

The Pennsylvania Workforce Leadership Program in Computer Security

N. Paul Schembari, *East Stroudsburg University of Pennsylvania*

Abstract – As indicated in the National Strategy to Secure Cyberspace [1], one of the priorities of the United States is to grow and then maintain the number of skilled professionals in Information Assurance. In fact, such professionals are needed at all levels of industry – from those implementing our networks to those researching and designing the technologies. The National Center of Academic Excellence in Information Assurance Education, East Stroudsburg University of Pennsylvania, has partnered with the NSA recognized (IA-CMM) firm Backbone Security, Northampton Community College, Monroe Career and Technical Institute, and northeastern PA secondary schools to address this priority. With funding from the Pennsylvania Department of Community and Economic Development we have created our 2 + 2 + 2 Workforce Leadership Program in Computer Security, a six-year program from the junior year of secondary school through the Bachelor’s degree, focused on growing the IA workforce. In this paper we will give an overview of our program and discuss some of the challenges in its design and implementation.

Index terms – Computer Security, Information Assurance, Education, Secondary School, Community College, Undergraduate

I. INTRODUCTION

The Pennsylvania Department of Community and Economic Development (DCED) is one of the commonwealth’s departments which promotes employment and business growth especially in emerging fields such as information assurance (IA). As indicated from its web site, the goal of DCED is “to foster opportunities for businesses and communities to succeed and thrive in a global economy.”[2] To help further this goal, DCED created its Workforce Leadership Grant program [3, 4] which allows secondary and post-secondary educational institutions the opportunity to work collaboratively on curriculum and employment opportunity development in technology based industries.

N. Paul Schembari is a Professor of Computer Science and Computer Security at East Stroudsburg University of Pennsylvania and Director of the University’s Computer Security Program. He now serves as Technical Director of the Pennsylvania Workforce Leadership Program in Computer Security.

In 2003, East Stroudsburg University of Pennsylvania (ESU) partnered with the Pennsylvania company Backbone Security as well as Northampton Community College (NCC) and Monroe Career and Technical Institute (MCTI) in the establishment of our 2 + 2 + 2 Workforce Leadership Program in Computer Security (WLCS). In this model, the “first 2” consists of the junior and senior years of secondary school, the “second 2” forms the initial two years of college, either at NCC or ESU, and the “last 2” corresponds to the culminating junior and senior level Bachelor’s experience at ESU.

The uniqueness of this program is in its design of two tracks, Academic and Operational. The Academic Track is geared for students who wish to earn a Bachelor’s degree in Computer Security from ESU, and hence would complete academic courses through secondary school and college. In the last two years of the program, these students complete courses such as Security Engineering, Risk Analysis, and Applied Network Security, earning the CNSS 4011, 4012, and 4015 certifications [5] and leading to IA careers as security engineers. The Operational Track instead focuses on students who wish to find employment either after secondary school or community college. These students complete operational coursework leading to the Computer Technology Industry Association (CompTIA) certifications A+, Network+, Security+, and Server+ [6], and then onto careers as IA specialists.

Another unique aspect of the program is its articulation agreements. Because the coursework is carefully controlled, students at each level have the opportunity to earn credits at the next level. For example, a student in the Operational Track who completes the Network+ certification at the secondary school level will earn credits in NCC’s Operational Track. As a second example, a student in the Academic Track who succeeds in the Computer Organization course at NCC will receive appropriate credits at ESU. The articulation feature allows for a seamless transition from one level to the next.

In the sections that follow, we will discuss the experiences of the 2+2+2 Workforce Leadership in Computer Security participants by looking at each phase of the program. We will discuss our challenges and our successes. Finally, we illustrate the future plans of the

program. It is our hope that this type of program can be replicated across the nation.

II. WLCS – PHASE I

East Stroudsburg University began its computer security program in 1999 by offering its first IA courses. By 2002 it was graduating students with a BS in Computer Security, the first full Bachelor's degree in information assurance in the nation. This BS program is based in core computer *science* for the first two years of the undergraduate experience, and then moves into core IA topics, such as Security Engineering, Cryptography, Risk Analysis, Network Security, etc. For a full description of this program, see Schembari's paper [7] from the 2005 Colloquium for Information Systems Security Education.

