

2006-883: AN INNOVATIVE TWO-PLUS-TWO TRANSFER AGREEMENT STRUCTURE WITH MULTIPLE TWO-YEAR COLLEGES IN ELECTRICAL ENGINEERING TECHNOLOGY

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An Innovative Two-Plus-Two Transfer Agreement Structure with Multiple Two-Year Colleges in Electrical Engineering Technology

Abstract

A two-plus-two transfer agreement structure in Electrical Engineering Technology (EET) has been established between eight two-year colleges in the Wisconsin Technical College System (WTCS) and Milwaukee School of Engineering (MSOE). The EET programs at most of the two-year colleges are based on and overlap significantly with their Electronics Technology programs. This format creates a valuable opportunity for students: they may earn the AAS-EET degree, the AAS Electronics Technology degree, or both. The Electronics Technology and EET programs at the two-year colleges, despite distinct curricula, all meet common statewide core electronics standards as established by the Statewide Electronics Leadership Team (SWELT) in the WTCS. All AAS-EET programs also meet entrance standards for the plus-two BS-EET (+2 BS-EET) program at MSOE.

Two technical calculus courses and two advanced electronics *bridge* courses, which promote a successful student transition from the two-year AAS-EET programs into the +2 BS-EET program, were adopted by most of the two-year programs. The bridge courses are described in detail. The courses have also run at several two-year colleges via an instructional television system. A comparison of the performances of students from the first two years of the former four-year MSOE EET program and the first group of EET transfer students to MSOE under the transfer agreements was performed in the first EET course within the plus-two curriculum at MSOE. This comparison determined no performance difference, i.e., the preparations of both student groups were indistinguishable.

Coordination among the WTCS AAS-EET programs and with the MSOE +2 BS-EET program is facilitated by regular statewide meetings of electronics faculty as well as other mechanisms. The transfer agreements are renewed annually to counter program drift and to enhance program evolution through input from multiple colleges and their industrial advisory committees. The performance of the transfer students in the +2 EET program at MSOE is noteworthy: despite no reduction in academic expectations within this program, there has been no student attrition due to academic reasons since the first group of transfer students started in 2003.

Introduction

The number of graduates of, and corresponding enrollments in, Associate of Applied Science (AAS) Electronics Technology and AAS Electrical/Electronics Engineering Technology (AAS-EET) programs, and Bachelor of Science in Electrical/Electronics Engineering Technology (BS-EET) programs nationwide experienced declines on the order of 40 to 45 percent from 1990 to 2000. Nationwide, there were 4738 AAS-EET degrees and 4597 BS-EET degrees awarded in 1990, and there were 2857 AAS-EET degrees and 2615 BS-EET degrees awarded in 2000.^{1,2}

The downward enrollment trend also occurred in the Wisconsin Technical College System (WTCS), a system of two-year public technical colleges in Wisconsin, whose primary mission is to prepare students for immediate employment in their disciplines through two-year, one-year, and certificate programs. Again, we use the number of graduates as an indicator of the enrollments. In the statewide WTCS during the 1989-90 academic year, there were 240 AAS-degree graduates in Electronics Technology. This number decreased to 102 during the 1999-2000 academic year. Milwaukee School of Engineering (MSOE), a private, non-profit university with a significant portion of program offerings in engineering and engineering technology, also experienced enrollment declines in its AAS-EET and BS-EET programs. At MSOE during the 1989-90 academic year, there were 17 AAS-EET graduates and 70 BS-EET graduates. These numbers decreased to 14 and 41, respectively, during the 1999-2000 academic year. These enrollment declines occurred despite a relatively healthy demand for graduates in Wisconsin between the recessions of 1992 and 2000.

The primary intention of the paper is to address how the WTCS and MSOE jointly addressed the enrollment difficulties through the development and implementation of statewide transfer agreements in EET. The transfer process that was developed was much more than simply a list of courses for which an AAS program must include equivalent courses. We have observed that students often find such course-based transfer processes uncertain and cumbersome. For example, there may be course combinations that satisfy the transfer requirements of one course. Often there is no transfer equivalent for a particular course. At its worst, the amount of transfer credit that the student receives depends on how aggressively the student negotiates with the individual who makes the transfer credit determination. In short, students often perceive course-based transfer processes lacking clarity and the opportunity for the initial development of a significant commitment to the program by the student is diminished. A considerable portion of the effort in the development of the statewide transfer agreements was expended on the process itself such that the transfer process enhanced student recruitment and retention.

We describe in this paper a two-plus-two (2+2) transfer agreement structure in Electrical Engineering Technology that has been established between eight two-year colleges in the WTCS and MSOE. Significant details are included to illustrate the operational principles within the transfer process. The historical backgrounds of AAS Electronics Technology programs in the WTCS and the EET program at MSOE are briefly examined to establish the context and motivation for the subsequent curriculum decisions and transfer-agreements development on a statewide basis. The AAS-EET curricula that were developed within the WTCS are described. Two transfer-strategic electronics bridge courses in the AAS-EET programs are examined because of the vital role of these courses in successful AAS-EET to BS-EET transfer.

