E-Collaboration Tools for Government Funded Projects: NHLBI-PEN Approach and Solution

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ABSTRACT

In this paper, we present the E-collaboration system that has been designed and developed during the first year of the NHLBI-PEN Government Funded Project. We start by presenting the design phase that led to the implementation of the E-collaboration tools of the project. Then, we describe the function of each e-tool, we discuss the impact on the project that they have produced and we present open issues for further implementations of the system. Even if a specific information technology expertise was needed in order to make our system operational, we believe that it can be easily replicated and used by investigators of other government funded projects who do not already have access to an E-collaboration system.

INTRODUCTION

In order to successfully manage a research project, keep it on track and fulfill its goals, it is essential for the team to frequently discuss plans, objectives, achievements and challenges. It is also important to have the ability to share large data sets while maintaining a high level of security and privacy. Meeting and exchanging results regularly are also essential for the success of the project.

Face-to-face communications have been considered as the most appropriate medium to share ideas, comments, and opinions and to reduce misunderstanding [1]. However, large government funded projects often involve researchers from different institutions and/or departments. Therefore it is not always possible to implement this direct mode of communication due to the challenges of distance and the increasing needs of time and cost savings.

Recent developments in information and communication technologies have enabled and facilitated new forms of inter-organizational collaboration [2]. The use of E-collaboration tools introduces a new concept of time and distance, modifies human interactions, creates a novel environment for decision making and changes the classic network of face-to-face relationships into a network of virtual relationships.

E-collaboration has been defined in many ways. For the purposes of this article, we adopt the definition proposed by the guest editors of the first special issue on E-collaboration, published in 2001 in the *Journal of Systems and Information Technology by Kock et al.* They describe E-collaboration as "collaboration among individuals engaged in a common task using electronic technologies" [3]. Our system includes not only computer based technologies but also simple telecommunication devices such as the telephone. We agree with Kock [4] and we believe our system should still be considered an E-collaboration system.

In the following sections we briefly introduce the NHLBI-PEN project and describe the context that brought us to the implementation of a set of E-collaboration tools. Then, we present the hardware and software platform, a detailed description of the function of each E-collaboration tool, and the reasons for their development. We discuss the issues and challenges we experienced during development and implementation along with the limitations of our study, results achieved, and concluding comments.

THE NHLBI-PEN PROJECT

The central mission of the NHLBI-PEN project is to develop a group of well-characterized and versatile nanoscale agents that can be assembled, labeled, targeted, filled, and activated as needed for the diagnosis and treatment of various diseases of relevance to the National Heart Lung and Blood Institute (NHLBI). The project started in May 2005 and it has been funded for five years. The research activities of this project are carried out at three different institutions: Washington University in Saint Louis, University of California - Santa Barbara, and University of California – Berkeley. The teams include researchers from different cultures and scientific backgrounds where about 80% are chemists.

NEEDS ANALYSIS

Remote collaboration initiatives are not common in chemistry departments where Information Technology resources are often limited. The departments usually provide only emails as form of communication, common Internet access and occasionally the possibility to share central equipments.

E-Collaboration requires a synergistic framework based on four components: strategy, organization, process and technology [5]. We believe that a system embodying this synergy is advisable and necessary in order to be successful. Following this assumption, the senior investigators of the NHLBI-PEN project designed a roadmap with the goal of developing a set of E-collaboration tools that could overcome the potential barriers to collaboration and information sharing created by the physical separation and schedule differences between the three Universities.

The road map was based on four stages: 1) requirement gathering, to understand and identify the needs of the users, 2) requirement specifications, to identify any system requirements and user goals that must be met for the system to be successful, 3) design prototype in stages, and 4) evaluating the design to assess the system, test the software and perform usability testing.