In order to attract more students into ESU's BS program, it was natural for the university to form partnerships with local community colleges and secondary schools. The nearest community college to ESU is Northampton Community College (NCC), with campuses in Allentown and Tannersville, PA. Secondly, ESU is located in Monroe County, PA, and the county's vocational – technical school is Monroe Career and Technical Institute (MCTI). NCC and MCTI were obvious choices for ESU in helping to grow its computer security program.

A. Curriculum with Multiple Exit Points

In 2003, the ESU-NCC-MCTI partnership obtained funding through the PA DCED Workforce Leadership Grant Program. This program required the partners to create a curriculum program spanning six years – from the junior year of secondary school to the senior year of college. Furthermore, the curriculum was required to allow for student exit every two years. That is, a student should be able to complete two, four, or six years of education and be able to find employment. Other requirements placed by the DCED program on the designers included the fact that the coursework needed to be sequential and based on industry needs.

The WLCS leaders chose five representatives for curriculum design – Ronald Cudworth of MCTI, Keith Hartranft of NCC (Allentown Campus), N. Paul Schembari of ESU, Glenn Watt of Backbone Security, and John Whipple of NCC (Tannersville Campus). The choice of Glenn Watt from Backbone Security was the key element in ensuring that industry needs were addressed in all aspects of the curriculum.

Since the ESU curriculum in computer security is quite rigorous, the WLCS developers were faced with the challenge of creating a program which would help train students for a career as an IA specialist at the end of

secondary school or community college and at the same time educate students to be properly prepared for an academic university program. To solve this problem, we implemented two “tracks” into the WLCS. The “Academic Track” was designed for students who would be interested in pursuing academic courses in secondary school and during the first two years of college, and then complete the BS in Computer Security at ESU. The “Operational Track” was designed for students who would seek employment after two or four years in the WLCS. In the sections below, we only discuss the secondary school and community college curricula in these tracks since the ESU curriculum is given in Schembari's paper [7].

1. Secondary School Curriculum

For the secondary school Academic Track, the following goals directed development:

- Provide students with a sound educational base
- Prepare students to enter post-secondary education
- Promote life-long learning which will enhance students' ability to become a productive member of society
- Provide students with an introduction to computer security – an Awareness Level which creates a sensitivity to threats and vulnerabilities

With the above goals, the following secondary school courses were selected as part of the Academic Track to help prepare students for a rigorous technical university program:

- Communications
 - College Preparatory English 9 – 12
 - Public Speaking
- Business Curriculum
 - Everyday Law
 - Keyboarding
 - Computer Applications (Office, etc.)
- College Preparatory Science
 - General Science
 - Biology
 - Chemistry
 - Physics
- College Preparatory Mathematics
 - Algebra 1 – 2
 - Geometry
 - Advanced Math (PreCalculus)
- Computing / Computer Science
 - Computer Literacy and Usage
 - Introduction to Programming and Computer Security

With regard to the “Introduction to Computer Security”, the following topics were chosen to be included in the curriculum, keeping in mind the CNSS standard,

NSTISSI 4011 [5]: Computer Security Ethical Issues, Communications and Automated Information System Basics, Computer Security Basics, Threats, Vulnerabilities, Risks, and Countermeasures or Safeguards. The implementation of this introductory curriculum will be discussed below in the section on Phase 4 of the program.

The Operational Track of the WLCS was the portion of the curriculum designed to allow for multiple exit points – either after secondary school or at the end of community college. The secondary school goals of this track which lead curriculum development included:

- Gain the employment skills required for an IA specialist
- Perform the tasks and duties of an IA specialist at the approved industry standard level
- Perform computer security in a safe and ethical manner, following prescribed procedures
- Develop leadership, communication, and teamwork skills
- Build a basic security toolkit
- Create and deliver a presentation on a specific topic in the computer security industry, specifically related to PC security
- Have the opportunity to take an industry certification test or the computer science AP exam

To meet these goals, the “Computer Technology – Security” program at MCTI was created. It should be noted that the primary architect of this program was Ronald Cudworth of MCTI. This is a three-year program of instruction, conducted at the tenth, eleventh, and twelfth grade levels which allows students to be trained to meet multiple CompTIA standards. Students in this program proceed through classes which allow them to meet the CompTIA A+, Network+, and part of the Security+ standards. Hence, students in the MCTI Computer Technology – Security program are engaged with IA at two levels:

- Awareness Level: Creates a sensitivity to the threats and vulnerabilities of information systems, and a recognition of the need to protect data, information and the means of processing them; and builds a working knowledge of principles and practices in IA.
- Performance Level: Provides the student with the skill or ability to design, execute, or evaluate IA procedures and practices. This level of understanding will ensure that graduates are able to apply security concepts while performing their tasks.

