"Writing Across the Engineering Curriculum: Challenges, Experiences, and Insights from the University of Toronto's Engineering Communications Centre"

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INTRODUCTION

Writing Centers have been in place throughout university systems since the early 1970s [1], as have Writing Across the Curriculum (WAC) efforts; both aim to use writing as a form of learning. That is, as students learn to write about their discipline, they also learn to think more critically about the content they are learning. When these concepts are placed into the Engineering school environment, both students and staff working in writing centers and WAC are faced with writing/reading about difficult technical concepts. There is a challenge faced with writing in the engineering field, and yet as difficult as some technical topics may be to discuss in writing, students benefit from going through the process of doing so. Writing Center and WAC staff and staff also have a challenge in this situation, and that is dealing with the vast and complex content knowledge that students across an engineering curriculum cover; where their counterparts in liberal arts and humanities have relatively easy access to content, writing specialists in the engineering field must deal with material that is often quite conceptually difficult to grasp.

While much research in our field is done on how engineering students best learn communications methods [2, 3], little focus is on how staff and staff deal with this technical content of their job. Our expertise in our own field is assumed, yet I doubt there are many writing instructors who can claim to never have felt a bit out of their league with the content of a student's technically-based writing assignment.

This paper concerns a question I have been thinking about for some time: How much technical/engineering knowledge does a humanities-trained communications instructor need to teach well in the engineering school environment? This question, is, however somewhat difficult to answer because the bottom line is that "it depends." It depends on the academic environment. It depends on the course involvement. It depends on the instructor, the student, and also on the assignment. The factors are so varied that it is almost impossible to come to a simple answer.

The question, however, is an important one because it is something that writing instructors working in an engineering staff face on a daily basis, and certain issues surrounding it certainly warrant exploration. Based on the insights and experiences of staff at the Engineering Communications Centre and Language Across the Curriculum (LAC) at the

University of Toronto's Staff of Applied Science and Engineering, this paper examines several aspects of this important issue. More importantly, I hope that the work presented in this paper begins a useful dialogue concerning both the challenges and potential solutions to help resolve the challenges by suggesting some training and professional development to help both our own instructors and those in similar situations. Specific cases from our group are used throughout the paper to demonstrate its central points.

BACKGROUND

University of Toronto's Language Across the Curriculum (LAC)
Structure and Mission
The University of Toronto's LAC mission is to provide engineering students with the written and oral skills necessary to effectively communicate to a wide range of audiences the knowledge they learn in their technical courses. LAC works with approximately 35 courses per year to design and support written and oral assignments, offers workshops and seminars, and operates the Engineering Communications Centre, which offers individual tutoring sessions. LAC also offers several credit and non-credit courses designed to help with various aspects of technical communication, such as professional writing, oral presentations, and confident conversation.

LAC Staff
LAC currently has three full-time staff members, including the program director and two associate directors. These three staff members are directly involved in graduate and undergraduate course design and coordination, individual tutoring, short courses, workshops, administration, and one-on marking sessions.

There are currently six part-time instructors, all of whom perform most of the same duties as the full-time staff. In addition to the part-time instructors are three part-timers who work on contract, and who primarily help with tutoring and marking.

All of our staff and staff come from humanities backgrounds, although some of us have worked in the sciences in some capacity. All of us, however, have found a rather comfortable home in the Engineering Staff. What we find uncomfortable at times, however, is that our own technical expertise in rhetoric and communication is often not enough: in order to fully engage with the students and their assignments, we need to have a foundational grasp of the technical content about which they are writing. Instructors at the LAC face two separate difficulties with content knowledge: Class-specific situations and "one-off" marking assignments in which the staff marks a writing assignment for a professor. Both situations present interesting difficulties and challenges, and both have begun to present the need for more formalized solutions.