Research has shown that it is much more economical to consider user needs in the early stages of the design [6]. In our road map, the needs and limitations of the end users were first inquired and analyzed, and then assumptions were transferred into the prototypes. This approach is well recognized as an effective strategy in designing ease-of-use products and systems [7],

The senior investigators of the NHLBI-PEN project identified four inter-organizational set of tools: information, communication, coordination and collaboration (see Table 1). For each of them, they defined a list of needs that had to be fulfilled by a specific E-collaboration tool. A time frame for implementation, based on months from the starting date of the project, was defined as well. The collaborative tools were selected among the ones presented here [8].

Given monetary constraints and the need to personalize software with specific routines, proprietary software was not a feasible option. In order to increase flexibility, independence from a third party provider was required. The system had to be highly reliable yet easy to maintain, administer and update, once fully operational. Synchronous and asynchronous tools had to be designed with the goals of increasing the communications and the sharing of data and results among the researchers. Easy access to and operation of the E-tools had to be addressed since most of the researchers in the project did not have an information technology background. Focusing on ease of use has been used to advance the product's release date [9].

In summary, the E-collaboration system had to be cost-effective (low cost of implementation), independent to industry and software/hardware vendors (open),

Table 1. Classes of inter-organizational information systems

Information	Communication	Coordination	Collaboration
WEB portal for sharing progress and general information about the project (available after 2 months). WEB portal for storing/remember events and meetings (available after 3 months). WEB site for storing goals and achievements of the researchers during skill development visits to other laboratories (available after 6 months).	Affordable conferencing system (available after 1 month). Research groups mailing list (available after 1 month). WEB site for facilitating the exchange of chemical samples between laboratories (available after 6 months).	Electronic document interchange tool (available after 4 months). System for monitoring the budget (available after 6 months).	Collaborative Planning (available after 10 months).

easy to integrate with the existing procedure/process and fast to deploy on a simple technology. [5]

NHLBI-PEN E-COLLABORATION SYSTEM

Following the plan provided in the road map, an E-collaboration system was designed and implemented. Initial use of the E-collaboration system was restricted to peripheral or uncritical activities and then implemented in full scale. This approach had many advantages: users learned to handle the new E-collaboration approach gradually without detracting from efficiency in their daily activities; technical implementation investment risks were minimized while the possibility of standardization was increased; and the E-collaboration system was tested adequately before going to full scale production.

HARDWARE AND SOFTWARE

The hardware and software platform used for providing the E-collaboration tools described in this paper, is based on a 2U rack Pentium III server class A by Ironsystems [10]. It runs Linux Debian with Apache as web server [11], PHP as scripting language [12], MySql as relational database [13], Webalizer for web statistics [14], and Postfix [15] as SMTP server. Telnet, FTP, DNS and other services have been uninstalled for security reasons. High levels of stability, fault tolerance, and availability are addressed by the use of RAID (Level 1) technology, daily backup policy on different supports (tape, external USB drive, and data storage devices), and redundant and uninterruptible power supply. Security policies are addressed by disabling physical and remote access to the server. Only a secret username has the privilege to log-in through a SSH connection from a subnet inside the Washington University in Saint Louis network. The SMTP server uses a mail relay provided by the department for spam filtering and virus protection. Specific firewall policies, directly controlled and managed by the IT office of the department of Chemistry at Washington University in Saint Louis, block access to the server except for port 80 (HTTP) and port 25 (SMTP). A daily report of the Internet traffic through these two ports is automatically created and checked regularly.

E-CONFERENCE TOOLS

The meetings of the NHLBI-PEN project are usually held in a conference room located at the School of Medicine of Washington University in Saint Louis. In order to reach a high level of participation and to increase the effectiveness of the meeting, a hybrid system, composed by an audio and a virtual office component, was developed. The audio component is based on a SoundStation VTX 1000™ Polycom system that allows communication, *via* telephone line, with the researchers in California. The two extra microphones and the speakers included in the Polycom system allow the circulation of comments, questions, and answers between all the participants (usually twenty in Saint Louis and seven in the two sites in California). The telephone service is provided by the university telephone department. The virtual office component uses a desktop sharing utility, based on VNC [16] that allows each site to be engaged in the meeting by following the PowerPoint presentations in real time. While one site actively initiates and controls their presentations, the other site can passively view. This virtual office component overcomes the limitation in following a distant presentation where the slide under discussion and the highlighted area of the slides by the presenter's laser pointer are unknown. The movements of the laser pointer are subsequently replaced by the movements of the mouse. This desktop sharing utility uses TCP/IP and it is available through a web site that works as proxy. A dedicated computer with Windows 2000 and VNC has port TCP 5900 open through the firewall. Two levels of password authentication are required to have access to the utility: one provided by VNC and the other by Windows.

