Case Study

Industry/Government/Academic Collaboration Connecting K-12 Education to a Pathway for In-demand, High Wage Computer Occupations

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Ishpi Information Technologies, Inc.
Topics

• Why We Are Here
• Swiss/German Dual “Learn and Earn” Model
• DoL Registered Apprenticeships
• Community Initiative Center of Excellence for Secure Software (CICESS)
• STEM Pathways to College and Careers
• Takeaways and “ASKs”
Takeaways

• **Sense of urgency** to address unsustainable trends and exploit rare economic development opportunity to create hundreds of thousands of middle class jobs

• Industry/government/academic coalition led by industry to address “skills gap” and talent pipeline

• Connect education directly to a job through a dual learn and earn **registered apprenticeship program (Nothing Else Works)**

• Develop **skilled workforce** based on validated competencies and industry standard certifications

• Apprenticeships are good for business with **positive return on investment**
Why We Are Here
The Future of Jobs and Communities

Top Perceived Technological Drivers of Change

<table>
<thead>
<tr>
<th>Driver of Change</th>
<th>% Rating This as a Top Driver</th>
<th>Time Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile Internet and cloud technology</td>
<td>34</td>
<td>2016-2017</td>
</tr>
<tr>
<td>Advances in computing power and big data</td>
<td>26</td>
<td>2015-2017</td>
</tr>
<tr>
<td>New energy supplies and technologies</td>
<td>22</td>
<td>2015-2017</td>
</tr>
<tr>
<td>The Internet of things</td>
<td>14</td>
<td>2015-2017</td>
</tr>
<tr>
<td>Crowdsourcing, the sharing economy, and peer-to-peer platforms</td>
<td>12</td>
<td>Felt already</td>
</tr>
<tr>
<td>Advanced robotics and autonomous transport</td>
<td>9</td>
<td>2018-2020</td>
</tr>
<tr>
<td>Artificial intelligence and machine learning</td>
<td>7</td>
<td>2018-2020</td>
</tr>
<tr>
<td>Advanced manufacturing and 3D printing</td>
<td>6</td>
<td>2015-2017</td>
</tr>
<tr>
<td>Advanced materials, biotechnology, and genomics</td>
<td>6</td>
<td>2018-2020</td>
</tr>
</tbody>
</table>

Why We Are Here
Ever Increasing Capabilities

Why We Are Here
Ever Growing Demand

A Snapshot of Internet Traffic

In March of 2016, typical use of the Internet included

- 7,206 tweets per second
- 722 Instagram photos per second
- 1,117 Tumblr posts per second
- 2,124 Skype calls per second
- 34,952 gigabits of traffic per second
- 54,240 Google searches per second
- 122,590 YouTube videos viewed every second
- 2,489,751 e-mails sent every second

Why We Are Here
Changing Jobs Profile

SOURCE:
P. Restrepo, 2015, “Skill Mismatch and Structural Unemployment,” Massachusetts Institute of Technology
Why We Are Here

Occupations Lost Due to Automation

Median probability of automation by an occupation’s median hourly wage.

SOURCE: Council of Economic Advisors (CEA), 2016, Economic Report of the President
Why We Are Here

Educational System’s Challenge

100 9th graders begin high school

77 students reach graduation
44 enroll in college
35 Students return for a second year
23 Students receive a post secondary degree within 150% of allotted time (Certificate, associates or bachelors)
18 immediately enter employment in State

23 do not graduate
33 do not enroll
9 do not return
12 do not

Works for only 18% - 23% of students

The challenge: How do we prepare the talent needed by business to be globally competitive

SOURCE: The State Pipeline Report 2015
Why We Are Here

National Security - Cyber Attacks

• Increasing number of cyber attacks against critical infrastructure
• 90% of attacks are successful by exploiting defects in software
• Software developers not trained to deliver software with fewer vulnerabilities
• 1.5 million cybersecurity jobs currently unfilled
Why We Are Here
Personal Identity Breaches

