AC 2011-570: A.A.S. + 2 = IOWA STATE UNIVERSITY BACHELORS OF ENGINEERING TECHNOLOGY: A IOWA GRASSROOTS SUCCESS STORY OF DEVELOPING A 2+2 FOR "CAREER TRACK" STUDENTS.

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AAS + 2 = Iowa State University Bachelors of Engineering Technology: A Iowa Grassroots Success Story of Developing a 2+2 for "Career Track" Students.

Abstract

The number of students currently enrolling in four-year programs in a computer-related area has not kept pace with the burgeoning demand for graduates. One potentially large, untapped, pool of students to fulfill the IT needs of industry by continuing their degree to a four year institution is community college students who have earned an AAS. The development of this 2+2 Computer Engineering Technology degree program to allow students who earn the AAS degree in a computer-related area and then come to Iowa State University to complete their four-year degree has been a cooperative effort between the 15 community college districts in Iowa and the ISU Department of Electrical and Computer Engineering. While the creation of a Computer Engineering Technology degree is not novel, the focus of ISU's program is on the ability to recruit and retain two-year community college students with AAS degrees is original. Unfortunately, students who elect to study a computer or information technology area and earn an AAS degree many times find themselves starting over again when they move on to a four-year institution. This is a historic artifact in which many of the courses do not transfer into a four-year institution's traditional computer-related degrees. The need for 2+2 degree programs for ASS students is evident not just in Iowa, but across the U.S. It is an emerging trend for high school graduates to stay locally and attend a community college as a lower cost alternative for entry into college. Additionally, ethnically diverse students, students with a lower socio-economic status and a higher proportion of females attend two-year institutions.

I. Introduction

Nationally the number of students entering into and completing degrees in science, technology, engineering and mathematics (STEM) areas is declining. These downward trends are significant and have been occurring over the past several years. A recent NAE report[1] noted that in addition to a declining number of students studying areas of basic scientific knowledge, the country is not producing enough professionals and skilled labor to apply technology in industry. The traditional computer-related college graduates with majors such as Computer Engineering, Computer Science, and Software Engineering are no exception to this large, overarching trend. While the bottoming out of student enrollment in computer science was documented in 2007 by Computer Research Association, the Fall of 2009 shows a hopeful 14% increase from that low.[2] However, this in no way offsets the shortage anticipated and, in fact, will take at least two to three years before these graduates are on the job market and even then there will be shortages of computer-related professionals for industry. Ironically this dramatic downward spiral in enrollment is occurring at the exact same time as the U.S. Bureau of Labor Statistics predicts computing will be one of the fastest growing U.S. job markets in the STEM areas for the foreseeable future; 71% of all new science or engineering jobs will be computing-related.[3] At the current rate of enrollments in computer-related areas, community colleges, universities, and trade schools are

not positioned to graduate the number of required candidates to fill new positions created by the projected job growth.[4]

Many institutions that offer Bachelor of Science degrees in Computer Science, Computer Engineering and/or Software Engineering programs focus on the theoretical foundations related to machine and algorithm designs and produce graduates who fill a need throughout the country in the design, engineering and development of new computer components, software, systems and products. However, in the light of an increasing demand and a declining pool from which to select, employers often indicate there is an unmet need for graduates with the technical and complex thinking skills necessary for careers in the design, application, installation, operation, maintenance and security of computer and/or network systems to support industry. While students who earn a two-year technical degree such as an Associates of Applied Sciences (AAS) in computer or information technology can meet some of these industry needs and can be technically competent, they do not have the full tool kit of engineering and complex problem-solving skills that employers desire.[5] Additionally, the learning outcomes for each two-year technical degree (AAS) are designated by their individual community colleges and focus primarily on installation and operation of technology. This creates an inherent gap between the AAS degree and articulation into a traditional 4-year Bachelor of Science degree. Both students and employers of the AAS students realize that they need something beyond the AAS degree to handle the complex systems used today, but the educational path for them to achieve this goal is not clearly defined or easy to follow. Additionally, the latest "Gathering Storm" report notes that today's work force must constantly be upgrading their skills sets to keep pace with the latest technologies that change every few years, if not every few months.[6] AAS students are no exception to this rule.