E-DOCUMENTS TOOL

The E-Documents Tool is based upon PHP Advanced Transfer Manager [17], a free web content management software. It allows the researchers involved in the project to collaboratively create, publish, share and retrieve data when needed. The main features available are: upload, download, delete or modify (users can only manipulate their own files). A super-user creates folders, has full control over all the files, and manages user accounts. In order to fulfill the requirements and the needs of the researchers, the main software package was upgraded. Specific routines were designed, developed, tested and finally added to the basic package in order to have an E-Documents Tool that can provide each user with 300 Mbytes of restricted space (Personal folder) and each research unit (identified as a senior investigator plus his/her researchers) with 2 Gbytes of restricted space. The new version also has a shared folder accessible by everyone that is used for transferring files among units. Finally, a special area has been created for the exclusive use of the Internal Operating Committee members. At the end of July 2006, the E-Documents Tool had 304 files uploaded, 270 Mbyte of data stored, and 44 active users (Figure 1).

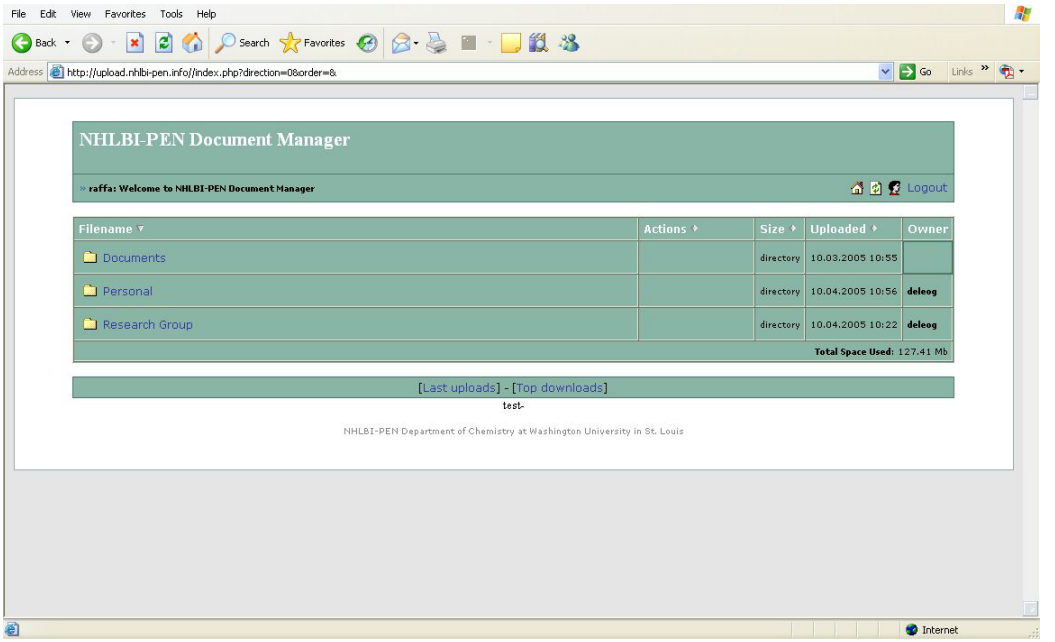
MAILING LIST TOOL

The researchers of the NHLBI-PEN project can utilize several mailing lists for easily contacting the members of each team. The mailing lists are both horizontal (for each of the 12 research teams) and vertical (for each of the 4 component: Materials Synthesis, Imaging, Animal Models, and Skills Development). The Internal Operating Committee has its own mailing list. In addition, a global mailing list that contains all the members is available.

