

## **Garden City – Design Throughout the Curriculum**

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### **ABSTRACT**

The Department of Civil and Environmental Engineering at Rowan University, with support from NSF, has adopted “Sooner City”, a virtual city developed by the School of Civil Engineering and Environmental Science at the University of Oklahoma. A more portable version of Sooner City has been developed, which makes it easier to adopt at other institutions. Called “Garden City” at Rowan, the virtual city is used in the undergraduate civil engineering program. Faculty use Garden City to demonstrate the context (i.e., human communities) of many civil engineering projects and provide continuity for design projects that extend over multiple courses. Undergraduates go to the Garden City website to access projects and related data and design information. They are also able to store reports at the website, creating an electronic portfolio. Finally, the Garden City website provides a central location for course webpages, tutorials, modules etc. The purpose of this paper is to provide detail on the Garden City project, particularly as it affects teaching design principles throughout the curriculum.

### **INTRODUCTION**

The following text is the Project Summary of “Sooner City - Design Across the Curriculum”, NSF grant # 9872505.<sup>1</sup> It is included here to provide a brief summary of the Sooner City project.

The School of Civil Engineering and Environmental Science (CEES) at the University of Oklahoma (OU) is embarking on a curriculum reform project entitled Sooner City. The project is in response to the call for more design in the curriculum, a call being made by the engineering accrediting agency, by practitioners who are dissatisfied with the design skills of graduates, and by faculty who want to promote higher-level thinking skills and improve retention.

For the project, incoming freshman will be given a plot of undeveloped land that, by the time they graduate, will be turned into a blueprint for certain segments of the city (time constraints prevent the design of an entire city). Design tasks include all facets of the traditional civil engineering program, such as site planning and layout, sewer and water infrastructure, water supply, wastewater treatment, buildings, transportation systems, channel design, floodplain analysis, and geotechnical work. A common, four-year design project unifies the curriculum and allows material learned in early courses to carry forward, unlike the “traditional” paradigm wherein courses frequently stand as independent entities with no apparent connection. Also, the project allows students to develop a professional design portfolio that can be presented to perspective employers, be used as a valuable reference for future design tasks, or be used as part of CEES’s outcomes-based assessment. Furthermore, Sooner City provides a natural forum for incorporating other pedagogical reform initiatives, such as just-in-time learning, collaborative learning, and laptop computing.

The primary goal of the project is to produce graduates who can consistently think at a higher level, and who are thus capable of handling open-ended design projects that require creativity, exploring alternative solutions, self-analysis, and awareness of economic, social, and political issues. The extent to which we meet this goal is being assessed through formative and summative evaluations by an external reviewer.

The project is unique in that it threads a common design theme throughout the curriculum, yet does so in a flexible, cost-effective manner that requires no change in the traditional sequencing of courses. Because it does not require major institutional support, nor lock faculty into a fixed syllabus, we expect the reform effort will be attractive to many institutions (with an obvious name change for the city) and be portable to other disciplines. Reform details will be disseminated via the Web and CDROM, and through traditional outlets such as conferences, journal articles, and local and national media.

Sooner City has been recognized as educational reform worthy of widespread adoption. NSF has showcased the project in the NSF Project Showcase at the ASEE national conference. Invitations have also been received to present Sooner City at the ASCE national conference (1998) and an NSF CAREER Workshop (1998). The project has been described in ASEE Prism and Engineering Times.<sup>2,3</sup>

RU received funds from the NSF CCLI program to adapt Sooner City, creating a more portable city, called “Garden City” at RU. Garden City rests firmly on the foundations of Sooner City. The basic elements of Sooner City have been repackaged, creating an integrated set of dynamic web pages that can be installed on any ASP enabled web server. For example, professors at institutions adopting the city can select their own city name, create links to their own courses, and select the main elements to be included in the city. They can select existing projects, data, and design criteria from Sooner or Garden City or add their own.