The transfer agreements are examined to underscore many of the numerous issues that are important in transfer agreement operation. The recruitment and advising of potential BS-EET students are explained to demonstrate the interdependent roles of these two functions. Features within the plus-two (+2) BS-EET program, which are important to the transfer process, are described. Two transfer-strategic courses in the +2 BS-EET program are described in the context of the advising process. Finally, results of the development of the statewide transfer agreements between the WTCS and MSOE are examined. Details that are specific to EET programs and particulars of the transfer agreement are provided in the appendices.

Comprehensive program assessment processes are not described in this paper – this is a topic for a separate paper.

Background

The state of Wisconsin has several educational systems. The public baccalaureate and graduate programs fall under the University of Wisconsin (UW) system. The first two years of many of the UW academic programs are also available at the University of Wisconsin Colleges (two-year campuses), also public. The state also has 16 public two-year technical college districts, the Wisconsin Technical College System (WTCS), which focuses on preparing students for employment after one or two full-time years (or equivalent) of education. The trades, technician, and engineering technology programs form a major portion of the WTCS course offerings. Eight districts within the WTCS currently offer associate-level EET programs, as listed in Appendix A. There are also a large number of private colleges within Wisconsin. Milwaukee School of Engineering (MSOE) falls in the latter group and currently offers the only ABET-accredited baccalaureate EET program in Wisconsin.

A brief description of the historical setting is given to establish the context of the transfer agreements to be described. WTCS students have transferred from Electronics Technology (electronic technician) programs into the BS-EET program at MSOE for over 30 years. The typical transfer student into EET was required to complete several courses at MSOE to bridge the gap between the associate-level Electronics Technology program and the former AAS-level electrical engineering technology program at MSOE. Typically, the areas that students needed were in technical composition and/or speech, one year of calculus, advanced electric circuit analysis, advanced electronic circuit analysis, and appropriate electronic specialty courses at the AAS level. Then the student would continue to complete the baccalaureate-level EET requirements. Up to an equivalent of three full-time years beyond the Electronics Technology program completion was common for these students.

In 1994, a group of electronics faculty and administration in the WTCS began a series of statewide meetings to construct a set of common standards for core electronics areas in the associate-level Electronics Technology programs. An original motivation for this effort was to make the transfer process from district to district within the WTCS straightforward for electronics technician students. This group, the Statewide Electronics Leadership Team (SWELT), produced four sets of core competency standards in electric circuits, electronic circuits, digital electronics, and microprocessors/microcontrollers. All districts agreed to utilize these standards within the curricula of their electronics programs, although the course structure and allocation of competencies to courses were devised by each district. These standards were implemented in the late 1990s. The consistency and improvement of students who transferred into the BS-EET program were qualitatively observed by MSOE faculty who evaluated the transfer credit of students from these programs since implementation of the standards.

As stated previously, the national declining enrollment trend during the 1990s in associate- and baccalaureate-level EET programs also occurred in the corresponding programs in the WTCS and at MSOE. By 2000, several Electronics Technology programs in the WTCS had seriously low enrollments and some districts even terminated the program. The AAS- and BS-EET

programs at MSOE also had significant enrollment concerns as the declining trend continued. In contrast to the declining enrollments, the demand for electronic technician and EET graduates in Wisconsin, however, was still healthy (up to the recession in year 2000).

This history was provided to establish the context of the dilemma: Why were statewide enrollments continuing to decline while the demand for these graduates was stable (to year 2000)? The electronics faculty within the WTCS independently provided a crucial observation: a growing number of parents were reluctant to consider associate-level programs for their children because they *perceived* associate degree programs to be terminal. There was a further decline in BS-EET enrollments after the discontinuation of the AAS-EET degree at MSOE, but this was probably due in large part to the recession and to part-time students losing company tuition remission. The faculty and administration in the WTCS Electronics Technology programs and the EET program at MSOE were forced to conclude that the recruitment model at that time was deficient.

The change of paradigm that triggered the subsequent success in EET programs occurred when the following key decisions were made:

- 1) The WTCS shall offer AAS-EET programs that entirely complete the requirements of the first two years of the BS-EET program at MSOE.
- 2) MSOE shall offer only the junior and senior years of the BS-EET program (the “+2 BS-EET” program).

Hence, a two-plus-two (2+2) EET program structure was born on a statewide basis. This arrangement immediately addressed the AAS “terminal program” concern of parents. The WTCS and MSOE electronics faculty had already been cooperating for several years to enhance transfer, and this progress was judiciously implemented to form transfer agreements between WTCS AAS-EET programs in five districts and the MSOE BS-EET program in 2000-2001. Three more districts were added within the next two years.

The offering of AAS-EET programs under a formal 2+2 transfer agreement structure lead to WTCS enrollments in Electronics Technology programs (including the new EET programs) generally reversing the downward enrollment trend. WTCS enrollments in electronics programs actually increased in this first year of the transfer agreements. The enrollment and retention results are described in the Results section.

AAS-EET Curricula

The AAS-EET curricula in the WTCS are based on their Electronics Technology programs for electronic technician preparation. The SWELT standardization of core competencies in electronics, as described previously, resulted in the Electronics Technology curricula from different districts having common student outcomes despite having different curriculum organizations and courses. The crucial differences between the WTCS Electronics Technology curricula and the AAS-EET curriculum requirements resided in technical composition, calculus, and advanced electric and electronic circuit analysis. These requirements for EET replaced electives and other courses in the Electronics Technology curricula that were not required for the

AAS-EET program. This was a modest effort – the Electronics Technology core as established under the SWELT standards required little to no modification. Common core competencies among the different Electronics Technology programs in the WTCS were instrumental to the viability of the statewide transfer agreements in EET as well as preserving the immediate employability of the AAS-EET graduates, the primary objective of WTCS programs.

