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# Using the Learning Outcomes Template as an Effective Tool for Evaluation of the Undergraduate Building Construction Program

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This paper describes the use of The Learning Outcomes Template (LOT) to perform continuous self-evaluation of a construction related academic program. This discussion is provided to help construction educators achieve their vision for their individual programs. Specifically documented is how the *LOT* is used in the horizontal and vertical integration of the Virginia Tech Building Construction curriculum. Learning Outcomes Template *LOT* described in this paper: 1) Provides the platform for a rational, dynamic approach for creating an effective applied academic model, 2) Helps to evaluate the balance between the construction education concepts of practical experience-based knowledge and academic inquiry, 3) Suggests how to integrate people and communication skills with the pragmatic building construction skills, and 4) Assists in assuring a construction program that maintains a strong identity while interfacing with Architecture and Engineering. Strategically, this template acts as a guide to the evolution of our curriculum as we weave vertical and horizontal integration into the curriculum of the Building Construction Department at Virginia Tech Results of the first year's use of the *LOT* are presented along with a description of the process, benefits, evaluation, lessons learned and recommendations for adaptation.

**Key Words:** Learning Outcomes, Building Construction Curriculum, Vertical Integration, Horizontal Integration, Construction Education, Team Building, Curriculum Development Tools, Curriculum Evaluation

## Introduction

A primary goal of the Virginia Tech construction education program is to be a source for dynamic, practical and innovative building construction knowledge. The cornerstone of building a strong construction education curriculum is the balance between practical experience- based knowledge and academic inquiry. To accomplish this goal, construction graduates must possess technical strength combined with the people and communication skills necessary to be successful in the global construction industry of the 21st Century.

At a time when many universities are being asked to do more with less, a challenge has been tendered which forces us to re-evaluate the way we do business. Faculties are smaller, student populations are growing and graduate programs are added without the benefit of added resources. No longer can universities continue with "business as usual." This environment has created an opportunity not only to examine the program's curriculum but also to implement changes that strengthen the educational mission. New methodologies and tools are needed to accomplish this mission. Strategically, this is being accomplished at Virginia Tech by adjusting

the current curriculum to provide for vertical and horizontal integration of the learning experiences in all Building Construction student course-work. The Learning Outcomes Template (LOT) is becoming a valuable tool in this process.

The *LOT* is a matrix showing which learning outcomes are addressed in each course; it also indicates the degree of emphasis placed on that particular outcome. The result is a grid showing when the students will acquire specific competencies and skill sets throughout their undergraduate course of study. (See Appendix A)

The *LOT* is being used to help us communicate as a faculty and make informed decisions as we attempt to:

- Develop a dynamic, practical, applied academic model,
- Balance the construction education concepts of practical experience-based knowledge with academic inquiry,
- Integrate people and communication skills with pragmatic building construction skills,
- Maintain a strong identity within the university and the industry.

## How the *LOT* Fits in with the National Perspective

The concept of curriculum integration has been talked and written about for numerous years. L.T. Hopkins (193 7) described the concept of curriculum integration as a means of fostering unity between the learning process and the learner. What occurs through "integration" is the melding of the learning process with student behavior. That is, knowledge is enhanced through experience, which, in turn, poses new challenges. These challenges generate further academic inquiry, thus completing a highly integrative cycle. The Virginia Tech Building Construction curriculum evolution process utilizes the *LOT* as a tool in horizontal and vertical integration to assure the fusion of theory and practical application. In so doing, we can plan for this cycle to be self-directing; the learner becomes the teacher in an extended learning environment, i.e. beyond the classroom and independent of the professor. In this way, the essence of construction education, that of self-directed problem solving, can be accomplished.

Educational reform requires that we emphasize "multidisciplinary content, teamwork and communications, hands-on and laboratory experiences, open-ended problem formulation and solving, and examples of 'best practices' from industry" (Synthesis Strategic Plan, 1995). The *LOT* helps us to plan for these emphases.

Construction education and the construction industry may be unique in that the focus has always been pragmatic problem solving in team-oriented situations. Virginia Tech's Building Construction Department has been unifying experience and academic inquiry through its senior capstone course for twenty years. We are now integrating that experience across the curriculum in a vertical sense, i.e. build teams comprised of sophomores, juniors, and seniors.

The philosophical foundation of creative problem solving has aroused National Science Foundation interest and industry support, which led to establishment of the Synthesis Coalition.