## **PORTABLE VIRTUAL CITY**

The main features of Sooner City (<http://www.soonercity.ou.edu/>) are Tutorial, FAQ, Courses, Instructors, Projects, Design Data, Design Criteria, Photo Gallery, Civil Engineering Resources, Common Info, and Electronic Learning Modules. The Tutorial and FAQ pages help users use the web site. The Course and Instructor pages are lists of links to OU course and faculty home pages. The projects page provides access to projects developed at OU. This page can be used by students and professors at OU and other Institutions. Professors can also upload their own files, e.g., project descriptions and design data. For each project a number of items may be accessed directly from the project page, including description, design criteria, design data, and related software. Some of these items are also available on separate pages. For example, students can use the Design Data and Design Criteria pages to find design information for all projects. The Photo Gallery contains pictures relevant to Civil Engineering. It can be used to make slide shows. The Civil Engineering Resources page will help faculty and students find resources on the web. The Common Information page contains information used by all students. Electronic Learning Modules are software that students can use to learn concepts and simulate civil engineering activities or design civil engineering products. A number of the pages are still under development, including Design Data and Civil Engineering Resources.

Any student, at any school, can access Sooner City; however, only OU professors can add projects to Sooner City or modify existing projects. While the Sooner City website is a valuable resource for identifying projects, obtaining data for those projects, and learning about the advanced teaching techniques used at CEES, it cannot be used to manage a specific “design throughout the curriculum” program at another school.

Garden City (<http://nebula.eng.rowan.edu/default.asp>) is created by software and databases that allow any Civil Engineering department to easily have their own city, just by installing the garden city software on an ASP enabled web server. The city is a dynamic web site that allows a department’s administrator and professors to jointly manage content, creating a single web site that students recognize as their city, where they go for all of their city-oriented projects. Alternatively, users can create their own website, perhaps using commercial software such as Blackboard and WebCT, and populate it with content (i.e., projects, data, design criteria,...) developed for Sooner or Garden City. This will probably require extra initial effort, e.g., to create a unified web site that students will view as their own city. Furthermore, existing commercial software is not designed to allow multiple professors joint management of website content.

The remainder of this section is used to describe the Garden City software. The Administrator uses database tables to store data used to dynamically create each page, every time it is accessed. For example, the Administrator can customize the city name, link the local institution's courses, determine which main pages will be included, select from existing projects, modules and criteria/codes and link to new ones, all by interacting with a number of database tables using forms incorporated into the software. The Administrator can also control access to pages on the website through the use of different levels of passwords: contributor; user; and guest. Contributors (i.e., professors) can access all pages and add content to most. Users (i.e., students) can access all pages, but can only contribute content to the Work pages, a page used by students to submit and store their work. Guests can access most pages, but cannot add content. Anyone can log into the site as a Guest. The Administrator does not need to be familiar with web page development. Similarly, Contributors can add links and upload files, such as project descriptions, onto the civil city server, without knowing how to develop web pages.

The main web pages of the portable city are given in Table 1. Examples of three pages in Garden City are given in Figure 1, 2, and 3.

Table 1: Web Pages of the Portable Civil City

Name	Description
Home	Contains links to the other main web pages, a brief description of Civil City, and an area where the local user can present news.
Courses	Contains links to courses associated with the city (with brief descriptions).
Modules	Contains links to modules associated with the city (with brief descriptions). Modules are software programs students use to simulate and design civil engineering facilities.
Projects	Contains links to design projects associated with the city (with brief descriptions).
Data	Data takes students to a central web page where they can gather the data they need to complete projects.
Design	Contains links to design criteria and codes students use to complete projects (with brief descriptions).
Work	Page students use to store their completed projects. Not accessible to guests.
Custom Pages	Up to 6 custom pages can be added. These can be pages of links, similar to the Courses page, etc., and thus created and managed by the Garden City software, or pages authored outside of Garden City. Pages can be configured to only be accessible to users (students) or contributors (professors).
Admin	Contains utilities the administrator uses to manage and customize the city. Only available to a logged in administrator.