LAC COURSE INVOLVMENT: Two cases

Class-specific Content

In terms of class-specific situations, we have a wide range of course involvement throughout the undergraduate and graduate program. Our first-year writing sequence includes two Engineering Communications courses that tend to be content-based, and which are geared towards helping our many international students get their English writing up to speed. Students who are not placed into the Technical Writing course that is taught by the English department are placed into one of two classes are taught by us, depending on their language skill. The two courses we teach are not English as Second Language (ESL) classes, but rather "Effective Engineering Communications." That said, the students are mostly non-native speakers and we are sensitive to the issues particular to this group. The aims of these classes are to introduce the students to basic concepts of written and oral communication, while introducing them to some basic concepts of engineering such as conducting research and writing reports. From a content perspective, the courses focus on simple ideas such as good and bad design, usability, and ergonomics. The idea is that these concepts are central to engineering, and yet they are easy enough for students to do simple reports on. The concepts are also easy enough for the instructors to grasp, but they require that the instructor understand them enough to teach the content at a level the students can work with.

One of our upper level undergraduate courses is a third year Engineering Science course that focuses on a rhetoric-based written and oral communication. While the course does not require the instructor to teach any engineering content, it does require that the instructor work as a coach with the students on a lengthy term project. On the most basic level, an instructor has to deal with coaching anywhere from fifteen to twenty extremely intelligent students through lengthy reports on topics of their choosing. Classes are usually grouped by engineering option, so instructors are at least limited to certain engineering disciplines at a time, such as electrical and computing, manufacturing, infrastructure, aerospace, nanotechnology, physics, and biomedical engineering. The topics of these proposals, feasibility studies, and case studies are often quite extensive and complex. On the flip side, some proposed topics are just impractical. The instructors of this course need to be able to quickly identify whether a student has chosen a good topic or not; they later need to be able to offer sound "coaching" through the writing process. The question is, however, how much do the instructors need to know in order to best help the students write about their topics? A reasonable answer is again "it depends," as the case described below shows.

Case #1
ESC 300: Engineering Science, Written and Oral Communications, Electrical and Computing Option

As is briefly outlined earlier, the Engineering Science course, Written and Oral

Communications (ESC 300) is founded in a rhetorical approach to both writing and presenting. The instructors have designed (and continue to modify) a course pack of writing principles that help students understand the shape and strength of argument. Much of the material is based on Stephen Toulmin's pattern of argument, which centralizes issues of data and claims being backed up with warrants, qualifiers, and rebuttals [4]. This rhetorical structure is backed with many examples coming directly from industry. The instructors of this class serve as both lecturers and coaches to the students through the require term project, which includes a literature review, three oral presentation, and a variety of report revisions.

While no engineering content is taught in the class, each student is expected to write and present their research on a technical topic. As a coach, it is critical that the instructors be able to engage in useful dialogue about that topic: In short, the instructor requires at least enough content knowledge to help direct the student. On the flip side, of course, is that it is the student's responsibility in this course to clearly present the information, thus effectively teaching the teacher. I must note that I tell my students on the first day of class that this is their responsibility. I bring to the table an expertise in technical and engineering writing, and they are expected to bring an expertise on a subject of their choosing.

Situation
One of the problems the students and LAC staff have with ESC 300 is that the Engineering Science department has placed this course as worth only one-half the credit of a regular half-year engineering course. Of course, as a writing course, the work requires a considerable amount of time from both students and instructor. Over the years of course design, the course instructors have streamlined the course material into one, term-long project with accompanying oral presentations. In addition to streamlining the content, another tactic has been successfully used: In spring 2002, the biomedical ESC 300 option was paired with Molecular Bioengineering; this pairing required lengthy consultations between the two instructors, and the ESC 300 students had different course requirements than their peers in other options.

This pairing model worked very well, and in the fall of 2002 the electrical and computing sections of ESC 300 were partnered with a technical course, but not in as formal a manner as the biomedical option. The electrical course assignment required that over the term, students design and build an automatic gain control circuit (AGC), and then defend their design at the end of the term. The ESC 300 component allowed the students to present an interim report on their project, with the aim of getting them to front load their circuit design project and learn about the different components before they began to build.