(Synthesis Strategic Plan, 1995) It is noteworthy that a major component of the Synthesis Coalition's mission is to develop a multidisciplinary "Bridging the Architectural/Engineering/ Construction Gap" curricular sequence. It can be suggested that the Coalition look at existing construction education models already bridging this "gap" using **vertical** integration. Vertical integration relates to the process of actively involving students, from freshmen to seniors, in an undergraduate capstone project.

Project Succeed, a consortium of nine southeastern universities engineering programs, is also being funded by the National Science Foundation. This funding is directed at developing a "system for creating transparent boundaries and methods for integration between courses, departments, schools, and colleges, and institutions within the academy." (Project Succeed Strategic Plan) This has led to many engineering programs exploring horizontal integration of the curriculum.

The April 1995 Journal of Engineering Education devoted a third of the issue to discussion of curriculum integration. Much of the literature discusses the concept of an integrated senior capstone course stressing participatory learning and creative problem solving. (Lonsdale, Mylrea, and Ostheimer; 1995; Lumsdaine and Lumsdaine 1995; Wilczynski and Douglas). Missing from the literature, however, is an example of integrating students of multiple skill and academic levels in a common capstone experience with a common, open-ended, problem-solving task. Having developed and directed a participatory senior capstone course for twenty years, the Virginia Tech Building Construction Department considered vertical integration of the experience to be the next logical stage of development. We are confident that teams of learners who focus on specific tasks will actually teach each other and, thereby, create a successful, problem-solving learning environment. Indeed, research indicates that cooperative learning increases productivity, fosters complex problem solving, and 'cements' the learning for the individual as well as the group. (Johnson, 1995)

Our philosophy and approach are, thus, consistent with current academic strategies to shift the paradigm of academic thinking in the technical/managerial fields to non-linear right brain pervasiveness. (Lumsdaine and Lumsdaine, 1995) Industry is aware of the need for communicators and creative problem solvers in a long-range global society. The university educational system is responding to this charge by a shift in educational philosophy that prepares students to solve problems successfully with dynamic and less-than-complete information, a strategy construction educators teach and construction professionals apply on a daily basis.

## The Use of the *LOT* in the Horizontal and Vertical Integration Process

Continuous quality improvement requires a contemporary Building Construction program to look within both the university and its own program and to the construction industry for mechanisms to achieve its objectives in more efficient ways (Auchey, 1989). The *LOT* provides a blueprint for creating a horizontally and vertically integrated Building Construction Program. In order to comprehend how the *LOT* Matrix works, it is important to understand the concepts of vertical and horizontal integration.

Vertical integration relates to the process of actively involving building construction students, from freshmen to seniors, in an undergraduate capstone project.

To accomplish vertical integration, the Virginia Tech program organized and scheduled theory-based BC core major courses in the fall and then the followed-up with application courses in a common lab experience for all BC students in the spring semester. In this way, first semester students learn concepts they can use in the following semester's integrated lab. In the common lab period, all sophomore and junior students worked in teams directed by a senior working on a capstone project. For this first year of implementation, the freshmen were observers.

Horizontal or cross integration relates to the process of assuring that all information presented in support courses, (engineering, communications, math, business, etc.) relate directly to skills being developed in the BC core major courses. The concept of horizontal integration also uses the larger context of the university to provide BC support courses for undergraduates in other curriculums.

To accomplish horizontal integration, the construction curriculum examined its goals and objectives along with all courses necessary to achieve these goals. Figure 1 provides a flow diagram of the BC curriculum investigation. We then examined the existing curriculum to determine the strengths established in the courses already being taught. (Figure I shows where the *LOT* Matrix comes into play in this process) Indeed, in many cases, it was simply a matter of fine timing existing course content to allow for vertical and horizontal integration. The *LOT* became the common tool to accomplish this tuning process. In a few cases, it helped us to determine that major revisions were required, depending on the program goals and mission.

Our goal at Virginia Tech has been to retain a strong technical emphasis based in engineering skills, balanced by practical business and managerial skills; revisions based on the *LOT* have helped us to keep focused on that goal.

The following diagram shows the Horizontal and Vertical Integration Process using the *LOT* as a self-evaluation tool.

Horizontal integration requires close coordination and acceptance by departments outside the construction core courses. BC core courses are taught by BC faculty, but support or service courses are taught by other departments.

