All thesis students are responsible for compliance with the requirements in this document. Specific requirements contained within this handout may not be omitted. Your thesis advisor must approve changes in the physical scope of the project in writing.

**PRELIMINARY REQUIREMENTS**

**Project Approval**

Prerequisites specified in the Auburn University Bulletin will be enforced. No course can be taken during the final term that conflicts with the scheduled Thesis course time. The Thesis student is responsible for completing a “Graduation Check” and verifying that all of the required course work has been satisfactorily completed.

The student must submit Project Plans with a Thesis Approval Form to the School of BSCI Office no later than the last class day of the preceding academic term. No Project Plans will be approved during semester break. A copy of the Approval form is located in Appendix A. Written approval is required prior to starting any thesis work. The approval form must be included in the thesis submittal as noted in the Thesis Assembly section of this document. Any project scope changes must be approved and noted on the approval form by the thesis reviewer at time of submission. Only one set of plans will be approved for each student. A student may apply for approval of a project up to two academic terms before graduation.

**GENERAL REQUIREMENTS**

**Course Administration**

Thesis Lab is in session during scheduled class time; attendance will be taken during that time period. A series of one-hour lectures relative to thesis will be conducted periodically by BSCI faculty and will be announced by e-mail. Attendance is mandatory for all thesis lectures. The lectures may cover the following topics: Estimating, Recap Sheets and Bid Forms, Scheduling, Contract Documents, Structural Assessments, Materials, Erosion Control and other related thesis topics as requested by the class. In addition, desk critiques with faculty and group meetings with faculty will occur on an ongoing basis. Attendance for all of these events is mandatory.

Three unexcused absences will be allowed without penalty. More than three will be reported to your thesis jury and will affect your final thesis grade. Absences will be excused at the discretion of your thesis advisor only as stated in the Syllabus.

The BSCI Thesis Laboratory is a space set aside for the use of the thesis students. The School of
BSCI acknowledges the effort it takes to complete an exceptional thesis project. Thesis students will have access to the Thesis Laboratory 24 hours per day, seven days per week unless the University schedules otherwise. A library atmosphere shall be maintained in the BSCI Thesis Laboratory. **Eating, drinking, smoking and spit cups are not permitted in Gorrie Center.** Radios without headsets are not permitted in the BSCI Thesis Laboratory.

For most Thesis class sizes, each student is entitled to one desk to work on. Desks and computer equipment are to remain as arranged by the thesis faculty so that the rooms can be used for an occasional class or exam. The computers in the Thesis Laboratory are protected by a fiber optic security system. This system does not allow for rearrangement of furniture or computers.

**Computing Support**

The computer is a valuable tool in the preparation of the thesis. The McWhorter School of BSCI recognizes that the students rely on computing to complete their thesis. Computers, printers, and plotters are available in Gorrie Center. The McWhorter School of BSCI maintains this equipment and will respond as quickly as possible to any problems. **However, it is the student’s responsibility to complete the project in a timely manner.** Any failure of computer equipment is not an acceptable excuse for a late or incomplete thesis project. **Students must make periodic backups to protect their respective progress. Students are completely responsible for their backup strategies.**

The School will provide all printing and plotter supplies. Each student should exercise caution and print only when necessary. **The printer is not a copy machine.** The more it is used, the more likely it will crash. **Do not open the printer for any reason! The printers are monitored 24/7. The cost of repairs due to student damage will be charged to the student and will have to be paid to be cleared for graduation.**

**Job Placement Assistance**

The industry recognition and appreciation of Auburn University Building Science is what attracts top construction firms to recruit. Your participation in the process is important to all of us. Companies will be making presentations and conducting interviews in Gorrie Center. **Honor your job interview commitments or cancel well in advance. Broken commitments can result in problems with the contractors returning to campus in the future. More information is available at the Gorrie Center main office.**

BSCI maintains an electronic job board cataloging jobs those firms that have job openings are available. Your communication with these firms should be professional and open. We also have current AGC and ABC national directories for your use.

**BSCI Graduate Exit Interview**

All students are **REQUIRED** to complete the graduate survey and participate in the exit interview process. The purpose is to continue to improve our program in all aspects; the input of our "most
recent alumni” is to ascertain their perspective on their experience in Building Science and to solicit their input and comments on the program and its future. A copy of the graduate survey must be completed online.

**THESIS SUBMITTAL REQUIREMENTS**

**General Requirements**

**Thesis projects will be accepted until 10:00 am on REFER TO CANVAS FOR DUE DATE.** The thesis will be turned in to the thesis instructor in the Faculty Conference Room, where a drawing will be held to determine thesis juries.

Thesis jury hearings will be completed on or before dead day of that academic term (Time & Location, TBA). Submit your approved drawings and specifications with your completed thesis for grading. Drawings and specifications will be returned after jury hearings. **Your name should be clearly marked and easily found on the outside of all your submitted documents.** Theses receiving a passing grade will be made available for pick-up on graduation day in the School of Building Science. All remaining theses will become property of the School of Building Science. The School reserves the right to retain copies of Theses for quality control and accreditation requirements. The jury is a formal presentation and defense of the student’s work. The student should be dressed as if making a formal presentation to a major prospective client. The student should take the RSMeans text used for pricing to the jury meeting.

The Thesis presentation should be of professional quality, as if you were presenting your company to a prospective client. **Your thesis document shall be in 8½” x 11” page format submitted in a “D” ring binder.** Your work should be neat, thorough and original. Improper grammar and misspelled words will lower your grade. Although all thesis work is to be your own, you may exchange ideas and discuss problems with other students. The faculty is available to answer questions appropriate to the courses they teach. The faculty will not, however, take the time to re-teach course materials. Nor will the faculty “pre-grade” portions of your thesis to “check if it has been done correctly.” Refer to your class notes for any necessary review. You may also ask questions of contractors, architects, suppliers, and building industry officials, preferably those associated with your project.

**THESIS ASSEMBLY**

Assemble the thesis in logical order (i.e., chronological). Number all pages, in ink, including assumptions, worksheets and summary sheets, documents, and other information. A complete Table of Contents is required listing the sections, titles and page numbers. It should show all divisions of work contained in the worksheets and summary sheets. Worksheets and summary sheets will have a dual numbering system; one number system for the estimate itself and one for the thesis document. The typical work sheet and summary sheet heading areas should be complete.

Carefully plan sequencing and dating of all documents; i.e., Bid, Agreement, Bonds, Billing, etc., so that they are reasonable and consistent. You may assume any dates required to complete the thesis such as the bid date, project start date and company start date. A project time line is required.
Printing and formatting should be done with an attention to readability of the final product (rotating content to fit a page, size of fonts, size of margins, etc.). Your thesis reviewer may reduce your overall grade at their discretion for inadequate attention to this requirement.

Include your full name, as registered with the university, and thesis semester on both cover and title page. Anticipate binding room on each sheet of paper when copying or printing. Do not submit a machine copy of your thesis. All documents must have original hand written signatures.

Minimum Requirements / Thesis Assembly Model

The minimum requirements and recommended assembly for a complete thesis are as follows (do NOT use Appendix B – Thesis Evaluation & Grading Criteria as your Thesis Assembly outline):

**Preliminary**
- Title Page
- A Complete Table of Contents w/ page numbers
- Thesis Proposal Approval Form
- Project Brief (include the original and revised versions)
- Assumptions
- Detailed Project Time Line of Events
- List of Student Selected Work w/ page numbers
- Approval form for Student Selected Work

**Company**
- Company History, Philosophy and Goals
- Organizational Chart
- Duties of Key Personnel
- Contractor’s Licenses
- Business Licenses (state and local)

**Financial**
- Contractor’s Qualification Statement
- Balance Sheet
- Income Statement - current and projected
- Financial Narrative including business position and strategies consistent with financial statements
- Financial Ratios and a thorough analysis of each: Net and Gross Margins, ROI, Current Ratio, Fixed Asset Newness, and Average Ages of Receivables and Payables
- Labor Burden Determination (home office and field)
- General Overhead Determination

**Project Estimate**
- Specification Take-off / Drawing Notes Issues
- BIM Model of Structure, including Quantity Validation
- QTO Worksheets (including Site Utilities)
Document earthwork quantities using "Earthworks" or other suitable program. Include printout of software including graphic image of cut/fill.