Challenges
The proposed link immediately presented a number of problems, first starting from the instructors, and then from the students. From an instructor standpoint, AGC technology was very difficult to understand. While the concept itself is quite simple (the circuit allows for a continual level of sound in telecommunication devices such as radios, cells phones, and hearing aides), the technical details necessary to discuss the material were quite

complex and include numerous calculations and equations, none of which the writing instructors could assess.

This particular assignment posed problems for the student as well, who quickly realized that if they chose the AGC option for their paper, they would be forced to learn the material independently, since it didn't coincide with the electronics course. As it was, the students didn't learn how to build an AGC until the very last lab at the end of the term. While this is not directly related to the instructors' concerns, there was the element that because the topic was so technical, the instructors were limited to the type of help they could offer.

When asked about their experience with the AGC option, students responded with both positive and negative comments. One student who was several years older than the rest of the class originally chose the AGC option, but quickly realized the independent nature of the project, despite the attempted link with the technical class. He switched topics early in the term and happily focused on a topic he had worked on during summer research.

Other students plugged along, learning week by week in their electronics course things that had nothing to do with their ESC 300 paper. Yet, many of these students did quite well in both classes, and ultimately felt as though they had learned something useful about the content. The instructors, however, struggled through the highly technical nature of the papers and relied heavily on the contracted teaching assistant.

Solutions
To help the instructors, LAC contracted help from the teaching assistant of the electronics lab in which the students were building the circuit. The TA reviewed the papers on AGC and identified the issues that the LAC staff could not. While this worked well enough, it also took part of the knowledge control out of the hands of the writing instructor.

The instructors dealt with the problem in their own ways, but kept open communication between each other. All instructors allowed the AGC project to be an optional, not a required, topic choice. This decision meant two things: First, the instructors were forced to become familiar with the now wide variety of topics in the class, instead of just the issues of AGC. That said, this approach was part of the original design of the class, and many of the topics chosen by the students were more accessible than AGC, and thus easier for the instructors to assess from a content perspective. Second, it still required that the instructors become familiar with basic AGC components and designs. Because this course, by it's "instructor as coach" nature, allows the instructor to become somewhat invested in the student project, each instructor felt compelled to gain at least a basic level of understanding of AGC design.

Conclusions
While this pairing model seemed to work well for the biomedical option, it is obviously not something that can be easily transferred with other courses unless there is a very strong commitment and involvement from the engineering professor, as is the case with

the biomedical example. The biomedical engineering professor who teamed up with ESC 300 is a very strong supporter of clear communication skills, and she willingly invested the time to help develop the paired courses so that both instructors benefited from the match. This was not the case with the electrical and computing engineering option, which made things difficult for the instructors of those classes.

One-off Marking Issues
In contrast to the in-depth engineering writing courses we teach, LAC staff often mark assignments for technical-content courses. In this case, the slang term "one-off marking" refers to the cases where a specific engineering course has contracted LAC staff to mark a specific writing assignment. Almost always, full-time LAC staff member is involved with the creation of the assignment, but those who mark the assignment have no direct link to the professor of the course, the students, or the course content. In short, the markers are set with the task of assigning a grade to a paper on a topic they likely know nothing about, written by students they nothing about.

These one-off marking sessions are by far one of the most difficult tasks for the LAC staff. Not only are the marking loads often quite large, with some people marking upward of 40 two-to-ten-page papers, but the quality of the writing varies tremendously, as does the content. In a recent attempt to help educate the markers on the content, the LAC has arranged information sessions with either the course instructor or a senior teaching assistant. In what is usually a single session, the markers get an informal, brief introduction to the material, and they have a chance to ask questions about the content. The problem, of course, is that most of the questions arise during the marking, not before. In these cases the markers usually pose a question to the instructor or TA, and include the entire group of markers in the correspondence. Sometimes the insight helps, other times it doesn't. In short, there is no good way to get through these assignments except to get through them.