This task was accomplished by working closely with departments teaching support courses, such as Math. We provided appropriate physical examples of abstract concept problems for BC students in these courses. This helped the students to relate to the value of the abstract information being discussed in the support course within the context of its value to them as a building constructor. This collaborative approach to course delivery used facilities and faculty more efficiently, especially since Virginia Tech has strong engineering and business courses.

The acceptance of the concepts of horizontal integration by the support departments has been very positive to date. We have been able to focus student-learning experiences in courses outside

BC. Further, support course faculty have become more familiar with our program and student needs.

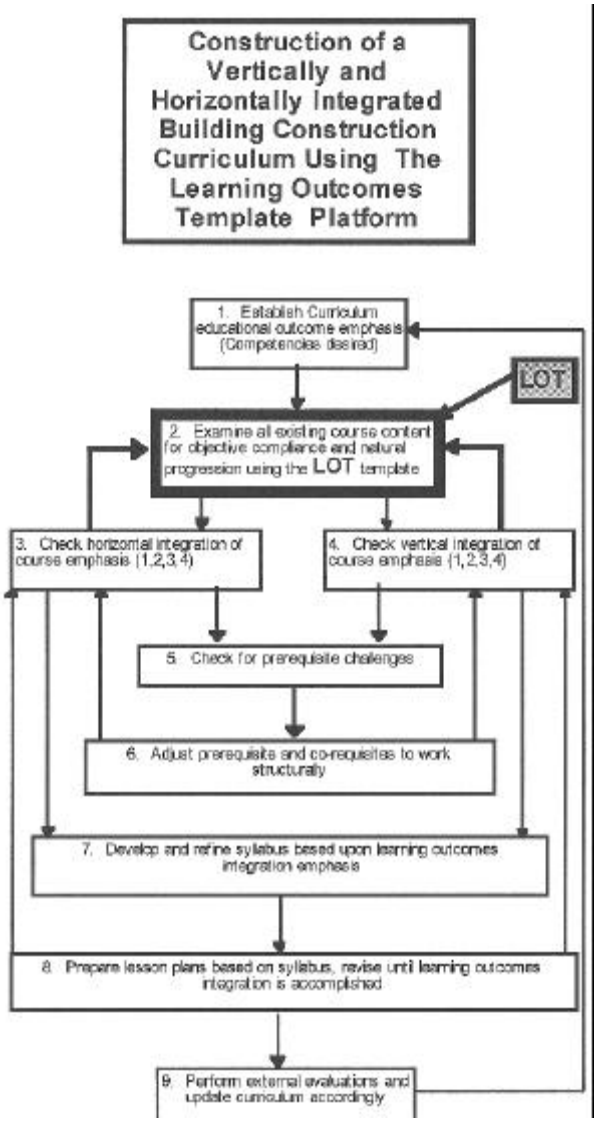


*Figure 1.* Flow process for implementing the *LOT* in the development of an integrated curriculum.

Vertical integration requires the determination of the learning outcomes expected to be achieved within the BC curriculum core. These competency and skill sets formed the basis for the matrix of the *LOT.* These competencies or outcomes are used to establish course objectives. They are the necessary link between program goals and course objectives.

The re-alignment of BC course emphasis has allowed us to split some of the higher credit courses into lower credit courses. One of the overall effects was a reduction of BC curriculum credit hours from 136 to 134 without a decrease in course content or knowledge transfer.

In addition, the realignment has provided an opportunity for non-BC students to participate in BC core courses, which has increased BC enrollment from non-BC curriculums, including architecture, civil engineering, mechanical engineering, technology education, business management, and interior design. This precipitated the offering of a minor in Building Construction.

## Four-Level Progression of Competency Evaluation in the *LOT* Matrix

The *LOT* is used to enhance, coordinate and focus each course and, thereby, ensure each students progress through four levels of skills acquisition: 1. philosophical, 2. competency, 3. proficiency, and 4. mastery. The *LOT* (Appendix A) was prepared for each core course and coordinated as a matrix within the curriculum to confirm, verify and correct course placement, content and focus.

The curriculum competencies were organized in a systematic format that allowed both horizontal and vertical progressions in the student's development toward the mastery level of the professional constructor. Student competencies are achieved by a coordinated progression through all four levels of skills acquisition.