Pricing Sheets including Site Utilities and unit prices (if required)
Job Site Overhead
Recap Sheet
Bid Calculation Worksheets (base bid, alternates and unit prices)
Explanation/Analysis of MEP systems
Subcontract Scope Statement for MEP systems, addressed to applicable specialty contractor(s)

**Project Documents**

Master Surety Agreement
Proposal Form with at least one alternate bid item
Bid Bond
Power of Attorney for Bond Agent
Agreement Form (per your specs.) w/acceptance of one alternate
Bond Application Form
Performance and Payment Bonds
Certificate of Insurance
Project Specific Safety Plan (DO NOT include MSDS sheets)
Sustainability Construction Assessment
Subcontract Agreement Short Form (AGC) w/ detailed scope of Work and listing of project documents as attachments.
Building Permit (not the application)
Project Cash Flow Projection
Submittal/shop Drawing Control Document
CPM Activity Worksheets
Schedule of Values Reports showing Period Costs for first three months, from which the pay applications are generated
Change Order prompting, i.e. RFI, Architect’s directive, etc.
Change Order QTO, Pricing, Recap sheets, and cover correspondence to Architect
Change Order (executed in first 3 months)
Payment Requests (for first 3 consecutive months)
Substantial Completion Documentation
Consent of Surety to Release of Retainage (when appropriate)
Affidavit of Release of Liens
Affidavit of Payment of Debts & Claims
Consent of Surety to Final Payment
Certificate of Occupancy
List of all required Warranties and at least two actual Warranties

**Structural**

Structural Assessment

**Project Schedule**

Color plot of original Bar Chart (with logic arrows), cost loaded, clearly indicating a timeline, all appropriate activities, their
durations, total float, and ALL logic/lag ties [front and end] for each activity.
Inclusion of Schedule Draft; to be returned to student upon submission of final project

Appendix
Site Utilization Plan (graphic and written narrative)

References
Reference all sources used in Thesis
Attach a complete copy of the Thesis Instructions

Electronic Files
Final Project Schedule (PDF format)
Estimate File (XLSX format)
BIM (RVT format)

Grading
Completing all the minimum requirements listed in the preceding section does not mean an automatic grade of “A”. If all items are included and most of the items are reasonably correct, then the student can expect a grade of “C”. Significant omissions and/or errors will result in a grade in the “D” range or an “F”. Additional copies of the items listed in minimum requirements will not be considered “Student Selected Work”. Per the University’s definition, an “A” is for superior work.

Thesis projects will be presented to and defended before a faculty jury. The jury will evaluate the projects for:

1. Meeting the minimum requirements listed in the Thesis Instructions in a manner appropriate to the student’s thesis project.
2. The accuracy and applicability of student selected work.
3. The integration of the minimum requirements and the student selected work into a cohesive whole.
4. The professional quality of the thesis document.
5. The professional quality of the student’s presentation and defense.
6. The student’s ability to explain the reason and meaning of each part of the thesis. (If you don’t know what it is, how it was developed, why it’s there, and what it means, it lowers your grade!)

The jury will assign a letter grade based on this evaluation. Possible grades are A+, A, A-, B+, B, B-, C+, C, C-, D+, D, D- and F.

If the thesis is graded as an "F" (failure), the thesis will be retained. The School Head will determine whether the student is allowed to retake the course using another approved set of drawings and specifications. An "IN" (incomplete) will be assigned only if extenuating circumstances warrant and requires the School Head's approval and per University mandated criteria.
A thesis that is submitted on time but that is not complete, will be evaluated and given a grade appropriate to the degree of completion and the quality of the work submitted. A thesis that is submitted after the designated time, but prior to **11:00 am** on the due date, will be penalized by a letter grade reduction. Theses will not be accepted for grading after **11:00 am** on the date due and an "F" will be assigned.

**Project Brief**

A brief overview of the project should be done prior to beginning your project. The brief is to be prepared as a formal business document summarizing the key project control aspects of your project directed to the owner of your construction company. The brief should address all of the following items:

- Identification of the 2 or 3 major risks on the job for your construction firm
- Identification of the work you plan to self-perform and what you plan to subcontract (you are encouraged to self-perform one trade)
- Identification of key dates: Bid, start, finish, etc.
- Identification of major site issues including earthwork requirements and site logistic issues if any exists
- Consideration for how quality will be measured
- Identification of 3 or 4 largest safety risks specific to this project
- Construction of a schedule of the key 10-15 items on the job (may be drawn by hand)

Along with the Project Brief, you are required to submit a separate document detailing your proposed “Student Selected Work”. This document must include the following:

- Your name.
- A written description of the selected work and the tasks involved in its completion.
- The anticipated time that will be spent on completing the selected work.
- Provide a place on the document for the reviewing faculty to make comments and to approve or disapprove the proposal.

This approval document must be included within your final thesis. Refer to the section at the end of this document for more specifics regarding the Student Selected Work.

The content in your project brief must to be specific to the project, refer to specific contract documents, and use concise industry terminology. The evaluation of the project brief is not only of the student’s knowledge of construction issues, but also the student’s ability to clearly communicate in writing.

**Project Brief shall be submitted via upload to Canvas by the end of class on REFER TO CANVAS FOR DUE DATES.**

The Project Brief will be graded by a random faculty member. You may consult with that faculty member concerning your grade and receive feedback about your thesis. Following your consultation with faculty, revise your Project Brief. In your final thesis, include both the original
and revised version of your Project Brief.

**Company and Project Documents**

All documents are to be fully executed as if real, and dated, signed and notarized where appropriate. The student is required to comply with all requirements contained within the contract documents by:

a. Compliance with the requirements, or  
b. Written assumption concerning the requirement approved by the Thesis Professor.

The student may have to provide additional documents to meet the minimum requirements depending on their project.

The student is required to set up an organization that is capable of constructing their project. Be realistic in relating organization and overhead to annual construction volume, and use good management principles in staffing your organization.

An analysis and determination of the unique annual overhead, fee objectives, and labor burden for field and office employees must be clearly demonstrated and explained for the most recent complete year as well as the projected values for the duration of the thesis project.

The faculty strongly requests that multiple copies of forms or reports such as subcontracts and state licenses should be omitted. All information included should have a purpose and only one example of an executed document is required. However, pay requests are required for three months. Any additional pay requests are not considered extras and should not be included.

Students are encouraged to be creative and original in the development of forms, letterheads and other documentation. However, the creation of these items can have a negative impact if they cause excessive paper use or do not add to the overall appearance of the document. Remember, "Fluff is not a substitute for substance."

**SPECIFICATION TAKE-OFF / DRAWING NOTES ISSUES**

The student shall provide an analysis of all items that impact time, money, or other risks that are associated with, but not be limited to, supplemental conditions, general notes on drawings, and all specifications. The analysis shall be presented in the form of an internal memorandum directed toward company employees affiliated with this project.

**COST ESTIMATE**

All scope changes must be approved by the Thesis Instructor and noted on the plans. In addition, all approved scope changes must be noted as a separate subsection on the student’s Assumptions Sheet document. Verbal approvals are not acceptable.

Each student is to create a comprehensive, detailed cost estimate for the selected thesis project.
Takeoff

The quantity survey can be accomplished using both manual and electronic tools. Tabulation of quantity takeoff into worksheets should be organized in such a manner as to allow intuitive review. Quantity takeoff sheets should be organized by trades, each sheet should be limited to a single trade. Students need to utilize a consistent methodology and an easy to follow audit trail. The audit trail should seamlessly blend both manual and electronic takeoff. With manual takeoff the audit trail should include a plan reference and further dimensional and location and orientation information to allow reviewers to retrace your steps and verify quantities. If electronic means are used for quantity takeoff the audit trail should include an explicit reference to an appended document (Onscreen Takeoff sheets w/image legend) which clearly demonstrates how the quantities were derived and where they came from. In using electronic means (such as Onscreen Takeoff, BIM, Earthworks, etc.) to quantity items on the project, information must be provided in the description of each item quantified to accurately identify the specific construction item. (For example: If quantifying interior gypsum partition construction items using Onscreen Takeoff, you should clearly define in the condition description for each partition type such as 1Hr FR, 6” Mtl Std 22ga, 5/8” Gypsum)

You will be required to justify your methodology for your calculated quantities. Waste and overages need to be considered on your quantity takeoff sheets. Quantities for Divisions 3, 4 and 5, must be extracted from the BIM Model (see BIM GUIDELINES section for more information).

Site work is a required item and must be estimated and priced in a detailed manner. In addition, it should be noted that site utilities and erosion control are to be taken off and priced as Site Work “subcontract” work. Proper analysis of the site work requirements is critical to the successful completion of a project. The student should understand the grading operations and the effects of shrinkage and swell. Using a cut/fill program is acceptable. However, the appropriate reports showing existing layers and volumes, proposed layers and volumes, structures, total cut and fill, existing elevation data and proposed elevation data must be included and incorporated in the thesis in an organized manner. It is required that the thesis student prepare a narrative in order to defend their understanding of earthmoving operations.

