

# **AC 2010-856: STUDENTS ISSUE INFRASTRUCTURE REPORT CARD GRADES**

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# Students Issue Infrastructure Report Card Grades

## Abstract

Students in three civil engineering courses developed infrastructure report card grades for aspects of infrastructure in Indiana. An assignment in each of these three courses was made in which the students developed a grade for a particular type of infrastructure. The three types of infrastructure investigated were drinking water, waste water, and solid waste. The results of the student efforts were shared with the Indiana Section, American Society of Civil Engineers (ASCE) for consideration and use in development of the Infrastructure Report Card on Indiana's Infrastructure. Students worked in groups of two over several weeks to complete the assignment. The *2009 Report Card for America's Infrastructure* by ASCE was presented to all students both in the printed form and on the Internet. The "Methodology - Development of the Report Card Grades" used by ASCE was presented to students and particular note was made of the sources of information referenced by ASCE. Additional sources of information relative to Indiana specific data for drinking water, waste water, and solid waste facilities and infrastructure were presented to the students. Nevertheless, students were encouraged to use creativity and to think outside of the box in their work and they did not need to follow any previous method used to assign infrastructure grades. The students completed the assignment by submitting two deliverables, a paper explaining the process to determine the grade and postcard sized graphic illustrating the resulting grade. The assessment of the assignment was primarily gauged by a survey form completed by the students. Furthermore, the instructor (author) offers reflections of the assignment, student efforts, and future improvements. Additional assessments measured by use of the student work in the Indiana Section efforts for their report card are ongoing. The assignments are well suited for ABET Criterion 3 Program Outcomes (g) an ability to communicate effectively; (h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context; and (j) a knowledge of contemporary issues.<sup>1</sup> An hypothesis of the assignment is if students take on an endeavor that practicing engineers are currently also doing as well as produce meaningful value in the work product for their efforts. The evidence of the student work and student survey responses indicates that students can take on such an effort. The meaningful value of the work product is not so evident.

## Background

Civil Engineers are the care takers of infrastructure. The first priority strategy of the American Society of Civil Engineers (ASCE) listed in the ASCE Strategy Management<sup>2</sup> is Infrastructure. ASCE has issued six infrastructure reports cards beginning in 1988 with the most recent in the Spring of 2009.<sup>3</sup> Civil engineering degree program curricula have been adjusted to emphasize infrastructure.<sup>4</sup> The message of the infrastructure report cards has reached major media outlets<sup>5</sup> and the highest levels of the United States Government including the President<sup>6,7</sup>, Senate<sup>8</sup>, and the House of Representatives<sup>9</sup> although multiple other examples exist. Nevertheless, the impact and value of the infrastructure report cards has been questioned<sup>10</sup> in ASCE publications. Many

sections and some branches in ASCE have developed their own infrastructure report cards<sup>11</sup> however, the Indiana Section, ASCE has not yet done so as of January 2010. There are ongoing efforts in the Indiana Section to complete such a report and discussions to include civil engineering students in these endeavors<sup>12</sup> included the possibility of senior design type projects. However, such collaboration did not materialize. Nonetheless, in multiple civil engineering courses in the Fall 2009 semester, individual course assignments were made for students to develop infrastructure grades on their own. Students in these courses were primarily juniors and senior majoring in civil engineering.

Only two students were common to more than one class and no student was in all three courses. Thus, the assignment was unique and not repetitive to the majority of students. Table 1 includes information about the type of infrastructure and student make-up for the courses involved with this assignment. The nature of students such as class standing and major did not impact any part of the assignment. However, this information is presented to provide the context and background of those completing the assignment.

Table 1.  
Type of Infrastructure and Student Make-Up

Course	Course Title	Type of Infrastructure	Student Make-Up
CE 3101	Environmental Engineering - Aqueous	Drinking Water	20 junior BSCE 3 senior BSCE 2 senior BSCHEG
CE 4103	Environmental Engineering – Non-Aqueous	Solid Waste	8 senior BSCE
CE 4133	Waste Water Treatment Design	Waste Water	6 senior BSCE 1 1 <sup>st</sup> yr. MSCE

BSCE = Bachelor of Science degree in civil engineering student  
 BSCHEG = Bachelor of Science degree in chemical engineering student  
 MSCE = Master of Science degree in civil engineering student

### The Assignment

One assignment each was made in three individual courses for students to determine a grade for infrastructure in Indiana. Different aspects of infrastructure were covered in the different classes. The course Waste Water Treatment Plant Design determined a grade for waste water infrastructure in Indiana. The course Environmental Engineering – Aqueous determined a grade for drinking water infrastructure in Indiana. The course Environmental Engineering – Non-Aqueous determined a grade for solid waste infrastructure in Indiana. Aside from the different aspects of infrastructure in different classes, the assignments were identical.