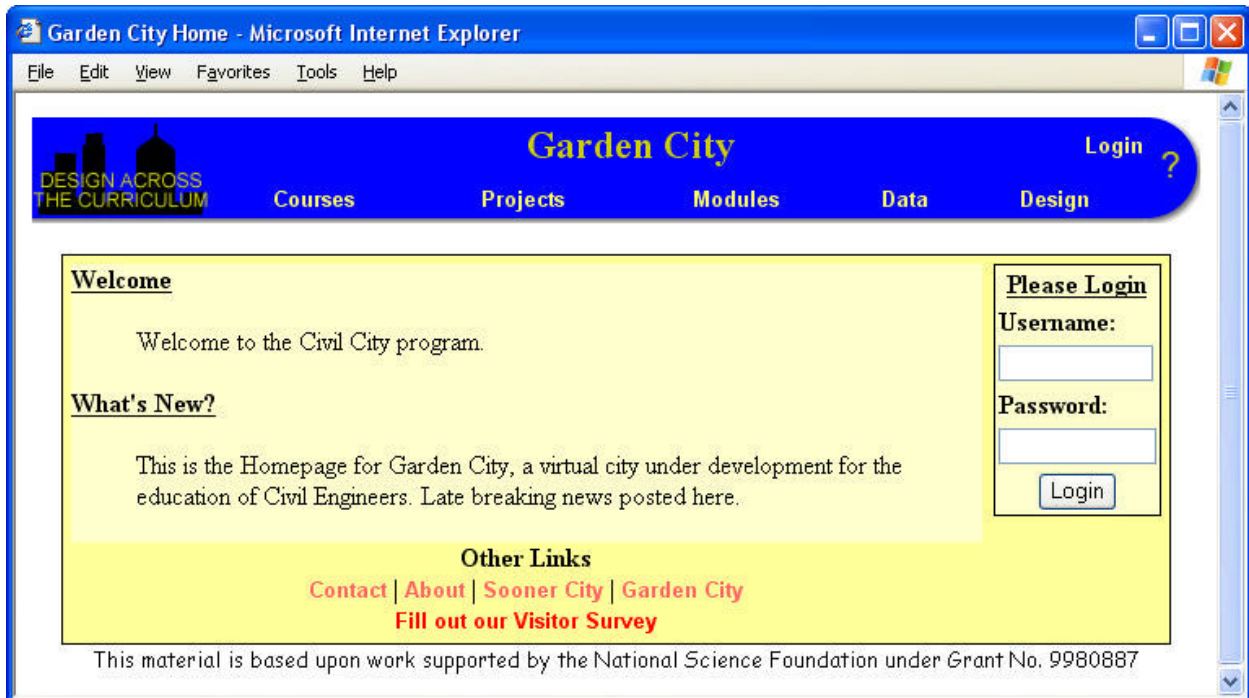


Figure 1: Homepage for Garden City

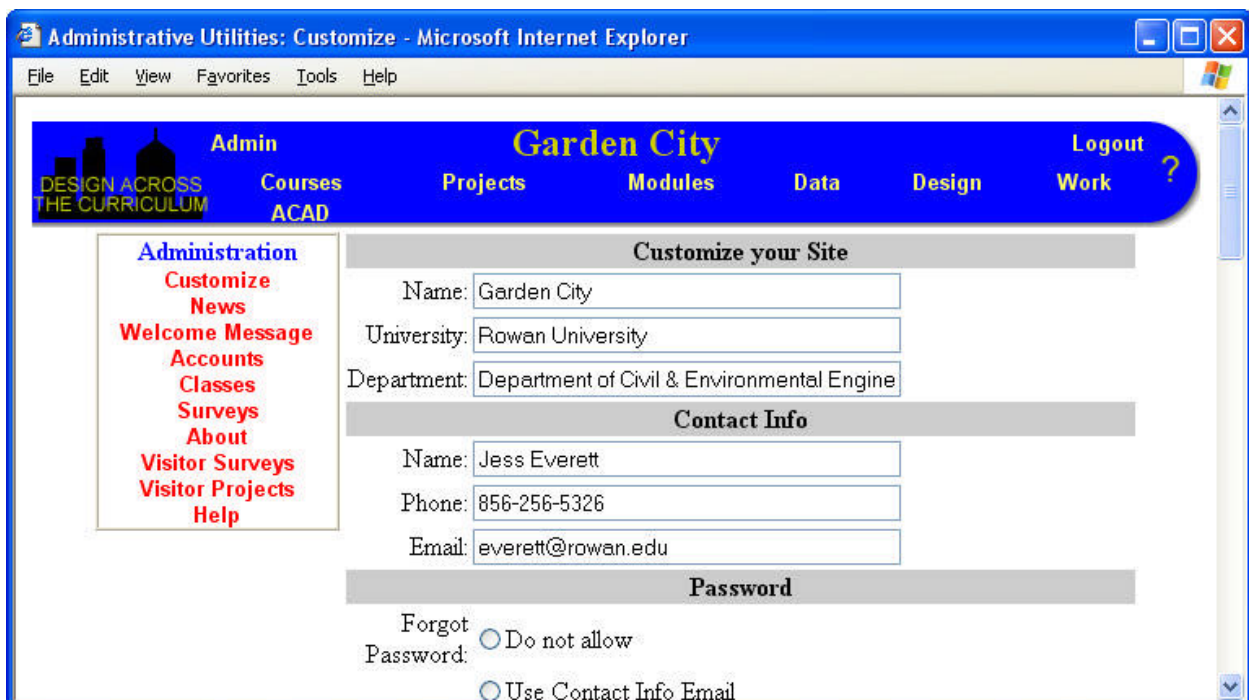


Figure 2: Administration page for Garden City

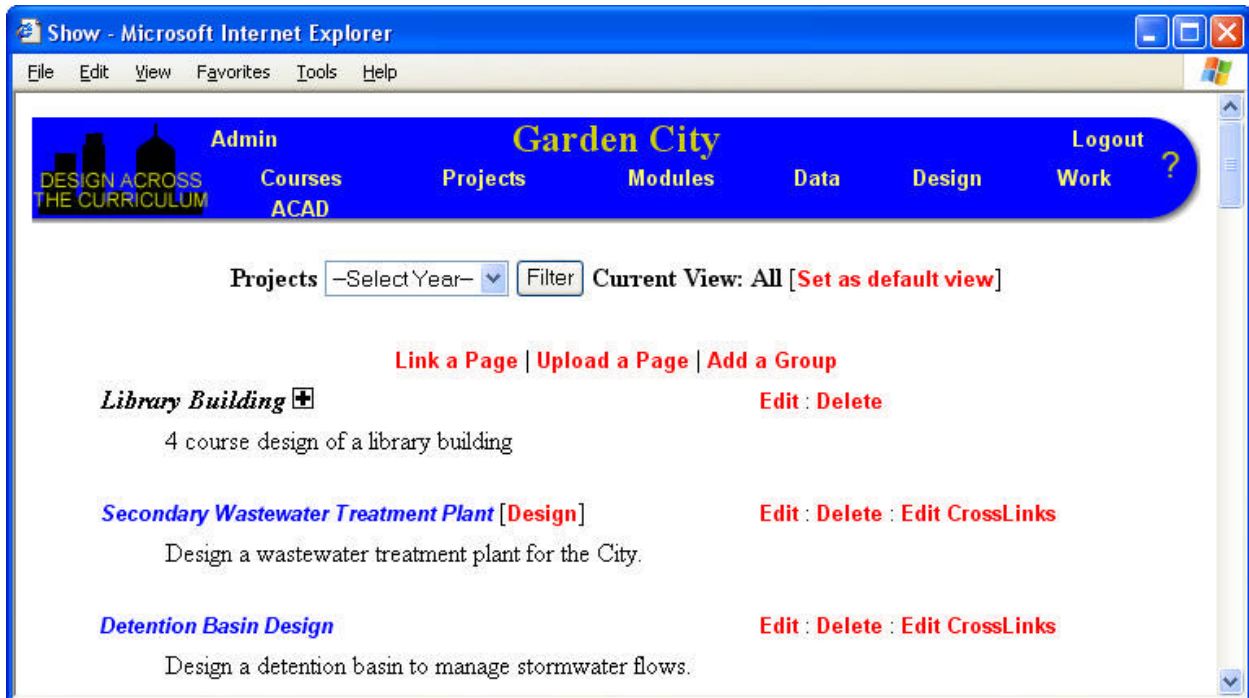


Figure 3: Course Page

Figure 1 is the city's home page, as it appears before logging in. It contains links to many of the main topic pages, described in Table 1. Guests can view all of the shown pages; however, Users must log onto the site in order to access protected pages, such as the Works page and a custom page used to give Rowan students to building plans. The ACAD page is password protected at the request of the companies donating the files. The Administrator can create additional custom pages. For example, a homework solution page could be added to the city that would be password protected such that only Contributors could obtain access.

Garden City is used just like Sooner City. In class, students are assigned projects. After logging in as a User, they access project descriptions using the Project page. If they need conceptual help, they use the Course page to access the appropriate course web pages or they can access helpful material via the Module page. They use the Garden City Data and Design pages to access data and design criteria needed to complete projects. They can save current and access past work using the Work page. Students can access the city for some time after graduation, allowing them to use their saved work as a portfolio.

