Transportation CAD-Laboratory

an Education Project

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16. Abstract

This report describes the restructuring of transportation courses at the Department of Civil and Environmental Engineering at the University of Maine to use CAD-software in student project designs. The current version of Bentley's MicroStation for Windows x86 is used. This report shows examples of student work from the 2004/2005 academic year. The overall effect of introducing computer-aided help, i.e. the Microstation software, as a design tool in the transportation courses is that the presentation quality of the designs have improved. Overall, the technical quality may not have improved but neither has it been impacted negatively. A major advantage with computer aided design is that modifications of 'final' drafts can be done numerous times without losing quality as when hand drawings are modified (irrespective of if ink or pencil is used). Other advantages are that measurements become more precise and that repeated characteristics easily can be duplicated. A major disadvantage is the time it takes students to learn to master the not so user-friendly software. Also, sketching which can be integrated when doing pencil designs still has to be done before going into the computer-based design.

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Abstract

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I want to thank everybody involved in this project. This includes numerous undergraduate students, Edwin Nagy who guided me as an instructor, and Will Manion and Bryan Pearce who are faculty members with skills in the area of computer-aided design.

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An Education Project

Introduction

The Department of Civil and Environmental Engineering at the University of Maine has been restructuring its introductory computer classes and started to teach students within the Department rather than have other departments teach computer classes. Beginning in 2003, one of the freshman courses is a CAD-course teaching the students MicroStation as a drafting tool. The current version used is Bentley's MicroStation for Windows x86. When students enter the sophomore year, they should all be proficient in at least the basics of this CAD-program. However, to make sure they continue to develop strengths in the area and that they use this software in applied courses, it is desirable that they in their sophomore year have design projects that also use this software. Transportation Engineering is one of the two applied courses that all civil engineering students take during their second year. In this course, they historically have two minor design projects, one of them being the design of a parking lot. Since a decade or more, a few students have used CAD-software but the majority of students have been supmitting hand-drawn designs. One reason MicroStation or AutoCad or other software has not been mandated is the lack of hardware and specialized software within the department, as well as the instructors inexperience with using such software. Within this education project we proposed to train the instructor and convert material to MicroStation format. The plan which was followed was outlined as follows:

1. Instructor is familiarized with general and specialized CAD programs
2. Conversion of plans into electronic format
3. Introduce CAD techniques into undergraduate courses in transportation.

Design of Parking Lot—CIE 225

The required sophomore design project where Microstation software—or other computer-aided desin software such as AutoCad if student elects to use his own software—has been used during the Spring 2004 and 2005 semesters is a parking lot design within CIE225 Transportation Engineering. Below is the exact assignment as given in 2005. The 2004 assignment was very similar.

Project 1, 2005

Due Tuesday March 22, 2005

- You are to (re)design the parking lot of the University Mall—not the one in Orono, but a fictional one, see enclosed Microstation file. Your task is to make the parking lot as attractive as possible to draw customers to the mall.
- Assume that all buildings are at given locations with entrances located as shown. However, the White-Aid drugstore and drive-through fast-food restaurant are being reconstructed and you can put drive-through windows and entry doors anywhere.

- Assume that the ground is more or less level (and you do not have to design vertical elevation for drainage).
- North is up on the plan (which can be considered when designing the area around the restaurant).
- A minimum of 5% of the surface area (including buildings) should be left impervious (green space). Try to locate 'grass areas' were they can be used and are aesthetically pleasing.
- Your task is to (more or less) maximize the number of parking spaces. Try to satisfy shop parking demand for convenient, nearby parking of 4 vehicles per 1000 square-feet of floor area. The demand for the restaurants is estimated to be 10 spaces per 1,000 square-feet. The medical clinic has a demand of 30 employee and 60 visitor spaces in total.
- American with Disabilities Act (ADA) must be met. Its requirements can be found at http://www.access-board.gov/adaag/html/adaag.htm#4.6 The most important aspects are summarized below.
- Consider the safety of people walking from their cars to shops, etc
- Make it possible for people who do not own cars to safely get to shops as pedestrians and bicyclists. Try to connect internal walkways with existing sidewalk along the 4-lane street. Assume that there is a bus stop on that street too—to satisfy transit requirements.
- Design the connection between the 4-lane street and the parking lot to be able to handle traffic safely. All driveways connecting to the street should be located within the 140-ft wide gap between the buildings.
- Today, there is a curb along the 4-lane street (just 'west' of the text "4-lane major collector road" which is typed in the outer lane for southbound traffic. Each lane is 12 feet wide. There is a 20-foot grass area between the curb and the 4-ft wide sidewalk. The Mall maintains the area within the black 'box' which includes the sidewalk.
- Passenger cars, with turning radii as shown in Figure 3.2, p. 53 of our textbook, must be able to access every parking space. Big trucks, WB-62s, as shown in Figure 3.3, p. 54, must be able to get into and out of the parking lot from the collector street without encroaching into lanes for oncoming traffic. They must also be able to get to at least the two areas marked "area to be accessible by truck." A WB-50 truck should be able to get to the front door of the medical facility, the drugstore and the restaurant. (I have WB-50 turning radii if you want them.)
- Start by sketching solutions on tracing paper or directly on the paper with a soft pencil. Your final solution should show every parking space, all striping and all curbs as well as green areas. Make it obvious if a line is a striping or a curb. Show walking paths and crosswalks (if you provide such) and other elements that you feel should be shown. Indicate which parking spaces are for handicaps. Signs and lighting can be shown. Indicate if any driveways are one-way. The final product ought to be in color. You can do it all by hand but you are encouraged to use a drafting program of your choice. Finally, count the number of parking spaces you provide in total and write down that number somewhere on (at the edge of) your plan. Specify how many of them are for handicaps.
- Excerpts from American with Disabilities Act (ADA)

4.6 Parking and Passenger Loading Zones

4.6.1 Minimum Number. Parking spaces required to be accessible by 4.1 shall comply with 4.6.2 through 4.6.5. Passenger loading zones required to be accessible by 4.1 shall comply with 4.6.5 and 4.6.6.

4.6.2 Location. Accessible parking spaces serving a particular building shall be located on the shortest accessible route of travel from adjacent parking to an accessible entrance. In parking facilities that do not serve a particular building, accessible parking shall be located on the shortest accessible route of travel to an accessible pedestrian entrance of the parking facility. In buildings with multiple accessible entrances with adjacent parking, accessible parking spaces shall be dispersed and located closest to the accessible entrances.

4.6.3* Parking Spaces. Accessible parking spaces shall be at least 96 in (2440 mm) wide. Parking access aisles shall be part of an accessible route to the building or facility entrance and shall comply with 4.3. Two accessible parking spaces may share a common access aisle. Parked vehicle overhangs shall not reduce the clear width of an accessible route. Parking spaces and access aisles shall be level with surface slopes not exceeding 1:50 (2%) in all directions.

4.6.4* Signage. Accessible parking spaces shall be designated as reserved by a sign showing the symbol of accessibility (see 4.30.7). Spaces complying with 4.1.2(5)(b) shall have an additional sign "Van-Accessible"…

4.6.6 Passenger Loading Zones. Passenger loading zones shall provide an access aisle at least 60 in (1525 mm) wide and 20 ft (240 in)(6100 mm) long adjacent and parallel to the vehicle pull-up space. If there are curbs between the access aisle and the vehicle pull-up space, then a curb ramp complying with 4.7 shall be provided. Vehicle standing spaces and access aisles shall be level with surface slopes not exceeding 1:50 (2%) in all directions.