Unfortunately, AAS students often find themselves at a dead end when it comes to continuing their educational coursework beyond the two-year technical degree.[7] Historically the coursework completed in earning a two-year technical degree (AAS) does not transfer credit into four-year degrees. Many times students who hold a two-year technical degree in computer or information technology must begin their educational career again with few or no credit hours when entering a four-year degree program. Further, students may have earned a similarly titled two-year degree, but not all the coursework, learning objectives or student outcomes are equivalent across conferring institutions, especially when no outside accrediting body such as ABET is used. In Iowa there are 15 community college districts, each offering their own version of computer or information technology programs where the student earns an AAS degree. Although the Common Course Numbering Database was a project undertaken by the State of Iowa and the Iowa Department of Education to align all courses and programs offered across all 15 community college districts in the state, a review of the database demonstrated the courses for the two-year technical degrees (AAS) in computer or information technology are not in tandem and do not map well to traditional four-year degree programs in computer-related areas. This inconsistency in learning outcomes, as well as the gap between a two-year technical degree and entry into a four-year degree, is a nationwide problem for community colleges and has been documented by Orr and Bragg.[8]

In an effort to provide students who attend a community college and earn the two-year technical degree (AAS) an educational path to earn a four-year degree, Iowa State University (ISU) has

developed a Bachelors of Engineering Technology (BET) in Information and Computer Engineering Technology (ICET) which focuses on the application of scientific, engineering and business principles. It not only provides these students opportunities to continue on to a four-year degree through applying their previously earned degree, but also produces a more capable technology worker to support industry needs. ISU has partnered with the 15 community college districts in the state to develop this new degree program that, through a series of community college program evaluations, articulates students with a two-year AAS in computer or information technology into the four-year program. This paper focuses on the cooperative effort undertaken between the community college districts and the ISU Department of Electrical and Computer Engineering to establish this program, data in support of the program's creation, and the curriculum. It is divided into six sections: Introduction; Program Inception; Curriculum Development; Data from Students and Potential Employers; Lessons Learned; and Future Directions.

II. Program Inception

The development of the ICET degree was an outgrowth of several on-going projects underway at ISU. During the summers of 2006-2010 ISU hosted an annual Community College Summit to help strengthen relationships between ISU and the community colleges in Iowa. All Presidents and Academic Vice Presidents of the 15 community college districts were invited to the ISU campus where they participated in general and break-out sessions on academic and administrative issues, as well as discussed obstacles community college students face when continuing their education at ISU. The ISU President and the Provost devoted their entire day to participating in the event and discussing issues with the attendees.

In the summer of 2007 the authors of this paper were asked to attend the Community College Summit to present and discuss a program targeted at getting high school students interested in information technology (IT-Adventures). The IT-Adventures program is an innovative program dedicated to increasing interest in and awareness of information technology among high school students using inquiry-based learning focused on three content areas: cyber defense, game design programming and robotics. The target audience for this project is high school students, especially those students who previously have not exhibited an interest in studying IT, as well as high school teachers, not necessarily information technology teachers, who would like to enhance their skills and teaching abilities in the IT area. The program combines educational programming, competitive events and service learning projects to accomplish its goals.[9] The IT-Adventures program is one of the authors' responses to the original "Gathering Storm" challenge to increase the number of U.S. citizens to pursue a degree in a STEM-related. The IT-Adventures presentation was made to the community college attendees to encourage them to reach into their local high schools to encourage students to participate in the IT-Adventures program, to mentor high school students and to work with the authors in running regional events. The authors had hoped for one or two community colleges with whom partnerships were possible. Instead, after the hour-long presentation, the large outpouring of positive responses to the presentation and the requests to find ways to partner with the existing program made the authors very aware that the community colleges in Iowa were eager for information and were looking for linkages to ISU.

Further, in an afternoon breakout session with the Academic Vice Presidents the authors heard the attendees, both individually and as a group, express a need to have their IT students find a way to continue on to earn a four-year degree. Throughout the afternoon sessions, the authors continued to think what connections could be made with the community colleges, their instructors and their students. At the end of the day, the authors left the meeting trying to decide what was the best way to channel this extreme interest and excitement in engaging high school students in IT, as well as their interest partnering on a broader scale. After some brainstorming, discussion and debate over the next few days, the authors decided to host a Community College Cyber Defense Competition (CCCDC) in December of 2007 and invite all computer science, electronics and IT programs at the community colleges in Iowa to participate in the event. This was the first community college cyber defense competition held in the U.S.

