

## Garden City: a distributed sharing community

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**ABSTRACT:** The Internet's potential to enhance engineering education depends in part on the development of appropriate Web sites and associated software. Distributed Sharing Communities (DSC) are communities of learners, eg faculty, students and/or professionals who share information over the Internet. Created through a US National Science Foundation (NSF) funded project, *Garden City* is a Web site that allows professors without advanced Web skills to create a DSC. In this article, the authors introduce DSCs in general, and Garden City in particular. Faculty can use Garden City to demonstrate the context (ie human communities) of many civil engineering projects and provide continuity for design projects that extend through multiple courses. Undergraduates can also utilise the Garden City Web site to access projects and related data and design information. DSCs are expected to become an important tool in engineering education.

### INTRODUCTION

The Internet's potential to enhance engineering education depends, in part, on the development of appropriate Web sites and associated software. Distributed Sharing Communities (DSC) are communities of learners, eg faculty, students, and/or professionals, sharing information over the Internet. Garden City is an evolving software package that allows persons with limited Web skills to create a database-driven Web site fostering a DSC centred on the civil and environmental engineering curriculum. The administrator uses html forms to name the site, and to create pages and accounts. Contributors (eg professors) log on to the site to add and view content. Members log on to the site to view content. Page access can be limited by account type.

The Internet is full of Web sites that help distributed communities share information. For example, Amazon.com and similar commercial Web sites serve distributed communities of shoppers [1]. People can do more than just buy products on these Web sites. For example, on Amazon, they can listen to bits of songs and look at example book pages, read product reviews and ratings or add their own, offer advice on products (*So you'd like to...*), and submit lists of preferred products (*Listmania!*). Web sites like Amazon create DSCs because users can contribute and comment on content. Thus, a distributed community of shoppers uses Amazon to share information about products.

Wiki (pronounced *WeeKee*) sites often go a step farther, allowing users to also edit content, even content added by other users. Furthermore, on wiki sites, users contribute the majority of content. A good example of a wiki site is Wikipedia, a free encyclopedia written collaboratively by its readers [2]. The purpose of Wikipedia is to create a complete and accurate free content encyclopedia. Readers can start their own pages, edit existing pages, add images, or comment on pages. As of May

2006, Wikipedia contained over 1,000,000 articles, on topics ranging from mathematics to fine arts [2]. By definition, wiki sites support DSCs.

The software used to create wikis is called collaborative software. Collaborative software allows people to collaborate on a Web site, even though they may not communicate in a synchronous manner or ever meet each other face-to-face. Software supporting DSCs can also be called collaborative. Before discussing Garden City, it is useful to examine some example civil engineering Web sites currently on the World Wide Web (WWW) for comparison purposes.

There are many Web sites devoted to civil engineering issues, including the following:

- iCivilEngineer.com [3];
- The American Society of Civil Engineering (ASCE) Web site [4];
- The Civil Engineering Virtual Library Web site [5].

The Web site iCivilEngineer.com is a knowledge portal used to collect and catalogue relevant Internet resources and explore how to take advantage of the Internet [3]. It includes a number of *Centers*, including the following:

- News: civil engineering and information technology (IT) news, big projects, recent failures, etc;
- Career: job sites, professional engineering examination guide, schools, virtual books, etc;
- Tools: unit conversion, stocks, local weather, etc;
- Resources: valuable civil engineering Web resources organised by technical topics.

It also includes a Web directory of links to many civil engineering Web sites. While a wonderful site filled with useful links, iCivilEngineer.com does not allow users to share

information and thus does not support a DSC. The Web site content is determined by its staff.

The mission of the ASCE is to provide essential value to its members, their careers, its partners and the public by developing leadership, advancing technology, advocating life-long learning and promoting the profession. The ASCE Web site has valuable information in a number of areas, including *Products and Services*, *Communities of Practice*, *Kids & Careers* and *Research Resources* [4]. However, direct control of content is by a small number of ASCE members; thus, the site does not support a DSC.

The Civil Engineering Virtual Library, part of the WWW Virtual Library project, is hosted by Georgia Tech [5]. It contains links to civil engineering entities divided into four groups, specifically: educational, commercial, journal and organisation. The agents of appropriate civil engineering entities submit specific information for approval and inclusion. Links are listed alphabetically under the four main categories. As such, the site only provides access to the Web sites of groups, not civil engineering topics. It is difficult to search. Because people in the civil engineering community can use it to share information, the Civil Engineering Virtual Library supports DSCs, although in a very limited way.