4.1.2 Accessible Sites and Exterior Facilities: New Construction

An accessible site shall meet the following minimum requirements:

(1) At least one accessible route complying with 4.3 shall be provided within the boundary of the site from public transportation stops, accessible parking spaces, passenger loading zones if provided, and public streets or sidewalks, to an accessible building entrance.

(2) At least one accessible route complying with 4.3 shall connect accessible buildings, accessible facilities, accessible elements, and accessible spaces that are on the same site.

(3) All objects that protrude from surfaces or posts into circulation paths shall comply with 4.4.

(4) Ground surfaces along accessible routes and in accessible spaces shall comply with 4.5.

(5) (a) If parking spaces are provided for self-parking by employees or visitors, or both, then accessible spaces complying with 4.6 shall be provided in each such parking area in conformance with the table below. Spaces required by the table need not be provided in the particular lot. They may be provided in a different location if equivalent or greater accessibility, in terms of distance from an accessible entrance, cost and convenience is ensured.

TOTAL PARKING IN LOT REQUIRED MINIMUM NUMBER OF ACCESSIBLE SPACES

1 to 25 - 1	101 to 150- 5	401 to 500- 9
26 to 50 - 2	151 to 200- 6	501 to 1000- 2 percent of total
51 to 75 - 3	201 to 300- 7	
76 to 100- 4	301 to 400- 8	
		1001 and over 20, plus 1 for each 100 over 1000

Except as provided in (b), access aisles adjacent to accessible spaces shall be 60 in (1525 mm) wide minimum.

(b) One in every eight accessible spaces, but not less than one, shall be served by an access aisle 96 in (2440 mm) wide minimum and shall be designated "van accessible" as required by 4.6.4. The vertical clearance at such spaces shall comply with 4.6.5. All such spaces may be grouped on one level of a parking structure.

EXCEPTION: Provision of all required parking spaces in conformance with "Universal Parking Design" (see appendix A4.6.3) is permitted.

(c) If passenger loading zones are provided, then at least one passenger loading zone shall comply with 4.6.6.

(d) At facilities providing medical care and other services for persons with mobility impairments, parking spaces complying with 4.6 shall be provided in accordance with 4.1.2(5)(a) except as follows:

(i) Outpatient units and facilities: 10 percent of the total number of parking spaces provided serving each such outpatient unit or facility;

(ii) Units and facilities that specialize in treatment or services for persons with mobility impairments: 20 percent of the total number of parking spaces provided serving each such unit or facility.