The following presents our approach to the development of this progression in the *LOT* Matrix. Note that the description of each level is based on the type of job this level of student/worker would perform (especially in the integrated capstone lab project). Suggested components are also listed.

### *Level 1: Philosophical (Preparatory Foundations)*

*Description*

This level establishes a fundamental understanding of the "Why" and "How" aspects of the construction industry.

*Components include*:

- Attitudes and Ethics
- Educational Background and Assessment of Previous Knowledge (beginning skill sets)
- Personal Background and Evaluation of Commitment
- Foundation Courses in Preparation For a Career in Construction.
- Communication Skills i.e. effective oral and written communication
- Basic Procedures on the Job Site

### *Level 2: Competency (Construction Course Knowledge Development)*

*Description*

This level emphasizes jobsite skill sets needed by a professional constructor.

*Components include*:

- Basic Construction Concepts (in and out of construction emphasis)
- Basic Construction Vocabulary (understanding and use)
- Using Problem-Solving (as it relates to industry: beginning case studies)
- Means and Methods of construction
- Basics of communication methods in construction, including oral, written, and graphic formats

*Level 3: Proficiency (Practice and Application In- and Out-of- Class)*

*Description*

This level applies the skill sets of a beginning project manager who works with contractors, sub-contractors and owners.

*Components include*:

- Mentorship Preparation -- Application of Theory -- Case Studies at Site
- Problem-Solving at Applications Level (Construction Case Studies)

*Level 4: Mastery (Analysis, Evaluation and Controls)*

*Description*

This level prepares the student with the skills to fully integrate his/her knowledge in a meaningful, real-life situation. These skills will prepare Building Construction graduates to be immediately productive for their employers as project managers or site supervisors. This level also prepares graduates for continuous learning in a changing workplace environment.

*Components include:*

- Internships or Mentorships--Full Integration of Theory and Practice at the Project Management Level
- Problem-Solving at the Analysis and Evaluation Level
- Control Mechanisms Used by the Construction Project Manager
- Project Team management and evaluation

## Implementation Process for the *LOT*

Every Building Construction Curriculum is going to have a personality unique to the educational philosophy of its base institution. The curriculum evolution process, however, has many similarities at all institutions. The *LOT* can be helpful in addressing those similarities. For that reason ' the following process is suggested:

1. Accurately identify and mutually agree upon the Mission and Goals of your curriculum.
2. Review your current course offerings for a natural pattern of competency development both horizontally (between support courses and core) and vertically (within core courses). Place the core courses along the horizontal axis of the *LOT*.
3. Determine the competency and skill sets that are required to be consistent with the mission statement and the goals of the curriculum. Place these along the vertical axis of the *LOT*.
4. Discuss and agree on the meaning and intensity of the levels of skill and competency development, i.e. philosophical, competency, etc. Use descriptors with meanings that describe what you want THE STUDENT to DO in your curriculum.
5. Have each faculty review his/her specific courses; identify the skills and competencies to be addressed in each course and determine to what level each is going to be developed.
6. Put together the composite *LOT* Matrix combining all of the faculty responses on one template. (See Appendix A)
7. When this Matrix is first completed by all faculty, certain discrepancies, omissions, overlaps and misinterpretations will become obvious. The real value of the *LOT* now becomes apparent. It becomes a dynamic, graphic reflection of your faculty's perceptions about the make-up of the current curriculum status. Fine-tuning can be undertaken with a clearer sense of curriculum goals and objectives.
8. Re-evaluate on a regular basis as new insights on course content and structure are discovered. Now is when the real self-evaluation begins.

The Virginia Tech Building Construction department made the following observations during the first year of implementation:

- You may be expecting that certain competency development has been accomplished in prior courses, when, indeed, it has not. That is, students may not have been exposed adequately to the concept in their previous courses.
- On the other hand, you may find that you are, in fact, doubling up on certain competency development when it may not be warranted.
- You may be expecting too high a level of accomplishment in several of the competencies or skill sets. The *LOT* can identify whether the competency was addressed in a previous course to the required level. (All of these conditions are time and quality wasters.)
- You may find that faculty members have a better basis for understanding what is expected to be taught in each course. They will probably find that they have different expectations. This is important for improving not only the inter-university, but also the inter-departmental communications process.
- Discussions between the faculty will slowly bring a better focus to the course content and better compliance with the curriculum goals.
- When there is collective agreement on the exact content and expectations for each course, the individual course syllabus can be re-written incorporating the expected learning outcomes.
- The revised syllabus can then be used to determine the course schedule and specific lesson plans.