2. Community College Curriculum

At Northampton Community College, an Academic Track and Operational Track were also designed. With the Academic Track, students can continue onto the ESU Computer Security program, and with the Operational Track students who are interested in employment after two years of college can join the workforce.

For the Academic Track, an alignment with ESU curriculum was needed. Since students in this track are planning transfer to ESU and continue in the BS in Computer Security program, students at NCC should complete the correct courses so that most would transfer. Since the first two years of the ESU BS in Computer Security are essentially a computer *science* program, the easiest method of alignment was with the NCC Associate of Science in Computer Science.

Because of the geographic proximity of ESU and NCC, these academic institutions had already worked together to align programs. Most of the programs’ co-requisite courses were already similar – Calculus courses were equivalent, Science courses with laboratory were equivalent, etc. With regard to the computer science curriculum, the two-year foundation of the ESU BS in Computer Security, three courses (twelve credits) were already aligned - ESU and NCC both offered a course in Introductory Programming and two courses in Data Structures. Other courses required at ESU during the first two years of the BS in Computer Security are Computer Organization, Assembler, and Operating Systems. NCC had a combined course in Organization and Assembler, but none in Operating Systems. It was decided to make a total of fifteen credits aligned, and so NCC made a change to their combined course (Organization / Assembler) to cover the appropriate topics to meet the requirements of the ESU Assembler course. Thus, the Academic Track at NCC was created to consist of courses in Introductory Programming, Data Structures (I and II), and Assembler, as well as co-requisites such as Calculus, Science, Technical Writing, etc.

For the NCC Operational Track, a new Associate’s degree was created – an Associate in Applied Science (AAS) in Computer Information Technology/Security (CITS). The main architects of this program were John Whipple and Keith Hartranft, both of NCC. The courses in this AAS degree were not intended to transfer to ESU, but some courses were possible for transfer *from* MCTI. This is because these courses were designed to meet the CompTIA certifications Network+, Security+, and Server+, course material which is also partially available in the MCTI curriculum. Hence, MCTI students who have completed the Network+ and Security+ certifications are able to attend NCC with college credits already awarded. In summary, courses at MCTI can transfer into

the NCC AAS degree in Computer Security, but these courses do not transfer to ESU.

The following goals for students lead the development of the NCC AAS CITS:

- Gain fundamental and comprehensive understanding of the current field of computer security upon which future growth within the field can be realized
- Have the computer competencies necessary to compete in the business world
- Use critical thinking to evaluate computer security problems and issues and explore options or their solution
- Use effective approaches for insuring computer and network security
- Gain experience in solving problems related to computer security and implementing their solutions
- Develop awareness of the ethical concerns and legal issues relating to computer security

The NCC AAS CITS was based on the existing NCC AAS in Computer Information Technology [8]. Using the courses required in the original degree, the new AAS now includes three courses in information assurance. Course descriptions are available from the NCC website [9].

- Introduction to Network Security
- Law and Ethics of Computer Security
- Measure/Counter-Measure

In summary, both an Operational Track and Academic Track have been created for students at NCC. Some courses in these tracks will transfer from MCTI and to ESU – at least fifteen credits available for transfer from each level to the next. It should also be noted that some students do take courses from both tracks based on their interests even though some of these courses do not transfer to the next level. When a student enters the next level without the necessary pre-requisites, any remediation that is necessary will occur at that level. For example, an Operational Track student at NCC can gain admittance to the ESU Computer Security major, but this student needs the Academic Track pre-requisites in order to be able to continue onto the Bachelor's degree. If the student has not completed the courses in Introductory Programming, Data Structures, and Computer Organization, these courses must be taken at ESU.