Yet, in the process of "getting through them," most of the markers note that through the various papers they review, they slowly build an understanding of what makes a good paper and what doesn't. They also begin to build a content knowledge on the subject, and thus can better tell which papers are addressing issues of the content accurately in the assignment. After a while, one can easily identify a "good" paper, and the general sense is that those good papers become resources for helping mark the others.

The problem with the above situation is that it is extremely time consuming. A teaching assistant or marker may be contracted to mark a certainly number of papers over a certain number of hours, but the learning curve for feeling confident about marking can add on several hours to the exercise. These hours may or may not be considered in the contract, but they are always present. It is in cases like these where a deliberate, easy-to-understand guide to the topic would help tremendously. Sample, well-written papers may also help ease the learning curve and save both time and frustration while marking. In either case, however, there is still a learning curve for the marker, and no matter how much anyone helps, the lack of content knowledge is a disadvantage for the marker.

Case #2
ECE 221: Electric and Magnetic Fields
The writing assignment for this course requires pairs of students to role play as a start-up company that is developing portable electronic displays, with the immediate goal being to create a 3"x5" sign using a simple household battery as a power source. The students write a brief proposal to a capital investment agency, the proposal must cover key issues such as the need for the technology, the thickness of the screen, the number of droplets to be used as pixels, the charge and power requirements, and the expected battery lifetime. The students are to do this within five pages and should be accessible to an average technical reader. The assignment material revolves around the theory of electrophoresis, which the students have learned in class. (Note: the students may include appendices that include calculations and additional tables and figures.)

Challenges
While the intended audience is indeed an "average technical reader," meaning that the LAC staff should be just fine, the key concepts are quite new to us. Electrophoresis, which deals with the separation of charged molecules using their different rates of migration in an electrical field, is easy enough to define, and moderately easy to understand in this context, is still a challenge for someone just being introduced to it. When you add to the mix a variety of different projects, all by students who have different writing levels and who are encouraged to "have fun" with their ideas, we are left with a steep assessment curve as to what makes a "good" paper.

While this issue is discussed in more detail below in terms of our benchmarking practices, it is important to note up front that most of these one-off marking sessions do not necessarily include any previews to the material. Due to time constraints and often tight deadlines, our staff often must read through assignments on their own and figure out how to deal with the content issues. That said, we do tend to circulate e-mail queries about difficult matter to see how various people are dealing with it, but again, this is a time consuming and somewhat inefficient, if not also inadequate process.

A secondary problem is marking with consistency throughout the group. Again, this is generally dealt with through group communication and benchmarking, but it remains a difficult problem with each new assignment. The following example highlights some of the issues we have with benchmarking grades.

In the case of the 3"x5" portable electronic display assignment, one student wrote a very nicely argued proposal for an electronic shelf label that ran off of the required household battery. The label was to be hooked up through a LAN system in a large supermarket, and would display the price of each individual item stocked in the store. A number of the markers were quite impressed with the idea. One person, however, quickly pointed out that it was pointless to have the display be powered by battery if the signs were to be linked to a central computer anyway; why would anyone want to worry about changing the batteries in what could potentially be thousands of signs in a store? For a while, this argument swayed the group into giving the paper a 6.5 out of 10; but then a counter

argument developed that, since the student claimed the display would have a lifetime of ten years and the battery would power each display from one to two years, why *not* consider this as a use? All of the sudden, the conversation returned to the quality of the student's argument and writing style, and over half of the group decided that the paper was actually more along the lines of an 8 out of 10 marks. The marking coordinator took this one step further and had the technical course professor mark it, and he agreed that the paper was in the 7.5 to 8 range.