This is not a 'one time' exercise; rather, it is a continuous quality improvement process.

## Revisions to the BC Curriculum Model resulting from Use of the *LOT*

Motivation to improve Virginia Tech's Building Construction curriculum grew from the fact that BC students took no BC core courses in two of the eight semesters in residence. This caused the student to lose touch with the faculty, student associations, and fellow BC students for 25% of their time in the construction program.

This situation, coupled with our desire to provide the finest full time undergraduate construction program, precipitated the use of the *LOT* in the development of the vertical integration in our undergraduate courses.

Appendix B presents a graphic representation of the present integrated BC curriculum. This chart shows the central curriculum core composed of BC courses supported on one side by science, math and engineering courses and the other side by communication and business courses. Course prerequisites and co-requisites are linked based on competencies. Each of the core courses is designed and developed systematically using the learning outcomes (competencies) as an organizational tool defining content and competency.

The BC core courses are organized to provide BC student contact hours every semester and to provide a combined integrated lab in each spring semester. This lab is intended specifically for BC undergraduates and occurs at a common period to facilitate participation of all BC students. Teams must have representatives from each year, with a senior as a project leader. In this way, a senior facilitates the learning process for lower division students while enhancing his or her own knowledge and management experience.

It should be noted that the present curriculum has decreased the number of credit hours in BC core courses by 2. We were also able to respond to one of the recommendations of a successful re-accreditation summary by decreasing the amount of Math (Differential Equations) by 3 credits and re-assigning those 3 credits as a Directed BC elective.

## Opportunities and Benefits Derived from the Use of the *LOT* Matrix

Opportunities and benefits derived from a fully integrated curriculum include, but are not limited to, the following to date:

- Proper competency emphasis is being introduced at the most effective time and place in the overall curriculum
- There is less chance of missing or unintentionally duplicating key concepts in the overall course syllabus.
- Continual evaluation of curriculum relevancy occurs, particularly concerning pre-requisites and co-requisites
- The BC faculty has a common platform upon which to discuss specific course goals and content (While the *LOT* Matrix does not tell everyone specifically what you intend to cover in a course, it does provide the means to highlight specific competencies and skill sets you intend to address)

- Students learn by teaching each other in the team-driven integrated lab.
- Conceptual and philosophical reinforcement of technical knowledge is accomplished.
- BC students improve their leadership and team building skills.
- All faculty and facilities are used more effectively and efficiently
- A higher concentration of student time in Building Construction is placed on skills development to mastery.
- Programs can anticipate and even offset the potential negative effects of forced curriculum hour reduction.

In addition, we have experienced other noteworthy results using the *LOT* Matrix in the integrative approach. We have found that use of the *LOT* can:

- Guide the process of evaluation and change so we do not have change for change sake but true continuous quality curriculum improvement.
- Precipitate the development of progressively more difficult problem solving skills at the appropriate levels of curriculum progression.
- Overcome the "If it ain't broke don't fix it" resistance that some faculty, administration, and alumni might have.
- Recognize and capitalize on increasing skill levels to teach management, leadership, and team building skills.
- Engage the entire BC undergraduate population in an integrated lab in a way that reinforces the skills being acquired at each individual's level of ability.
- Provide a guide for improving the combined effectiveness of faculty team-teaching efforts.
- Help students understand the natural process of information acquisition throughout their academic experience.
- Help students to learn and better retain knowledge by being involved in the teaching process.

## The *LOT* as a Continuous Quality Improvement Evaluation Tool

The final aspect necessary to implement a vertically and horizontally integrated curriculum is to create tools and mechanisms for continuous evaluation and feedback. Evaluation at Virginia Tech is intended to occur both internally and externally. To make this work, the faculty will continually be asking each other, "Is it working, and how do we know it is?" The *LOT* is an ideal tool for each faculty member to use as he/she evaluates what should be taught to what degree of intensity in each course. In addition, the *LOT* can provide external entities, including accrediting teams, with an appropriate means of assessment.

Internally, we use the *LOT* as a check on decisions regarding what and how much we should be covering in each course. We can use it to record responses from interviews with our students on how they perceive the value of the course content. Perception of the user is an important component of any evaluation. Using hierarchical levels of skills in the vertically integrated labs will encourage multiple perceptions from both novices and experienced students. One unique

component of the evaluation is that it deals with what the student learns as well as with what the student is able to teach.