The assignment sheet was brief. The assignment, determine a grade for infrastructure, was recognized by students as much of their life revolves around grades. The concept of a grade, a letter that is either A, B, C, D, or F was used to emphasize one objective of the assignment,

which was to effectively communicate information. Assigning such a grade in a manner that is readily understood by the public to convey a range of excellence through failure and a reason that reports cards exist not only in academics and school but in reports such as the infrastructure report cards. The other objective of the assignment was for students to be creative and think outside of the box to resolve a problem, developing an infrastructure grade. The ASCE Infrastructure Report Card website was reviewed and discussed in class and videos available at this website were shown to each of the classes.<sup>13</sup> Students were shown that more information was available about the ASCE Infrastructure Report Card but that detail was not discussed in class.<sup>14</sup> Students completed the assignment by submitting two deliverables. Deliverable one was a paper explaining the process of developing the infrastructure grade. The paper limits were two to five pages. Deliverable two was a postcard sized graphic to convey and illustrate the infrastructure grade determined in the process the students conducted. Deliverable two was explained as something that would capture attention and make a person interested in reading the report. Students were encouraged to discuss the assignment and their progress both during class and outside of class on an individual basis with the instructor.

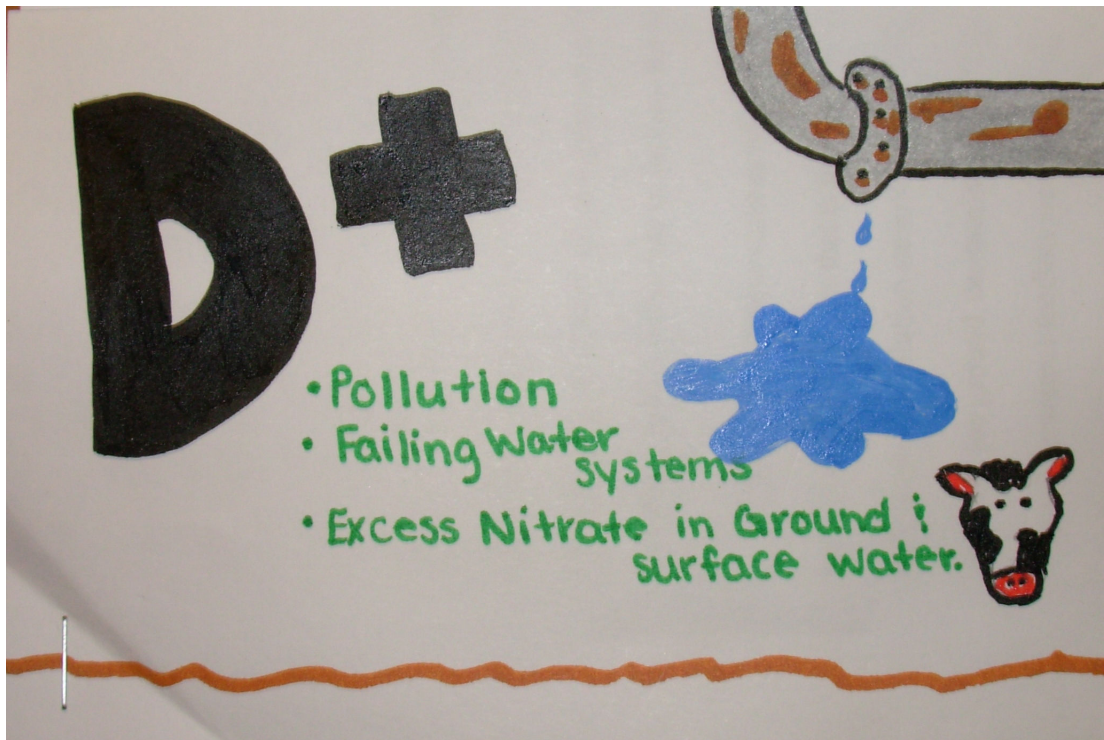
## **Student Efforts**

The assignment included three milestones so that the work progressed over several weeks and to persuade students to not wait until the night before the due date to complete the work. Students identified sources of information for the first milestone, which consisted primarily of lists of several URLs. However, a few students contacted government agencies and practicing civil engineers. Draft versions of the two deliverables comprised the second milestone. This permitted the instructor to evaluate individual progress in a critical manner. Some students did not link the draft work with the references that were provided earlier or the drafts were evidence of rather trivial effort to that point. The students who had completed more effort in their draft work benefited a great deal because this enabled the instructor to write specific comments about how to improve their work such that they could earn a very high grade. The students who elected to discuss the assignment and their progress with the instructor virtually assured that they would earn a grade of A on the assignment.

All students completed the assignment. Some students completed the assignment in outstanding fashions looking into detailed aspects of infrastructure and making judgments about how infrastructure was in the range of excellent to failure. These students developed algorithms and performed quantitative analysis of data, most of which was obtained from government agencies. Other students completed the assignment in average manners. These students typically did not perform any quantitative analysis but based the infrastructure grade they determined on qualitative factors and in some cases just anecdotal information. Only one student submitted deliverables that suggested trivial effort to the assignment. No students used the same or even similar methodologies to determine their grade. Some students accessed data from the Indiana Department of Environmental Management or the Environmental Protection Agency that were representative of the entire state. Other students looked at water plants or waste water plants in various geographic regions of the state while one group of students looked just at the largest communities in the state. A more complete analysis of the different processes used by the students is planned for a future paper. The postcard sized graphics ranged from simple