These difficulties in marking can be quite serious, and as the above example shows, it is possible that it is the student who gets penalized for these difficulties. Granted, many of the papers we mark are quite clear cases and are very easy to grade; the difficulty seems to come into play when we get a paper that challenges our understanding of the content. Without a strong content knowledge in the engineering discipline, it is very difficult for the markers to assess whether a student argument is sound or not. With no technical expert to confer with, we are left to our own devices and to what can often be a difficult and divided discussion on the assignment's mark.

Solutions

The primary solution for an assignment like this is to set up brief tutorials with either the engineering TAs or course instructor; these sessions allow us to openly discuss some of the content issues that we find difficult. While this is an ideal solution, it is also quite difficult to coordinate, and it is time consuming. Moreover, most people find that they don't really have good questions to ask until they get into their stack of marking; consequently by the time they get into their stack of marking, they have usually read enough papers to have begun acquiring a basic understanding of the technical content. Perhaps interim tutorials are the answer, not preliminary information sessions.

Aside from providing extensive tutorials and preparation materials for our markers, there really is no strong solution to this problem. Or at least, we haven't found a good one yet. The best we can aim for at the moment is to actually require the *technical course instructor* to communicate better with us about the assignment requirements. It may help us to provide each instructor with a specific set of questions to answer before we get into the assignment; these questions would aim to target some of the common difficulties we have with on-off marking assignments.

Conclusions

In short, one-off marking assignments are by far the most difficult marking challenge we face though the ECC. In order to trying to provide the best constructive communication "teaching moments" through our feedback and comments, the markers find that they need to have their own solid technical understanding of the material. With the main aim of these one-off marking assignments being to provide moderately consistent grade ranges from all markers, and to get through the material as quickly as possible, it is likely that these assignments will continue being problematic, especially in cases where the technical course instructor does not provide adequate insight into the assignment requirements. As noted above, it may be in our best interest to take a much more active roll in telling the technical

course instructors what we need from them.

RECOMMENDATIONS

Through the rapid growth of the LAC, several things have become apparent. First is that the Centre has matured to level that includes a number of established staff who know the ropes and who have been involved with courses for several years. These people have, over the years, learned quite a bit about how engineering students are trained, how they think, and more importantly, what some of the fundamental engineering concepts are. In addition to becoming familiar with the engineering environment and material, these instructors and markers have seen assignments from previous years, and are thus somewhat familiar with the content and expectations of the courses. The problem is that it has indeed taken *years* for people to acquire this comfort level in the engineering environment. Our aim now is to begin constructing some core training materials and strategies to help improve the confidence and content knowledge of all LAC personnel on a considerably quicker timeline. The ultimate aim is to help decrease the learning curve to something that is a bit more manageable than a "seat of your pants" approach, and allow our instructors to focus on what they excel at, which is teaching communication issues.

While it would be ideal if we could take a crash-course in "Engineering Concepts for Dummies," we have neither the time nor the cash to do this. Moreover, the variety of course involvement that the LAC staff is involved with means that not everyone is working on the same material. As a result, the best we can do is to begin training people on an assignment-by-assignment basis throughout the year, and supplement that with a few more general professional development days once the term ends. There are, as noted above, a number of things we already do, and even more that we need to seriously consider implementing.

Bench-marking and content meetings
Most of our "one-off" and course-specific marking assignments begin with a meeting in which the group reviews, grades, and discusses sample papers. These sessions usually offer the first glance at our own problems with the technical content in the sense that we may encounter a very well written document that, quite simply, does not consider the technical details of the assignment.

The benchmarking sessions we hold are, all in all, quite useful. They are, however, quite time consuming. The issue is difficult though: we require the conversation time to work out some of the technical content, and to see who knows what – and have them explain it to the rest of the group. It is quite difficult to get that knowledge into an assignment-specific training document, but this may well be a partial answer to the time problem. If nothing else, providing a primer on the assignment material and bench-marked cases may speed up the learning time for the markers.