We comment on an interesting observation: several WTCS students choose to earn both the AAS Electronics Technology degree and the AAS-EET degree due to the approximately three-quarters commonality between the programs. A known reason for earning both degrees is the desire to expand job skills for immediate employment. We speculate other reasons of curricular availability when students are off-track and the relatively low tuition at the AAS level in the public two-year colleges.

The AAS-EET curriculum requirements for 2+2 transfer into the BS-EET program at MSOE were established and designated in the EET transfer agreements between colleges in the WTCS and MSOE. (The two-year colleges within the WTCS are hereafter referred to as “Technical Colleges.”) These requirements are listed in Appendix B. Students who take the AAS-EET curriculum prescribed in any of the transfer agreements *automatically satisfy* the +2 BS-EET program admission curricular requirements. Specifically, if all courses specified in the transfer agreement are successfully completed by the student with grades of C or above, and the student’s AAS-EET GPA is 2.75 or above, then the student has automatically satisfied the transfer admission requirements into the +2 BS-EET program at MSOE. This feature is particularly attractive to potential students and parents because the uncertainty of course-by-course transfer credit evaluation is removed. The student’s status as an on-track junior is guaranteed in this approach. Overall, the negatively-perceived “terminal program” concern was replaced by the positively-received bona-fide 2+2 attribute.

As previously stated, the particular AAS-EET curricula in the WTCS vary from college to college. Consult the web sites cited in Appendix A for the specific EET curriculum at each Technical College. A model AAS-EET curriculum that is representative of these curricula, but not identical to any one of them, is shown in Appendix C.

EET Electronics Bridge Courses

The courses that are unique to EET relative to Electronics Technology are now described. The technical composition course is available in all districts and just needed to be specified as a required course in the AAS-EET curricula. The calculus courses start with analytic geometry and progress through single and multivariable calculus. Typical coverage is contained in the first ten chapters of *Technical Calculus with Analytic Geometry*, 4th ed., by Peter Kuhfittig (Thomson-Brooks/Cole, 2006), for example. The development of the mathematical capability of students is essential to their success in the subsequent +2 BS-EET program.

The two other unique courses at the AAS-EET level are generically named DC/AC III and Electronic Circuit Analysis. These courses are called *electronics bridge courses*, because through them students extend their background and analysis capabilities in electric and electronic circuits from an AAS Electronics Technology level to the AAS-EET level. These courses were

incorporated into all but one of the WTCS AAS-EET curricula. The major topics in each course are listed in Appendix D.

The emphasis in both electronics bridge courses is on the development of significant results that are used in the applications, i.e., students learn the developments and derivation approaches as well as the applications of the significant results. This preparation is crucial to student success at the BS-EET level. These electronics bridge courses are the primary reason that the AAS-EET transfer students from eight different Technical Colleges have a consistent preparation, capability, and success in electric circuit analysis when they enter the BS-EET program at MSOE. It is worth noting that this common background among students who enter the BS-EET program at MSOE appears to promote communication, interaction, and bonding of the students to their colleagues, the EET faculty, and the college.

These electronics bridge courses have also been offered over Instructional Television (ITV) within the WTCS to support districts that have a low course enrollment in a particular term or to support evening offerings of the courses for those students who cannot attend day sessions. Instructional technology is effective to support statewide course offerings of relatively specialized courses such as the electronics bridge courses. Individuals interested in this instructional format should contact Richard Lokken (lokkenr@matc.edu).

Transfer Agreements

Currently there are 119 ABET-accredited baccalaureate programs in engineering technology that are categorized by ABET as being in the electrical discipline³. The web sites for the institutions associated with these programs were searched for the words "articulation" and "transfer," in an attempt to determine whether or not each of these programs had transfer/articulation agreements specific to the program (that is, in addition to the usual institution-wide policy on transfer of individual courses). Among these 119 programs, 31 programs had websites that referred to transfer/articulation agreements that were specific to the electrical-discipline engineering technology baccalaureate program. Of these 31 programs, nine programs had transfer/articulation agreements that were presented as course-based agreements, that is, lists of transferable courses specific to the electrical program. Another 18 of the 31 programs had program-level transfer/articulation agreements that cited *specific* AAS-level program(s) that *in their entirety* would transfer from *other* institution(s). The remaining four of the 31 programs had transfer policies that permitted *any* AAS-level engineering technology program (usually accreditation was required) to satisfy the first two years of the BS-level program.

The previous data suggest that program-level EET transfer agreements are relatively rare. Only 18 of the 119 baccalaureate programs investigated have the type of transfer/articulation agreements that cite specific AAS-level program(s) that would transfer in their entirety from other institutions. This paper describes the innovative transfer agreements developed by the WTCS and MSOE, which are program-level agreements, and explains the benefits of this type of transfer agreement. We believe other engineering technology programs could benefit from agreements of this type.