Do not take off demolition work, trees and shrubs in landscaping, lawn sprinkler systems, fire alarm and/or sprinkler systems, or any low voltage wiring. Include these items in the bid amount by estimating a lump sum price for each item. The thesis faculty will provide limited guidance in this area. Do not assume this work will not be accomplished. Be prepared to explain your approach to these lump sum prices.

You may design your own worksheets, summary sheets, and recap sheets as long as they are similar to those used in Project Controls. Worksheets, Summary Sheets, Job Overhead Sheets and Recap Sheets may be completed in pencil, but must be neat and legible. All estimating work should be self-explanatory to a reviewer and demonstrate an easy-to-follow audit trail throughout the estimate. Be sure to highlight totals on worksheets which are carried forward to summary sheets and totals on summary and job overhead sheets which are carried to the recap sheet indicating the page number of the destination in the appropriate manner. You will be required to justify your
methodology, waste and conversion factors, and all computation in your estimate.

**Pricing**

You may use spreadsheet software to price all items in a format similar to the pricing sheets. Provide the pricing guide page number and line number after each item priced on the summary sheet. The reference column is for the work sheet number and should be provided for all items on the pricing sheets.

Pricing sheets should reference quantity takeoff sheets from which the quantities were derived. Pricing sheets should also be limited to a single trade per sheet. In no event should more than one trade be included on a pricing sheet, but often a single trade will require more than one sheet. It is appropriate to summarize cost information for each trade at the end of its last pricing sheet and then for that information to be forwarded to the recap sheet.

On-Screen Take-off, or other estimating software may be used to take-off and price all sections. All computer estimate reports should be produced in a manner to easily review the information. It will be the student’s responsibility to clearly present the information in a format that shows the audit trail, crew designations and makeup, systems/work groups procedures, the pricing according to the current RSMeans being used, and proper calculation of unit prices and subcontractor mark-ups.

Develop "raw" (raw means no general contractor markup) prices for all work done at the project site including subcontracted work. You may estimate each subcontractor's total markup at 22% to 32% if the work is totally subcontracted; the mark-up is 40% and 45% if only labor and equipment are subcontracted. *While these markup rates are somewhat arbitrary for this exercise, you have to show in some form (and be prepared to defend) what factors are included in the markup.* Show subcontractor markup on the final pricing sheet for each trade. Highlight the subcontractor quote (including markup) and carry to Recap sheet.

The bid must include at least two alternates with the estimate and on the proposal form. If no alternates are listed in the specifications, the student is required to submit an addendum to the bid documents that creates the alternates. **One (1) alternate must be accepted in the agreement with the owner.**

**Use the proposal form and the Bid Bond form from the project specifications, if provided.**

As in industry, the alternate is accepted after bid day and before the contract is written. The student must prepare the prices for these items separately for the owner to select. The student can select which will be accepted.

**You are required to show the calculations of any unit prices required on your bid for additive or deductive work.** These unit prices should include markup. Also, show the calculations for
contract change orders and alternate bid items including markup.

**Special Pricing Considerations**

Price all concrete by the cubic yard, rebar by the ton, and structural steel by the ton. The only exception is that the square foot/square yard pricing can be used for sidewalks and paving.

Connections for steel, wood, etc., may be estimated on the summary sheet as an adjustment to the quantity (additional materials). Use proper judgment by interpolating or adjusting RSMeans line items.

Determine the quantity and type of all wood and light gage metal roof trusses. Use the RSMeans pricing data for your truss pricing or an actual truss manufacturer quote. The contractor/subcontractor will still need additional material for bracing and labor to erect the trusses.

If it is necessary to adjust pricing in RSMeans, use proper judgment when interpolating between line items. Add price adjustments to your list of assumptions and be prepared to defend your methodology.

**Recap**

The recap sheet is “part and parcel” to the pricing sheet and in addition to summarizing the project’s cost. It also provides a document that an estimator could use for bid day evaluation. Therefore, each line item on the recap sheet should be organized by trade. The recap sheet should reflect if the estimator plans to self-perform or subcontract the work. Recap sheets are used to add indirect cost and markups to the estimate. Recap sheets need to be produced for alternates, change orders and unit prices.

**BIM GUIDELINES:**

All thesis students MUST create a BIM model for the structure in their projects, as described below. Any BIM software available in the McWhorter School labs may be used.

<table>
<thead>
<tr>
<th>Frame</th>
<th>Required</th>
<th>Not Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>Foundations, columns, beams, braces, load bearing walls, retaining walls, rebar (foundation &amp; walls), elevated slab on deck, ground floor slab, OWSJ and joist girders</td>
<td>Connections, base plates, anchor bolts, partitions and other miscellaneous steel</td>
</tr>
<tr>
<td>Concrete Frame</td>
<td>Foundations, columns, beams, load bearing walls, retaining walls, rebar, elevated slabs, ground floor slab (foundation, beams, columns &amp; walls)</td>
<td>Formwork, slab on grade outside the footprint of the building.</td>
</tr>
</tbody>
</table>
Wood Frame | All load bearing components of the building, foundations, rebar, braces | Partitions

Students **MUST** use quantities from the models above in their estimates (See thesis folder for formatting and quantity extraction instructions). When using electronic means for quantity takeoff the audit trail should include an explicit reference to an appended document which clearly demonstrates how the quantities were derived and where they came from.

Students are to perform a quantity validation on one major component from the modeled components. The quantity validation must demonstrate a student’s complete understanding of the use of BIM in quantification of construction items. The quantity validation is a check to ensure the accuracy of model extracted quantities versus the manual takeoff method. For example: one major component that may be selected to complete the quantity validation is the total cubic yards of slab-on-grade concrete extracted from the model and a manual takeoff comparison.

**PROJECT SCHEDULE**

The work plan and project schedule must correspond to the project's cost estimate. You must include CPM Activity Worksheets to justify activity costs.

*A draft project schedule shall be completed and submitted no later than the end of class on REFER TO CANVAS FOR DUE DATES.* It should contain a calendar timeline, and milestone activities with durations for the complete project including construction. The schedule should be represented in a clear, legible, organized manner, and it should follow standard CPM drawing conventions, contain a title block, date and legend, and not exceed a sheet size of 36"x 48". It will be submitted in a 9” x 12” manila envelope with the student’s name, project name, thesis semester, and DRAFT SCHEDULE neatly and legibly written on the cover. This schedule will be inserted into the thesis when the thesis is submitted. **While this submission should be complete, it should be a draft that demonstrates your understanding of how the building will be assembled, and its relativity to your pricing of equipment, crews, and overhead.** The draft should be in bar-chart form, should include a time scale plus all activities and logic ties. Obviously, your final schedule may (and likely should) reflect refinements to this draft. Make sure you retain or make a copy of the draft, as you will **not** be allowed to reference it after it has been submitted.

Time-based items in the estimate must agree with the scheduled time frame of the project. The pay requests are derived from the cost loaded CPM schedule and are representative of the planned progress of the work. Each category of work must be planned and scheduled. The schedule should contain a sufficient number of activities (100 activities +/-, excluding procurement activities) for the Project Manager to coordinate the work on a weekly basis. The sequence of activities should represent the Project Manager's plan and follow standard construction practices. In addition, the schedule should show procurement activities including fabrication and delivery of critical and other time-sensitive materials to the jobsite in time not to delay the project.

Each activity must be assigned an earned value in order to produce an anticipated "Early Start Earned Value Curve." The student must include on this diagram an anticipated "Income Curve"
based on the Early Start Earned Value Curve, as well as an anticipated “Actual Costs Curve”. The student will then produce and include a report showing the cash flow projection of the project based on the plotted curves.

The student will assign a "Schedule of Value" code to each activity and produce a SOV report. The codes in this report will correspond with the G703 pay request cost items and agree with the pay request amounts. Therefore, if the schedule is updated, the earned value should equal the pay request amount without the stored material.

The student is required to update the schedule for the first three months of the project and produce a SOV report that verifies the pay request amounts based on “costs this period” as well as “costs to date.”

For scheduling-related reports, the student shall include only the following: 1.) a Classic Schedule Report and a Detailed SOV Report for the initial, as-planned schedule, 2.) an updated Detailed SOV Report for each of the three updates.

Schedule Activity Worksheets should be sorted by activity and include totals for each activity as well as an overall total. A list of items not assigned to activities and included in the markup must be included as part of the schedule activity worksheets. The individual and total $ value of these items must be shown on the list.

**PROJECT MANAGEMENT**

Use the forms (Proposal, Bond, Contract, Pay Request, etc.) furnished with your specifications. If none are provided, use the latest version of AIA forms.

It is required to complete the pay request documents for the first three months of the project. Show stored materials on each request. It is not realistic for a job not to have stored materials in the early months.

