



Filling in the Gaps: An Interdisciplinary Approach for Teaching Professional Competencies to Graduate Engineers (Work in Progress)

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Jeff first joined UW-Madison's faculty in 1989 as an assistant professor in the Department of Civil and Environmental Engineering, where he co-founded the Construction Engineering and Management Program and developed the construction curriculum. In addition, he has authored and co-authored papers on the subject of educating civil engineers. His body of work demonstrates his commitment to using emerging technology in the classroom to prepare the next generation of engineers and other students for the challenges of the future.

Jeff was honored in 2014 with an Outstanding Projects and Leaders Lifetime Achievement Award by the American Society of Civil Engineers. He holds a bachelor's degree in civil engineering from University of Cincinnati, master's and doctoral degrees from Purdue University, and is a registered professional engineer in Wisconsin.

Jeff grew up in a construction family where his father ran the field operations for a small regional contractor in northeast Ohio. He spent his youth working in construction, learning the value of hard work, integrity, organization, and leadership. He has always respected the important role of labor in achieving project success.

Strongly influenced by his sister, who has Down syndrome, Jeff values the importance of family, the joys of life, and the appreciation of differences and diversity.

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The need: Engineering employers cite skills gap in new graduates

In recent years, multiple reports have noted the need for engineering graduates to demonstrate more than just technical competence in order to enter and thrive in workplaces¹⁻³. In a 2010 NSF sponsored study on engineering practice and identity, engineers themselves noted the gap in their fluency with certain skills such as communication and essential business concepts including economic analysis, project management, and team leadership⁴. Highlighting the need in the engineering market, these skills are also echoed when employers describe attributes of highly effective engineers⁴.

However, an analysis of typical graduate engineering curricula shows little focus on the explicit development of these professional skills in coursework offerings. As a means of addressing this gap, this paper describes a suite of courses under development at the University of Wisconsin-Madison (UW) which are being built to address the needs of online graduate students who seek a more comprehensive and interdisciplinary skillset to prepare them for a wider realm of professional opportunities than their discipline specific coursework alone can provide. These courses are intended to offer flexible, high-impact, interdisciplinary learning in an online environment to complement a graduate's Masters-level coursework in engineering or other professional discipline.

While online graduate students at UW seek to enhance their professional lives through specific study in their discipline, they also recognize the need to be knowledgeable and conversant in a broader set of business and professional skills⁵. They are not alone in this pursuit, as numerous calls from industry and academic circles have been issued for these skill sets in the workforce¹⁻³. As a primary provider of online graduate engineering degrees at UW, the Department of Engineering Professional Development recognized this need voiced from the students, faculty, and industry alike.

Advanced online engineering degrees close part of the gap

The University of Wisconsin-Madison (UW) Engineering Professional Development Department (EPD) has an established reputation for leadership in distance education. The UW's graduate programs target nontraditional student audiences and exemplify the *Wisconsin Idea*, the notion that the university should serve individuals and communities throughout the state, the nation, and the world. This notion is central to the development of the Professional Literacies suite of courses as it seeks to develop professionals who have the confidence and academic preparation to reach beyond the boundaries of their discipline specific training and make meaningful connections to benefit themselves and the world.

Professional online master's degree programs at UW are designed to meet the learning needs of working professionals in context. The very nature of these degree programs and their intended audience creates a need for subject matter and pedagogical methods that are not often part of a traditional degree program. In addition to disciplinary content, students in these programs need

to develop professional literacies, knowledge, skills, and attitudes that facilitate the application of their coursework in their personal and professional lives.

The Department of Engineering Professional Development (EPD) has more than 15 years experience in providing professional online degree programs to practicing engineers and technical professionals. From the onset, EPD identified the need for providing instruction to develop professional literacies. Two EPD graduate courses, *Network Skills for Remote Learners (NSRL) EPD 378* and *Essential Skills for Engineering Productivity (ESEP) EPD 641* develop literacies related to managing the learning environment and enhancing personal effectiveness.

As professional master's programs proliferate at UW, faculty members from across campus have identified the need for common courses, similar to NSRL and ESEP, in their curricula. In addition, a growing number of programs have voiced the need for additional course offerings that address common professional literacies that are called for by employers.

Unfortunately, many of these programs are unable to deliver such courses for a variety of reasons. Some cite their lack of facility with the subject matter, while others point to instructional resource constraints within their schools and colleges. However, the need for a comprehensive series of professional literacies course offerings was clear; the next steps were to decide who would be responsible for developing, delivering, and assessing them.