The transfer agreements developed jointly by the WTCS and MSOE were developed to transfer each of the applicable WTCS AAS-EET programs *in its entirety*. Students in the AAS-EET programs know that if they meet the requirements of the AAS-EET program for transfer into the +2 BS-EET program, they can then enter the BS-EET program as on-track juniors. This type of process minimizes the uncertainty that students often have when transferring between institutions that do not have a transfer agreement, and eliminates the effort required to identify courses at the first institution that will satisfy a list of courses at the second institution.

The transfer agreements are in effect for one year and are *renewed annually*. This requirement forces the faculty at each Technical College and MSOE to meet and review assessment data, consider changes, update contact information, etc., and is a primary guardian against curricular drift. Once the transfer agreements are updated, appropriate administrators and faculty approve and sign them. This last step serves as a periodic reminder of the transfer agreement to administrators who are not exposed to it on a daily basis.

The EET transfer agreement document is organized into the following primary sections:

- Title Page/Purpose
- Requirements for Admission into the +2 BS-EET Program
- Technical College AAS-EET Course Listing
- Provisions
- Reverse Transfer Credit Listing (+2 college to the Technical College)
- Institution-Specific Information
- Guidelines for use of the +2 BS-EET Institution Name and/or Logo
- Signature Page

These transfer agreement sections are described in detail in Appendix E. Such details are quite particular to the specific academic programs and secondary to the fundamental transfer agreement process. However, they are essential to the long-term success of the student transfer process and associated relationships between the institutions/programs. The *Provisions* section incorporates several of the detailed procedures in transfer agreement operation.

There are several formal mechanisms by which faculty and administration between the institutions meet to address transfer agreement issues. One mechanism is via the visits by +2 BS-EET faculty to the Technical Colleges (described later). Another mechanism is via the statewide meetings that are formally arranged by the Wisconsin Technical College System Board. Faculty from all of the WTCS districts that offer electronics programs meet on statewide issues and trends as they relate to AAS-level electronics programs. The +2 BS-EET faculty have been graciously invited to participate in these meetings since the late 1990s, which they have. Finally, the AAS-EET and +2 BS-EET faculty have called statewide EET-specific meetings, often annually, to address both macroscopic and detailed program and transfer issues. We remark that we often look forward to these meetings because we not only have another opportunity to visit each other in person, but the generation of new ideas is truly stimulating.

Plus-Two BS-EET Student Recruitment and Advising

The operations of +2 BS-EET student recruitment and advising are grouped together because they occur together. Formal recruiting for the BS-EET program usually begins with presentations to AAS-EET students at the Technical Colleges. Personnel, usually faculty, from the +2 BS-EET institution present to AAS-EET students in an appropriate classroom setting (lecture or laboratory, at the AAS instructor's discretion) at the Technical Colleges. The presentation is guided using a computer slideshow, but the presenter encourages interaction with the student audience. The presentation is somewhat generic, i.e., it covers issues that students should address if they are considering to continue their education beyond the AAS degree. Major issues addressed in the presentation, adapted as necessary to the particular audience, include:

- The presenter's background – begins the student bond to the +2 BS-EET program
- Transfer agreement concept, process, and admission requirements
- The transfer process: application, transcripts, transfer evaluation, academic plan
- Financial aid process (especially important for private colleges) and transfer scholarships
- Overview of the +2 BS-EET curriculum, including a few samples of topics with which the AAS-EET student can relate
- Scheduling logistics and program features – again, strategic information that continues to build the student bond to the BS-EET program through familiarity
- Student organizations at the +2 BS-EET institution and the importance to be involved in them (usually, this is an “eye-opener” to AAS-level students)
- Short summary of the highlights of the educational environment at the +2 BS-EET institution
- An explicit invitation to the next open house at the +2 BS-EET institution

Handouts during the presentation include the +2 BS-EET curriculum tracks, a promotional brochure on the college and program, a sheet that lists open house dates and logistics, and a permission form. The purpose of the permission form is for students to give permission to the appropriate faculty and administration at both institutions to exchange information and records, and to discuss the student's situation, for the purpose of transfer evaluation and program improvement (especially assessment results and samples of student work). This communication is especially important for students who have transfer credit from other institutions and/or those students who have taken different courses to satisfy the AAS-EET requirements in order to validate them for the BS-EET requirements. The student and both institutions each receive a copy of the permission form. The form satisfies FERPA requirements. To date, among the students who have expressed interest in transfer, none has refused to sign the form.

Sometimes, as time permits, the +2 BS-EET faculty presenter will give a sample lecture on an electronics topic that the students are actively studying at the Technical College. This straightforward action influences many students in the viewpoint that the +2 BS-EET program is not an unconquerable obstacle but instead a program in which they can succeed, a program that continues and extends the applied learning style to which they are accustomed, and even a program that they could enjoy. The bonding to the +2 BS-EET program continues.

A question on the differences between engineering and engineering technology often arises. The classroom presentation is a good time to address this issue. A page from the MSOE academic catalog, also available on the web, is utilized (<http://www.msoe.edu/eecs/et/EngVsTech.shtml>).

After the presentation, the faculty from the +2 BS-EET program is available for individual student advising. It ranges from simple answering of other questions to comprehensive academic advising for those students who are about to enter the +2 BS-EET program. In other words, BS-EET students usually receive their initial academic advising on the premises of the Technical College. This routine not only continues the student bonding to the +2 BS-EET program, but it strengthens the assertion that the AAS-EET program and BS-EET program have indeed coordinated a seamless 2+2 transfer process.