E-RESEARCHER VISITS TOOL

The researchers of three universities are encouraged to schedule frequent short visits to other laboratories involved in the project. Throughout the year, post-doc and graduate students spend a few intensive days in other research groups to learn about additional procedures and methodologies that they have not yet experienced. The E-Researcher Visits Tool stores the researcher's name and email, information

Figure 1. The e-document tool (home folder view)

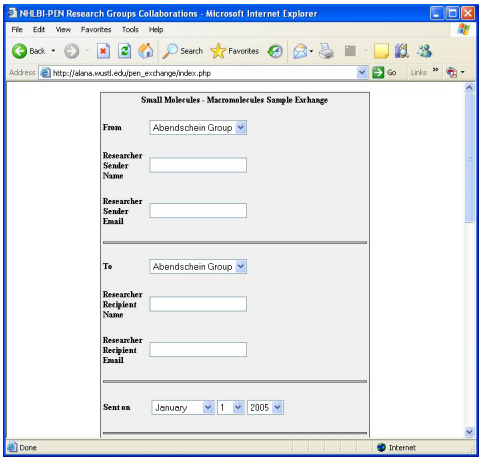


about the research group where he/she belongs, the group that he/she is visiting, and the goals and accomplishments of the visit. At the end of July 2006, the E-Researcher Visits Tool had 17 visits stored. A web site, password protected through the Apache htaccess policy, allows anyone in the project to have access to the E-Researcher Visits Tool.

E-SAMPLE EXCHANGE TOOL

The E-Sample Exchange Tool stores the information and the data of the chemical samples that have been transferred between research groups. There are two different sample exchange tools: one for Small Molecules-Macromolecules and one for Nanoparticles. A user-friendly web interface was developed in order to

Figure 2. E-sample exchange tool (insert a new record view)



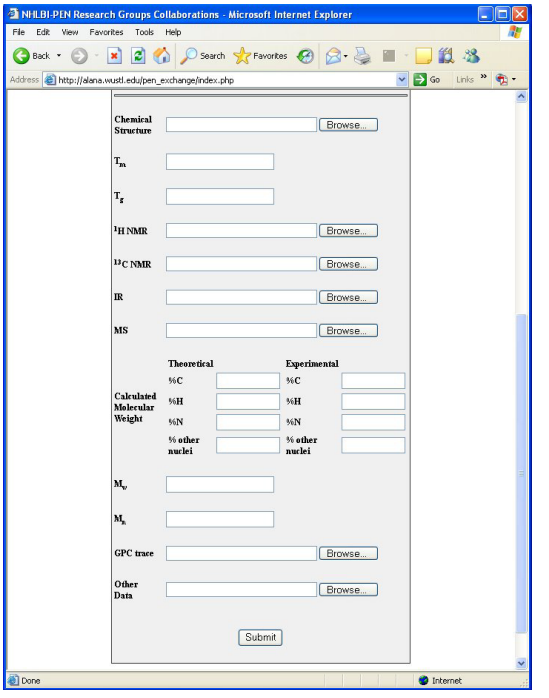
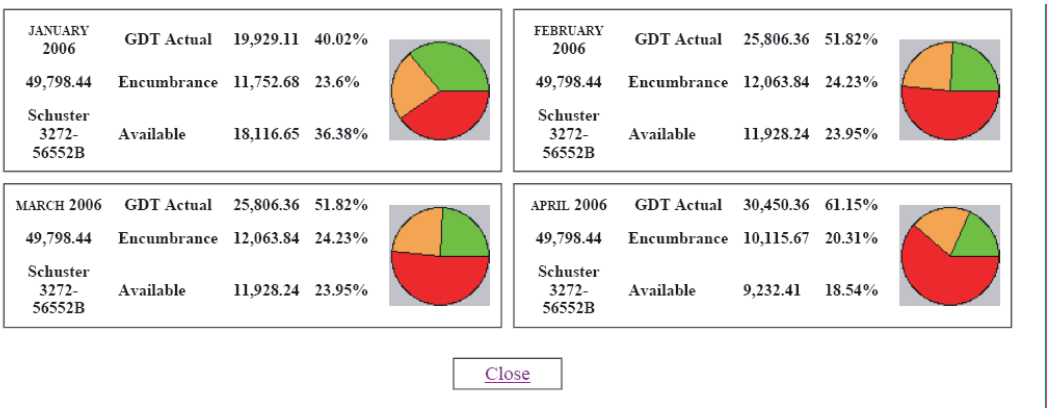