statements with data to creative representations of the infrastructure grade. Image 1 is example of a postcard graphic and two additional examples are provided at the end of this paper.

Image 1  
Example Postcard Graphic



The results of the student efforts were shared with the Indiana Section, American Society of Civil Engineers (ASCE) for consideration and use in development of the infrastructure report on Indiana's infrastructure if the students granted permission to the instructor to share this information.

### Assessment

Three types of assessment were conducted for this assignment. The primary assessment was a survey form completed by students. Additional assessment was reflections by the instructor (author) as well as feedback and use of material the students created by the Indiana Section in the section infrastructure report card.

Students were invited to complete an assessment survey form covering the assignment as well as to offer their deliverables to the Indiana Section for consideration in the section infrastructure report card. A majority of students agreed to complete the assessment form and all but one

student was interested in providing their efforts to the Indiana section although some students elected to do so anonymously.

Students had the option to provide general comments and suggested improvements to the assignment. The following are some examples of student comments:

- This was a good assignment. I struggled to find information to assign a grade.
- It was a good assignment that was different from my normal classes.
- Opened my eyes to all the different aspects included in infrastructure.
- Assign in bigger groups.
- Assign as individual project.
- Very well paced assignment.
- Would have loved to spend more time on the project, but with 4 other classes it was hard to focus on one particular assignment.

Two students expressed interest in making formal presentations of the work they had done. Having students work in groups is desired so that the process used by various ASCE groups working on similar tasks is more closely mimicked. The comments provided above indicate that some students like this aspect of the assignment while one student did not like working in groups. Students worked on the assignment in pairs that the students selected themselves. The most quiet and reserved students may have ended up partnering with someone who they did not work well with. The most common theme to student comments and suggested improvements was to tell the students more clearly what to do. This was good in regards that it was clear evidence that students had to figure out on their own how to determine a grade but it was not good that these students did not recognize that figuring out a process to assign a grade to infrastructure was the assignment itself. One statement repeated by the instructor in the various classes was that engineering is not just putting numbers into equations to compute results. This assignment was not just providing some equation such as  $X + 3 = Y$  for the students to work with. The students were not provided an equation or function or even informed of an  $X$  value to use to compute a value  $Y$ . The students needed to determine a value  $Y$ , an infrastructure grade by not only resolving what data and information to use as input, the dependent variables such as  $X$ , but also what process or function that this input put in to.

The assessment survey forms contained 11 statements that students marked as strongly disagree, disagree, neutral, agree, or strongly agree. Table 2 contains results of the student assessment.