Thus, the classroom presentation serves as a strategic vehicle to promote bonding of the AAS-EET students to the +2 BS-EET program as much as it serves as an efficient information distribution mechanism. We find this approach as the most effective recruitment tool into the +2 BS-EET program. However, a portion of faculty load is required to implement this recruitment approach.

We remark that some time during the visit to the Technical College is set aside for the faculty from each institution to meet and discuss assessment data, potential curriculum and course changes, trends, program promotion, etc. The visit is essential to both recruitment and maintaining effective program relations.

Students who transfer to the BS-EET program again receive academic and “other” advising when they attend the first advising session for new students, usually during the summer. This pre-enrollment advising is usually a formality: checking of final transcripts to confirm all BS-EET admissions requirements are met, instructions on what to do if the requirements are not yet complete, and registration. The students receive their class schedules for the first term. The “other” advising especially becomes important during this advising session. It usually covers the non-academic logistics of attending college: housing, parking, books, initial time management planning, a visit to the financial aid office, etc. This information is crucial to student retention for non-academic reasons. The next usual advising occurs in a transfer orientation seminar and in the first technical course, both of which are described in the next section.

Plus-Two BS-EET Curriculum Features

The +2 BS-EET program at MSOE is a junior and senior years-only EET program. As previously documented, the student who enters this program has completed the AAS-EET degree requirements, usually at one of the eight Technical Colleges. Detailed information on the +2 BS-EET program, curriculum tracks, and courses at MSOE are accessible at <http://www.msoe.edu/eecs/et/>.

The +2 BS-EET program is offered on both a full-time track and a part-time track. The courses required are identical on both tracks. Both tracks are currently offered on an evening basis (defined as 5:00 p.m. and later). The course offerings for the +2 BS-EET program are primarily during the evening because the current enrollments are not large enough to support offering

separate day sections of courses for full-time students and evening sections for part-time students, and because most part-time students work during the day.

The full-time track requires two full-time academic years to complete. The part-time track requires four part-time years, including one course per summer, to complete. The term and evenings in which each course is scheduled are fixed. The courses on the part-time track are scheduled on the same evenings throughout any given academic year, thus permitting part-time students to plan their academic year well in advance. There is good balance between lecture and laboratory each term. These features are especially important time-management advantages to part-time students, who are generally employed full-time and often have families.

The full-time and part-time tracks are offered *simultaneously*, i.e., any particular non-elective course offering serves both full-time and part-time EET students on the same days and times. This feature placed a constraint on curricular layout in the sense that all course prerequisites must be met simultaneously in both tracks. We suggest two guidelines to simplify curricular layout. First, eliminate helpful but unnecessary prerequisites. Fewer prerequisites lead to fewer convoluted prerequisite scenarios. Second, arrange the tracks such that when the junior year in the full-time track is completed, the first two years of the part-time track are completed (this should automatically occur if the tracks are offered simultaneously).

Two Transfer-Strategic BS-EET Courses

Two courses in the +2 BS-EET program are discussed here due to their strategic role in the transfer process. The first course, a transfer orientation seminar (OR-307S), is typically offered in seven hours on the Saturday at the end of the first week of classes. The purposes of the course are for students to develop good familiarity with the institution, appropriate personnel, and procedures without which students often quickly develop great frustration, and to continue the bonding process of the student to the institution. The typical major topics include:

- Introductions to each other and the faculty present
- Explanation of the differences between engineering and engineering technology
- Library tour and explanation of library policies, procedures, and resources
- Computer account login and email setup, if necessary, to insure that all students have computer network accessibility (one of the otherwise greatest sources of student frustration)
- Campus resources and offices pertinent to the student
- Academic and time management skills
- Diversity

The *Introductions* serve to remind each student that they are “not alone” – there are many transfer students at MSOE. This course is required but offered at no cost to transfer students. The course includes a lunch that is sponsored by the Tau Alpha Pi chapter at MSOE. Members from other student organizations are also available during the lunch so that the new transfer students can meet and interact with current students as well as learn about some of the student organizations. Survey results from the students have indicated that this course is valuable in their transition to the university environment.

The second transfer-strategic course (ET-3051 Signals, Circuits, and Systems I) is the first technical course that all EET students who enter the program take, whether on the full-time or the part-time track. The instructor begins the course with inquiries to insure that all students have addressed their logistics requirements, such as laptop computer account setup and software loading, as well as referrals to appropriate individuals or offices for parking, access cards, and the like. The initial attention to the logistical needs of the EET students that occurs in pre-enrollment advising sessions, in the transfer orientation seminar and in this first technical course has virtually eliminated front-end student attrition due to non-academic reasons. Furthermore, these courses appear to further strengthen the bond that the students develop to their colleagues, the EET faculty, and the institution, all significant factors in retention.

A second aspect of the transfer-strategic nature of this first technical course is academic. In this course, students must integrate their previous learning from the electronics bridge courses that were taken at their AAS-level colleges. Besides being an inherent concept reinforcement vehicle, this course serves as the primary bridge from the electronics bridge and calculus courses that were taken at the AAS-EET level to the +2 BS-EET curriculum. Numerous EET students have told their instructors that in this course they realized that they were “in the right place,” that they could “handle” the academic rigors of a BS-EET program, and that they were committed to completing the program. Although anecdotal, such comments have been numerous and the retention results to date clearly support the value of these two courses in that regard.