Lot to be designed

Figure 1 Assignment 2005

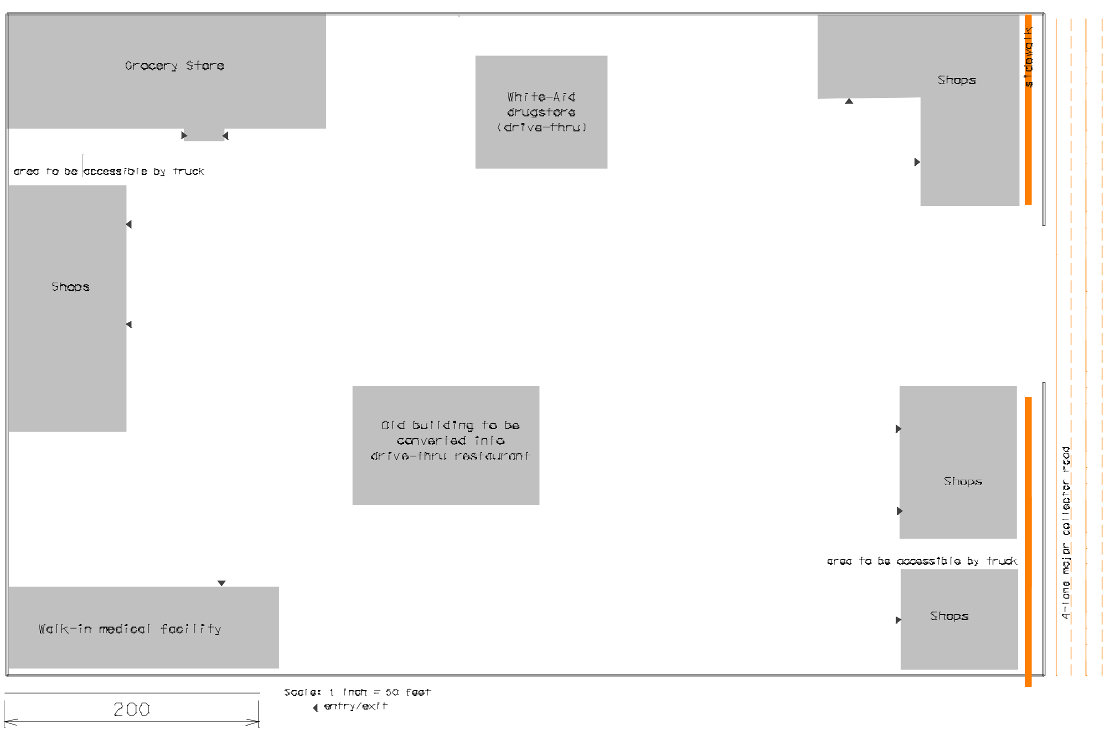

Figure 2 Assignment 2004

Examples of Student Work, 2005

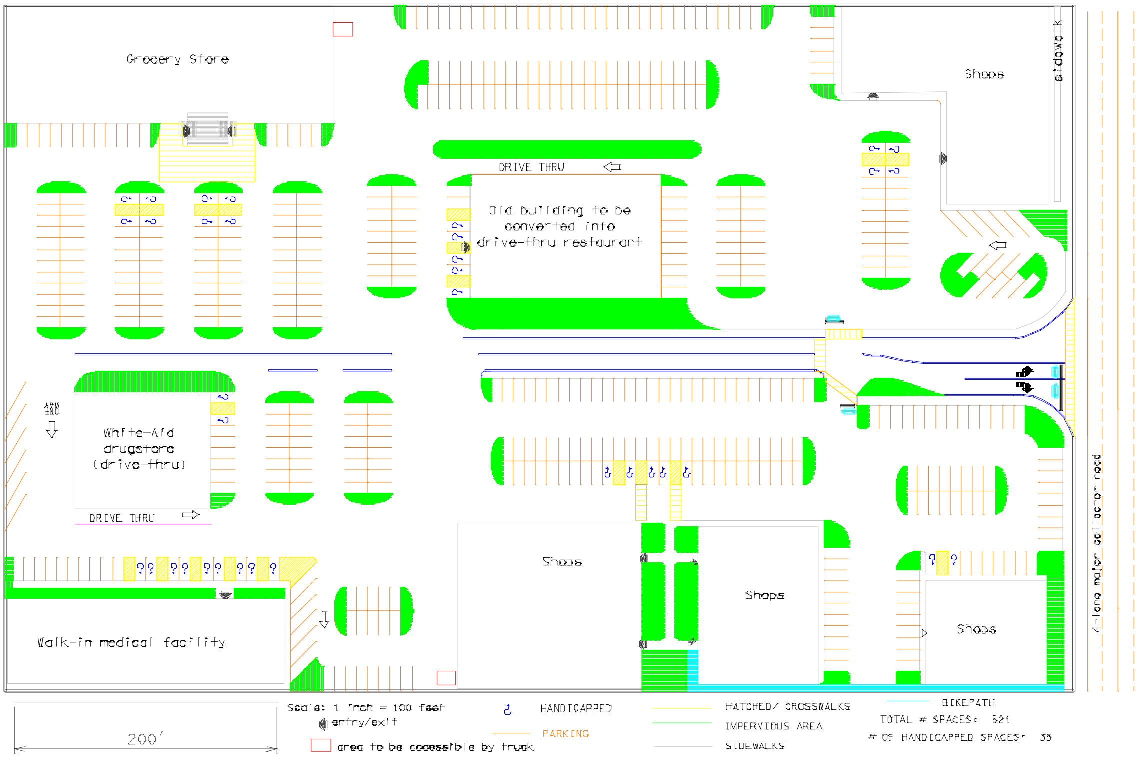

Figure 3 Parking lot by Sarah Mosley, 2005

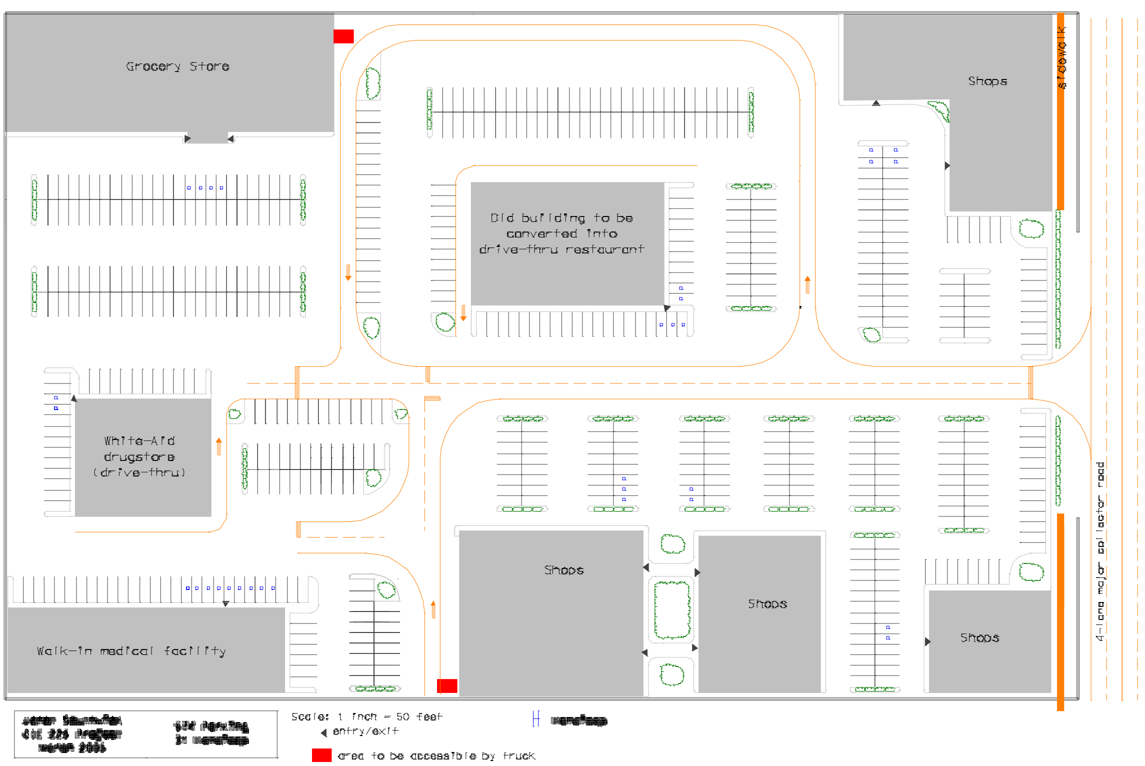

Figure 4 Parking lot by Janet Southwick, 2005

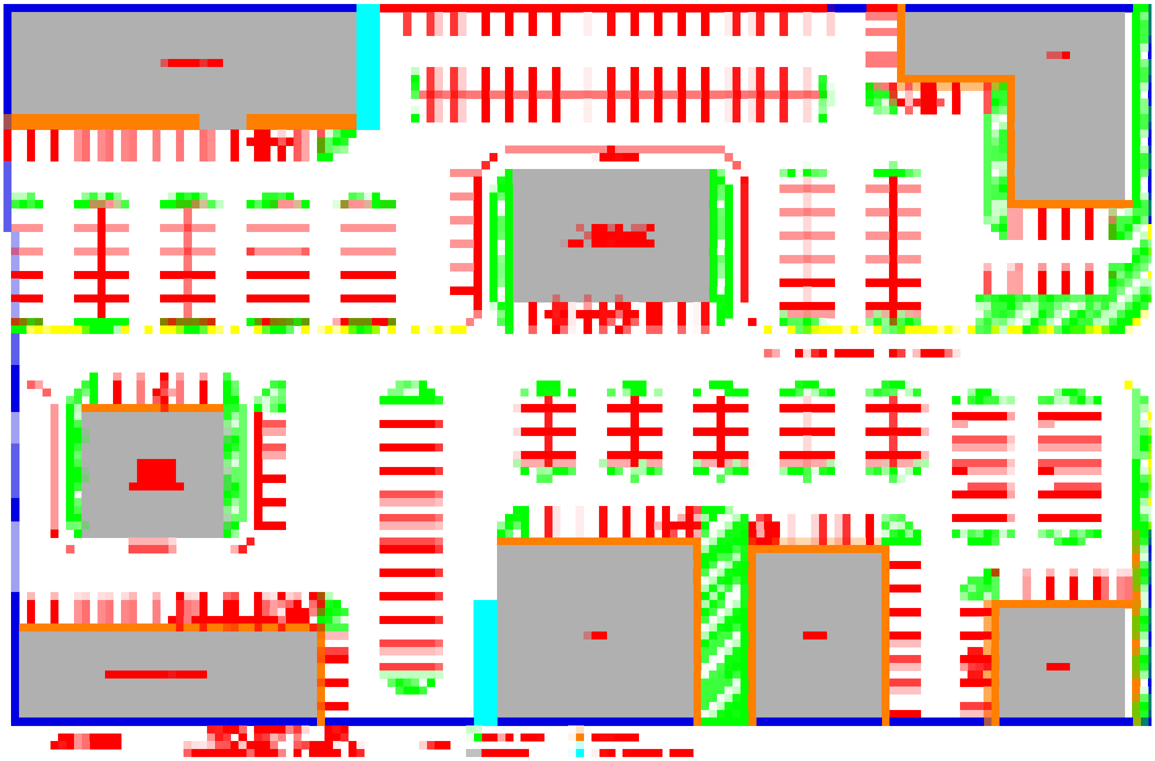