The "Schedule of Values" for the pay request is a breakdown of the work for the owner to approve payments. The breakdown should identify the major subcontractors and/or work areas. SOVs limited to the 16 CSI Divisions are not acceptable.

Execute all documents (fill in all blank spaces including correct signature, stamps and seals). Clearly identify the drawings and specifications in the contract agreement. Do not include any documents that are not required by your project. Use the AGC subcontract agreement form rather than the AIA document for your required subcontract.

The thesis is to include a list of submittals and shop drawings for the project with identification of the vendor/party responsible for originating each and the scheduled/required delivery date for each submittal. This list is to be developed from the submittal requirements given in the project specifications. Major procurement items (+/- 10 each) should be included in the schedule.
The student is required to execute a change order during the first three months of the project. This change order will be reflected in the pay request(s) as is appropriate. The change order amount and scope of work will be at the student’s discretion. The actual work required in the change order does not have to be accomplished during the first three months. The scope of the change order must be such that the contract duration and/or the contract sum is/are changed. The complete process of prompting/correspondence with the Architect on aforementioned scope change is required. Worksheets and Summary Sheets showing the changes are required.

SITE SPECIFIC SAFETY PLAN

Company Safety Policy (10%):
Briefly state the importance of the health and safety of your employees to your company?
What is your company’s Experience Modification Rate (EMR)? A new EMR is issued to companies each year by the National Council on Compensation Insurance (NCCI) based on the number and value of claims over the last three years. How does your present EMR effect your company? (Insurance premiums, OSHA fines, lost time, morale, litigation, job opportunities, etc.)

Safety Manager (10%):
How do you plan to access the hazards and regulate the safety program for this project?
Who is your safety manager?
Who does he report to?
How is safety information from this project communicated to upper management?
What is the role of each level of management in safety for this project?
What are the rules for non-compliance for the workers? Supervisors?

Planning (40%):

Initial Review - Job Hazard Analysis (JHA)
Perform an initial review of the project and select at least one hazard that is inherent with the project based on its location, topography, weather conditions, active campus, etc. Describe and give visual illustrations for the hazard and your method(s) of hazard mitigation. Include a risk assessment of the hazard.

<table>
<thead>
<tr>
<th>Hazard</th>
<th>A condition, set of circumstances, or inherent property that can cause injury, illness or death</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk</td>
<td>An estimate of the combination of the likelihood of an occurrence of a hazardous event or exposure, and the severity of injury or illness that may be caused by the event or exposure</td>
</tr>
</tbody>
</table>

Ongoing Review – Job Safety Analysis (JSA)
Perform a review of at least two hazards that will be encountered during the construction phase of the project due to nature of the work, construction procedures, hazards inherent with this type of construction, etc. Perform a Job Safety Analysis providing a step by step process of the work activity with hazards encountered at each step and mitigation measures to be enacted. Describe the OSHA standards that apply. Include visual illustrations. Explain why these two hazards are considered high risk on this project. Describe the specific training procedures required for your
employees prior to engaging in these specific work processes and/or prior to their exposure to these specific hazards.

Hazardous Communication Program (20%):  
How are you going to communicate information concerning the hazardous materials that will be encountered by your employees during the course of this project?  
What is your plan for providing, maintaining, and updating the MSDS sheets as materials are brought onsite? **DO NOT include printed MSDS sheets in the finalized thesis.**  
What is your policy on container labeling of materials?  
What provisions have you made for the storage of hazardous materials during the construction phase?  
Provide at least one example of how your hazardous communication process will work to inform and protect your employees from a specific hazardous material that will be used on your project during the course of construction. (Lead, silica, acetylene, gasoline, etc.)  
Develop a Safety Data Sheet for the above substance and two additional hazardous materials on the project in accordance with the specified 16-section format that went into effect in June 2015 and with the Globally Harmonized System (GHS) pictograms.

Injury/Accident Plan (20%):  
What is your plan to provide care for your employees if they are injured while working on this project?  
Who are you going to contact when an accident occurs?  
Where is the nearest hospital or source for emergency responders? Provide a map showing route and the distance/time to the facility.  
What are you provisions for first aid? (First Aid Kits, Eyewash stations, trained personnel) Does the proximity of your jobsite require that a person trained in first aid be present to meet the OSHA requirements?  
What are your procedures for accident investigation and reporting? (OSHA 301 form, accident recreation, interviews with witnesses, determination and elimination of the root causes of the accident)  
Describe your accident prevention/rescue plan for one activity/hazard that will be encountered on this project (suspension trauma during steel/precast erection, confined space rescue plan, excavation cave-in, etc.) Tell how you have made preparations in advance so that you will be ready if an accident occurs.

**STRUCTURAL ASSESSMENT**

**Structural System:**

Include a conceptual assessment of the structural systems of the building. The assessment must provide a detailed explanation and identify the following:

a. The basic structural system for carrying vertical loads. Include diagrams that trace the path of vertical loads in the structure from roof to ground. A section view through a major axis of your building would be used for this. Make use of gravity force vectors of
differing weights to indicate accumulation of load from roof to ground. A detailed verbal
description must accompany the graphic one.

b. The basic structural system for carrying lateral loads (wind). Include diagrams that trace
the path of lateral loads applied to the structure. A plan view of your building indicating
the reacting structural elements for wind load striking each of the major building axes
is required. You should use different colors or separate diagrams for each wind direction.
Show section views with wind load vectors for clear demonstration of how wind loads
travel to the ground. A detailed verbal description must accompany the graphic one.

Special Structures (for students with wood/metal pre-fab trusses or pre-engineered metal
buildings)

a. For students with pre-engineered metal buildings, substitute traditional steel members for
prefabricated members and complete the following:
   a. Develop a paragraph indicating the substitutions you plan to make (bar joists for
typical purlins, wide flange members for girders, etc.)
   b. Determine the required size of members noted in a.
   c. Develop a price for the structure sized in (b).
   d. Develop a paragraph indicating the difference in the cost of the structure between
your approach in the estimate and your answer in (c). Reflect on the differences.

b. For students with wood/metal pre-fab trusses, complete the following:
   a. Select a typical truss and sketch an elevation of that truss. Select a possible layout
of web members. Show all dead and live loads applied to the truss on a plf basis
along the top and bottom chord or as a point load at truss joints. Essentially,
indicate the vertical load on a horizontal projection of the truss.
   b. Produce a plan(s) of trusses showing all required temporary bracing. You may use
any accepted national standard for bracing such as Alpine’s “Builders Guide for
Trusses”.
   c. Design and provide a sketch for the diagonal brace at the end of the truss that takes
the force to the ground. (This item may also be used for the temporary bracing
design requirement of the thesis.)

Temporary Structure:

Students must provide one detailed structural analysis of a temporary structure such as that
identified below, such as the concrete formwork for one of the major building components,
elevated slab, wall, beam or slab. The analysis must include detailed load determination, selection
of appropriate materials, and structural analysis, including strength, stiffness and stability
considerations. A virtual model of the temporary structure should be provided. The work should
also include a temporary compression ground brace for wall or truss system: size and spacing of
braces must be determined considering lateral (wind) loads, slenderness ratio, strength analysis,
connectors and anchorages, etc.

- Example 1: Trench shoring: determine soil lateral loads, design sheeting, wales and shores
considering slenderness, strength, and deformations.
• Example 2: Elevated slab formwork design: determine all sources of gravity loads to design sheathing, joists, stringers, and shores, considering strength and stiffness. Stability must be considered in slenderness of shores and system stability in lateral bracing of overall shoring system.

• Example 3: Wall or column form: determine all loads to calculate lateral form pressures, and design sheathing, studs, wales and ties considering strength and stiffness. Determine lateral stability.

MECHANICAL, ELECTRICAL AND PLUMBING

Provide a complete scope of work for HVAC, Plumbing, and Electrical contracts. The intended audience for each scope of work is the applicable specialty contractor.

Provide descriptions of the HVAC, Plumbing, and Electrical systems shown in your project. Include the following as a minimum:

HVAC System:
(1) Describe the components of the system or systems (AH, VAV, RTU, Chiller, cooling tower, piping, pumps, type of duct, etc.).
   A. The purpose of each component.
   B. How the component works.
   C. How the components work together.
(2) Discuss the controls of the system and who installs the controls.
(3) Discuss the process of the cooling cycle through the system.
(4) Discuss the process of the heating cycle through the system.
(5) Discuss the energy conservation measures, if any, for the building.
(6) Why was this system used as compared to another?
(7) Discuss the impact of the HVAC system on the schedule.