In the CCCDC community college students design, implement and defend a network running real world services against a team of "hackers" on the ISEAGE Internet testbed. This testbed is non-portable and requires the college students to remotely connect into the environment to setup and configure their servers and services for approximately one month prior to the competition. Then, the students and their faculty member(s) travel to Ames to compete for two days defending their network from attacks. The CCCDC was created to challenge the community college students to solidify concepts learned in their classroom and laboratory exercises, as well as keep them interested and engaged in their chosen career track.[10] The fourth annual CCCDC was held December 3 & 4, 2010. While a blizzard caused several teams to have to cancel their planned trips, there were still 75 students in attendance and 15 teams representing 6 community college districts. This is the second time an ice storm or blizzard has occurred just prior or during the competition and the authors are planning to move the event forward in the academic calendar to avoid further weather related problems. Table 1 shows the four year participation in the CCCDC. On December 4 & 5, 2009, the third year of CCCDC competition, there were 19 teams with a total of 90 students participating. These 19 teams represented 10 community college districts or two-thirds of the 15 total community college districts in the state.

Table 1. Participation in the Annual Community College Cyber Defense Competitions

	Fall '07 *	Fall '08	Fall '09	Fall '10 *
Community Colleges	6/3	7	10	8#/6
Teams	7/4	9	19	19/15
Students	50/35	52	90	90/75

* The first major winter storm of the season limited participation. The first number is those who signed up and the second number is those who were able to attend.
# There were two faculty members who participated in 2009 whose personal schedules did not allow them to bring teams in 2010.

After the success of the first CCCDC, the authors of the paper continued to consider ways to solve the second request of the community college Academic Vice Presidents -- the need for their students to continue on to earn a four year degree. In light of the "Gathering Storm" report and the others cited above that document the number of students currently enrolling in four-year programs in a computer-related area has not kept pace with the burgeoning demand for graduates, it seemed there was a need to look for other, yet-untapped sources of students.

Logically, one potentially large, but at the same time very diverse, group is community college students. The number of students who are choosing to attend a two-year institution is on the rise. Nearly half of the undergraduate students enrolled in the U.S. were served by a community college. Community colleges also serve more of the underrepresented populations, both ethnicity and gender. Since 1985, more than half of all community college students have been women. In addition, the majority of Black and Hispanic undergraduate students in this country study at these colleges.[11]

Further, community colleges play a growing role in the education of high school graduates and provide a lower cost alternative for entry into college. Many states are implementing post-secondary education models that encourage high school graduates to enroll in local two-year community colleges so they can either join the workforce immediately after two years or go on to a four-year institution. Since it is an emerging trend for high school graduates to stay local at a community college as a lower cost alternative for entry into college, it is important that these students select a path to a computer-related career that allows them to continue on to earn a four-year degree. Unfortunately, students who elect to study a computer or information technology area and earn an AAS degree many times find themselves starting over again when they move on to a four-year institution. Historically, many of the courses do not transfer into a four-year institution's traditional computer-related degrees which are research and design focused. Because students at community colleges are more ethnically diverse and come from lower socio-economic status levels than the population at four-year institutions, it is the very unrepresented groups in STEM areas of study who can fall victim to this trap.[12] By providing an avenue for graduates with two-year technical degrees (AAS) to successfully continue their education to earn a four-year degree, the ICET program provides an opportunity to reach more underrepresented populations, specifically females and minorities, in a STEM area of study.

Like the national community college trends, in the Fall of 2010 Iowa community colleges saw an increase enrollment of 4.8% with four of the more urban community colleges seeing 10% increases in enrollment. This latest increase comes on the heels of a 14.3% growth in the Fall of 2009.[13] The Fall of 2009 increase represented the fastest growth spurt since 1975.[14] While the projection is for enrollments at community colleges in Iowa is expected to stay relatively constant or decrease slightly in 2011, across the nation community college enrollments are expected to continue to grow in 2011. Iowa community colleges also follow the national pattern of having a higher percentage of minority representation in their enrollments. While the 2008 US Census reported that 10% of Iowans were non-white, in the Fall of 2010 Iowa community colleges served 14.5% of students who are minorities as compared to the three state universities that have approximately 9% of their students who are minorities. Nearly 30% of all students enrolled in community colleges in Iowa are in a career and technical track. Additionally, in the career and technical education tracks at Iowa community colleges, females outnumber males in enrollment. At four-year institutions, it is well-known that males outnumber females in computer-related fields.

Because the AAS degree articulation into the traditional Computer Engineering degree offered by the ISU Department of Electrical and Computer Engineering would leave students needing at least an additional three years of coursework as shown in Figure 1, the authors began to explore

other possible degree types and majors that would enhance and build upon the skills and interests of the AAS students.