Figure 5 Parking lot by Jonathan Rose, 2005

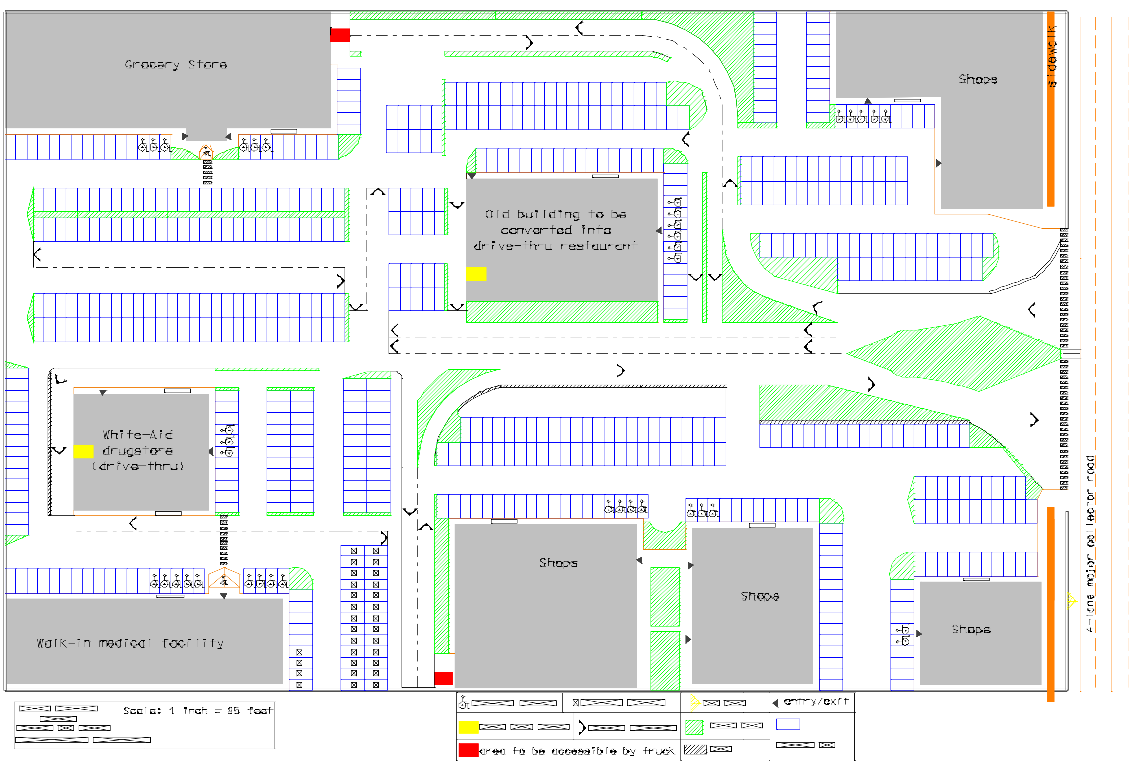

Figure 6 Parking lot by Steven Pasquine, 2005

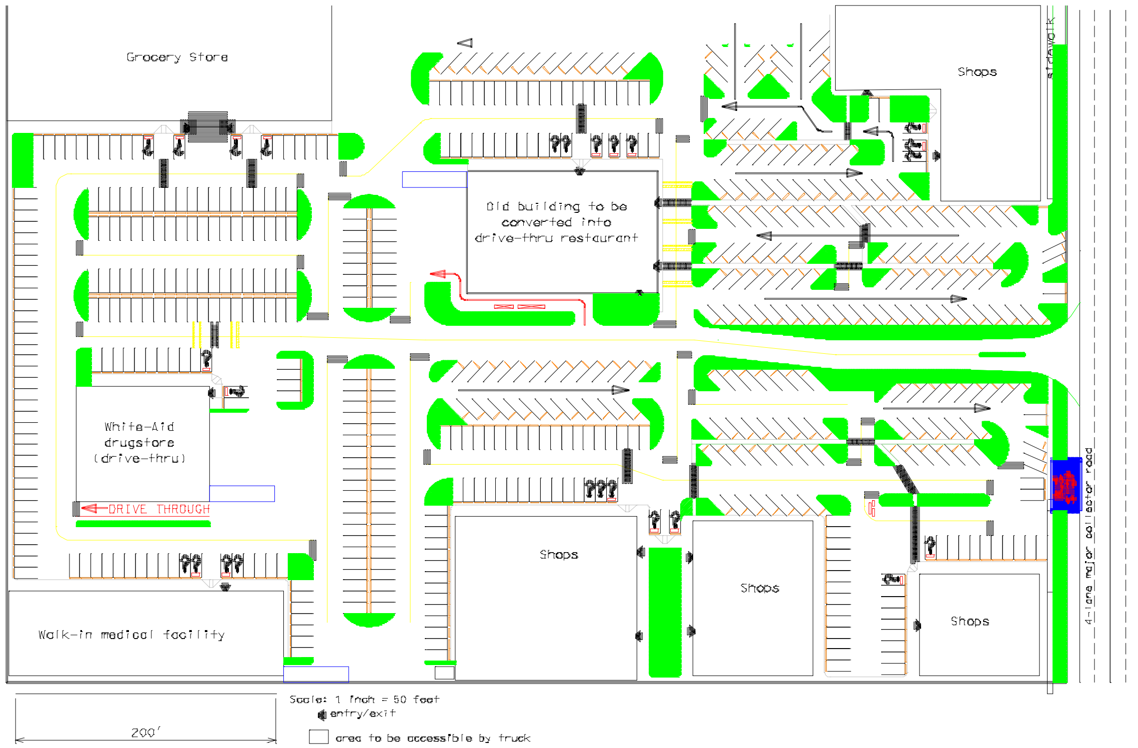

Figure 7 Parking lot by Philip Gagnon, 2005

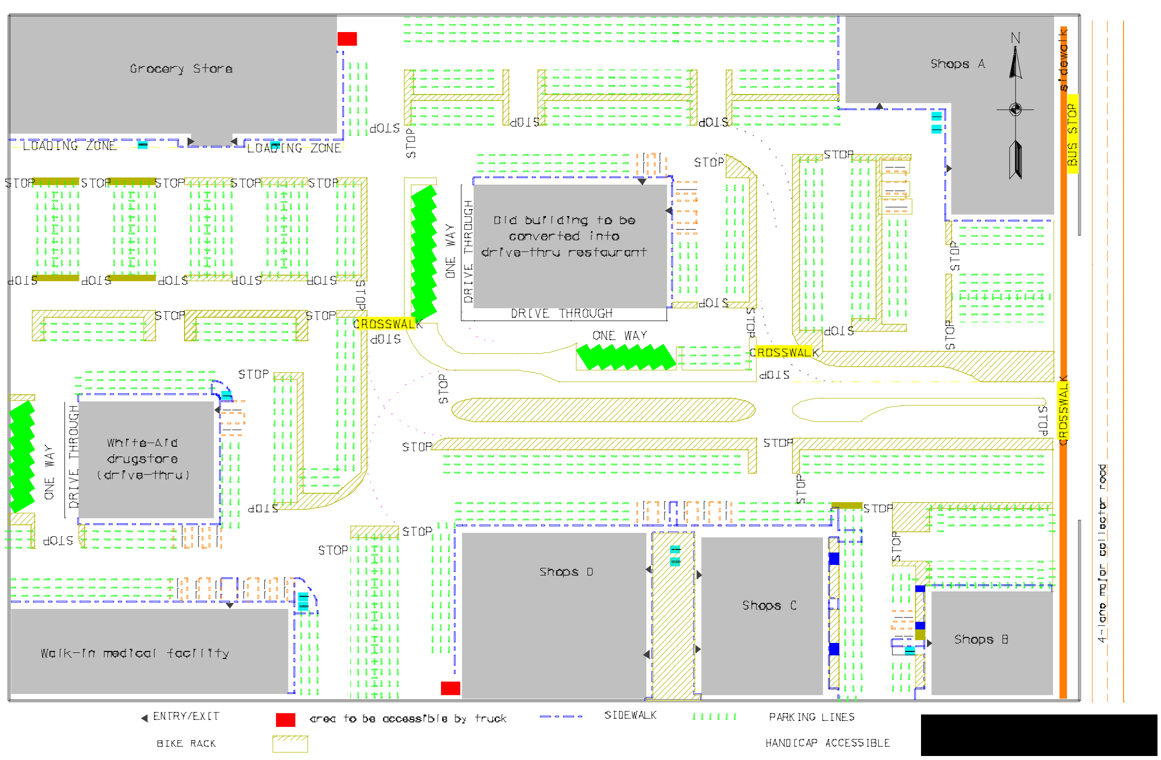

Figure 8 Parking lot by Alec Aman, 2005

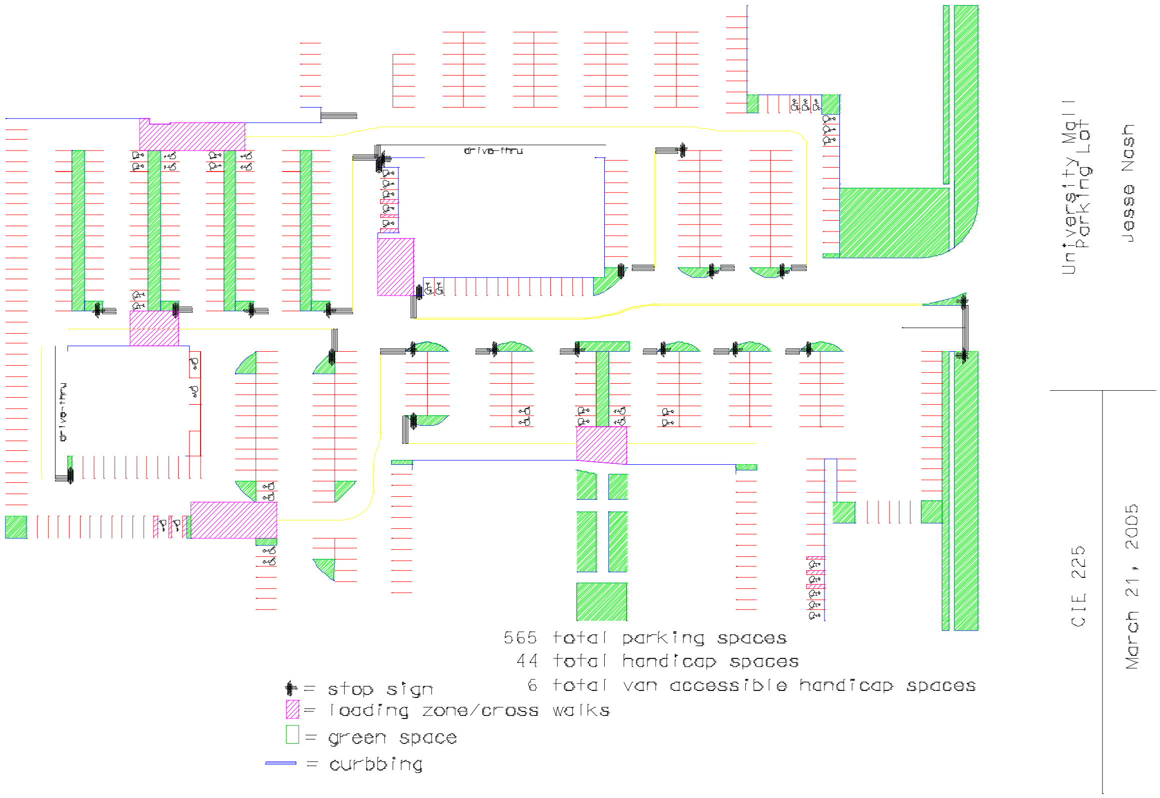

Figure 9 Parking lot by Jesse Nash, 2005