Figure 3. E-budget tool (monthly progress view)

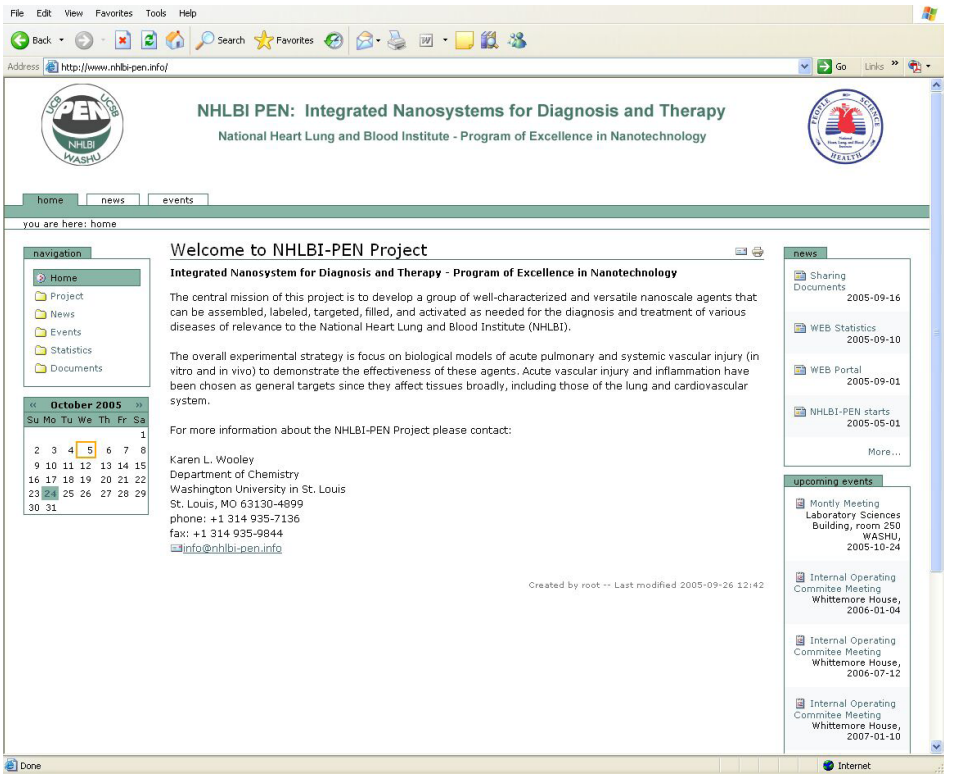


guide the researchers in creating a new record that contains general information and detailed data about the sample. General information includes the names and email addresses of the researchers who sent and received the sample, the date of sending, and an identification code. Detailed data consists of the chemical structure, the calculated molecular weight, the GPC trace, and other chemical properties. As in the case of the E-Researcher Visits tool, a web site allows anyone in the project to have access to the data. At the end of July 2006, the Sample Exchange E-Database contained 19 entries for Small Molecules – Macromolecules and 14 entries for Nanoparticles (Figure 2).

E-BUDGET TOOL

The E-Budget Tool keeps track of all the expenditures of each research group. This tool is available only to the Principal Investigator and her administration office. The budget of each research group is updated on a monthly basis and it shows the spent, the encumbrance and the available amounts. A color pie chart simplifies the visualization of the status of the budget and it is available in two formats. The first chart visualizes the research group budget situation by months, and it is used for monitoring the expenses over a long period of time. The second format gives an overview of all research groups by a selected month (Figure 3).