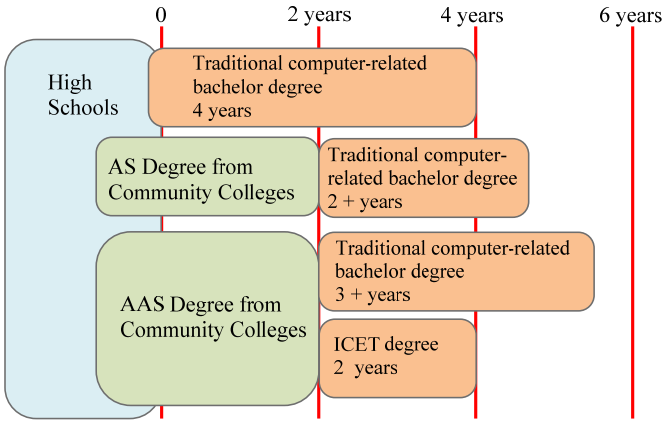

Figure 1. Time to complete traditional bachelor degrees in computer-related fields such as Computer Science, Computer Engineering and/or Software Engineering compared to Information and Computer Engineering Technology

Therefore, it was decided to create the new ICET degree that will be ABET accredited and is designed as a merger of the outcomes from both the Computer Engineering Technology criteria and the Information Engineering Technology criteria established in the ABET accreditation documentation.[15] A part of the program educational objectives for the new program states: "Graduates should establish peer-recognized technical expertise together with the skills to articulate that expertise and use it for problem solving in the design, application, installation, operation, and/or maintenance of computer systems, networks, associated software systems, including system development, integration and implementation, using contemporary practices." With its creation, we were able to find a possible 2+2 solution to the problem faced by those ASS students as shown in Figure 1.

A report jointly conducted by the Institute of Electrical and Electronic Engineers (IEEE) Computer Society and the Association for Computer Machinery (ACM)[16] graphically depicts the differences in curricula for five fields including Computer Engineering, Computer Science, Information Systems, Information Technology and Software Engineering. An augmentation[17] of this overview report further points out a gap in curricula content needed to supply the type of technology workers that is increasingly required by industry and argues that a Computer Engineering Technology degree fills this gap. It is this lack curricular area in which the ICET program fits.

Figure 2 shows the gap in student production and skill sets that currently is not be fulfilled with the traditional programs coming from two-year degree and four-year degree programs.

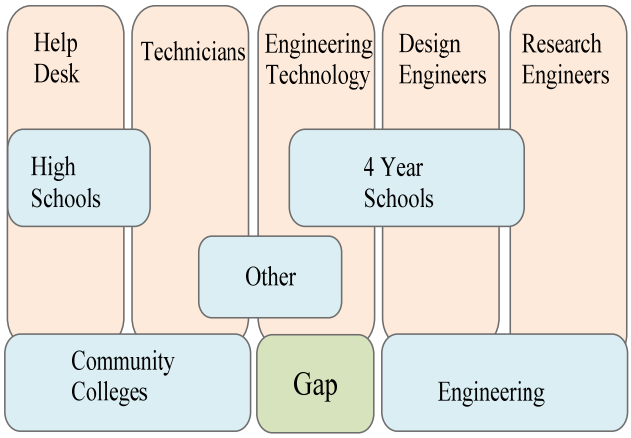

Figure 2. Gap in Production of Graduates

To validate our idea to create a new degree program, the authors engaged the information technology faculty at the Iowa community colleges to examine the 2+2 degree proposal and provide input into its creation. To facilitate this input and determine if there was interest to pursue the development of the ICET degree program, a workshop was held with the community college computer and information technology faculty. This workshop was concurrent with the second annual CCCDC in December of 2008. The faculty attendees encouraged ISU to pursue the degree and agreed to help develop the program as well as examine their own programs to ensure their students' success. While the authors had been thinking and focusing on currently enrolled students, the community college faculty highlighted another untapped group of potential students. Those who have graduated two to four years ago and were now looking for ways to improve their skills for promotion.

This encouraged the authors that the students, faculty and administrators of the community colleges were interested in the degree creation, but we needed to determine if there were employers looking for a graduate with these types of skill sets. The authors conducted a workshop in December of 2008 with major potential employers in the state. The workshop was funded by and co-sponsored with the Iowa Department of Economic Development. These potential employers were used as a focus group to begin a gap analysis of graduate skills, industry needs and learning outcomes. After initial work was concluded, the potential employers helped develop an online survey instrument that was electronically distributed to employers statewide. The information, which was collected over the Summer of 2009, demonstrated an unmet need by industry in the state for graduates with the ability to apply computer and engineering skills to business[5] and are discussed further in the Results Section of this paper.