PLUMBING System:
(1) Potable water supply source, waste discharge point for sanitary and storm.
(2) Type and location of water pipes.
(3) Type and location of sanitary sewer pipes.
(4) Discuss the pumps in the systems.
(5) Discuss any controls in the system.
(6) Discuss the hot water source and distribution (re-circulation or non-re-circulation)
(7) Discuss the impact of the plumbing system on the schedule.

ELECTRICAL System:
(1) List service amperages and voltage to the MDP.
(2) List operating voltage(s).
(3) Describe the control systems.
(4) Describe the electrical from the entrance, meter, and/or MDP through the sub-panels.
(5) Describe the building equipment needs other than lights and receptacles (pumps, AH, Chiller, RTU, elevators, etc.).
(6) Describe the types and locations of conduit.
(7) Describe the emergency power system.
(8) Discuss the impact of the electrical system on the schedule.

The estimate for the MEP portion of the project may be completed with a cost per square foot price (from Means) for the MEP subcontracts.

**SUSTAINABLE CONSTRUCTION ASSESSMENT**

You are to conduct an assessment of your project building to demonstrate that you understand how the design and construction of your building reflects the basic principles of sustainable construction. Set out below are specific tasks to complete that relate to principles of sustainable construction. You are to answer these as they relate specifically to your building.

1. The USGBC through its LEED certification program has different certification programs for different construction projects.
   a. Select the current certification program that would be applicable to your construction project and locate and reference at least two resources or tools from the USGBC website that set out the requirements of the specific certification program.

2. During construction a contractor should consider the environmental impacts of construction activities on the site and its surroundings. A LEED Pre-requisite on any LEED certified project is to reduce pollution from construction activities by controlling soil erosion, waterway sedimentation, and airborne dust.
   a. Review your project documents to identify any national, state or local requirements that control site erosion and sedimentation.
   b. Identify 6 specific measures incorporated into your project that reduce pollution from construction activities. Describe how each measure helps to reduce pollution using illustrations obtained from project documentation or other sources.

3. Sustainable construction projects seek to minimize non-renewable energy consumption, protect water resources and conserve water consumption. This is accomplished through good design and operating the building using sound environmental practices. A LEED Pre-requisite on any LEED certified project is to provide fundamental commissioning and verification to support the design, construction, and eventual operation of a project that meets the owner’s project requirements for energy, water, indoor environmental quality, and durability.
   a. Review your project documents to identify and summarize any specific requirements related to commissioning and verification.
   b. Review the document *New Construction Building Commissioning Best Practice* by the [Building Commissioning Association](https://www.bca.net). Identify and describe the contractor’s commissioning responsibilities during the construction phase for a project such as yours.
c. Identify 6 pieces of commissioned equipment from your project that might be included in the construction checklist and describe the specific commissioning process for at least one piece of equipment.

4. Sustainable construction projects seek to use environmentally preferable products in the construction process. The LEED certification process seeks to minimize the embodied energy and other impacts associated with the extraction, processing, transport, maintenance, and disposal of building materials and gives credit for using construction products that provide building product disclosure and optimization.
   a. Choose 3 construction products used in your project that you believe are environmentally preferable.
   b. Locate the product manufacturers website and use the information available to explain how these products seek to minimize the embodied energy and other impacts associated with the extraction, processing, transport, maintenance, and disposal of building materials

5. Another sustainable construction principle is to reduce construction and demolition waste disposed of in landfills and incineration facilities by recovering, reusing, and recycling materials.
   a. Identify 3 material streams used in your project where waste materials could be diverted from landfill or incineration.
   b. Describe with specific reference to your project how the 3 waste materials streams will be collected during the construction phase and processed locally after they leave the site. Your description should include a site utilization plan highlighting key features specific to waste management (i.e. dumpsters, salvage material lay down)

6. The quality of the indoor environmental is essential in sustainable construction projects. LEED certification seeks to promote the well-being of construction workers and building occupants by minimizing indoor air quality problems associated with construction and renovation. This is achieved by developing and implementing an indoor air quality (IAQ) management plan for the construction and preoccupancy phases of the building.
   a. Identify the requirements and procedures and describe how you would protect the air distribution system (for example ductwork) during construction.
   b. Give an example specific to your project and describe how you would protect absorptive materials stored on-site and from moisture damage.

Related References:


**STUDENT SELECTED WORK**
Students are required to add relevant information into their thesis document. The information should be insightful and provide the faculty with additional understanding concerning the project or the construction process as seen by the student. All student selected work must be pre-approved at the time the Project Brief is turned in (refer to the section for Project Brief deliverables). The Student Selected Work submitted should involve **approximately 40 hours of work** completed by the student. Time spent working and assisting other students will NOT be considered valid student selected work. Examples of “Student Selected Work” are listed below:

**E-Portfolio:**

Students are strongly encouraged to engage the use of the e-Portfolio as a “reflection” exercise of the work they are completing within the Building Science thesis. More about the ePortfolio project can be obtained at the Office of University Writing.

**Cost Analysis:**

The student can identify a component of the building and do a value analysis to determine which system may be better to use. The analysis needs to address the cost of the item, its effect on the schedule and the life cycle cost. The important thing to remember is to identify and analyze various systems. The project can remain the same.

**Temporary Structures:**

In addition to the information required in the Structural Assessment section, the student could do in-depth investigations of several areas. Trenching, bracing wood trusses, bracing masonry walls, structural steel bracing and shoring could all be studied as they relate to your specific project. The complete design could include sketches, citations from applicable codes or OSHA sections, connection details, construction sequencing and other relevant information.

**Scheduling:**

Project planning is an area that the student could explore. Creating a detailed Work Breakdown Structure which represents the organization of the project is acceptable. This plan should be reflected in the actual schedule that is required.

Creating a detailed Two-week Schedule that deals with a specific operation or area of the project could also enhance the thesis. This schedule could be used by the superintendent to direct field personnel or coordinate subcontractors. This could also represent a project meeting schedule where the actions of the last week and the next two weeks would be discussed. This schedule would be more detailed that the overall project schedule, but represent the activities that need to be completed during the time period.
APPENDIX A: BSCI 4990 – THESIS PROPOSAL APPROVAL FORM (version 1-7-13)

This form is to be submitted directly to the BSCI Office, along with drawings and separately bound specifications. The student is encouraged to submit the drawings and specs. on a USB drive in PDF format. The Thesis Instructor will make notations on this sheet as to their approval and any special requirements. After the project has been approved, the BSCI Office will return a copy of this form and the plans/specs/cd to you and retain a copy of this form for filing. If disapproved, the plans/specs/cd and form will be returned to you. The Building Science Office phone number is (334) 844-4518.

Today’s Date: ____________ Semester & Year you will take Thesis: _______________

Full Name of Student (as in AU Banner): ______________________________ AU e-mail: _______________________

Exact Title of Project on Plans/Specs: __________________________________________________________________

Name of Architect: __________________________________________________________ Date of Plans: ___________

Architect’s Project #: ___________ Location of Building, City: ______________________________ State: _________

Cost of Project: _________________________________ (Should be between $1,000,000 and $3,000,000)
Use actual bid figures or A/E’s or G.C.’s estimate/budget.

Building Floor Area (should be approximately 9,000 - 12,000* s.f.) ________________ No less that 7,000 s.f. of the area must have finished floors, partitions, walls and ceilings. * BIM Thesis is a minimum of 15,000 s.f.

Types of buildings that do not lend themselves to be good Thesis projects and will not be approved:

- Pre-engineered roof trusses and wall systems
- Pre-engineered metal buildings or pre-cast walls
- Branch banks
- Wal-Mart or supermarket type buildings
- Drug Store projects (CVS, Walgreens, etc.)
- Houses or Apartments

Select Yes or No to the following questions.