III. PA DEPARTMENT OF COMMUNITY AND ECONOMIC DEVELOPMENT REQUIREMENTS

To review, the WLCS Academic Track allows students to complete six years of academic coursework leading to a BS degree in Computer Security at ESU. The WLCS Operational Track allows students to complete two years

of computer security curriculum at MCTI leading to at least the CompTIA A+ and Network+ certifications. At NCC the WLCS Operational Track allows students to complete computer security courses leading to the CompTIA Security+ and Server+ certifications. With this design, we have been able to meet the commonwealth requirements that students are able to complete two, four, or six years of education and are then employable.

A. Sequential Curriculum Meeting Industry Needs

As mentioned above, requirements on the WLCS placed by DCED included the fact that the curriculum should be sequential and meet industry needs. With regard to sequential curriculum, it is clear from the structure of the WLCS that students must complete one level (secondary school or community college) before continuing onto the next level (community college or university, respectively). Second, meeting industry needs was accomplished by having Glenn Watt of Backbone Security as one of the curriculum architects. In fact, because of Mr. Watt's experience in curriculum design as part of the team who created ESU's BS in Computer Security, his expertise was invaluable. Furthermore, assessing industry needs with regard to the WLCS has been an ongoing process since 2003. The current efforts in this area will be discussed in the section below on Phase 5 of the program.

B. Articulation

Another DCED requirement included articulation among the three curriculum levels. As shown above, one method for meeting this requirement was with the use of CompTIA certifications. MCTI students in the Operational Track have the ability to complete the CompTIA A+ and Network+ certificates. Furthermore, MCTI is now expanding their coursework to include all of the Security+ certification. The completion of these certifications then allow for college credit to be awarded at NCC. In fact, with the correct combination of courses, students can earn at least 15 NCC credits while at MCTI. Other methods for articulation also exist. Since secondary school students have the ability to complete Advanced Placement coursework [10], completing the AP exams with a high enough score also allows for secondary school to college articulation. Of course, the AP course in Computer Science (A or AB) is the most recommended course for such articulation.

On the next level, articulation occurs between NCC and ESU. It should be noted that the courses designed for the Operational Track at NCC *do not* articulate to ESU. Articulation between NCC and ESU occurs as part of the Academic Track. The classes mentioned above at NCC as part of the AS in Computer Science are equivalent to

the courses in the first two years of the Computer Security Major at ESU, and so these fifteen credits can transfer. Also, AP credits and many general education credits articulate between NCC and ESU. In fact, because ESU is part of the PA State System of Higher Education (universities owned by the commonwealth), a comprehensive Academic Passport [11] exists which allows PA community college students to transfer up to 45 credits from NCC to ESU, especially for general education. Hence, students who have completed four years of our 2+2+2 program (secondary school and NCC) should have earned approximately 45 credits which are accepted at ESU. Students who intend to complete the BS in Computer Security must, of course, complete all requirements of this degree.

C. Certificates and Internships

PA DCED also requires Workforce Leadership programs to promote nationally recognized certificates and internships for students at all levels. We have seen how students at each level have the ability to earn nationally recognized certificates: secondary school students in the Operational Track can earn the CompTIA A+ and Network+ Certificates; community college students in the Operational Track can earn the CompTIA Network+, Security+, and Server+ certificates; and, ESU students earn the CNSS 4011, 4012, and 4015 certificates.

With regard to internships, here we have met one of our challenges. At ESU, internships are required of all Computer Security majors, and we have been able to place all of our students in such positions. However, at the secondary school and community college levels, internships have been hard to find. To meet this challenge, we are currently in the process of developing a *Career Recruitment and Internship Program* to allow students of all levels appropriate work experiences in computer security. The design of this program is in its early stages, so we cannot yet comment on success or failure.

D. Guarantee

PA DCED also requires its Workforce Leadership programs to “guarantee” the success of students. From the Workforce Leadership Grant Guidelines [12]:

“The guarantee or warranty shall provide for the retraining of individuals who become employed or who enroll in the next sequence of education, in the event of employer or institutional dissatisfaction. Thus, the guarantee or warranty is used to assure the academic and technical competence of

individuals who complete each sequence of the program.”