Results

Although the AAS degree programs in Electronics Technology within the WTCS have continued to decline in enrollment between 2001 and 2005 (headcounts of 655, 649, 568, 470, and 440, chronologically), the AAS degree programs in Electrical/Electronics Engineering Technology (EET), which have been included in the 2+2 transfer agreements since 2000-1, have had significant enrollment growth that *exceeds* the decline in Electronics Technology enrollments. Over this same period, the EET enrollment headcounts were 108, 221, 308, 472, and 514. This trend indicates an increasing attraction to the WTCS AAS-EET programs, which have transfer agreements to the MSOE +2 BS-EET program. Thus, the total enrollments of both AAS programs together have increased from 763 to 954 in five years. In addition, the approximate three-quarters overlap between these Electronics Technology and EET programs has resulted in relatively healthy enrollments in the courses common to both programs.

During 2003-4, the average annual starting salary for the 65 WTCS Electronics Technology graduates was \$28,079, and the average starting salary for the 41 AAS-EET graduates was \$32,000.

In fall of 2003, the first year of EET transfer students from AAS-EET programs under the transfer agreements, ten of the 17 WTCS AAS-EET graduates from 2002-3 started with junior standing in the +2 BS-EET program at MSOE. In addition to these ten new transfer students, thirteen returning MSOE students having junior standing continued their studies following essentially the same program path as the ten new transfer students. This resulted in a total of 23 EET students starting the +2 BS-EET program at MSOE at the beginning of the junior year, and

allowed comparing new transfer students with returning MSOE students. The purpose of this comparison was to assess the extent to which the WTCS AAS-EET programs were able to provide a preparation equivalent to that which was in the past provided by MSOE. The performance differences in exams, assessment homework, and laboratory reports *were insignificant* between the two groups of students. At the end of the 2003-04 year, only two of those 23 students had dropped from the program, and in both cases for nonacademic reasons. Since the fall of 2003, overall attrition has been five to ten percent each year, again with no student attrition due to academic reasons.

In fall of 2004, 24 students, including 21 of the 41 WTCS AAS-EET graduates from 2003-4, started in the +2 BS-EET program at MSOE. In fall of 2005, 24 students, including 20 of the 51 WTCS AAS-EET graduates from 2004-5, started in the +2 BS-EET program at MSOE. Most of the AAS-EET graduates who did not transfer to the BS-EET program at MSOE sought full-time employment. It appears that the plus-two mode of the BS-EET program will continue to be viable with respect to enrollment numbers.

The first BS-EET graduates from the 2+2 EET program under the transfer agreements graduated in spring 2005. All of the transfer students in this group were successfully employed in a position in their field within the standard six-month window following graduation. The overall placement rate of BS-EET graduates from MSOE for 2004-5 was 92 percent (one student was not placed). The average annual starting salary was \$48,000 (\$44,000-\$54,000). These results compare favorably with pre-transfer agreement BS-EET graduates: the overall placement rate of BS-EET graduates from MSOE for 2003-4 was 89 percent (one student was not placed). The average annual starting salary was \$46,375.

Conclusion

The decline of enrollments in AAS Electronics Technology programs and a BS-EET program in Wisconsin was reversed through the development and implementation of statewide transfer agreements in Electrical Engineering Technology. The 2+2 transfer agreements removed the “terminal degree” perception at the AAS level, the major difficulty to healthy Wisconsin Technical College System Electronics Technology enrollments. Adoption of core electronics competencies among the various districts of the WTCS was instrumental to transfer agreement formation on a statewide basis. Despite different curricula, the eight AAS-EET programs in the WTCS all completely fulfill the transfer requirements of the BS-EET program at MSOE. AAS-EET graduates from the WTCS transfer to the +2 BS-EET program at MSOE as on-track juniors. Two AAS-level electronics bridge courses have proven to be indispensable to the success of AAS-EET transfer students in the +2 BS-EET program.

The transfer agreement document is a roadmap to the operations and policies that govern the transfer relationship. The annual renewal of the transfer agreements is central to sustaining an ongoing dialog among the EET faculty as well as maintaining awareness of the EET transfer agreements at an institutional level.

We have found that classroom visits and presentations by BS-EET faculty at the Technical Colleges are a highly effective means to recruit AAS-EET students into the +2 BS-EET program.

Conducting initial academic advising during the visit further helps to build the bonding of the student to the +2 BS-EET program and institution. It is convenient to also hold meetings between the AAS- and BS-EET faculty during these visits.

The +2 BS-EET program at MSOE receives well-qualified AAS-EET graduates from the Wisconsin Technical College System, who have a relatively consistent preparation for the program. Pre-enrollment advising, a transfer orientation seminar, and a strategic first technical course are important to high retention. A +2 BS-EET curriculum can be organized to accommodate both full-time and part-time students simultaneously in an effective manner. The transfer and operational practices described in this paper have led to virtually zero attrition due to academic difficulties and/or dissatisfaction with the transfer process to the +2 BS-EET program.