Table 2  
Results of Student Assessment Survey Form for All Classes

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
This assignment was interesting.		1	8	21	2
I had to think creatively to complete this assignment.					
The postcard/graphic aspect of the assignment made me effectively communicate information in a manner that I would have not done otherwise.			8	17	7
It was challenging to determine a method or process of developing an infrastructure grade.		2	9	13	7
I had to analyze and interpret data for this assignment unlike traditional course assignments.			5	16	10
I had to “think outside the box” to complete this assignment.		1	8	19	3
I considered the impact of global, economic, environmental, and societal issues to complete this assignment.		3	7	20	2
I have a more complete knowledge of contemporary issues related to infrastructure after completing this assignment.			4	27	1
I believe this assignment will help me to formulate and solve engineering problems.		2	13	15	2
I considered how to exchange my ideas through this assignment.		1	13	14	3
The assignment made me more aware of infrastructure.			4	20	8

Responses to survey items related to ABET program outcomes suggest that the assignment can be used as evidence that students achieve these outcomes. Although a more positive response was expected, an ability to communicate effectively through graphic methods is substantially supported by student responses. Understanding the impact of engineering solutions in a global, economic, environmental, and societal context is supported to a slightly less degree. A future

assessment form would likely not include the term global since the assignment was based on infrastructure in Indiana. It is thought that the word global, while present in the ABET criteria, may cause students to rate this item less positively since the infrastructure was just in one state. Knowledge of contemporary issues is the most strongly supported outcome as well as the survey item that had the most positive response from students.

The instructor (author) provides the following reflections as the second assessment of the assignment. The assignment was a positive factor in each of the classes used. The student survey results indicate positive opinions. Some students included images on their postcard graphic which were not referenced and likely copied from some Internet source. Students were penalized for using any graphic that did not appear to be generated by them and was not referenced. The instructor made many comments on draft documents indicating “Do NOT Plagiarize” and discussed plagiarism in class. Nevertheless, it was the very disappointing to observe so many instances of plagiarism. A discussion with the department Chair regarding the instances of plagiarism and responses to it was held. The result of this discussion was to reduce student grades with a penalty. In general students did not show adequate references to material they accessed from the Internet. No students adopted a methodology<sup>15</sup> in line with that used by ASCE to determine infrastructure grades. This methodology was not explicitly presented to students so as to not limit their creativity although it was expected that some students, would find the methodology by reviewing the ASCE infrastructure report card website in more detail than was done in class. The instructor was disappointed that no students followed methodology presented on the ASCE Infrastructure Report Card website. While the ASCE Infrastructure Report Card was presented to students by watching videos in class and reviewing some pages of the website, not all the details of the website were discussed in class. It was expected that some students would have gone through the ASCE website in more detail. This may be an indication of student research methods of just using a search engine and browsing the first responses rather than reading through information in detail. In general, the instructor was pleased with the deliverables that the students submitted. One student submitted efforts related to a type of infrastructure that what was not assigned to that class. Students demonstrated initiative to search out and find information. The instructor considers the variability in grade processes as a positive as it indicates students did not mimic each other’s work. The positive instructor reflection has faded with time but the overall sense of the assignment is still positive. However, improvements can be made to the assignment. Improvements and changes that are being considered for future similar assignments include:

- requiring some quantitative analysis in the process to determine the grade,
- provide instruction on use of graphics,
- provide instruction on referencing material from sources,
- a milestone to review various ASCE infrastructure report cards (sections and branches),
- a milestone to review efforts and work submitted by past students,
- a milestone to review efforts of students in the same class (their colleagues), and
- grade the assignments more critically, particularly if students review past student work.

The improvement that is most apparent to the instructor (author) is the need to assess the assignment more clearly and more directly.



It is clearly recognized that the novelty is lost in making the assignment in future classes. Moreover, the timing of any future infrastructure report card being completed by the section is not known but unlikely to be for several years and certainly will not occur each semester. Thus the incentive for students to participate in a project of larger scope than just a class assignment will not be available again for some time. Options are to look at other states or at more detail for some communities rather than the entire state. The student makeup of the university is such that students attend from several mid-western states so using the same assignment for another state may not matter much to students at all. Other aspects of infrastructure can also be graded as different classes are taught. Roads, airports, and transportation systems can be graded in transportation engineering courses; bridges can be graded in statics, concrete, or steel courses; and dams can be graded in fluid mechanics or hydraulics courses.