In the December of 2009, a second workshop with community college computer and information technology faculty was held during the Third Annual CCCDC to report back on progress of the ICET degree and to continue to receive input and feedback on the curriculum. In January 2010, an articulation meeting was held to evaluate each community college's courses and learning outcomes and to map them to the ISU ICET courses. This same meeting also demonstrated the uneven learning outcomes and skill levels from different community colleges and brought to the front the need for bridge modules to be developed to help all students have equal footing when

they transfer into the program. The bridge modules which are under development are briefly discussed in the Future Directions section of this paper. A faculty workshop was also held in conjunction with the Fourth Annual CCCDC. A timeline that depicts the work to date is shown in Table 2.

Table 2. Work Completed on Information and Computer Engineering Technology Degree

	Yr 1	Yr 2			Yr 3			Yr 4		Yr 5	
	Su '07	Fa '07	Sp '08	Su '08	Fa '08	Sp '09	Su '09	Fa '09	Sp '10	Fa '10	Sp '11
ISU Community College Summit Presentation and Discussion	X										
First Annual Community College Cyber Defense Competition (CCCDC)		X									
Begin work on the Information and Computer Engineering Technology degree in ISU Department of Electrical and Computer Engineering			X								
ISU Community College Summit Presentation and Discussion				X							
Second Annual CCCDC					X						
CC Faculty Workshop - Continue development of Information and Computer Engineering Technology degree					X						
Workshop with major potential employers of new Information and Computer Engineering Technology graduates					X						
Creation of statewide survey of potential employers						X					
Conduct statewide survey of potential employers							X				
Third Annual CCCDC								X			
CC Faculty Workshop - Continue development of Information and Computer Engineering Technology degree								X			
Articulation agreement work with CCs									X		
Fourth Annual CCCDC										X	
NSF funded security training for CC instructors project										X	
Next phase of articulation with the CC										X	X

III. Data from Community College Students and Potential Employers

Students

As part of the Third and Fourth Annual CCCDCs, the students were given a survey to gather demographic information, their interests and their post-graduation plans. There were 80 students who completed the survey in December 2009 and 57 who completed in December 2010. Again, the reduced number in December 2010 was due to a winter storm that impacted the total attendance at the event.

As shown in Table 3, two-thirds of the students who participated in the CCCDC were second or third year students at their respective community college. Fifty percent of the students who completed the survey took four years of high school math, while an additional quarter took three years of math. While the number of years of math and science required courses to graduate high school can vary from school district to school district, the minimal number the state of Iowa

required was one year each in the 2004-2005 academic year but has increased to two each in 2010-2011 academic year. Additionally, at least two-thirds of participants in the CCCDC had taken three or more years of science in high school. These numbers show the students who participated in the CCCDC have taken above the state's minimum required number of math and science courses and are as prepared as other students in Iowa to continue to a four year degree program. Further, 50% of the students who participated in the CCCDC had a 3.00 or higher high school grade point average, while an additional 20% had a 2.67 average.

A majority of the students who completed the survey reported they were earning an AAS degree; in 2010 100% of the participants were AAS seeking students. In 2010 students were asked to rate on a 7-point Likert scale ranging from Strongly Disagree to Strongly Agree the likelihood that they would continue on to a four year college upon graduation from their community college program. Approximately half of the participants in the survey intend to continue their education to earn a four year degree. And additional 30% selected the neutral response category indicating they are undecided about whether they will earn a four year degree.

Table 3. CCCDC Student Demographic Information

Year in School	2009 (n=75)	2010 (n=57)
First Year	25 33.3%	17 29.8%
Second Year	37 49.3%	34 59.6%
Third Year	13 17.3%	6 10.5%
Degree Type	**2009 (n=75)**	**2010 (n=55)**
AAS	50 66.7%	55 100.0%
AS	21 28.0%	0
Other	4 5.3%	0
Intend to continue to a 4 year college upon graduation from my community college program	**2009 (n=79)**	**2010 (n=57)**
Strongly Disagree to Somewhat Disagree	17 21.5%	14 24.6%
Neutral	22 27.8%	17 29.8%
Somewhat Agree to Strongly Agree	40 50.6%	26 45.6%

Potential Employers

In the fall of 2008 the authors in conjunction with the Iowa Department of Economic Development held a workshop with representatives from several major potential employers in the state. The meeting was the beginning of a gap analysis to see what the industry needs and/or what is missing in the current graduates placed in their companies. Additionally, attendees were asked to forecast what type of skills an employee would need to have in 15 years. The goal of the exercise was to determine if and how a new proposed degree could be mutually beneficial to students seeking a four-year degree and employers wishing to hire them.