Externally, we will be soliciting follow up responses from graduates and their construction industry employers relative to the quality of the preparation of the graduate to be successful on the job. The competency and skill levels addressed in the *LOT* make an ideal basis for discussion with employers about what they think the students should be learning while in school. The intensity levels achieved in each course provide a better basis for the employer to understand what a student should be capable of performing upon graduation. Indeed, employers will be able to pick up and continue the development of the graduate from the very onset of employment.

The *LOT* will be an invaluable tool for the ACCE accrediting team to assess comprehensively what, when and how the material is covered. The Matrix shows clearly what competencies are being addressed in each course and to what level of intensity. Further, ACCE feedback will mean more to the faculty as it relates to the modification of specific course content.

## Conclusions and Lessons Learned Using the *LOT To* Date

Communication is the key to success in making the changes required for successful vertical and horizontal curriculum integration. The *LOT* Matrix provides an ideal communication platform for making sure all faculty are saying what they mean and understanding the same information about each course. The faculties involved will almost always come to the curriculum-planning table from different perspectives because of their background and differences in personality styles. The tendency is, at first, to try to force everyone into a common mold of curriculum change acceptance. This approach is loaded with negatives, which can and probably will, put valuable minds at odds with each other. It is far better to accept the differences in teaching approaches and styles and capitalize on those differences by approaching the changes on a step-by-step basis, evaluating and adjusting as you go. The *LOT* helps all personality styles understand the content and emphasis in a course using a common communication platform. If your approach is correct and positive results are being experienced, the faculty will probably enter into and continue to support the integration process using the *LOT* with a more constructive spirit. The results of encouraging differences to surface and be tested should prove to be a very positive experience if everyone involved feels that his/her input has been considered honestly and fairly.

Using the *LOT* to discuss the competencies and skills emphasis proposed in each course with the students affected is also paramount. Their feedback is an important part of the communication process. Change in any form is stress producing. Knowledge about the reasoning behind the change is very important for the students affected; they will be better equipped to adapt to and enhance the change. The *LOT* Matrix should help them see the logic of the flow of competency and skill development throughout the curriculum.

Be careful of the amount of change you undertake at any one time. Small steps are better than grand leaps, especially when students are involved. Much valuable information and feedback from the students will occur particularly when difficulties arise or student expectations are at

odds with course content. We expect to get even more good feedback as we integrate the juniors into the process. The early responses of the sophomores and seniors ranged from resistance to anger at being used as the 'guinea pigs in this first integrated lab'. Fortunately, because we only involved two of the classes, the magnitude of the change and corresponding stress was manageable to the extent that the students once provided with reasons they could believe in, were very supportive of the changes. The net results were new or renewed energy emanating from the two classes involved, improved support for the program and lab, and increased enrollments from outside related disciplines.

Plans calling for integrating the freshman and Junior classes in 1997 have been modified based on the first semester's trial integration experience. We now plan to actively involve only the juniors and sophomores in the integrated lab; the freshmen class will be involved only as observers to team presentations. This will give them an idea of exactly what a building constructor does prior to their entering the sophomore year; this should help address the challenge of student confusion regarding their chosen profession. Information regarding the reasons and benefits of the integration are already being transmitted to all classes formally in writing and informally by 'word of mouth'.

The restructuring of the BC core courses enabled us to offer a minor in Building Construction; this minor program is now in place and has received candidates from Architecture, Mechanical Engineering, Business Administration and Civil Engineering.

The benefit of splitting large credit hour courses into two courses, one each semester, has improved communications between the classes and the faculty. The students have more contact time with their fellow students, both in class and in extracurricular activities like the Construction Consortium (a composite of memberships in several construction related associations such as AGC, NAHB, ABC, etc.

One of the benefits of the horizontal integration effort has been the development of a process for providing the Math Department with physical examples of construction related problems that demonstrated the application of abstract Math concepts. During this process, the BC faculty concur-red that they were hard pressed to find a valuable application for differential equations theory in the BC Curriculum. This meant one of two things: either there was no need for the Differential Equation competency or we are not expanding the BC skill set sufficiently to be presenting coursework that requires the use of Differential Equations. We decided that there is probably no need for our students to be taking Differential Equations. The ACCE accreditation team came to that same conclusion after reviewing our curriculum mission statement. The net result was that we discontinued the requirement for Differential Equations and created room in our curriculum for another directed elective related to the business of Building Construction. For those programs facing credit hour cutbacks, using the *LOT* to make these hard decisions is a worthwhile exercise.