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Appendices

Appendix A Wisconsin Technical College System (WTCS) Districts that offer Electrical Engineering Technology (EET) Programs

Table A.1 WTCS Districts that offer EET in Wisconsin

District in the WTCS	Location that offers EET	Current EET Program Web Address
Chippewa Valley Technical College (CVTC)	Eau Claire (Gateway*)	http://www.cvtc.edu/apps/catalog/proginfo.asp?program=10-662-1
Fox Valley Technical College (FVTC)	Appleton	http://www.fvtc.edu/areasofstudy/?ID=tp7.asp%3FID%3D10-662-1%26YEAR%3D2006
Gateway Technical College (GTC)	Racine	http://cws.gtc.edu/programs/eleceng/eet_home_page.htm
Madison Area Technical College (MATC-Madison)	Madison	http://matcmadison.edu/matc/ASP/showprogram.asp?ID=2943
Milwaukee Area Technical College (MATC-Milwaukee)	Milwaukee (West Allis)	http://www.matc.edu/documents/catalog/Electronic_Engineering_Technology_AAS_Degree.html
Northeast Wisconsin Technical College (NWTC)	Green Bay	http://www.nwtc.edu/Programs/PDFs05-06/Electrical_Engineering_Technology.pdf
Waukesha County Technical College (WCTC)	Waukesha (Pewaukee)	http://www.wctc.edu/web/areas/electronics/elecengineer/elecengineer.php
Western Wisconsin Technical College (WWTC)	LaCrosse	http://learn.wwtc.edu/circuit/EDPrograms/programsp.htm

*Not to be confused with Gateway Technical College

Appendix B Requirements for Admission into the Plus-Two BS-EET Program

The curricular requirements for transfer are designated as “Topical Areas for Competencies Required for Admission into the MSOE +2 EET Program” in Table B.1. The specific wording for the actual competencies is contained within the course documentation at each Technical College, but they all follow the SWELT guidelines in the core electronics courses. The typical AAS-EET program in the WTCS currently has 70 semester credits, 69 of which are listed below (one credit is classified as “other”).

Table B.1 Topical Areas for Competencies Required for Admission into the MSOE +2 BS-EET Program

Item	Topical Area [typical number of semester credits]
1	Written Communication [6] a) written composition b) technical reporting c) laboratory reports [embedded within required coursework]
2	Mathematics a) trigonometry [4] b) algebra [4] c) calculus (single- and multi-variable) [8]
3	Social Sciences [6] a) psychology b) sociology
4	Economics [3]
5	Science: physics of mechanics and heat [3]
6	DC/AC Circuits and Circuit Analysis Techniques a) basics through series-parallel circuit analysis, including superposition [6] b) advanced basics through nodal, Thevenin, Norton, and complex power (see bridge course DC/AC III) [3] c) frequency response analysis, including steady-state transfer functions and Bode plots (first-order circuits only); (see bridge course Electronic Circuit Analysis) [3]
7	Electron Devices and Electronic Circuit Analysis a) diodes, BJTs, FETs, OP-AMPS, other linear ICs [7] b) bias and small signal analysis, including equation development (see bridge course Electronic Circuit Analysis) [credits are in item 6c]
8	Digital Electronics [4]
9	Microprocessors/Microcontrollers: architecture, assembly language programming, interfacing [5]
10	Electronic Communications: basic concepts (BW, spectra, etc.), AM, FM, basic digital communications [4]
11	Electric Power/Controls: three-phase, transformers, motors, generators, PLCs [3]
12	Computer Literacy [embedded within required coursework] a) Windows OS, wordprocessor, and spreadsheet b) circuit simulation (currently MultiSIM or PSpice) c) assembly language programming (in item 9)

Appendix C Representative AAS-EET Curriculum

Table C.1 Model AAS-EET Curriculum in the WTCS

Semester	Course Title	Credits
1	Digital Electronics	4
	DC / AC I	3
	Intermediate Algebra/Trigonometry	4
	Written Communications	3
	Sociology	3
	Electronic Fabrication, Software Apps., or other	1
	Semester Total	18
2	DC / AC II	3
	Electronic Devices I	4
	Pre-Calculus	4
	Technical Reporting	3
	Economics	3
	Semester Total	17
3	Electronic Devices II	3
	Microprocessors	5
	DC / AC III (electronics bridge course)	3
	Calculus I	4
	Physics I (mechanics and heat)	3
	Semester Total	18
4	Electronic Circuit Analysis (electronics bridge course)	3
	Motors/Generators/PLCs	3
	Electronic Communications	4
	Calculus II	4
	Psychology	3
	Semester Total	17
AAS-EET Program Total		70

Appendix D Electronics Bridge Courses in the WTCS AAS-EET Programs

Representative coverage, both topics and depth, for all topics in the two electronics bridge courses (see Table D.1), except the last topic in each course, is reflected in chapters 9 through 16 of *Contemporary Electric Circuits—Insights and Analysis*, 2nd ed., by Strangeway, Petersen, Gassert, and Lokken (Prentice-Hall, 2006).