After the presentation and the initial work on the gap analysis, a group brainstorming session ensued which helped to sharpen the focus on the needed skill sets, as well as provided a rough outline of outcomes needed from courses in the new program. The outcome from this meeting was the development of an online survey that was administered to Iowa based businesses and industries to help determine the core competencies and the potential demand for the graduates.

Seventy-nine companies responded to the online survey which was administered during the summer of 2009. Figure 3 shows the type of industry for which the respondent worked.

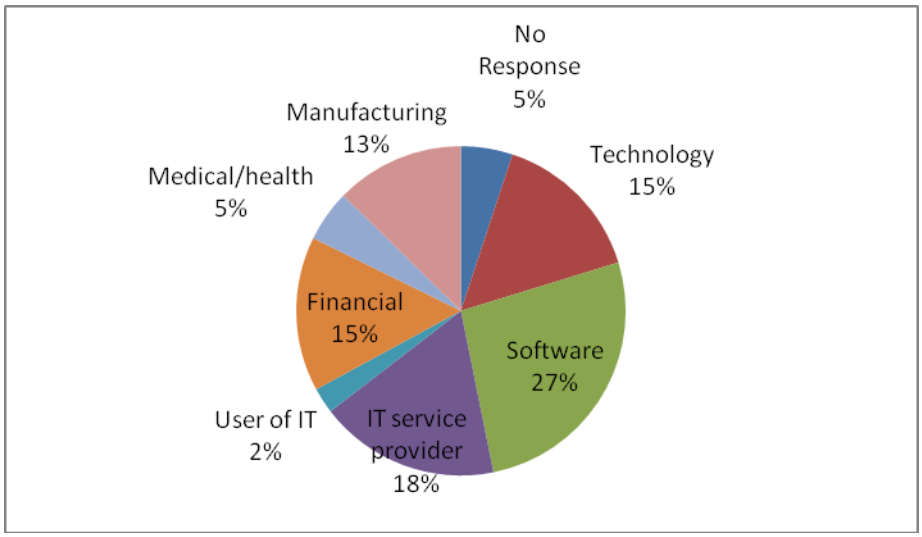

Figure 3. Type of Industry For Which the Respondent Worked

The Table 4 shows the summary of the skills desired by the companies grouped into three categories identified as important: personal, technical and conceptual. Interestingly, the highest scoring personal skills were ability to adapt and ethics, followed closely by the ability to collaborate. Security and infrastructure/networking were the top rated technical skills employers were looking for, while problem-solving abilities were the top ranked conceptual skill employers valued. A theme among both the personal skills and the conceptual skills was the ability to think on their feet and solve the companies' problems which are the skills a 2+2 degree can offer an AAS student. The company representatives were also asked to provide feedback on possible focus tracks for the degree as shown in the table.

Table 4. Skills Desired by Companies

		Minimum	Maximum	Mean
Personal Skills	Customer service	1	5	4.18
	Leadership	2	5	3.91
	Ethics	3	5	4.70
	Collaboration	2	5	4.57
	Privacy and Personal data	2	5	4.39
	IT not central to business	1	5	3.48
	Technical writing and communication	2	5	3.92
	Interview skills	1	5	3.16
	Life-long learning	1	5	4.04
	Ability to adapt	3	5	4.73
Technical Skills	Infrastructure and networking	2	5	4.10
	Process design	1	5	3.75
	Supporting legacy systems	1	5	3.23
	Interfacing old and new systems	1	5	3.59
	Implementation of package software	1	5	3.62
	Service oriented architecture	1	5	3.67
	Data mining and information handling	1	5	3.49
	Data structure and normalization	1	5	3.53
	Table driven design	1	5	3.30
	Security	2	5	4.41
Conceptual Skills	Organizational change	1	5	3.47
	Problem-solving	4	5	4.82
	Business processes and reengineering	1	5	3.68
	Systems Development Life Cycle	1	5	3.71
	Business continuity	1	5	3.89
	Disaster recovery	1	5	3.76
	Fault tolerance	1	5	3.73
	Total cost of ownership	2	5	3.68
Tracks	Networking	1	5	4.11
	Security	2	5	4.18
	Software programming	1	5	3.91
	Software application support	1	5	3.91
	General IT	1	5	3.94

The companies were also asked to provide estimates of the number of IT related jobs they are expecting to fill in the next five years and in the next five to 10 years. The Figure 4 shows the number of companies expecting to fill one of the job number ranges. For example, 53 companies are expecting to fill between zero and 25 positions within the next five years. It is important to remember, these numbers were collected during the summer of 2009 in a downward trending economy.