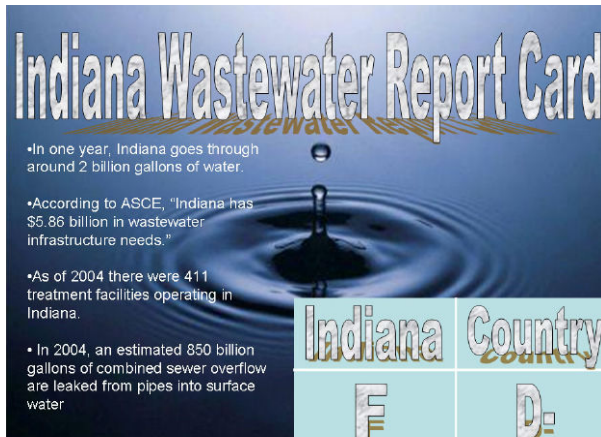
Evaluation of the student work by ASCE members working on the Indiana Section infrastructure report card is ongoing. Results of their assessment will be available in the future. However, to this date no portion of student work has yet been adopted by the Indiana Section for use in their efforts to create a report card on infrastructure in Indiana.

## **Conclusion**

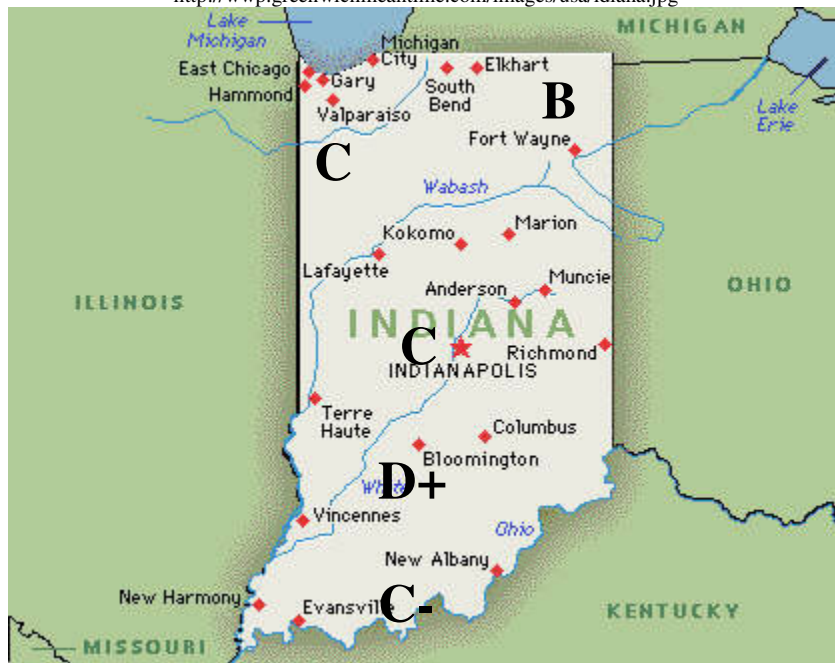
Students in three civil engineering courses developed infrastructure grades for waste water, drinking water, and solid waste infrastructure in Indiana. Student responses indicated positive comments about the assignment. Furthermore, ABET Criterion 3 Program Outcomes (g) an ability to communicate effectively; (h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context; and (j) a knowledge of contemporary issues appear satisfied based on these student responses. A reviewer of this paper offered that the assignment “helps to develop [their] ‘life-long learning’ skills ... as they [students] are required to seek out information on their own ... determine what they need to know ... and then determine where they can go to get the answer.”<sup>16</sup> The assignment was judged as positive by the instructor and there are plans to continue such an assignment in the future and incorporate improvements. The author encourages others to consider such assignments for students to develop infrastructure grades in courses they teach and welcomes feedback on their findings.

Students were offered the opportunity to present their work product efforts to the Indiana Section, ASCE for consideration and use in the Indiana Section infrastructure report card project. While the students overwhelmingly elected to offer their efforts, the response from the Indiana Section was less positive. As of March 2010, no portion of the student’s efforts had yet to be included in the ongoing efforts to produce an infrastructure report card for Indiana. The Indiana Section, ASCE is in the process, approximately seven months of a one year project, to determine grades for various aspects of infrastructure in Indiana. Students completed this assignment in approximately six weeks.

Additional postcard graphics include:



<http://www.greenwichmeantime.com/images/usa/indiana.jpg>



## Indiana's Drinking Water

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