DSCs can be used to improve engineering education, but little has been accomplished to date. The purpose of this article is to describe and evaluate a DSC Web site created at Rowan University: Garden City, used to provide continuity for design projects that extend over multiple courses and years.

## GARDEN CITY

Garden City is a collaborative software package, developed at Rowan University, the Civil and Environmental Engineering Department, that can be used to easily create Web site-centred DSCs. Garden City software creates Web sites where:

- Flexible administration can be accomplished by persons with relatively limited Web programming skills;
- Access to pages is controlled by password;
- Contributors (eg professors) can contribute, edit and view content;
- Users can search and view content on most pages and contribute and edit content on select pages;
- Guests can search and view content on most pages;

Garden City is an adaptation of Sooner City, a program and Web site created at the University of Oklahoma (OU) to foster excellent teaching and encourage design throughout the civil engineering curriculum [6][7]. Support for the Garden City project was provided by the NSF (Award # 9980887) and Rowan University. Undergraduate students were instrumental in code development; many of the students participated through the engineering clinic [8]. In Sooner City and Garden City, student projects are centred on a hypothetical city and continue across courses and years. This helps students better understand both civil engineering practice and the interconnectedness of different courses.

The Garden City software has been used at the Civil and Environmental Engineering Department at Rowan University (RU) to manage its design throughout the curriculum programme [9][10]. However, any institution can use the Garden City software to create its own DSC. The main pages

are *Home*, *Courses*, *Modules*, *Projects*, *Data*, *Design*, *Work* and *Administration*. Custom pages can be added and main pages can be renamed.

Most of the pages consist of lists of links, with short descriptions, to content contained on the Garden City server or elsewhere on the WWW. Such pages are referred to here as *link-pages*. The information used to dynamically create link-pages is stored in a database created by the administrator and contributors to the Web site. Pages in Garden City can also be authored in the usual way, eg by writing html code.

The *Course* page contains links to civil and environmental course Web sites at Rowan University. The *Modules* page has links to software programs or tutorials that can help students understand civil engineering phenomena, solve related problems, or simulate related systems. The *Projects* page (see Figure 1) has links to the projects professors assign to students. The *Data* page has links to the data students use to complete projects. Similarly, the *Design* page has links to design criteria students use to complete projects. Students utilise the *Work* page to upload reports onto the Garden City server. This can be used to submit reports to their professors, store reports for later use, eg to solve future projects, or show prospective employers. Professors use the *Work* page to access student reports. The *Administrator* page is used by the administrator to manage the Web site.

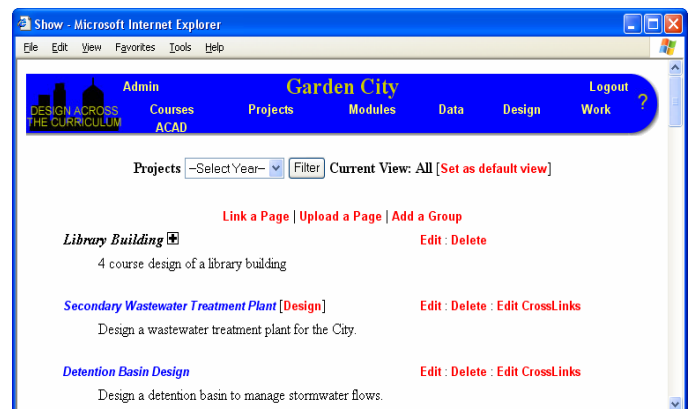


Figure 1: The Garden City projects page.

The Administrator has access to a number of screens that allow for the easy management of the Web site. The Administrator uses database tables to store data used to dynamically create list-pages every time they are accessed. For example, the Administrator can change the city name, link the local institution's courses, determine which main pages will be included, select from existing projects, modules and design criteria and link to new ones, all by interacting with a number of database tables using forms incorporated in the software. The administrator also manages accounts. Four types of accounts are used: *Administrator*, *Contributor*, *User* and *Guest*. Page access and ability to add/edit links or content are controlled by the account system. The city administrator does not need to be familiar with Web page development, static or dynamic.