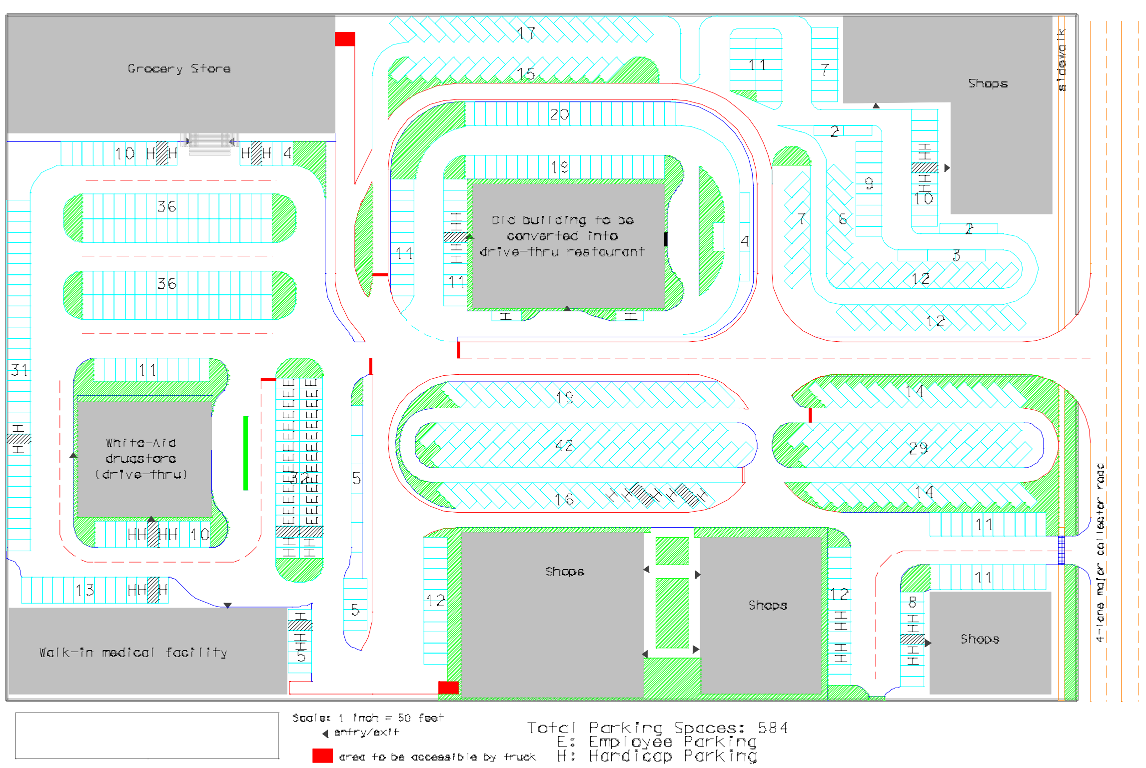

Figure 10 Parking lot by Kirby Davis, 2005

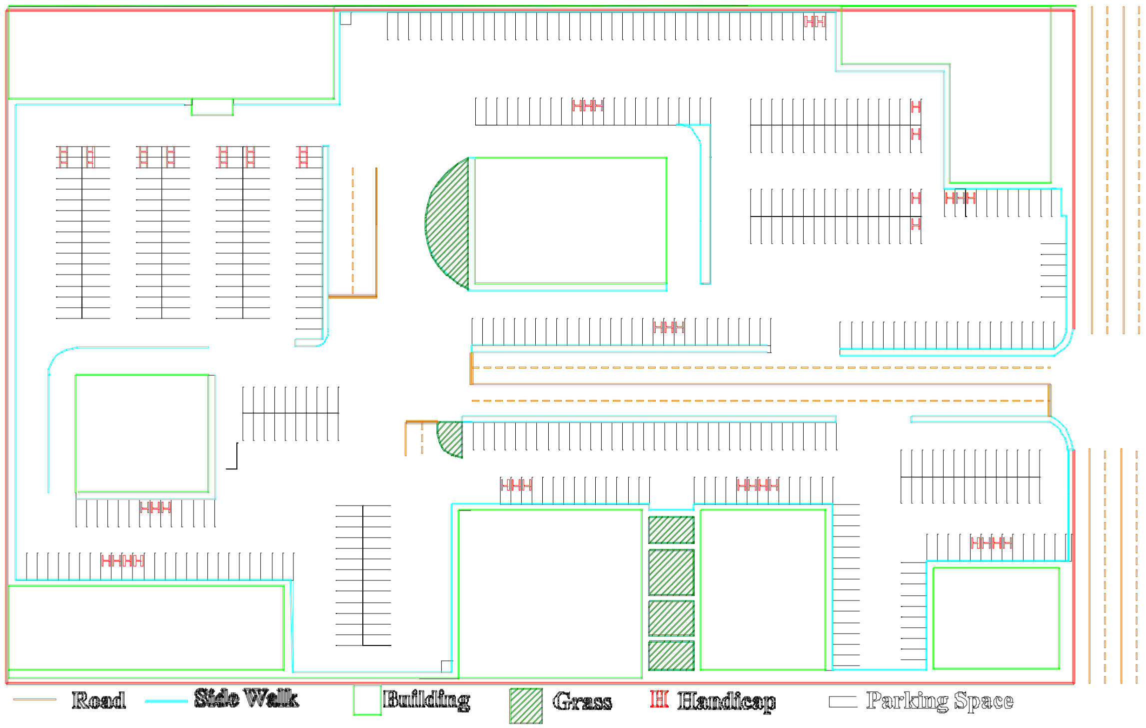

Figure 11 Parking lot by Nicholas Achorn, 2005

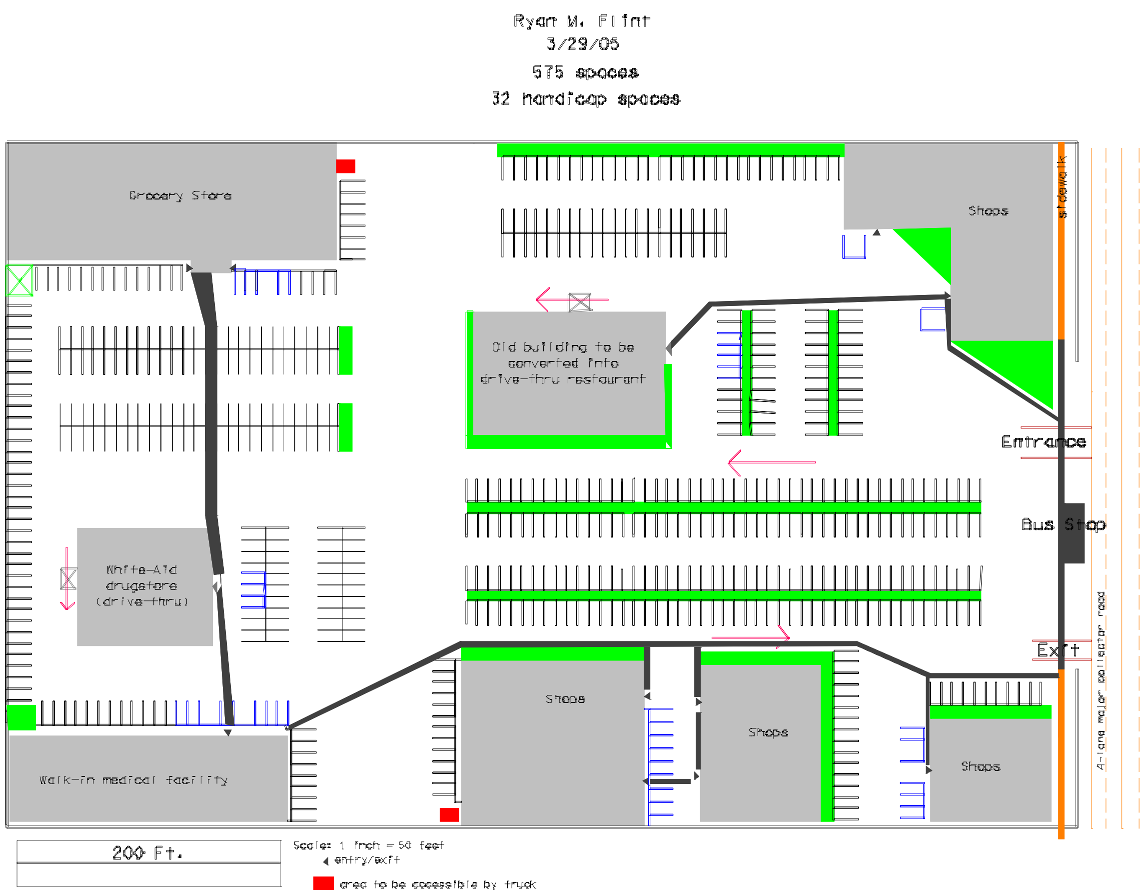

Figure 12 Parking lot by Ryan Flint, 2005

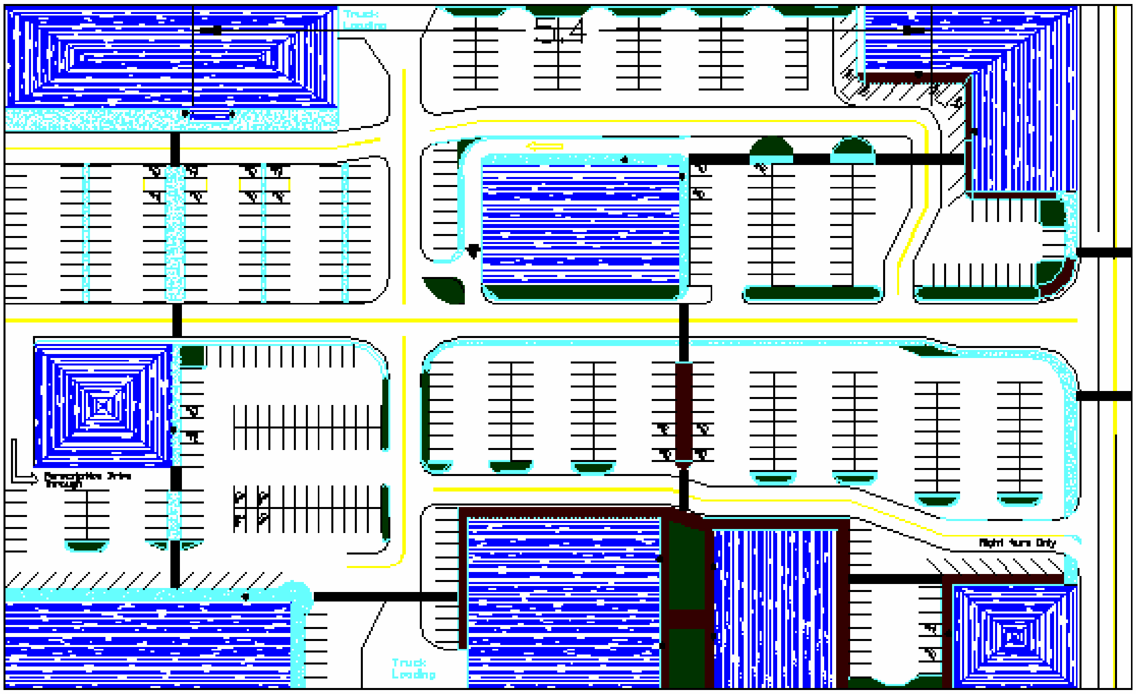

Figure 13 Parking lot designed in Auto Cad by Zechariah Jamison, 2005