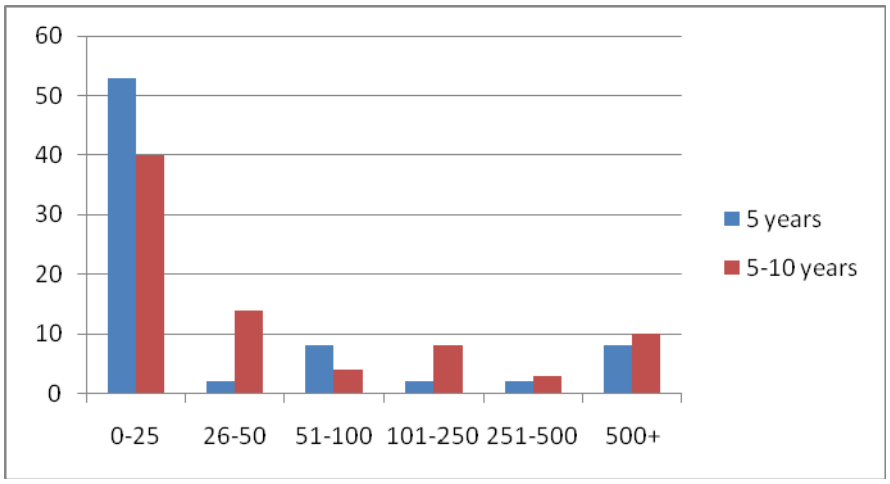

Figure 4. Number of Companies and the Number of Jobs Expected to be Filled

IV. Curriculum Development

After working with the focus group, evaluating the survey results and working with the community college faculty members, the following curriculum was developed. Table 5 is a listing of the courses in the ICET program. Courses with the notation (CC) are those which are able to be transferred into the ICET program from the Iowa community colleges with whom articulation agreements have been reached. Not all community colleges offer all courses to transfer in, so the articulation agreements are very specific to each school. Additionally, there are some objectives that need additional enhancement at certain schools and bridge modules, which are discussed in the Future Directions Section of this paper, are being developed to compensate for these short-comings. A number of the technical electives and the non ICET focused course will also articulate from the community colleges

Table 5. ICET Curriculum

Summary:

Credit	
48.5 (CC)	Non ICET focused (counts 10 credits of math & science taught by ECE)
48	Core
24 (CC)	Technical Electives
5	Required courses
126.5	Total

Core:

Number	Credits	Title
110	4	Numerical problem solving tools
171 (CC)	4	Engineering technology problem solving in a Windows OS environment
172 (CC)	4	Engineering technology problem solving in the UNIX environment
220 (CC)	4	Basic Networking concepts
231 (CC)	4	Circuits and Electronics for IT
240 (CC)	4	Computer systems and Architecture
250	4	Computer scripting
251 (CC)	4	Web Applications Development
241	3	Enterprise Computing
342	3	Virtual Resource Management
320 (CC)	4	Computer & network security basics
210	3	Mathematical Foundations of IT
211	3	Simulation methods for IT
CprE 281	4	Digital Logic
MIS 437	3	IT project management (MIS 437 Project Management)
MIS 433	3	Database systems (MIS 433 Database Management Systems)
Total	48	9 credits are counted as math & science

Required:

Number	Credits	Title
101	R	Orientation
166	R	Professional Orientation
294	R	Program Discovery (EE, CprE 294)
394	R	Mentoring (EE, CprE 394)
491	3	Senior design I (EE, CprE 491)
492	2	Senior Design II (EE, CprE 492)
494	R	Portfolio (EE, CprE 494)
Total	5	

V. Conclusions and Lessons Learned

The creation of this 2+2 degree program has been a cooperative effort between the 15 community college districts in Iowa and the ISU Department of Electrical and Computer Engineering. While the creation of a Computer Engineering Technology degree is not novel, the focus of ISU's program is on the ability to recruit and retain two-year community college students with AAS degrees is original. The long-term goal for this degree program is to allow students to earn their AAS degree in a computer-related area and then come to Iowa State with only two years of coursework left to complete.