Staff training: professional development workshops

Over the last year and a half the LAC group has begun implementing professional development sessions in which staff participate in small workshops and discussions concerning our day-to-day practice. These professional development days, however, may need to begin including some focused sessions on how to approach various types of technical assignments. This of course, is part of the challenge. What we need to do as a Centre, and what I suspect any other group would have to do, is collect the long list of course involvement and topics, and from there begin to synthesize some of the major technical concepts that are present in those courses. In short, we need to begin to develop our own technical literacy in a more formal manner than we have in the past.

It would quite realistic to provide interesting short sessions or readings to help improve our basic understanding of science. The emphasis here is a basic understanding; this foundational understanding will help significantly during conversations with students, and will, in the long run, help us understand what they are trying to communicate.

Get an engineer on staff: engineering advisors
This is a tough one. Obviously, most engineers aim to go into a profession in their field; the pay is undeniably better, and many engineers aim to work in the field in which they have trained. That said, I have met my fair share of engineering students who decide to go into something else at the end of their degree; I have also met a fair share of professional engineers who have decided to go into writing or teaching midway through their engineering career. More importantly, and as our large course involvement proves, the University of Toronto has a good number of engineering professors who actively work to help incorporate written communication skills into the student curriculum. Some of these professors have also been quite helpful in helping the ECC staff with the technical content of specific assignments, but they could increase their role by working even closer with us at times.

Develop an assignment database
Something that our group is actively engaged in at the moment is to consciously begin collecting assignment samples and information throughout the year. While the assignments tend to change from year to year, the course involvement remains somewhat stable, and thus offers us a chance to become familiar with the course assignments before we actually are faced with marking them. Granted, new technical knowledge will come into play with each new assignment, but at the very least the course aims and basic engineering and science principles may remain the same.

Learn from industry
Over the past year and a half, the LAC director has begun consulting for industry. This involvement in industry practice has done a few things for our group. On the course-level, the director – who is also an ESC 300 instructor – has begun bringing his new understanding of industry practice into the ESC 300 course curriculum via writing samples and situations. While this is quite beneficial, it also presents the problem that he

understands specific content matter better than his colleagues who are also teaching the course. This has not been a major concern for us, but it does reinforce the difficulties presented with how in order to really understand the material, one must be directly involved with it.

Ideally, we would all have time to and would want to be involved with industry practice on a level that allowed us to become better versed in some particular field of engineering. Unfortunately that is not practical. This it not to say that this idea will not develop more fully down the road; already we have one additional instructor who has recently begun training industry professionals, and another who works with the new aid agency Engineers Without Borders.

CONCLUSIONS

As I noted at the beginning of this paper, the issue of assessing and improving the technical literacy of humanities-trained staff and staff who work in the engineering school environment is a challenging one. On the one hand, it is important to recognize the expertise these people have in their own field and not to consider them second-class citizens because they are not engineers. On the other, it is important to recognize that, as in our particular case, we work across the entire engineering curriculum; we work with students and professors from all fields of engineering, and we are expected to communicate effectively in all situations. The fact of the matter is that there is a lot of material to be familiar with, and it should come as no surprise that at times we struggle. The aim here is to alleviate the struggle, and begin making the challenges less time consuming and difficult. By supporting each other, and by actively seeking support from the engineering school environment, we can begin to strengthen the manner in which we teach our engineering students to communicate their technical knowledge, and thus enhance this very important aspect of engineering education.

Bibliography

1. Peter Carino, "Early Writing Centers: Toward a History," *The Writing Center Journal* 15, no.2 (1995): 103

2. Winsor, D.A., *Writing Like an Engineer: A Rhetorical Education*, 1986. Charles Bazerman (ed.) Rhetoric, Knowledge, and Society.

3. Winsor, D.A., "Ordering Work: Blue Collar Literacy and the Political Nature of the Genre," *Written Communication*, 17, 2000, 155-184.

4. Bizzell P. and Herzberg B. "Stephen Toulmin" in: *The Rhetorical Tradition: Readings from Classical Times to the Present.* 1990. Bedford Books of St. Martin's Press, Boston.