When the Administrator logs onto the city, he or she sees an additional button on the home page, titled "Admin" (Figure 2). The "admin" button is a link to a number of screens that allow the administrator to manage the city site (Figure 2). The administrator has the ability to customize the site, select the main pages, create custom pages, change content, manage accounts, etc.

Figure 3 shows the Project page as viewed by a contributor, i.e., someone logged onto the site as a professor. Some of the content shown on the page is visible to Users or Guests. For example,

the filter button allows anyone viewing the page to select the type of projects shown, by year (Freshman through Senior). Similarly, anyone would see the main links and descriptions (e.g., “Library Building”, “Secondary Wastewater Treatment Plant” and “Detention Basin Design” and the “Design” Button to the right of “Wastewater Treatment Plant”. Clicking on the “Design” link provides immediate access to design criteria associated with that project.

Some of the items on the Project page shown in Figure 3 are visible only to Contributors. This includes “Edit”, “Delete”, “Edit Crosslinks”, “Link a Page”, “Upload a Page”, and “Add a Group”. When a Contributor logs onto the website, 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 website. Active links and groups are shown on the website. Inactive links and groups are in the data base, but are not shown to users or guests on the website. Contributors 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 will also be made inactive.

Contributors click on “Edit Crosslinks” to change the links associated with the “owner” link. Crosslinks are links that show up to the right of the main links on a page. They allow easy access to related materials. For example, the “Design” link next to the “Wastewater Treatment Plant” link in Figure 3 is a crosslink.

The default crosslink setup is: (1) Courses associated with Projects and (2) Projects associated with Modules, Data, and Design. This means that, when a User views the Course page, the word “Project” will appear after any Course link that “owns” Project links. If the User clicks on “Project”, all of the project-links or project-groups “owned” by this course will show up below it, indented (see below for a description of groups). If the user clicks on “project” again, the links disappear. This allows students to easily find all of the projects associated with a given course. Similarly, 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” link(s) show up, e.g., if “Modules” is clicked, Module-links associated with the project will appear. Clicking on the same word will make them go away. Clicking on a different word (e.g., “Data” instead of “Module”) will make the module links go away and the data links show up. This allows a student working on a given project to quickly find associated resources. Similarly, Contributors designing projects that depend on the projects of other contributors can quickly find the latest material.