Required Items for Thesis Proposal Approval:

Do you have a complete set of bound Specifications, Division 0 thru Mechanical/Electrical/Plumbing? ___ Yes ___ No
Do you have the following forms in the General Conditions: Bid Proposal, Agreement? ___ Yes ___ No
Do you have complete Civil drawings (u.g. utilities, grading, parking, elevations, erosion control, etc.)? ___ Yes ___ No
Do you have complete Architectural drawings (doors & windows, interiors, ceiling, elevations, etc.)? ___ Yes ___ No
Do you have complete Structural drawings (foundations, floor & roof framing, wall sections, etc.)? ___ Yes ___ No
Do you have complete Mechanical drawings (HVAC, ductwork, equipment schedules, piping, etc.)? ___ Yes ___ No
Do you have complete Electrical drawings (lighting fixture schedule, power, panel board schedule, etc.)? ___ Yes ___ No
Do you have complete Plumbing drawings (non-pressure & pressure piping, fire protection, etc.)? ___ Yes ___ No

Required Items for Thesis Class (strongly recommend inclusion in Thesis Proposal):

Do you have a Geotechnical Report? ___ Yes ___ No
Do you have any Formwork required such as retaining wall, elevated slab, columns, etc.? ___ Yes ___ No
Do you have a Finish Hardware schedule in the specifications or listed on the drawings? ___ Yes ___ No
Do you have any Alternates in the Bid Proposal and/or specifications? ___ Yes ___ No
For BIM Thesis only: Do you have CAD drawings and digital specifications? ___ Yes ___ No

Student Comments Regarding Proposal: ______________________________________________________________
______________________________________________________________________________________________

BSCI Office Approval: __________________________________ Date: ____________

BIM Thesis Faculty Approval: __________________________________ Date: ____________

Thesis Instructor Approval: __________________________________ Date: ____________

Thesis Instructor Comments & Special Requirements for approval: __________________________________________
______________________________________________________________________________________________

______________________________________________________________________________________________
<table>
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<tr>
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<th>LEED Assessment</th>
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<tbody>
<tr>
<td>5%</td>
<td>LEED Certification Selection and completion.</td>
</tr>
<tr>
<td></td>
<td>Environmental impacts of construction activities on the site.</td>
</tr>
<tr>
<td></td>
<td>Commissioning.</td>
</tr>
<tr>
<td></td>
<td>Environmental, community, and thermal performance.</td>
</tr>
<tr>
<td></td>
<td>Construction waste management.</td>
</tr>
<tr>
<td></td>
<td>Indoor environmental quality.</td>
</tr>
</tbody>
</table>

### General Overview

- Understanding the Plans
- Understanding the Specifications
- Understanding Materials
- Understanding Methods
- Organization of the Book
- Appearance of the Book
- Misc. Factors

### Project Brief

- Refer to Page 7 in the Rules & Regulations document for content required.
- Refer to Rubric 6 for written criteria.

### Thesis & Company Items

- Title Page Subcontract Scope Statement for MEP systems
- Table of Contents with page numbers
- Thesis Proposal Approval Form
- Assumptions
- Spec. Telope - Division 1 & Plan Notes Issues
- Detailed Project Timeline
- List of Student Selected Work with page numbers
- Company History, Philosophy, and Goals
- Organizational Chart
- Duties of Key Personnel
- Contractor’s Licenses (State and Local)
- Reference all sources used in Thesis
- Project Brief

### Financial

- Contractor’s Qualification Statement
- Income Statement - current and proposed
- Financial Narrative including business position and strategies consistent with financial statements.

### Project Schedule

- CPM Activity Worksheets (activities derived from cost estimates, cost loading the schedule, SOV #s, etc.)
- Full Project Schedule (critical path, procurement activities, etc.)

### Project Documents

- Master Surety Agreement
- Bid Bond
- Power of Attorney for Bond Agent
- Certificate of Insurance
- Building Permit (not the application)
- Subcontract Agreement Short Form (AGC) w/ detailed scope of Work and listing of project documents or attachments.
- Substantial Completion Documentation
- Certification of Occupancy
- Certificate of Confidentiality
- Certificate of Acceptance
- Certificate of Safety to Final Payment
- Consent of Surety to Release of Retainage (when appropriate)

### Project Estimate

- Document earthwork quantities using ‘Earthworks’ or other suitable program. Include printout of software including graphic image of earth.
- Calculate Building Quantities
- Choose appropriate Technology for Creating Estimate
- BIM Model
- Create an Estimate
- Identify the structural components of a building
- Create an estimate using BIM
- Classify loads on buildings
- Calculate internal member forces in structural elements of buildings
- Determine internal stresses on structural bending elements
- Structural Steel Design with an emphasis on long-term design.
- Classify loads on buildings
- Identify common methods of stabilizing structural frames
- Design and Construct strong, stiff, and stable temporary structures and forms.
- Classify Loads on Buildings
- Calculate internal member forces in structural elements of buildings
- Determine internal stresses on structural bending elements
- Requires 40 hours of work for full credit.
- Design and Construct strong, stiff, and stable temporary structures and forms.
- Classify Loads on Buildings
- Calculate internal member forces in structural elements of buildings
- Determine internal stresses on structural bending elements
- Requires 40 hours of work for full credit.

### Student Selected Work

- Regulations
- Create a Safety Plan
- Create a Plan for Compliance

### Total Points =

### Grade =
# Appendix B, Rubric 1: Estimate

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Key Metric</th>
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<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>Student Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classify Materials and Methods by Trades</td>
<td>Recapped and organized estimate according to appropriate trades</td>
<td>All items organized well and assigned to appropriate trade</td>
<td>Minor errors in organization and classification only</td>
<td>One key item with significant organization or classification issues</td>
<td>2-3 key items with significant organization or classification issues</td>
<td>More than 3 key items that were organized or classified poorly</td>
<td></td>
</tr>
<tr>
<td>Calculate Building Quantities</td>
<td>Is it complete?</td>
<td>All items were addressed correctly</td>
<td>All items addressed, but some minor errors were made in the QTO</td>
<td>One major omission or error in the QTO (may also include minor errors)</td>
<td>2-3 key omissions or errors in the QTO (may also include minor errors)</td>
<td>More than 3 key omissions or errors in the QTO (may also include minor errors)</td>
<td></td>
</tr>
<tr>
<td>Choose Appropriate Technology for Creating Estimate</td>
<td>There is a consistent level of detail through the estimate, and the audit trail is obvious</td>
<td>Solid choices were made for creating the estimate. A consistent level of detail and audit trail are clear and well developed.</td>
<td>Generally good choices were made to create the estimate. Some minor errors in level of detail or audit trail may be present.</td>
<td>One major issue associated with choice of technology for the estimate. Inconsistencies in level of detail or the audit trail occur.</td>
<td>2-3 inconsistencies in level of detail or the audit trail.</td>
<td>Significant issues with level of detail or audit trail throughout the estimate.</td>
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<tr>
<td>BIM Model</td>
<td>Are required items included in the model, the quantities obtained appropriately validated, and integration of quantities into the estimate documented?</td>
<td>Model is complete. Quantity validation for one major component complete. Integration of all quantities extracted is clearly documented with an audit trail.</td>
<td>Model is generally complete. Quantity validation for one major component is missing. Integration of most quantities extracted is clearly documented with an audit trail.</td>
<td>Model lacks 2-3 key items. Quantity validation for one major component is missing. Integration of quantities extracted contains one major error with regards to documentation and audit trail.</td>
<td>Model lacks 2-3 key items. Quantity validation for one major component is missing. Integration of quantities extracted contains 2-3 major errors with regards to documentation and audit trail.</td>
<td>Model lacks a significant number of key items. Quantity validation for one major component is missing. Integration of quantities extracted contains more than 3 major errors with regards to documentation and audit trail.</td>
<td></td>
</tr>
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<td>Create an Estimate</td>
<td>QTO, Pricing, Recap, Alternates, Bid Proposals, Documents</td>
<td>All required items are included, and no errors or omissions are evident</td>
<td>Only minor errors or omissions noted</td>
<td>One key item with significant errors or omissions</td>
<td>2-3 key items with significant errors or omissions</td>
<td>More than 3 key items that were omitted or entered with errors</td>
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</table>

<table>
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<tr>
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<th>Key Metric</th>
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<th>Student Score</th>
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<td>Total Score</td>
<td>(Sum of all points above)</td>
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<td></td>
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<td>This score to overall rubric</td>
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<tr>
<td>% of total Points</td>
<td>(Total Score/25)</td>
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## Appendix B. Rubric 2: Sustainability