A vertically integrated capstone lab requires extensive preparation. If your program is considering this type of activity, identify and start preparations for the capstone project as far in advance as possible so that all the necessary documentation, course syllabi and support materials are coordinated and available when needed.

Finally, and most important, *time is of the essence* when making the change to the vertically integrated curriculum. Initially, much more time is required of the faculty and students to accomplish the integration. With additional experience, this initial time investment will be repaid by other economies, such as the time saved by having the students teach and mentor other BC students.

In conclusion, everyone has to be aware of the benefits going into this process. The basic rules still apply:

- People do things for their own reasons, not yours. Therefore, everyone has to buy into this process for his/her reasons. You may have to help your faculty and students find those reasons.
- People do things to avoid pain or to gain pleasure. Therefore, if you are going to be successful in your attempts to integrate your curriculum, you may have to help the people involved find the pleasure and avoid the pain of the process.
- In short, the emphasis in re-engineering a curriculum needs to be placed on building better linkages, rather than on implementing shortsighted cost cutting measures. The *LOT* can be an invaluable tool for improving communications between those linkages.

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# Appendix A

Analysis of Competency and Skill Development Emphasis Across Building Construction Program

| LOT Worksheet | Building Construction Core Curriculum | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Levels of Student Learning Expectations in the course<br>1. Has attained a Philosophical Foundation<br>2.Has attained a level of Competency<br>3. Has attained a level of Proficiency<br>4. Has attained a level of Mastery | BC 1214 Intro to Bldg Const I | BC 1224 Intro to Bldg Const II | BC 1224 Integrated Lab | BC 2314 Construction Principles I | BC 2324 Construction Principles II | BC 2364 Integrated Lab | BC 3314 HVAC | BC 4314 Building Systems Technology | BC 3624 Integrated Lab | BC 4454 Construction Practice I | BC 4464 Construction Practice II | BC 4564 Integrated Lab | Expectation Level at Graduation | |
| **Skills and Competencies** | | | | | | | | | | | | | | |
| **Building Sciences** | | | | | | | | | | | | | | |
| Be Familiar W/ Construction Materials | 1 | 1 | | 2 | 2 | 2 | 2 | 2 | 2 | | | 3 | 3 | |
| Understand Const. Mech. & Elect Systems | | | | 1 | 2 | 2 | 3 | 3 | 3 | | | 3 | 3 | |
| Design/Analyze Building Structures | | 1 | | | 2 | 2 | | 3 | 3 | | | 3 | 3 | |
| Understand Influence Of Bldg. Codes | | 1 | | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | |
| **Means and Methods** | | | | | | | | | | | | | | |
| Understand Const. Language & Methods | 1 | 1 | | 2 | 2 | 2 | 3 | 3 | 3 | | 4 | 4 | 4 | |
| Be Able To Select Bldg. Sys. & Comp. | | 1 | | 1 | 1 | 1 | 2 | 2 | 2 | | | 3 | 3 | |
| Accurately Interpret Project Specifications | 1 | | | 1 | 1 | 2 | 2 | 3 | 3 | | | 3 | 3 | |
| Be familiar with Temporary Structures | | 1 | | 1 | 1 | 1 | | 2 | 2 | | | 2 | 2 | |
| Accurately Interpret Construction Drawings | | 1 | | 2 | 2 | 2 | 2 | 3 | 3 | | | 4 | 4 | |
| **Project Control** | | | | | | | | | | | | | | |