The Administrator can change the cross-link set up on the customization page (Figure 2). For example, a solutions page could be created that would be cross-linked to the projects page (and password protected so only professors could see it).

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. See below.

Contributors click on "Link a Page" to add a link to the page. They fill out a form (Table 2) and click an "Add" button. The link is automatically "owned" by the Contributor that added it. Depending on the cross-linking selected by the Administrator, additional drop down menus may be included. These allow Contributors to associate links from different pages, e.g., a project can be associated with a course, or data and design criteria associated with a project.

A contributor clicks on "Upload a Page" to upload a file and link it from a page. They fill out a form similar to the one used for "add a link", except they must select a file on their local computer for upload. A link will appear on the website, that allows users to access a file now stored in the Garden City server.

Table 2: Add a Link Form items

Form Item	Description
Name	Name of the link
ID	Identification number for link (e.g., course number). Optional.
Web Address	Web Address of the link. Should be the full URL, not relative.
Description	A short description of the link.
Filter Options	Filter options are used by Users to filter the records shown on a page. The Filter option choices are specified by the Administrator. Use "cntrl" to select more than one.
Active	Active links are shown on the web site. Inactive links are included in the database, but not shown on the website.
In Group?	Check the "yes" box and select a group from the drop down list if you want the link to be included in a group. You may need to <u>add a group</u> first.
Display	If "In the current window" is checked, the link will open under the banner, replacing the page of links. If "In a new window" is checked, the link will open in a new window.
Cross-link	Select associated links on other pages (Will only appear if page is cross-linked)

Groups are used to assemble links under a single title. The group "Library Building" is shown in Figure 3. A user clicks on the group title, and the group members appear below it, indented to the right. A contributor clicks on "Add a Group" to add a group to a page. They fill out the group form (Table 3) and click the "Add" button. The group is automatically "owned" by the Contributor that added it. Links are assigned to groups via "Edit" links. Groups are used to allow Contributors and Users easy access to associated projects, projects which may happen in different courses and even different years of the curriculum. If an active group is made inactive or deleted, all links associated with the group will also be made inactive.

Table 3: Group Form

Form Item	Description
Name	Name of the group
Description	A short description of the group.
Filter Options	Filter options are used by Users to filter the records shown on a page. The Filter options are specified by the Administrator. Use "cntrl" to select more than one.
Active	Active groups are shown on the web site. Inactive groups are included in the database, but not shown on the website. Any link assigned to an inactive group



	will also be inactive.
Cross-link	Select associated links on other pages (Will only appear if page is cross-linked)

## MULTI-CLASS AND YEAR PROJECT DEVELOPED AT ROWAN

The software aspects of Sooner and Garden Cities are not as important as the content, specifically, the projects. Table 4 is used to list the projects developed at OU and Rowan. 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 program at Rowan University are linked together through Garden City projects. The courses are Analysis and Design of Steel Frames, Foundation Engineering, Transportation Engineering, and Water Resources Engineering.

Table 4: Projects

<b>Projects developed at OU</b>	<b>Projects developed at Rowan</b>
Automated Lock and Dam System	Building Site
Earth Dam	Culvert system
Bungee Drop	Energy dissipation structure (stilling basin)
Office Building	Concrete gravity dam
Wind Farm	Pump Selection (municipal water supply system)
Fire Station Layout	Penstock sizing (hydroelectric plant)
Pump Station Design	Wastewater treatment plant
Water Distribution System	Water treatment plant
Groundwater Supply	Site investigation report and drilling plan
Surface Water Supply Reservoir	Steel building
Water Demand	Concrete building
Numerical Modeling	
Mapping	
Transportation Corridor	
Floodplain Analysis	
Wastewater Treatment Facilities	
Water Treatment Facilities	
Bridge Design	
Pavement Design for Interstate Corridor	
Population Projection	
Sanitary Sewer System	
Urban Drainage System	