<table>
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<th>Criteria</th>
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<th>Grading Scale</th>
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<td>LEED Certification Program Selection</td>
<td>Correct Program Selected</td>
<td>5</td>
<td>Some generic non project specific reqs identified</td>
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<td>Environmental impacts of construction activities on the site (5 Points)</td>
<td>Identify requirements that control site erosion and sedimentation.</td>
<td>5</td>
<td>All project specific reqs identified and fully described and illustrated</td>
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<td>All project specific measures identified and fully described and illustrated</td>
<td>4</td>
<td>Less than 6 project specific measures identified and/or descriptions lacking detail</td>
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<td></td>
<td>Fundamental commissioning and verification (5 Points)</td>
<td>3</td>
<td>All responsibilities identified and some description</td>
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<td>Environmental impacts of construction activities on the site (5 Points)</td>
<td>2</td>
<td>All responsibilities identified but little description</td>
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<td></td>
<td>Identify and describe 6 specific measures</td>
<td>1</td>
<td>Some responsibilities identified but little description</td>
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<td>Identify and describe 6 specific measures</td>
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<td>No evidence of project docs review</td>
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<td>Identify and summarize project commissioning &amp; Verification requirements</td>
<td>5</td>
<td>Documents reviewed and all reqs identified</td>
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<td></td>
<td>Identify and describe contractor responsibilities</td>
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<td>All responsibilities identified and some description</td>
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<td></td>
<td>Identify and describe contractor responsibilities</td>
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<td>All responsibilities identified and some description</td>
</tr>
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<td>Identify 6 pieces of equipment and describe one process in detail</td>
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<td>No evidence of project docs review</td>
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<td>Environmentally preferable products (5 Points)</td>
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<td>Website information used to explain all ways the 3 products reduce environmental impact</td>
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<td>Website information used to explain some of the ways the 3 products reduce environmental impact</td>
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<td>Explain how products are environmentally preferable</td>
<td>2</td>
<td>Website information used to explain some of the ways 2 products reduce environmental impact</td>
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<td>Explain how products are environmentally preferable</td>
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<td>Non-product information used to explain some of the ways 2 products reduce environmental impact</td>
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<td>Explain how products are environmentally preferable</td>
<td>0</td>
<td>Non-product information used to explain some of the ways 3 products reduce environmental impact</td>
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<td>Reduce construction waste (5 Points)</td>
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<td>3 material streams identified</td>
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<td>Describe how materials collected and processed</td>
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<td>Collection &amp; processing of material streams for all 3 are described &amp; are project specific</td>
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<td></td>
<td>Describe how materials collected and processed</td>
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<td>Collection &amp; processing of material streams for all 3 are described but are not project specific</td>
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<tr>
<td></td>
<td>Describe how materials collected and processed</td>
<td>2</td>
<td>Collection &amp; processing of material streams for 2 are described &amp; are project specific</td>
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<td>Describe how materials collected and processed</td>
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<td>Collection &amp; processing of material streams for 2 are described but are not project specific</td>
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<td>Describe how materials collected and processed</td>
<td>0</td>
<td>Only 1 Collection &amp; processing of material stream described</td>
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<td>Indoor air quality (IAQ) management plan (5 Points)</td>
<td>5</td>
<td>Requirements, and procedures are project specific and description is consistent with industry best practice</td>
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<tr>
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<td>Indoor air quality (IAQ) management plan (5 Points)</td>
<td>4</td>
<td>Requirements, and procedures are not project specific and description is not consistent with industry best practice</td>
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<tr>
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<td>Indoor air quality (IAQ) management plan (5 Points)</td>
<td>3</td>
<td>Requirements, and procedures are not project specific and description is not consistent with industry best practice</td>
</tr>
<tr>
<td></td>
<td>Indoor air quality (IAQ) management plan (5 Points)</td>
<td>2</td>
<td>No Requirements, and procedures identified</td>
</tr>
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<td>Indoor air quality (IAQ) management plan (5 Points)</td>
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<td>No Requirements, and procedures identified</td>
</tr>
<tr>
<td></td>
<td>Indoor air quality (IAQ) management plan (5 Points)</td>
<td>0</td>
<td>No Requirements, and procedures identified</td>
</tr>
<tr>
<td></td>
<td>Example of protective absorptive material</td>
<td>5</td>
<td>Example is project specific and description is consistent with industry best practice</td>
</tr>
<tr>
<td></td>
<td>Example of protective absorptive material</td>
<td>4</td>
<td>Example is not project specific and/or description is not consistent with industry best practice</td>
</tr>
<tr>
<td></td>
<td>Example of protective absorptive material</td>
<td>3</td>
<td>Example is not project specific and/or description is not consistent with industry best practice</td>
</tr>
<tr>
<td></td>
<td>Example of protective absorptive material</td>
<td>2</td>
<td>Example is not project specific and/or description is not consistent with industry best practice</td>
</tr>
<tr>
<td></td>
<td>Example of protective absorptive material</td>
<td>1</td>
<td>No example given</td>
</tr>
<tr>
<td></td>
<td>Example of protective absorptive material</td>
<td>0</td>
<td>No example given</td>
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**Total Score** (Sum of all points above) | This score to overall rubric | | | |
| **% of total Points** (Total Score/25) | | | | |
### Appendix B, Rubric 3: Structure

<table>
<thead>
<tr>
<th>Name:</th>
<th>Key Metric</th>
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<th>3</th>
<th>2</th>
<th>1</th>
<th>Student Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Identify the structural components of a building</strong></td>
<td>Verbal description of structural system that includes graphic depiction in either 2D or 3D</td>
<td>All key structural elements are identified along with their function. A clear understanding of structure is presented.</td>
<td>Description covers almost all structural components of the structure with most member functions addressed. The student has an understanding of items presented.</td>
<td>Approximately half of the members are identified with function shown. The student lacks some understanding of the structure.</td>
<td>Key elements of the structure are not included in the description and a lack of understanding of components is evident.</td>
<td>Key structural elements are not identified. Student lacks an understanding of components of the building.</td>
<td></td>
</tr>
<tr>
<td><strong>Identify common methods of stabilizing structural frames</strong></td>
<td>Verbal description of lateral system that includes graphic depiction in either 2D or 3D</td>
<td>Lateral load resisting system is clearly identified. Student illustrates how load is transmitted to lateral system.</td>
<td>Lateral load resisting system is clearly identified. A lack of clarity is present in how the load is transmitted to the system.</td>
<td>Lateral system is address but is not complete. Student does not have clear connection with how lateral load is transmitted to the foundation.</td>
<td>Lacks sufficient detail in the lateral load system of the building. A lack of understanding is present.</td>
<td>Fails to identify correct lateral system and does not attempt to identify lateral load flow.</td>
<td></td>
</tr>
<tr>
<td><strong>Classify Loads on Buildings</strong></td>
<td>Verbal and graphical depiction of building loads</td>
<td>All dead loads, live loads, and wind loads are correctly shown on the building.</td>
<td>Loads shown on building are generally correct but lack sufficient detail for full credit.</td>
<td>Either dead loads, live loads, or wind loads are incorrect.</td>
<td>Two of three key loads are incorrect or not sufficiently addressed.</td>
<td>Loads on the building are not clear or are not addressed.</td>
<td></td>
</tr>
<tr>
<td><strong>Trace the path of vertical and lateral loads through structural components of a post and beam building</strong></td>
<td>Verbal and graphical depiction of building loads</td>
<td>All loads are shown clearly transmitting to the ground.</td>
<td>Load paths shown are generally correct but lack sufficient detail to confirm all are resolved to the ground.</td>
<td>Load paths shown have minor errors or lack clarity.</td>
<td>One load case is not resolved to the ground. Others are generally correct.</td>
<td>Neither gravity or wind loads are resolved to the foundation.</td>
<td></td>
</tr>
<tr>
<td><strong>Design and Construct strong, stiff, &amp; stable temporary structures and formwork</strong></td>
<td>Temporary structure analysis</td>
<td>Temporary structure design is complete and accurate</td>
<td>Temporary structure design lacks minor details or has minor errors</td>
<td>Temporary structure design lacks at least one major component or has one major flaw</td>
<td>Temporary structural design is not complete or multiple errors are present</td>
<td>Lack of understanding of temporary structure design and construction</td>
<td></td>
</tr>
<tr>
<td><strong>Calculate internal member forces in structural elements of buildings</strong></td>
<td>Temporary structure analysis</td>
<td>Forces for all elements were determined and sufficiently resolved.</td>
<td>Forces for all elements were determined, but some were not resolved.</td>
<td>Most member forces were determined and resolved.</td>
<td>Major errors are present in the structure analysis of forces in temporary members.</td>
<td>Little or no effort was made to determine internal member forces within temporary structural members.</td>
<td></td>
</tr>
<tr>
<td><strong>Determine internal stresses on structural bending elements</strong></td>
<td>Temporary structure analysis</td>
<td>All members for temporary structure have internal stresses identified and sufficiently resolved.</td>
<td>All members for temporary structure have internal stresses identified but may not be sufficiently resolved.</td>
<td>Most members in the temporary structure have internal stresses identified and resolved.</td>
<td>Major errors are present in the structure analysis of stresses in temporary members.</td>
<td>Little or no effort was made to determine internal member stresses within temporary structural members.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grading Scale</th>
<th>5</th>
<th>4</th>
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<th>2</th>
<th>1</th>
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<tbody>
<tr>
<td><strong>Total Score</strong></td>
<td>(Sum of all points above)</td>
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<tr>
<td><strong>% of total Points</strong></td>
<td>(Total Score/35)</td>
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### Appendix B, Rubric 4: Safety