Figure 4. Web portal (home page view)



WEB PORTAL

The NHLBI-PEN web portal is available at http://www.nhlbi-pen.info (see Figure 4). Since the beginning of the project, the NHLBI-PEN team has been using the web portal for informing the community on new events and news. The status of the project, its progress and future plans are updated regularly. The web portal was developed using Zope [18] and Plone [19] and it provides a common interface and a single entry point to the other NHLBI-PEN E-Collaboration tools and services. The web portal contents can be easily updated by anyone, even without training in Hyper Text Markup Language (HTML).

DISCUSSION

The roadmap described in this paper is related to the first year of the NHLBI-PEN project. All the E-collaboration tools, except the collaborative planning, have been implemented and are fully operational.

The need for developing the E-collaboration tools presented in this article comes from the absence of collaborative systems at the three universities involved in the project. It is true that a teleconference system was available at each site but it was not free of charge, was difficult to reserve and the telecommunication standards used were not the same. Moreover the cost of using such systems cannot be billed directly to the grant and is not usually covered by the indirect costs of the departments. The possibility that the government agency that provides the grant would provide such E-collaboration tools free of charge does not seem realistic too.

Moreover, specific budgets for supporting IT personnel are not usually included in grant proposals. Thus, costs related to the initial investment in hardware should be considered when E-collaboration tools are planned. However, these costs would be a small percentage of the total budget of the project.

We believe the interface to our E-collaborations tools is easy to use. The researchers of the NHLBI-PEN project only need an e-mail account and a browser to have access to all the tools. Our monthly meetings have been attended often by researchers traveling in other countries or away from their offices. A wireless access point was enough for giving them the opportunity to participate. However, in order to increase the user-friendliness of our entire system, we are planning to develop a central log-in management system that stores the user's information. This would allow the user to log into each tool with the same id and password.

Bulletin boards for extended conversation and chat, where real-time text messages appear on both users screens, have not been implemented because they were not considered beneficial to the project. However, the development of a web based task list including a set of actions to be performed, pending activities, and unresolved problems is in progress. The E-Sample Exchange tools will have a "store room" section where researchers can look at the samples that are available in each group, place an order and receive the chemical at their labs. The implementation of a web based free educational tool to fulfill the skills developments component goals has been planned. Initial investigations suggested the use of Moodle [8].

Linux has been preferred to Windows as the operative system platform because more open source software is available under Linux. It is also easier to maintain once installed. We believe that the knowledge required to run a Linux server is equivalent to the one needed to administer a Windows 2000 Server.

Although the system is easy to maintain, we believe that a maintenance service (hardware and software) should be in place in order to guarantee availability of the E-tools to the researchers.

CONCLUSION

With the development of new technologies, and information communication technologies, in particular, teams have evolved to encompass new forms of interaction and collaboration. This paper demonstrates that E-collaboration tools can be used in a research funded project and that the implementation is not difficult to achieve.

The NHLBI-PEN E-collaboration system brings geographically dispersed research partners together, and supports the communication, coordination, cooperation, and sharing of data between the distant locations. We have described a system that allows the researchers of government funded projects to adopt the use of low-cost E-collaboration tools for increasing productivity and team work.

This study does not present any data about user's evaluation of the E-tools because a survey for collecting user feedbacks has not yet been developed. We only know that each E-tool has been extensively used. We are also aware that the number of the users in the NHLBI-PEN project would not have been enough statistically to make any definitive statements about the quality of our E-collaboration system.

However, we have acknowledged a transformation process from traditional (offline) communications toward hybrid services that combine elements of traditional collaboration and E-collaboration. Our E-collaboration solution is presented to improve the existing processes and provide the vehicle to establish new forms of collaboration.

Finally, we believe that a set of E-collaboration tools such the ones described, should be provided by the Universities using indirect cost budgets.

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