In order to provide this guarantee, the participants have included a 90-day evaluation period. If a student who has moved to the next educational level or is now employed is considered unsatisfactory during this review period, the previous institution will provide retraining. However, such retraining has never been used since 2003. We believe this is because of the fact that students entering employment are competent with regard to national certifications, and those proceeding to the next educational level have been deemed competent in rigorous coursework.

E. Outreach – Teachers and Students

As a final component of the WLCS program in 2003, it was imperative to foster both teacher and student involvement. In one area, we met a challenge, and in the other we met a success.

As curriculum designers and current or future teachers of the program, five professional were clearly already involved in the program – Ronald Cudworth of MCTI, Keith Hartranft and John Whipple of NCC, N. Paul Schembari of ESU, and Glenn Watt of Backbone Security, who taught classes as an adjunct at ESU. In order to involve other teachers, we thought it best to offer a short course covering introductory IA topics – the idea of “Training the Trainer.” This three-day workshop was offered during August 2003 with only a handful of teachers in attendance. Thus, our hope of involving many teachers was not realized. It is possible that this was due to the fact that the workshop was offered while school was not in session, but we cannot be sure. In the section below on Phase 2 of the WLCS, we discuss how this problem was addressed.

The second outreach component concerned student involvement. We obviously needed to get students interested in computer security so that they would enroll in our programs. To encourage student participation, we conducted multiple sessions with students and professionals. Some of these sessions involved professionals making presentations to students. Our most successful venture in this regard was the creation of a Computer Security Summer Camp. This four-day camp, offered mostly at the MCTI facilities, includes hands-on activities in computer security for secondary school students. Besides the involvement at MCTI for three days, on a fourth day students tour the security labs at NCC and ESU, with a hands-on presentation in cryptography at ESU. After an ESU-provided lunch, the students then tour the facilities at Backbone Security.

IV. PROGRAM EXPANSION

In each year since 2003, PA DCED has supported expansion of the WLCS program. This support has allowed the participants to involve more teachers, more students, create new educational opportunities, and continue the successful summer camp. In fact, in each year the Computer Security Summer Camp as described above has been offered to between twenty and thirty students. We now summarize each of the expansion phases of the WLCS, omitting further discussion of the summer camp. For a summary of the program and expansions as given by the PA DCED, see the 2+2+2 Workforce Leadership Grants Page [13].

A. WLCS – Phase 2: Academic Secondary School Involvement

In 2004, one of the major goals of the WLCS was to involve more secondary schools as part of the program. The natural choices were the secondary schools in Monroe County, PA (where ESU is located) including East Stroudsburg School District, Pleasant Valley School District, Pocono Mountain School District, and Stroudsburg School District. Further, because of previous contacts, we also included Delaware Valley School District in adjacent Pike County, PA.

To expand the program to include these school districts, the program implementers took each secondary school's curriculum and selected a "Career Pathway" to match the WLCS Academic Track. A Career Pathway defines the courses a student should complete while in secondary school to continue onto the specified career. Each secondary school was now able to use professionally recommended coursework as part of a Career Pathway in Computer Security. The coursework was selected so that students would be able to successfully continue in the WLCS and eventually complete the ESU BS in Computer Security.

Also with regard to secondary school outreach, we needed to solve the problem of secondary school faculty involvement. That is, we needed a method to bring our program to secondary school faculty and gain their interest with the hope that this would spread to the students. We decided that the best technique for such involvement was using teacher-in-service training. With the approval of the secondary schools' administrations, professionals provided teachers training in introductory topics in computer security with sample lesson plans that the teachers could use in their own classrooms. Topics covered included Password Security, Identity Theft, Malicious Code, etc.

B. WLCS – Phase 3: Promoting Student Involvement

Obviously, through the years the WLCS has promoted further student involvement. In 2005, a major push was made in this area with multiple visits by professionals to middle and secondary schools of the included school districts. During these "mini-camps," hundreds of students and faculty were exposed to topics in Computer Security, all with the goal of encouraging students to enter the field as part of the WLCS. Students and faculty learned and experienced introductory material with regard to the confidentiality, integrity, and availability of data, computer security risks, careers in computer security, computer attacks, computer security laws and ethics, etc.

One of the most successful sessions of this phase was a workshop at Pleasant Valley High School. Here, a total of approximately twenty Pleasant Valley teachers and students worked together to first build their own PCs, and then learn computer security topics in a hands-on manner with these PCs. For example, by the end of the session, the students and teachers were "sniffing" data with the PCs they had built.

