission phase of the process is briefly discussed.

The division chair will visit the site and type a request for manuscripts to be sent to all ASEE-SE members. An email will automatically be generated and sent to all registered members. The email will contain a link to the correct portion of the website for uploading the manuscript. Following this link, the potential author will visit the site, enter all relevant information and submit the manuscript. Based on the author's input, the system will send notification via email to the chair of the appropriate division. The division chair will then return to the website via the enclosed link and select potential reviewers from a list of available faculty. An email will then be sent to any selected reviewers inviting them to review the manuscript. At this point, the faculty member can either accept or

decline to enter into the review process, thereby terminating the submission phase and triggering, if desired, the start of the review phase.

Figure 5. Beta version screenshot of initial page after successful login.

The advantages of the system extend well beyond the obvious reduction of time investment required to manage ASEE-SE conferences. When active, the system will serve as a central repository for all papers throughout their submission and review life-cycle. Because all user activity is stored in a database and current information automatically linked to the user upon login, difficulties associated with losing files or editing the incorrect version are removed. It can be accessed from anywhere at anytime, providing a large advantage over having to swap papers under review between systems and storage media. It also sets the stage for easily-generated statistics and analysis of conference related processes. It is also expected that by offering a center for ASEE-SE research activity, communication will be improved between members, thereby enhancing the overall value knowledge sharing in general.

Conclusion

The ASEE-SE system discussed in this manuscript has been initiated. The system is slated to be used in future conferences, which will be an excellent opportunity to evaluate its impact on the paper review process. In order to maximize the use of ICTs in the conference setting, there are many more options and features that could be developed to supplement the automated paper review process described in this manuscript. The system has been created in a way that is easily adaptable to other ASEE divisions with minimal coding and allows for the addition of new modules for expanded functionality. As an example, the authors recommend that a web-based conference preference and scheduling program would be a powerful upgrade to the system. Utilizing this, attendees could visit a webpage and select the tracks that they would like to attend. After this, algorithms in the program could automate complex and time-consuming processes like scheduling, room selection, minimize concurrent events, presentations, etc, further lessening the burden on program and division chairs. Also, as the audio/video capabilities of the web continue to improve, the merits of using such systems in conference settings can be explored.

The benefits that this system will bring to ASEE-SE are an important example of how ICTs are influencing engineering education. If these new technologies can be harnessed effectively, they are poised to greatly increase the quality of education in general and especially technical fields such as engineering. This paper has presented an example of how this can be accomplished while at the same time demonstrating how engineering students from

different specializations can work together on a valuable project. It is important to note that the ASEE-SE conference paper review system did not require the purchase of any new equipment, nor did it use any methods that were not well known and well documented. In this light, the solution described in this manuscript is not very impressive or novel. However, this fact is one of the most impressive and important aspects of the project: Anyone with some programming skills and a few good tutorials could produce it. One may indeed wonder why this wasn't done before; and that is exactly the right question to ask. Simple solutions such as this are greatly needed in the academic environment and they point toward an excellent way for information technology to benefit engineering knowledge sharing with minimal expense in the information age.

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