Because these courses held such potential for professional Masters programs across disciplinary lines, the Division of Continuing Studies at UW believed that a common set of courses targeted specifically to address a set of 10-14 identified professional literacies would be of significant value to the larger university. In addition, by opening these courses to multiple online degree programs across disciplinary lines, students and instructors could create learning environments that are rarely seen at the graduate level.

Given EPD's track record of providing credit and non-credit courses that address learning needs common to working professionals, and given EPD's portfolio of learning resources in instructional technology and support, DCS requested that EPD partner with them on the development and delivery of graduate level professional literacies courses.

An interdisciplinary approach to professional literacies

As a result of Engineering Professional Development's extensive experience in fostering new online graduate degree programs, it has established a process in working with departments to create and grow successful programs. The initial stage of that process involves extensive market studies to determine the market needs for programs and benchmark program goals within industry needs.

To study market needs, EPD staff gathered and reviewed a large amount of qualitative data. This included information from the competency models from key industries and benchmarks used in a number of technology-based companies and agencies. Analysis was done on the "Bodies of Knowledge" crafted by relevant engineering societies and professional organizations to help inform the draft list of literacies. In addition, EPD performed interviews with industry professionals and reviewed job descriptions and current job postings across disciplinary lines to triangulate what literacies were consistently cutting across discipline-specific boundaries.

With a wealth of market research to draw upon, EPD drafted the initial list of professional literacies. The initial draft of professional literacies drawn from this work is provided in Table 1.

Table 1 – Initial Draft of Professional Literacies (Phase 1)

Literacies	Supporting Attributes
Proficiency in the digital environment (DE)	<ul style="list-style-type: none"> • Understands and manages supporting networks • Understands and manages learning and work activities in the DE • Manages personal information in the DE
Effective communication	<ul style="list-style-type: none"> • Employs verbal and written communication successfully to address complex technical and business issues • Employs processes and tools to effectively manage meetings and presentations • Evaluates the quality and accuracy of others' communication
Financial and business acumen	<ul style="list-style-type: none"> • Understands and differentiates sources of financial information • Employs financial information in the development of business strategies and decision making • Employs financial information in management business operations
Ingenuity and Innovation	<ul style="list-style-type: none"> • Creates an environment of intellectual and technical curiosity • Challenges established technologies and practices • Translates innovations into viable business opportunities, assuring reliable implementation
Leading teams	<ul style="list-style-type: none"> • Engages methods to build trust, cooperation, and affiliation among team members • Engages methods to effectively work across organizational and cultural boundaries • Establishes systems to enhance the functionality of team activities
Project management	<ul style="list-style-type: none"> • Applies appropriate project management methods to project scale, complexity, and context • Manages critical elements of projects, including scope, deliverables, schedule, resources, communications, finance, and risk • Implements effective measurement and control systems within a project

Change management	<ul style="list-style-type: none"> • Engages a systematic approach to change management • Applies effective, research-based methods and tools to change management • Implements strategies to assure institutionalization of change initiatives
Business negotiation	<ul style="list-style-type: none"> • Employs objective criteria to evaluate the quality and desirability of negotiated agreements • Creates proposals that provide opportunity for mutual gain • Separates personal interests and positions from problem solutions • Develops business alternatives to negotiated agreements
Legal fluency	<ul style="list-style-type: none"> • Understands and applies basic legal rules and concepts regarding contracts • Understands and applies basic legal rules and concepts of intellectual property (including patents, copyrights, trademarks, trade secrets) to business methods • Understands and applies basic legal rules and concepts of product liability, safety, product labeling, and consumer protection regulations to business ventures
Managing information	<ul style="list-style-type: none"> • Understands information-quality heuristics and organization • Understands issues of security and efficiency for distributed team information management • Understands and applies basic email and social media management strategies

Once the initial literacies were identified, feedback was solicited by EPD and DCS from graduate online programs campus-wide. Through town-hall meetings, surveys, and meetings with program directors, the list of potential courses was further refined and continues to be honed as the courses get matched to instructors, more specific interdisciplinary learning objectives, and scheduling needs.

One of the main aims of the course suite is the ability for these courses to complement a student's discipline specific degree program studies. Because most online graduate students cannot add additional semesters to their study plans, these literacies courses are designed to be 1 credit, 8 week online offerings that can be added within the course load of a semester without delaying time to graduation.

Due to their truncated schedule, these courses offer tremendous flexibility to students who may wish to complete two courses in a semester; one course could be completed in the first 8 weeks and another completed in the last 8 weeks of a semester. Keeping the courses at a one-credit load was also important for students and programs to answer a need in the curriculum without adding undue cost or time constraints to students that a 3-credit course in any of the subject areas would entail. Another financial benefit of these 1 credit offerings can be realized for part-time students who, through increasing their credit load from 3 to 4 credits with the addition of one literacies course, will be eligible for financial aid.