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<tr>
<th>Criteria</th>
<th>Key Metric</th>
<th>Grading Scale</th>
<th>Student Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create Company Safety Policy (maximum of 0.5 points)</td>
<td>Policy statement of safety in company culture, Company EMR and its importance</td>
<td>Clear, concise, well organized safety policy statement with discussion of EMR</td>
<td>All required information addressed with minor errors or omissions</td>
</tr>
<tr>
<td>Compose Site Specific Safety Plan (maximum of 0.5 points)</td>
<td>Identify safety manager, safety management reporting chain, roles and responsibilities of company management and supervision, actions to be in response to safety violations</td>
<td>Clear, concise, well organized safety management process with all required information included and well organized</td>
<td>All required information addressed with minor errors or omissions</td>
</tr>
<tr>
<td>Create Job Hazard Analysis (JHA) (maximum of 2 points)</td>
<td>Identify hazardous activities specific to the project and formulate ways to eliminate/mitigate hazards</td>
<td>Two job specific hazards are identified. Hazards are clearly defined using construction documents and OSHA standards. JHA correctly addresses actions to eliminate or mitigate identified hazards</td>
<td>Two job specific hazards are identified. Hazards are somewhat defined using construction documents and OSHA standards. JHA addresses actions to eliminate or mitigate hazards with major errors</td>
</tr>
<tr>
<td>Develop Hazardous Communication Program (maximum of 1.0 point)</td>
<td>Communicate information on hazardous materials to workers, location and access to MSDS sheets, labeling and storage of hazardous materials</td>
<td>Clear, concise, well organized hazard communication program that includes all required information</td>
<td>All required information addressed with minor errors or omissions</td>
</tr>
<tr>
<td>Create Site Specific Injury/Accident Plan (maximum of 1.0 point)</td>
<td>Provisions for first aid, evacuation plan for severely injured workers, accident investigation and reporting, location and contact information of nearest hospital and emergency responders</td>
<td>Clear, concise, well organized site specific injury/accident plan that includes all required information</td>
<td>All required information addressed with minor errors or omissions</td>
</tr>
</tbody>
</table>

**This score to overall rubric**

(max 5 points)
### Appendix B, Rubric 5: Schedule

<table>
<thead>
<tr>
<th>Name:</th>
<th>Criteria</th>
<th>Key Metric</th>
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<th>3</th>
<th>2</th>
<th>1</th>
<th>Student Score</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Develop Work Breakdown Structure at Consistent and Appropriate Level of Detail</td>
<td>Thoughtful and Consistent Listing of Activities, Grouped Appropriately</td>
<td>All Project Components (including Procurement) Broken Down at Sufficient Detail by which to Direct the Trades, and at a Consistent level of Detail</td>
<td>Minor errors or omissions in breaking down components into activities</td>
<td>1 to 2 key omissions or errors in breaking down or organizing the project components</td>
<td>3 - 5 omissions or inconsistencies in key components into activities</td>
<td>More than 3 key components that were broken down poorly or at an inconsistent level of detail</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Calculate and Apply Reasonable and Appropriate Durations</td>
<td>Are Durations Reasonable Relevant to Crew Sizes, and to the Overall Project Duration?</td>
<td>All activities assigned a reasonable duration based on logical crew sizes and overall project duration</td>
<td>1 - 2 minor errors in the assignment of reasonable duration, causing minor problems with sequence and/or the critical path</td>
<td>1 or 2 problematic errors with key activity durations, causing issues with overall sequence and the critical path</td>
<td>3 - 5 problematic errors with key activity durations, causing issues with overall sequence and the critical path</td>
<td>More than 5 significant errors in assignment of durations, causing significant problems with overall sequence and the critical path</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Assign Relationships and Constraints Demonstrating Understanding of the Building and Site's Sequence</td>
<td>Major Phases of the Project (Site, Structure, Skin, Rough-In, and Finishes) have Relativity in Sequence</td>
<td>Overall, and at a detailed level, sequencing of all activities is logical and efficient</td>
<td>Reasonably well sequenced, with only 1 or 2 minor relationships or constraints causing issues that could be improved</td>
<td>1 or 2 major sequencing issues that are causing notable problems with overall project sequence</td>
<td>3 - 5 major sequencing issues caused by questionable or improper relationships or constraints</td>
<td>Significant issues with relationships and sequencing in general, resulting in a project schedule that is improbable or seriously questionable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Leverage the Software Platform to Appropriately Reflect the Information, Sequence, Critical Path</td>
<td>Critical Path Illuminated, Relationships Shown, Numerical Data Shown (duration, Start Date, Float), and Sequence Understood Easily</td>
<td>CPM Software Platform Output demonstrates a mastery of its use</td>
<td>Output is reasonably successful, with only one or two minor issues with the software use reflected</td>
<td>1 or 2 significant issues with the student's facility in the software reflected</td>
<td>3 - 5 significant issues with the use of the software reflected</td>
<td>Submission shows serious lack of understanding or facility with the use of the platform in articulating a project schedule</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Create a Comprehensive Project Schedule</td>
<td>Submission Shows a Comprehensive Understanding of the Building and Site Components, Their Sequence and Constructability, and Represented Properly in the Software Platform</td>
<td>A well organized Work Breakdown Structure (including Procurement) with reasonable durations and relationships/logic applied, all demonstrated with mastery of the software</td>
<td>Only minor errors, omissions, inconsistencies, and/or problems noted</td>
<td>Only 1 or 2 significant errors, omissions, inconsistencies, and/or problems noted</td>
<td>3 - 5 major errors, omissions, inconsistencies, and/or problems noted</td>
<td>Student does not demonstrate minimal ability to effectively create a comprehensive project schedule</td>
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<td></td>
<td>Total Score</td>
<td>(Sum of all points above)</td>
<td>This score to overall rubric</td>
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<td>3</td>
<td>2</td>
<td>1</td>
<td>Student Score</td>
<td></td>
</tr>
<tr>
<td>Context of and Purpose for Writing</td>
<td>Includes considerations of audience (owner or general construction company), purpose, and the circumstances surrounding the project brief.</td>
<td>Demonstrates a thorough understanding of context, audience, and purpose that is responsive to the assigned task(s) and focuses on all elements of the work.</td>
<td>Demonstrates good consideration of context, audience, and purpose and a clear focus on the assigned task (e.g., task aligns with audience, purpose, and context)</td>
<td>Demonstrates some awareness of context, audience, purpose, and to the assigned tasks (e.g., begins to show awareness of audience's perceptions and assumptions)</td>
<td>Demonstrates minimal attention to context, audience, purpose, and the assigned tasks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content Development</td>
<td>Relevant and compelling project specific content</td>
<td>Uses appropriate, relevant and compelling project specific content to demonstrate mastery of the subject.</td>
<td>Uses appropriate, relevant and compelling project specific content to explore ideas within the context of the writing.</td>
<td>Uses appropriate and relevant project specific content to develop and explore ideas through most of the writing.</td>
<td>Uses appropriate and relevant project specific content to develop simple ideas in some parts of the writing.</td>
<td>Content is not project specific, relevant nor appropriate in the majority of the writing.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disciplinary Conventions</td>
<td>Formal and informal rules inherent in the expectations for writing in the construction discipline</td>
<td>Demonstrates detailed attention to and successful execution of a wide range of conventions within construction management including organization, content, presentation, formatting, and stylistic choices.</td>
<td>Demonstrates consistent use of important conventions particular to construction management including organization, content, presentation, and stylistic choices</td>
<td>Follows expectations appropriate to the construction discipline for basic organization, content, and presentation.</td>
<td>Attempts to use a consistent system for basic organization and presentation.</td>
<td>Does not meet expectations appropriate to the construction discipline for basic organization, content, and presentation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sources and Evidence</td>
<td>Uses reliable sources that are project specific to develop ideas appropriate for the construction discipline</td>
<td>Demonstrates skillful use of high quality, credible and relevant project specific sources to develop ideas in the writing.</td>
<td>Demonstrates consistent use of high-quality, credible and relevant project specific sources to develop ideas in the writing.</td>
<td>Demonstrates an attempt to use of high-quality, credible and relevant project specific sources to develop ideas in the writing.</td>
<td>Demonstrates an attempt to use project specific sources to develop ideas in the writing.</td>
<td>Few or no project specific sources are used to support the ideas in the writing.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control of Syntax and Mechanics</td>
<td>Solid language that communicates meaning with clarity and fluency</td>
<td>Uses language that skillfully communicates meaning to readers with clarity and fluency, and is virtually error-free.</td>
<td>Uses straightforward language that generally conveys meaning to readers. The language in the writing has few errors.</td>
<td>Uses language that generally conveys meaning to readers with clarity, although writing may include some errors.</td>
<td>Uses language that sometimes impedes meaning because of errors in the usage.</td>
<td>Paper is difficult to read or follow due to significant errors in the usage of words and phrases in the document.</td>
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<tr>
<td></td>
<td></td>
<td>Total Score (Sum of all points above)</td>
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