*Contributors* (eg professors) can add and edit links on link-pages and upload content as files onto the Web site server. Links can be to files stored on or off the Garden City Web site server. Contributors can create their own content. They can view all of the projects and related content linked via the Web site, even for projects created by others. This helps multiple

*Contributors* create multi-course and year projects, without needing extensive synchronous meetings.

*Users* (eg students) use the links created by contributors to find content needed to complete projects, including project descriptions, data, and design criteria. In class, *users* are assigned projects. They access project descriptions using the *Projects* page of Garden City. If they need conceptual help, they can use the course page to access the appropriate course Web sites or they can access helpful material via the *Module* page. They use Garden City to access the data and design criteria needed to complete projects. They can save current and access past work using the *Work* page. *Users* can access the city for some time after graduation, allowing them to use their saved work as a portfolio.

Guests can view almost the entire city; however, people must log onto the site as a User in order to access the *Work* page or other protected pages. For example, on the Garden City Web site, a custom page with links to design drawings for complex buildings is password protected at the request of the professional engineering companies donating the files.

When contributors log onto the site, they see more links than do students. For example, on the *Projects* page, professors will see extra hypertext, including *Link a Page*, *Upload a Page*, *Add a Group*, *Edit*, *Delete* and *Edit Crosslinks* (shown in Figure 1). They click on *Link a Page* to add a link to the page. Links can have both a title and a short description. The subsequently created link is automatically *owned* by the professor who added it. Such a link would be to a page located on any server.

The professor clicks on *Upload a Page* to upload a file onto the Web site server and link it from a Garden City page. He/she fills out a form similar to the one used for *add a link*, except that he/she must select a file on their local computer for upload. A link created in this way will be to a file located on the Garden City host server.

Groups are used to assemble groups of links under a single title. A user clicks on the group title, and the group members appear below it, indented to the right. For example, the building project described in a subsequent section of this article, used by four different professors in four different courses, could be presented as a group. On the *Projects* page, the four project descriptions would be found under a single group, eg called *Library building* (see Figure 1). A professor clicks on *Add a Group* to add a group to a page. Once the group is created, the professor can edit appropriate individual links, assigning them to the group.

Active links and groups are shown on the Web site. Inactive links and groups are in the database, but are not shown to users or guests on the Web site. Professors see inactive links and groups at the bottom of a page in red. If an active group is made inactive or deleted, all links associated with the group are also made inactive.

When a Contributor logs onto the Web site, any link or group owned by that Contributor will have *Edit : Delete : Edit Crosslinks* shown to the right of the name. An administrator will see this to the right of all links. Contributors click on *Edit* to change settings for the link or group. They select *Delete* to delete the record from the database and Web site.

Contributors click on *Edit Crosslinks* to change the cross-linking for an *owner* link. Cross-linking allows users to quickly find related links. The default cross-link set-up is:

1. Courses cross-linked to projects;
2. Projects cross-linked to modules, data and design.

Thus, when someone views the *Projects* page, projects that *own* module, data, or design-links will show up with the words *modules*, *data* and/or *design* on the same line. Clicking on any of these words for a given project will make the *owned* links show up indented below the project link, eg if *modules* is clicked, then the module-links associated with the project will appear. Clicking on the same word will make them go away. Clicking on a different word (eg *data* instead of *module*) will make the module links go away and the data links show up. The default cross-linking allows students to quickly locate the projects associated with a given course and the modules, data and design information for a given project. In Figure 1, the Secondary Wastewater Treatment Plant project has data-links, indicated by the word *data* to its right.

The Administrator can change the cross-link set up on the *Administration* page. The cross-linking selected by the Administrator will affect the make-up of the *Link a Page*, *Upload a Page* and *Add a Group* forms. If a topic page is cross-linked to one or more other topic pages, the *link a page*, *upload a page* and *add a group* forms will include drop down lists that the user can use to select *owned* links.

Garden City has been operated at Rowan University for over three years. The goal of Garden City was to adopt Sooner City in the civil and environmental engineering (CEE) curriculum at Rowan University, thus providing a four-year integrated design experience for Rowan undergraduates. More than 30 projects have been developed at the OU and Rowan. At Rowan, projects have been introduced in Water Resources Engineering, Water Treatment Wastewater Treatment and Design, Advanced Water Resources Engineering, Hydraulic Design, Geotechnical Engineering, Foundation Engineering, Advanced Transportation Engineering, Structural Engineering I & III, and Solid Waste Management.