As shown in the Results Section, the students who chose to earn an AAS degree have the necessary high school math and science courses, as well as high school grade point average, to continue for a four year degree and be successful in its pursuit. Additionally, half of the respondents intend to continue their degree, but, perhaps, have not looked beyond their current degree program on what earning a four year degree will entail. And, another nearly 30% are undecided about whether they will want to continue on to earn a four year degree. The need for 2+2 degree programs is evident not just in Iowa, but across the U.S. It is an emerging trend for high school graduates to stay locally and attend a community college as a lower cost alternative for entry into college. Additionally, ethnically diverse students, students with a lower socio-economic status and a higher proportion of females attend two-year institutions. The development of a 2+2 program is expected to increase access to four-year degrees in computer-related area for these populations of interest. Both students and employers want the technical skill sets and the problem-solving abilities a four year degree offers. Students who start at community colleges should not be penalized for their choice of computer and information technology degrees when they try to move on to a four year institution. With the addition of the ICET degree, ISU is creating a new paradigm for these students to continue their career path.

While the 2+2 degree program is workable, the diversity of student experience and the variance of learning objectives for the courses among the existing two-year technical degrees (AAS) in computer and information technology earned at Iowa community colleges was underestimated by the authors. The articulation work completed in January 2010 demonstrated the variety of course objectives and skill development that ranged from community college to community college. To ensure students who have earned a two-year technical degree are successful in their coursework in the ICET degree program, the following steps are being implemented as part of the program development and are discussed in the Future Directions Section.

- Transfer learning communities will be established and will emphasize team work, group projects and group activities to enhance students' social and educational lives within the University. Upperclassmen and faculty interaction will be a key focus of these learning communities to ensure successful transitions.

- Bridge modules need to be developed to help students who have not completed certain types of training at their college which are necessary to be successful in the degree program.

Additionally, it has become apparent to the authors that if the Iowa community college programs were ABET accredited it would make articulation easier and also help ensure the basic skills were covered so the dependence upon the bridge modules would be reduced.

VI. Future Directions

The need for a smooth transition for two-year transfer students to four-year degree programs is well documented.[18-23] However, much of this work focuses on students who earn Associates of Sciences degrees (AS) and started their two-year career with the intention to transfer to a four-year degree program. While it is possible to learn lessons from this work, work focused on the successful transfer of students earning two-year technical degrees (AAS) in areas such as computer or information technology is still in its infancy. [24-26] Because AAS degrees in computer or information technology are specific to operating systems and focus highly on laboratory and hands-on exercises, these students need their technical skills augmented with applied problem-solving in the technical areas, helping them transition from technical worker to complex problem solver. Additionally, because there are different learning outcomes in each of these technical degree programs at different community colleges, the students are not equally well-equipped to begin their work in the four-year degree program.

Two steps are currently being implemented to help AAS students be successful in their transfer from their community college experience to their ISU four degree program. First, transfer learning communities will be established. ISU has prior experience with learning communities and by emphasizing team work, group projects and group activities students' social and educational lives within the University are enhanced. Additionally, learning communities provide an opportunity for interaction with other upperclassmen, as well as faculty involvement and support.

Second, bridge modules are being developed to help students who have not completed certain types of training at their college which are necessary to be successful in the degree program. The bridge modules under development focus on preparing the student who has earned a two-year technical degree (AAS) in computer or information technology to enter the four-year ICET curriculum. The bridge modules are expected to promote preparedness for and success in their coursework for the students who complete them.

Additionally, discussions have begun about the computer and information technology programs at the community colleges in Iowa working on attaining ABET accreditation. These discussions took place at the faculty workshop held in conjunction with the Fourth Annual CCCDC and are preliminary at best. However, ABET accreditation of the two-year program enhances the ICET degree program and makes articulation at ISU more straightforward.

The creation and evaluation of bridge modules, as well as the implementation of a learning community specifically for the students who hold a two-year technical degree (AAS) into the Information and Computer Engineering Technology degree, are critical pieces in the success of the students earning their four-year degree, becoming a complex problem solver and providing industry with the type of technology workers desired. The addition of ABET accreditation for

the two-year programs would also add to the preparation of the students to come to ISU to earn their four year degree. The first transfer students are planned to be admitted for Fall 2011.

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