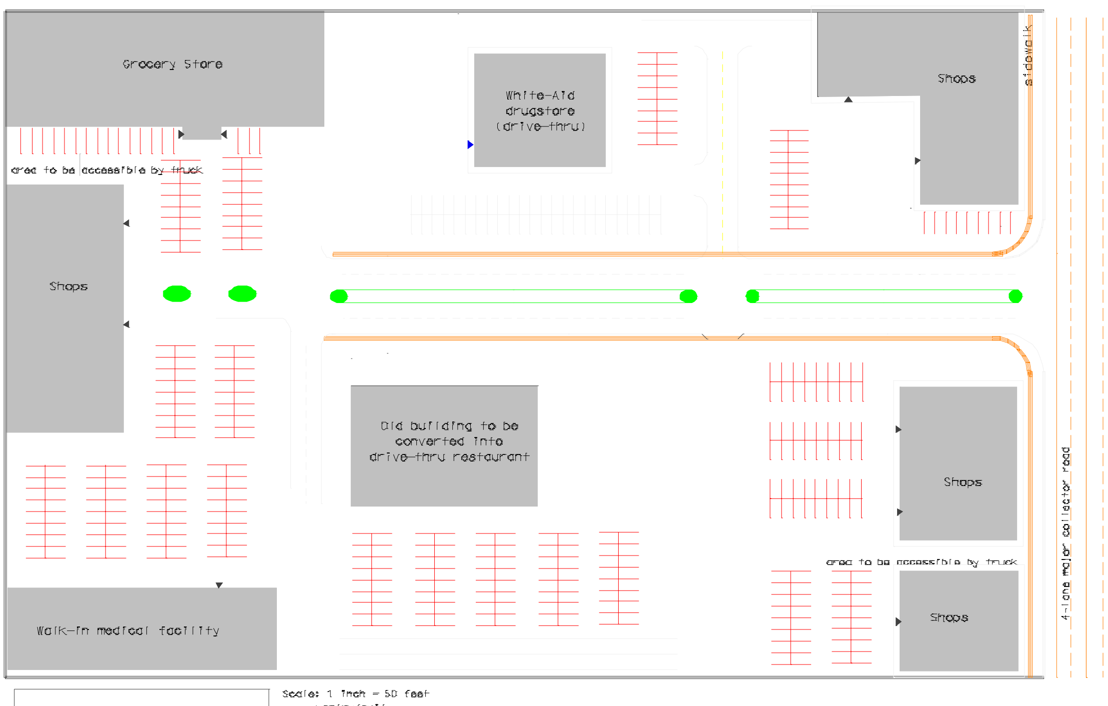

Figure 14 Example of student parking lot design, 2004

CIE 424 Urban Transporation Planning, Spring 2005

The Urban Transportation class of 2005 also had a design project in it. Some students worked on alternative locations of a new bridge across the Stillwater River between Interstate 95 in Maine (near Exit 