Projects developed at Rowan include the following:

- Design elements of concrete building;
- Design elements of steel building;
- Site investigation report and drilling plan;
- Water treatment plant;
- Secondary wastewater treatment plant;
- Economic and engineering optimisation of penstock sizes for a hydroelectric plant;
- Selection of a pump for a municipal water supply system;
- Hydraulic design of a concrete gravity dam;
- Design of an energy dissipation structure (stilling basin);
- Hydraulic design of a culvert system;
- Water surface profile analysis of a stream using the computer program HEC-RAS;
- Peak run-off determination;
- Design of a community solid waste management system.

The software aspects of Sooner City and Garden City are not as important as the content, specifically the projects. One of the goals of the Garden City project is to demonstrate linkages or interrelations between courses. This can be accomplished using

projects that share data or require information found in one course be used in another. As an example, four courses in the CEE programme at Rowan University are linked together through a Garden City project related to a building site. The courses are as follows:

- *Analysis and Design of Steel Frames*;
- *Foundation Engineering*;
- *Transportation Engineering*;
- *Water Resources Engineering*.

The group *Library Building*, shown in Figure 1, provides access to the projects. In *Analysis and Design of Steel Frames*, students start the semester tracing load paths through the proposed building and perform structural design of building components and systems. In *Foundation Engineering*, students prepare a site investigation plan and then use the results of the investigation to make recommendations for building foundation designs. These recommendations are based, in part, on the column loads calculated in the structural course. In *Transportation Engineering*, students design an approach road to the building. In *Water Resources Engineering*, students prepare a pre- and post-development runoff analysis, and locate and design storm sewer facilities that need to account for, and be coordinated with, the site paving and grading.

Resources required for the project are architectural plans for the proposed building (a simplified plan with regular geometry can be used rather than actual architectural plans for this project), access to appropriate structural design and building codes, site topography and a proposed site map indicating building and pavement locations, weather data, traffic data and geotechnical data for the site.

## EVALUATION

Annual evaluations were performed on Garden City for three years [11]. They indicate that students' concept of design and mastery of skills improves while at Rowan. Furthermore, students found the projects that have been implemented to be useful. However, at the end of three years, the projects were still not linked well across courses. The concept of using a hypothetical digital city continues to be an interesting, but somewhat elusive, endeavour. Faculty are stressed for time to develop, implement and grade projects. Undergraduate engineering students may be so focused on the learning material required of individual courses that only connections between directly related courses, eg *Water Resources* and *Advanced Water Resources*, are retained. Most students are interested in the infrastructure aspects of civil engineering, but few students, neither upper nor lower students, see the relationship between what they want to do as a career and social and political considerations. The majority of students do acquire an increasing sense that economic considerations are important. Past cohorts have indicated that work on senior projects helps the most to bring together the multitude of skills necessary to design a complete project.

While Garden City was evaluated for three years, the Web site changed greatly during that time, with still more changes to

come. It is hoped that as the Web site continues to improve, professors improve existing and develop new projects, and that the projects are better integrated across courses and years. In this way, the benefits of the Garden City Web site-enabled DSC will continue to grow.

## CONCLUSIONS

Garden City is an adaptation of Sooner City, a virtual city on the Web that supports design throughout the civil engineering curriculum. The goal of Garden City was to convert Sooner City into a more portable software package, one that can be utilised at any institution. A software package has been created that can be used by any institution to manage design throughout the curriculum. Furthermore, additional projects have been developed for use in Sooner, Garden or, indeed, any City.

Future work includes convincing additional institutions to adopt the concept using the Garden City software. Additional projects continue to be developed. Finally, the Garden City software can be improved, making it easier to use and adding functionality, such as the ability of users (students) to review items. Alternatively, a multi-institution version of Garden City could be developed. The benefit of DCS can increase exponentially with the number of contributors.

## ACKNOWLEDGEMENTS

The authors acknowledge the generous support of this project by the NSF (Award # 9980887) and Rowan University. They also appreciate the efforts of those undergraduate students who helped develop software contributions, namely: Matt Grosse, Mike Ciocco, Laura Coleman, Will Kim, Eric Hansen, Django Cisse, Brian Cleary, Brad Smith, Pat Violante and Glen Roames.

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