The overall concept of the associated projects described here is the development of a building site. The group “Library Building” in Figure 3 provides access to the projects. Currently, the project involves a library building designed for a campus site; however, the specifics are easily changed to suit instructor needs. 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 the students prepare a site investigation plan and then use the results of the investigation to make recommendations for building foundation designs. These recommendations must use the column loads calculated in the structural course. In Transportation Engineering the students design an approach road to the

building. In Water Resources the students prepare 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 is being 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. The following are details of the projects for each course, as provided to the students.

### ***Analysis and Design of Steel Frames***

**Assignment 1** – Given the architectural plans for the proposed building, trace the load path through the structural system and use appropriate building codes and your structural analysis skills to determine the appropriate loads for design of each component.

**Assignment 2** – Design the joists and beams for the structural system of one floor for flexural strength and deflections looking at several options for direction and spacing of joists and compression flange bracing.

**Assignment 3** – Design the building columns.

**Assignment 4** – Redesign the joists treating them as composite or partially composite sections to take advantage of the floor slab.

**Assignment 5** – Design the joists-to-beams and beams-to-column connections considering both welded and bolted options.

### ***Foundation Engineering***

This is the first in a series of report that you will be preparing to complete the foundation design of a library building at the Purdue University Calumet campus. The reports will be compiled to form your final foundation design report, which will be submitted at the end of the semester. You will also present your findings at the end of the semester during the design presentations.

You are the geotechnical consultants on the following project. You are required to write a letter to Warren George Drillers outlining your site investigation plan. To justify your site investigation recommendation plan, you will have to prepare a geotechnical engineering report that summarizes your findings from a preliminary investigation. The information required to perform the preliminary site investigation is given, but you are not limited to just this information. If you can determine or obtain any other information pertaining to the site as a result of your preliminary investigation, state and reference it in your report.

The site is a new library building to be built on the Purdue University Calumet campus in Hammond, Indiana. The site is located in northwestern Indiana in Lake County. The site location, with respect to the nearest access roads is given. Design Details are as follows. Building Dimension are 330 ft × 120 ft. Each bay is 30 ft × 20 ft. The building has 5 floors. Service loads for a library building are Average live load = 100 psf and Dead load = 75 psf.

### ***Water Resources Engineering***

A new library building is planned for the University campus (Figure 4). The site location for the building is approximately 325 feet x 220 feet in size, as shown in the figure below. The maximum elevation change over the length of the site is 0.50 feet.

When completed, the building will occupy about 85% of this area. The soil type at the site is a mix of compacted Downer Loamy Sand and Aura loams, split evenly between the north and south halves of the site. Due to years of students walking across the lawn, normal Hydrologic Soil Group classifications may not apply.

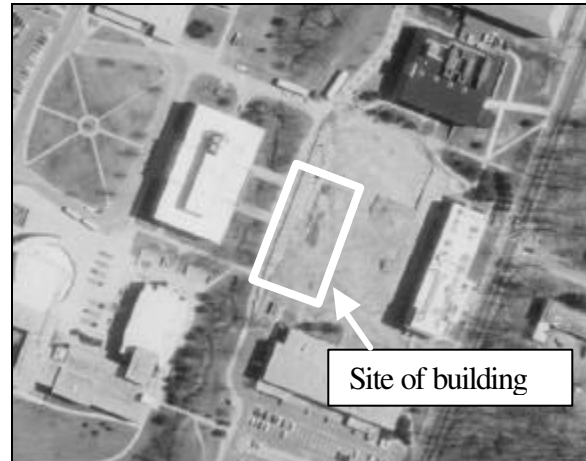


Figure 4: Library System

The rainfall intensities for the closest weather station are shown in the Table 5.