### Breaches

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Breaches</th>
<th>Breaches with more than 10 million identities exposed</th>
<th>Total Identities Exposed</th>
<th>Average Identities Exposed per Breach</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>1,523</td>
<td>11</td>
<td>1.2B</td>
<td>805K</td>
</tr>
<tr>
<td>2015</td>
<td>1,211</td>
<td>13</td>
<td>564M</td>
<td>466K</td>
</tr>
<tr>
<td>2016</td>
<td>1,209</td>
<td>15</td>
<td>1.1B</td>
<td>927K</td>
</tr>
</tbody>
</table>

In the last 8 years more than **7.1 billion** identities have been exposed in data breaches

Source: Symantec Internet Security Threat Report April 2017
Why We Are Here
Browser Vulnerabilities

Source: Symantec Internet Security Threat Report April 2017
Why We Are Here
Websites with Vulnerabilities

Source: Symantec Internet Security Threat Report April 2017
Why We Are Here

Cybersecurity Skills Shortage

1.5 Million
MORE cybersecurity professionals will be needed to accommodate the predicted global shortfall by 2020
Source: NSCA 2015 Global Information Security Workforce Study

On average, 52% of IT professionals surveyed stated fewer than 25% of all applicants were qualified

The biggest skill gaps of today’s cybersecurity professionals

72% Ability to Understand the Business
46% Technical Skills
42% Communication Skills

Fastest cybersecurity demand sectors are in industries managing consumer data

30% Manufacturing and Defense
40% Professional Services
16% Finance and Insurance
14% Other
Burning Glass Technologies

Cybersecurity job postings took 8% longer to fill than IT job postings overall
Source: NSCA 2015 Global Information Security Workforce Study

18% Growth
Computer and mathematical occupations will grow much faster than the average job during 2012–2024

Expertise required for various cybersecurity roles in demand

- Information Security
- Network Setup
- Auditing
- Network Protocols
- Core Database, Coding and Scripting
- Systems Administration
Source: Job Market Intelligence: Cybersecurity Jobs, 2015

Fastest growing skills in cybersecurity job postings

- Python
- HIPAA
- Risk Management
- Internal Auditing
- Audit Planning
Source: Partnership for Public Service

Approximately 10% of the current cybersecurity workforce are comprised of women

Hardest to fill skills in cybersecurity job postings

Software Architecture
Network Attached Storage (NAS)
Software Issue Resolution
Internet Security
Legal Compliance
Data Communications
Platform as a Service (PaaS)
Computer Forensics
Internal Auditing
Apache Hadoop

Source: National Initiative for Cybersecurity Education
## Why We Are Here
### Cost of Status Quo

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two-year and four-year college</td>
<td>$400 billion per year</td>
</tr>
<tr>
<td>Post-secondary workforce education and training</td>
<td>$600 billion per year</td>
</tr>
<tr>
<td>Skills gap</td>
<td>$160 billion per year</td>
</tr>
<tr>
<td>Time for new employees to reach full productivity</td>
<td>&gt; Five months on average</td>
</tr>
<tr>
<td>Replacing an employee</td>
<td>Ranges from 6 to 24 months of the position’s salary</td>
</tr>
</tbody>
</table>

Source: Georgetown University Center on Education and the Workforce
Swiss Vocational Training Model
# Apprenticeship Dual Model Computer Programming (Secure Software)