C. WLCS – Phase 4: Online General Education Coursework

To continue the success of Phase 3, we planned to involve more students in the program, especially at the secondary school level. The method we chose was to allow students to complete college credit while still in secondary school, besides the already existing articulation in the WLCS. Furthermore, a course in University General Education would be useful in attracting students who might not have already chosen one of the tracks of the WLCS.

At ESU, for multiple years we have offered a general education course called PC Security and Privacy (CPSC 105), an IA awareness course [14]. This course is intended for first year college students with no prerequisites. In fact, any advanced secondary school senior should also be able to succeed in this course. Hence, it was decided to allow this course to be available to the secondary schools included in the WLCS.

A stumbling block with ESU course availability for secondary school students is commuting distance. One of the participants, Delaware Valley High School, is actually a one-hour drive from ESU. Clearly, ordinary classroom delivery would prohibit much student involvement. Hence, it was decided that this course should use a distance education delivery system to maximize secondary student participation.

As part of the WLCS during the 2006-07 academic year, the CPSC 105 course was updated so that it is now ready

for online delivery. This course is currently (AY 2007-08) in the process of being approved by ESU for distance education delivery, and it is hoped that the course will be offered in this manner in Fall 2008. The goal is to include students from each of the WLCS secondary schools as well as NCC as course participants. Furthermore, the online lessons are currently available for WLCS participants to use in their own coursework.

D. WLCS – Phase 5: Outreach and Internship Program

During the current academic year, the goals of the WLCS have been to continue our outreach and create an Internship Program so that employment experiences are available to students at all levels of the WLCS.

With regard to outreach, our objective is to work with secondary school guidance counselors to help more students become interested in IA as a career. An Outreach Committee has been formed consisting of secondary school teachers, administrators, and guidance counselors, along with staff from MCTI, NCC, and ESU, and we are developing an IA Career Poster and Video. These media would then be available for all guidance counselors to direct students to the IA career.

To help promote internships, an Internship Committee has been formed consisting of secondary school, MCTI, NCC, and ESU staff. The charge of this committee is to involve local companies to promote internship experiences. A second method to promote internships may be explored in the future – a local facility which allows students to obtain employment experience where the sole purpose of this facility is the students' learning.

V. CONCLUSION

The Pennsylvania 2 + 2 + 2 Workforce Leadership Program in Computer Security is considered one of the most successful Workforce Leadership programs in the commonwealth, actually having won a PA Governor's Award of Excellence. Students have been highly involved in the program – for example, in AY 2006-07, 451 students were exposed to computer security topics as part of coursework. Furthermore, students graduating from the various levels have been easily able to find employment. How can such a program be replicated?

One of the biggest challenges for the WLCS has been the coordination of eight secondary schools, two campuses of a community college, and a university. This challenge involves personnel as well as curriculum. With regard to curriculum, programmatic coordination, and development, the program has been successful because of the involvement of dedicated and knowledgeable

professionals - Ronald Cudworth of MCTI, Keith Hartranft and John Whipple of NCC, N. Paul Schembari of ESU, and Glenn Watt of Backbone Security. With regard to personnel coordination and maintaining contact with the administrations of the eleven academic institutions, credit goes to Mary Frances Postupack and Faith Waters, both of ESU, Carolyn Shegelski of MCTI, and Matthew Connell of NCC. Multiple other professionals have also contributed to the success of the program over the years, especially the secondary school teachers who have helped their students become interested in IA as a possible profession.

Our recommendation for replication of the WLCS is the creation of a team of at least one individual at each educational level who is knowledgeable in IA in addition to an industry professional. These individuals must act as champions of the combined program. Furthermore, the team members must remain open-minded to working with professionals at all educational levels, must remain willing to learn from all team members, and must be ready to help the other team members learn. This team must then work at each of the educational levels to help encourage students and teachers to become interested in IA.

For our future, the WLCS will grow by encouraging more student and faculty involvement at all levels, including middle schools. Furthermore, one of our goals includes replication throughout the commonwealth of PA involving communities that desire such a program. The challenge will be to find qualified professionals who are eager to work together.

VI. REFERENCES

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