There are several programs which already see the benefit of the Professional Literacies courses (PLC) and have plans to require certain offerings as elective options in their program curricula. Among these programs, some existing ones know that their students desire more preparation in a particular subject area, while others that are just launching got feedback from their market studies which indicated the need for particular offerings that would otherwise not fit into their planned curricula⁵.

One example of an existing program using the PLC courses is the Master of Engineering Management program which will offer courses from the PLC suite in Negotiations, Legal Fluency, and Innovations to students starting in 2016. Upcoming programs that are relying upon the PLC suite to fulfill course offerings in Communication, Project Management, and Economic Analysis include the Master of Applied Computing and Manufacturing as well as the Master of Manufacturing Systems Engineering.

The pedagogical model for the courses

While the full suite of courses is still in development, the intended structure of each course will follow a similar pedagogical model to ensure quality across offerings. Each course will:

- Be taught through both synchronous (S) and asynchronous (A) elements, including:
 - Weekly webconference seminars (S)
 - Weekly, topical discussion forums (A)
 - Online office hours with instructor/TA (S)
 - Recorded lectures or other video content (A)
 - Instructor and peer assessment of activities (A/S)
- Engage key faculty from content area home-departments to lead instruction
- Keep course section enrollment to <30 students/section
- Use EPD standardized course documentation that includes:
 - Clear learning objectives that drive course activity
 - Lessons and assessment deliverables that support identified learning objectives
 - Schedule and deadline expectations that are clearly outlined
- Use a singular, consistent Learning Management System (LMS) to host each course, regardless of the student's home program LMS platform
- Provide a student overview/welcome video from each instructor to connect with students prior to the start of the course

This pedagogical model was born out of EPD's prior experience with online graduate programs and course offerings and has been proven to deliver a high-quality educational experience to our students. In particular, the mixture of both synchronous and asynchronous learning activities addresses students who need the flexibility that an online course provides, without sacrificing the personal interaction and dialogue with faculty and peers that a quality graduate course can provide. Similarly, using enrollment caps for course sections will help ensure that each student is able to fully participate in the course and make meaningful connections with his/her peers.

The interdisciplinary nature of these courses also offered unique logistical challenges to their pedagogical structure. Because students will be coming into the courses from potentially 40 other programs, we needed to ensure a seamless process for getting students access to the course and acquainted with the learning platform in order to minimize their extraneous processes and allow them to quickly focus on the content of the course. Likewise, because the students will have such varied backgrounds, we wanted them to feel welcomed into the course in a personal way that supported their learning. Instructor overview videos answer this need by walking students through the course and quickly orienting them to the expectations and opportunities the course will provide. Welcome videos are filmed at various university landmarks as well, helping to solidify the connection to UW for our online students.

Professional literacies courses establish and evolve

The original draft of the literacies courses included 10 course offerings. Based on preliminary feedback from departments, programs, and instructors, the list of courses has expanded to a more detailed set of 13 offerings. At this writing, the course suite has evolved to include the following:

- Managing Change in Organizations
- Leading Teams
- Effective Oral Communication Practices for Professionals
- Effective Written Communication Practices for Professionals
- Managing Information
- Creating Breakthrough Innovations
- Effective Negotiation Principles & Strategies
- Key Legal Concepts for Technical Professionals
- Digital Proficiency
- Project Management
- Business and Financial Acumen
- Principles of Sales and Marketing for Professionals
- Professional Ethics

Two courses, Managing Change in Organizations and Managing Information, have been built and are ready to be launched in Fall, 2015. Two additional courses, Digital Proficiency and Effective Oral Communication Practices for Professionals, are completing their development and are anticipated to be launched in the same semester. EPD is working with departments and programs to develop courses in the suite and match appropriate faculty to each course offering. As courses are developed and demand for various offerings grows, EPD will work with programs to predict enrollment and schedule courses to match demand. We look forward to

running our first round of pilot courses in the Fall 2015 semester and gathering data to further improve the courses and the larger course suite for students.

As these courses develop, we anticipate them not only filling in the skills gap that our students and programs have frequently identified, but also adding a facet of rich interdisciplinarity to their educational experience that they would otherwise rarely get. Professional Literacies courses offer a perfect opportunity to fulfill the calls for increased interdisciplinary teamwork to better prepare engineers for success in their cross-disciplinary workplaces¹ and in the global economy at large².

Currently, these courses are being developed as a suite of options for online graduate program students to choose from, however a future vision includes bundling them as a capstone option for graduate students – both online and on-campus. This potential capstone option would answer the need to prepare our graduates with a broader set of skills and interdisciplinary literacies⁶ giving them a competitive edge as they seek the jobs of tomorrow.

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