<table>
<thead>
<tr>
<th>2-3-year dual model “learn and earn” program</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>On the job training</strong></td>
</tr>
<tr>
<td>Employment contract executed between company and apprentice</td>
</tr>
<tr>
<td>Dual work study model with increasing hours under company supervision and mentorship as training progresses</td>
</tr>
<tr>
<td>Standard apprenticeship topics defined by industry and aligned with Carnegie Mellon University / Software Engineering Institute</td>
</tr>
<tr>
<td><strong>Class room instruction</strong></td>
</tr>
<tr>
<td>Full time student AAS degree in Secure Software Development at local community college</td>
</tr>
<tr>
<td>Dual work study model with more classroom hours at the beginning</td>
</tr>
<tr>
<td>Curriculum created by Carnegie Mellon University and adopted to meet industry requirements</td>
</tr>
<tr>
<td><strong>Practicum examination and standard industry certifications to validate competency</strong></td>
</tr>
</tbody>
</table>
Youth Unemployment

Source: German American Chamber of Commerce Midwest
An Emerging K-14 Model for High Schools

Tier 1 Courses: Intro and Survey
Tier 2 Courses: Specialized
Tier 3 Courses: Specialized
Tier 4 Courses: High School Diploma
Tier 5 Courses: Completion

Career Explorations Group Job Shadow Program
Career Coach Mentoring
Pre-Apprenticeship Program
Apprenticeship Program
Ongoing mentorship and support

Source: Colorado Business and Schools in Collaboration
The Funding Model

As program grows, state, federal and foundation funding will be replaced by support from the business community.

Source: Colorado Business and Schools in Collaboration
• An exciting national renewal and reimagining of registered apprenticeship
• Learn, borrow and steal from Europe
• Expand in new, non-traditional industries and occupations
• $165 million in new funding for Registered Apprenticeship
## Core Components of Registered Apprenticeship

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Employer Involvement Is Integral</strong></td>
<td>Employer is the foundation for the RA program and must be directly involved and provider of OJL</td>
</tr>
<tr>
<td><strong>Structured On-the-Job Learning with Mentoring</strong></td>
<td>Minimum of 2,000 hours Structured and Supervised</td>
</tr>
<tr>
<td><strong>Related Training and Instruction</strong></td>
<td>144 hours recommended per year</td>
</tr>
<tr>
<td></td>
<td>Parallel</td>
</tr>
<tr>
<td><strong>Rewards for Skill Gains</strong></td>
<td>Increases in skills brings about increases in earnings</td>
</tr>
<tr>
<td><strong>National Occupational Credential</strong></td>
<td></td>
</tr>
</tbody>
</table>
Employer-Led Collaborative Design
Registered Apprenticeships and Community Colleges

**Registered Apprenticeship-College Consortium (RACC)**

**302** Colleges joined the RACC

**957** Apprenticeship Training Centers

- Electrical Training ALLIANCE
- Finishing Trades Institute
- Heat & Frost Insulators & Allied Workers
- Sheet Metal and Air Conditioning Industry
- National Elevator Industry Educational Program
- United Association of Plumbing & Pipefitting

**15** National, Regional, State Organizations

- American Association of Community Colleges
- AFL-CIO Building and Construction Trades Council on Adult and Experiential Learning (CAEL)
- Colorado Community College System
- North Carolina Community College System
- Ohio Association of Community Colleges
- Ohio Board of Regents
- Oregon Department of Community Colleges and Workforce Development
- Collegiate Consortium for Workforce and Economic Development
- South Carolina Technical College System
- Southeast Maritime & Transportation Center (SMART)
- Technical College System of Georgia (TCSG)
- University of Alaska System
- VA Tidewater Consortium for Higher Education
- Wisconsin Technical College System
Why Apprenticeships?