Table D.1 Major Topics in the WTCS EET Electronics Bridge Courses

DC/AC III	<p>phasors, impedance, AC series-parallel circuit analysis (review; formalize complex number operations)</p> <p>superposition</p> <p>nodal analysis</p> <p>Thevenin's and Norton's theorems</p> <p>complex power</p> <p>ideal transformers</p> <p>three-phase (balanced)</p> <p>BJT and FET bias equations (including derivation)</p>
Electronic Circuit Analysis	<p>variable frequency circuit analysis</p> <p>transfer function development/manipulation into Bode form</p> <p>Bode plots of electric circuit frequency response</p> <p>resonant circuit analysis</p> <p>small signal BJT and FET amplifier analysis: gain, transfer functions, break frequencies, Bode plots of amplifier frequency response</p>

Appendix E Details of the Transfer Agreement Organization

The *title page* contains the names of the two institutions and the purpose of the transfer agreement. The conditions for transfer included in the title page are:

- “In particular, any (name of the Technical College) student who
- a) successfully completes all courses in the Electrical Engineering Technology program at (abbreviation of the Technical College) with a grade of C or better (not C-) in each course,
 - b) successfully completes all other specified courses [such as those designated for elective slots] at (abbreviation of the Technical College), as defined in this transfer agreement, with a grade of C or better (not C-) in each course, and
 - c) meets the MSOE admission requirements for transfer students into the Electrical Engineering Technology program at MSOE, with a cumulative GPA of 2.75 or greater for full acceptance, or with a GPA of 2.50 to 2.74 for acceptance on probationary status,
- shall be admitted with junior status into the BS in Electrical Engineering Technology program at MSOE.”

The *Requirements for Admission into the +2 BS-EET Program* are the 12 items in Appendix B along with the course number(s) at the Technical College for the course(s) that satisfies each requirement. The *Technical College AAS-EET Course Listing* is the AAS-EET curriculum at the Technical College that automatically satisfies the curricular requirements of the transfer agreement. This page is especially useful for students – it gives them a straightforward roadmap to both the requirements for the AAS-EET degree at the Technical College as well as for transfer to the +2 BS-EET program at MSOE.

The *Provisions* section is the “fine print” of the transfer agreement. It generally has no effect on students who complete the AAS-EET program on a two-year full-time track, take all required courses, and meet grade and GPA requirements. Each provision is briefly described to underscore some of the issues that are involved in the operation of the transfer agreements.

1. Guidelines are provided for the use of the name of each institution by the other. The motivation is to insure that each college complies with accreditation and institutional criteria in promotional, advertising, and marketing media. Costly and/or embarrassing miscues are significantly reduced.
2. The effective period and annual renewal requirement for the transfer agreement are elaborated to account for the *two year lag* between when a student begins the AAS-EET program and when the student enters the +2 BS-EET program, and includes exception clauses such as changes in accreditation requirements.
3. The transfer policy is stated for students who complete the AAS-EET program over a period exceeding two years, and curriculum changes occur. Efforts are made to accommodate the student in the +2 BS-EET program, but junior status is not guaranteed.
4. The conditions and approval mechanisms for curriculum changes which could impact the transfer agreement during the annual period in which it is in effect are stated.
5. Permission is granted for promotion of the transfer agreement by +2 BS-EET personnel in appropriate Technical College classroom settings and other appropriate functions. This provision ensures access to the foremost recruitment pool for the +2 BS-EET program.
6. The personnel who may *formally* present the transfer agreement are specified to insure that the transfer agreement is accurately communicated to constituencies.
7. The right of each institution to access *appropriate* electronics instructional course materials of the other institution is established. The purpose is to assist faculty from both colleges in developing and maintaining their coursework to insure the appropriate topical coverage and depth for EET electronics courses as well as for ongoing assessment.
8. The qualifications of the AAS faculty who teach the electronics bridge courses are stated. The qualifications match those expected under TAC-ABET accredited AAS-EET programs.
9. The electronics bridge courses and calculus courses are specifically defined. Requirements for timed-examinations and delivery of assessment materials are specified. The intent is to insure that students are prepared to learn effectively in the university environment that exists in the +2 BS-EET program institution.
10. The approval mechanism of exceptions to the C or better course grade policy is established. The intent is to allow an “early” technical course with a passing grade below a C to transfer if the evidence in appropriate subsequent courses warrants the exception. No exceptions are permitted for the electronics bridge courses.
11. Cooperation between the two institutions on the assessment of student outcomes in order to further improve both EET programs and the transfer agreement is mandated.
12. Specified courses taken at the +2 BS-EET institution must be accepted for curricular credit at the AAS-EET institution if grades are C or above (“reverse” transfer credit). The intent is to facilitate coordination between the programs to help off-track students complete the AAS-EET degree.

The courses referred to in provision 12 are specified in a *Reverse Transfer Credit Listing* section in our transfer agreements. The *Institution-Specific Information* section lists the faculty and administration who are responsible for the operation of their EET programs, including those who make approvals per the *Provisions* section, along with contact information.

The promotion of the AAS-EET program to the public resides mostly with the Technical Colleges. The *Guidelines for use of the +2 BS-EET Institution Name and/or Logo* section is provided to assist the Technical Colleges in utilizing the +2 BS-EET institution name and logo in the development of promotional materials for the EET program.

The *signature page* lists the administration and faculty who formally approve or have a primary role in the transfer agreement. Typically, the college president, the academic vice-president, the dean/department head that manages the EET program, the head of admissions, and the EET program director (with whatever titles that represent these functions) are included for each institution.

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