193) and the University of Maine campus. The figures below show such possible locations of a new bridge and access roads.

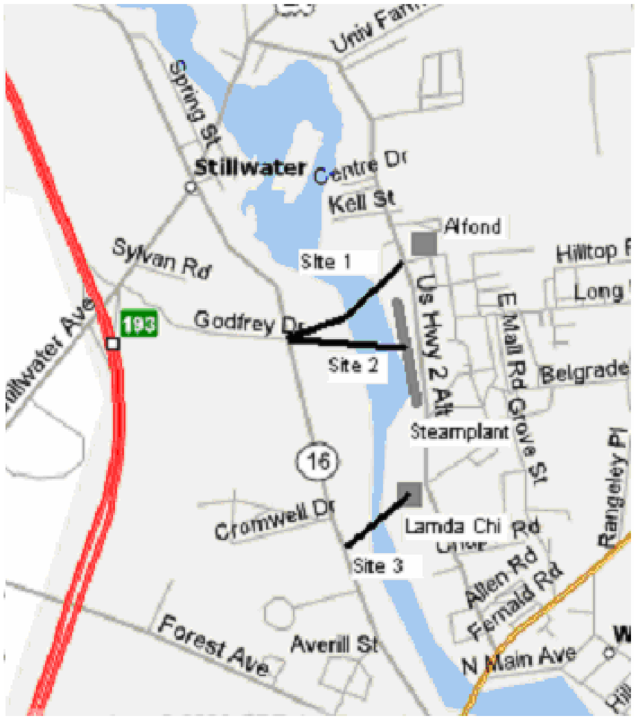

Figure 15 Possible locations for bridge across the Stillwater River

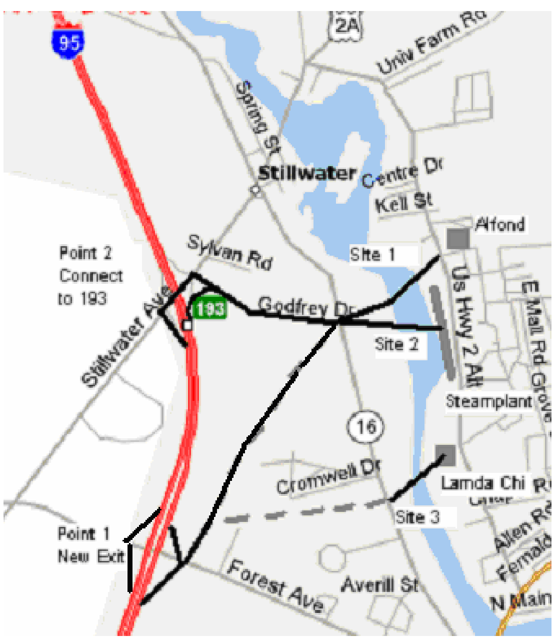

Figure 16 Connections from bridge to Interstate   Figure 17 Aerial photo showing same area