| Structure and Maintain Project Controls | | | 1 | 1 | 1 | 1 | | 2 | 2 | 3 | | 3 | 3 | |
| Develop Project Budgets | | | 1 | 1 | 1 | 1 | | 2 | 2 | 3 | 3 | 3 | 3 | |
| Apply the Process of Project Scheduling | | 1 | | 1 | 2 | 2 | | 2 | 2 | 4 | 3 | 3 | 3 | |
| Apply the Art of Project Scheduling | | | | 1 | 1 | 1 | | 1 | 1 | 2 | 2 | 2 | 2 | |
| Coordinate Overall Project Activities | | 1 | | | | 1 | | 1 | 1 | 2 | 2 | 3 | 3 | |
| **Performance Improvement** | | | | | | | | | | | | | | |
| Use effective Graphical Communications | 1 | 2 | | 2 | 2 | 2 | | 3 | 3 | 3 | 3 | 3 | 3 | |
| Communicate Well Orally & In Writing | | 1 | | 1 | 1 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | |
| Implement Continuous Quality Control | | | | 1 | 1 | 1 | | 2 | 2 | 2 | | 2 | 2 | |
| Applying Team Building Principles | | 1 | | 1 | 2 | 2 | 2 | 3 | 3 | 3 | | 3 | 3 | |
| Apply Decision Making Skills | | | | | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 3 | |
| Apply Value Analysis Concepts (LOC) | | | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | |
| **Labor Management** | | | | | | | | | | | | | | |
| Understand Principles of Managing People | | | | 1 | 1 | 2 | | 2 | 2 | 2 | | 3 | 3 | |
| Apply Safety and OSHA Requirements | | 1 | | 1 | 1 | | 1 | 1 | 1 | 2 | 2 | 3 | 3 | |
| Understand What Motivates People | | | | 1 | 1 | 1 | | 1 | 1 | 2 | | 2 | 2 | |
| **Field Operations** | | | | | | | | | | | | | | |
| Coordinate Project Disciplines | | | | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | |
| Control Material Delivery & Handling | | | 1 | 1 | 1 | 2 | | 2 | 2 | 3 | 3 | 3 | 3 | |
| Expedite Purchase Orders & Subcontracts | | | 1 | 1 | 1 | 1 | | 2 | 2 | 3 | 3 | 3 | 3 | |
| Handle Shop Drawing Procedure | | 1 | | 1 | 2 | 2 | | 2 | 2 | | 3 | 4 | 4 | |
| Identify Elements of Project Risk | | 1 | | 1 | 1 | 1 | | 2 | 2 | | | 2 | 2 | |
| Comprehend Project Closeout Process | | | 1 | | 1 | | | | 1 | 2 | 2 | 2 | 2 | |
| **Estimating** | | | | | | | | | | | | | | |
| Compile Project Information | 1 | | | 2 | 2 | 2 | | 3 | 3 | 4 | 4 | 4 | 4 | |
| Perform Quantity Take-off | 1 | | | 2 | 2 | 2 | | 2 | 2 | | 3 | 3 | 3 | |
| Understand the Art Of Estimating | | 1 | | 1 | 1 | 1 | | 2 | 2 | | 2 | 2 | 2 | |
| Assemble and Manage The Bid Process | 1 | | 1 | | 1 | 2 | | 2 | 3 | 3 | 3 | 3 | 3 | |
| Apply Computerized Estimating | | | | 1 | 1 | 1 | | 2 | 2 | | | 2 | 2 | |
| **Company Operations** | | | | | | | | | | | | | | |
| Understand Const. Co. Financial Mgmt. | 1 | 1 | | | 1 | 1 | | 1 | 1 | | 2 | 2 | 2 | |
| Coordinate Governmental Reviews | | 1 | | | | | | 1 | 1 | 1 | | 1 | 1 | |
| Use Computerized Spreadsheets | 1 | 1 | | 2 | 2 | 2 | 3 | 3 | 3 | 4 | | 4 | 4 | |
| Use Word Processing System | 1 | | | 2 | 2 | 2 | 3 | 3 | 3 | 3 | | 3 | 3 | |
| Understand Components of Leadership | | | | 1 | 1 | 1 | | 1 | 2 | 2 | | 2 | 2 | |
| Understand Apply Professional Ethics | 1 | | | 1 | 1 | | | 1 | 1 | 2 | 2 | 2 | 2 | |
| Understand Construction Contract Law | | | | 1 | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | |
| Be Familiar With International BC Issues | | 1 | | | 1 | | | 1 | | | 1 | 1 | 1 | |
| Understand Principles of Negotiation | | | | 1 | 1 | 1 | | 2 | 2 | | | 2 | 2 | |
| **Total Emphasis in This Course** | 11 | 21 | 7 | 43 | 54 | 57 | 31 | 83 | 86 | 70 | 52 | 115 | 115 | |

LOT worksheet

RJA 02/25/07

## Appendix B

*Building Construction Program of Study for:*