Table 5: Rainfall Intensity-Duration-Frequency for Garden City

Time (min)	Rainfall Intensity (inches/hr) for Return Periods of:					
	2 yrs	5 yrs	10 yrs	25 yrs	50 yrs	100 yrs
5	4.60	5.70	6.50	7.50	8.00	9.00
10	3.60	4.60	5.30	6.10	6.80	7.40
15	3.00	3.90	4.50	5.20	5.80	6.20
20	2.60	3.50	3.90	4.70	5.00	5.60
25	2.36	3.00	3.50	4.10	4.50	5.00
30	2.10	2.70	3.10	3.70	4.00	4.50
60	1.36	1.77	1.97	2.33	2.61	2.83
120	0.77	1.10	1.21	1.30	1.61	1.75

In order to file permits for site work, you must determine the peak runoff from the site in its natural state, and after development, for the 10, 25, and 50-year storm events.

Your tasks:

1. Determine the hydrologic soil groups (HSG) for each soil type
2. Determine the time of concentration of flow ( $t_c$ ) for the site
3. Determine rainfall intensity for the 10, 25, and 50-year storms
4. Determine the runoff coefficient(s) for the site, in pre- and post-developed conditions
5. Determine the peak runoff from the site for each of the design return periods, for pre- and post-developed conditions.

### ***Transportation Engineering***

A new approach road is being constructed to access the building. The approach road has to be designed for a 50-year traffic with one Million 18,000 lb Equivalent Single Axle Loads. Use both the AASHTO and AI flexible pavement design procedure to determine lowest initial cost of pavement section for conditions and materials given below. Present your answer by drawing the cross-section of the pavement on the subgrade. The section is a fill section, which requires that the final elevation of the pavement be 50 inches above the level of existing subgrade.

Effective roadbed soil (subgrade) resilient modulus is as follows. In winter (mid-December to late February) it is 25,000 psi. In Spring (early March to late April) it is 1500 psi. In summer (early may to mid-December) it is 5000 psi. Additional data are given in Table 6.

Table 6: Additional Data

Material	Modulus, psi	Cost (\$/ sq. yd.-in.)
Asphalt Concrete	250,000@68°F	1.70
Crushed stone	25,000	0.40
Pit-run gravel	12,000	0.32
Excavation	-	0.25

Students may use as many or as few of these materials you wish in your design, the only stipulation being that the surface must be asphalt concrete. Once again, the final combination you select should be based on minimizing the initial cost of pavement construction.

Based on the knowledge of the granular material's properties (gradation, permeability, etc.), the construction site location, it was determined that the crushed stone has good drainage characteristics and will be saturated less than 5% of the time. The pit-run gravel was determined to have fair drainage characteristics and will be saturated as much as 25 % of the time. Make sure you comply with the minimum thickness requirements specified by AASHTO.

### **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 is to convert Sooner City into a more portable software package, one that can be used at any institution. A software package has been created that can be used by any institution to manage design throughout the curriculum. Copies of the software can be obtained from Dr. Everett. Furthermore, additional projects have been developed for use in Sooner, Garden, or any City. What remains is for additional institutions to adopt the concept, using the Garden City software and developing more projects.

## ACKNOWLEDGEMENTS

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## BIOGRAPHY

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Yusuf Mehta

Yusuf Mehta is an Assistant Professor of Civil and Environmental Engineering at Rowan University, Glassboro, New Jersey. He obtained his Ph.D. from Pennsylvania State University in 1999, M.S. from the University of Oklahoma in 1995, and his B.S. is from the University of Mumbai, India in 1993. His research interests include Pavement Materials and Superpave Technology, Highway and Pavement Design, Pavement Management and Rehabilitation, Modeling of Pavement Systems, Traffic Engineering, Reliability and Statistics.

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Matt Gross is a senior in the Computer Science program at Rowan University. He has worked on the city since Summer 02.