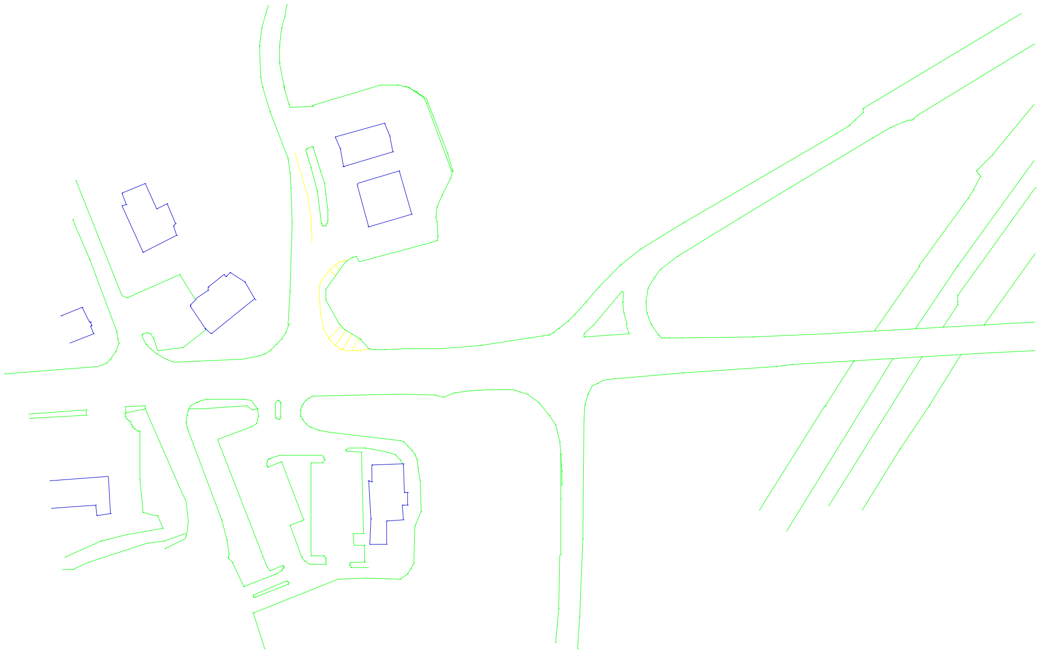

Figure 18 Microstation drawing of area at Exit 193 of I-95 in Maine

Figure 19 Aerial photo of same area as shown in Figure 18 and Figure 20

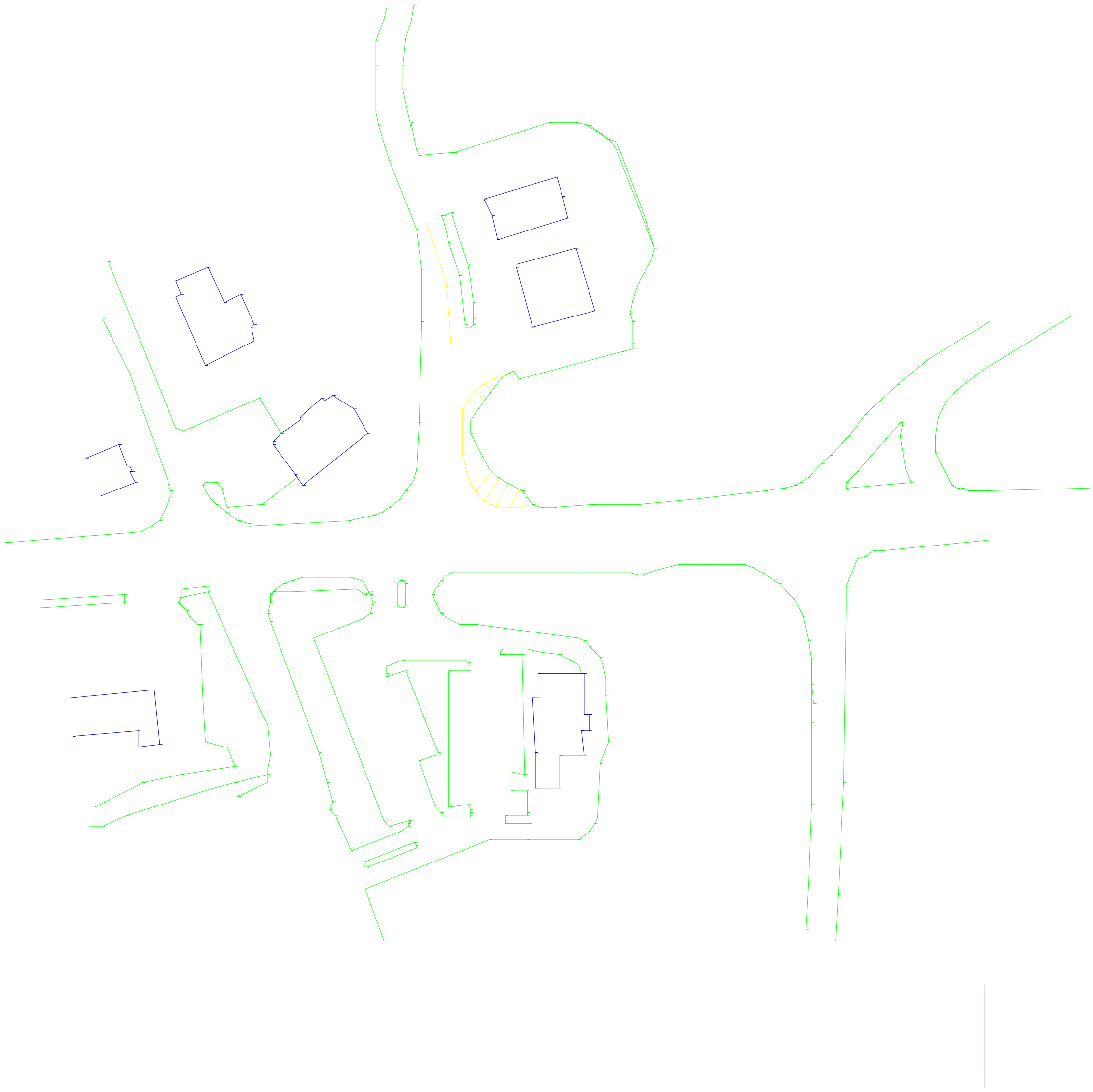

Figure 20 Microstation detail of the area near Exit 193 of I-95 in Maine

Results and Conclusion

The overall effect of introducing computer-aided help, i.e. the Microstation software, as a design tool in the transportation courses taught in civil engineering at the University of Maine is that the presentation quality of the designs have improved. Overall, the technical quality may not have improved but neither has it been impacted negatively. A major advantage with computer aided design is that modifications of 'final' drafts can be done numerous times without losing quality as when hand drawings are modified (irrespective of if ink or pencil is used). Other advantages are that measurements become more precise and that repeated characteristics easily can be duplicated. A major disadvantage is the time it takes students to learn to master the not so user-friendly software. Also, sketching which can be integrated when doing pencil designs still has to be done before going into the computer-based design.