Because Nothing Else Works
CICESS

• Community Initiative Center of Excellence for Secure Software
• Solving Cybersecurity Skills Shortage With Apprenticeships and Certifications
• Launched successfully in Fall 2015, partnering with Illinois Central College and the Peoria Public Schools
A Unique Collaboration – Industry, Government, Academe

- Community Initiative Center of Excellence for Secure Software (CICESS)
- National Institute of Standards and Technology
- Department of Labor
- Carnegie Mellon University Software Engineering Institute
- ISHPI, CEFCU, Ill. Mutual
- Illinois Central College (ICC)
- Qualified Secure Software Development Professionals
- ISHPI, CEFCU, Ill. Mutual
- Illinois Central College (ICC)
Goals

• One of the largest available skilled workforce for secure software
• Direct connection between education and a job without accumulating debt
• World-class education providers with core common standard curriculum offerings
• A standard competency-based, registered, apprenticeship program with uniform guidelines
• Central Illinois is the destination choice for an exciting career
• A skills formation and workforce development model scalable to other occupations and other communities across the nation
DoL Registered Apprenticeship IT Occupations

- Application Developer
- Computer Programmer
- Database Technician
- Help Desk Technician
- Information Assurance Specialist
- IT Generalist
- IT Project Manager
- IT Specialist
- Network Support Technician
- Computer Programmer (Secure Software)
CICESS Design – 1

• Standard academic curriculum leading to first-in-the-nation AAS Degree in Secure Software Development
• Berger Aptitude Test (B-Apt) for Computer Programming for entry to the apprenticeship program
• Standard apprenticeship curriculum based on Carnegie Mellon University Software Engineering Institute (CMU/SEI) process models
• Validate secure software development competencies – (ISC)$^2$ CSSLP, SEI PSP Developer certifications
CICESS Design – 2

• Alternating classroom and on-the-job apprenticeship training in the dual model
• Recurring and one-time-only fees from participating employers for ongoing program administration, apprenticeship curriculum development, and train-the-trainer materials
• Guidelines for minimum hourly wages for the apprentices with flexibility to meet varied human resources practices of participating employers
CICESS Value Proposition

- Augmentation of employers’ current workforce development methods
- Ability to plan for and satisfy future needs for hard-to-fill secure software developers
- Ability to build a secure software talent pipeline that includes women and minorities who are trained, mentored, and certified
- A cost-effective solution to training and retaining new workers in secure software development
- High retention rates when apprentices become full-time employees
AAS Degree
Secure Software Development

CS I: Programming in Java
CS II: Programming in Java
CS III: Advanced Programming in Java
Structured Query Language
Introduction to Relational Database
C# Programming
Mobile Application Programming
Introduction to Computer Security
Secure Coding
Introduction to Assured Software Engineering
Database Administration
Structured System Analysis

Two electives in computer programming, web, or networking, depending on employer needs

Students must also take 19 credit hours in general education courses.
Aligned with Federal Initiatives

• DoL American Apprenticeship Initiative
• DoL Registered Apprenticeship Computer Programming (Secure Software) Occupational Standard
• DHS/NIST Cybersecurity Workforce Framework
• NIST Initiative Cybersecurity Education
• NSA Centers of Academic Excellence
CICESS Integrating K-14 High School and Apprenticeships

• Career Pathways to Jobs for the Future
• CS for All – Foundation
• STEM Occupations
• Early College High School
• STEM – Pathways to College and Careers Academy
• Planned for Fall 2018 - 2019
CS for All

• National Computer Science for All movement
• Enable all students in grades K-12 to achieve CS literacy as an integral part of their educational experience
• Chicago Public Schools
  – Students will become global citizens who understand the ubiquity of computing and be able to use their knowledge to embrace technology, to revolutionize their communities, our nation, and the world.
  – New graduation requirement for computer science for the graduating class of 2020.
“The future of the economy is in STEM. That’s where the jobs of tomorrow will be.”

Overall, STEM occupations are projected to grow faster than the average for all occupations. And wages in these occupations were generally higher than the median for all occupations in May 2013.

High-employment, fast-growth occupations include computer systems analysts, applications software developers, and systems software developers.

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Job openings, projected 2012–22</th>
<th>Employment</th>
<th>Median annual wage, May 2013</th>
<th>Typical entry education</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2012</td>
<td>Projected 2022</td>
<td></td>
</tr>
<tr>
<td>Software developers, applications</td>
<td>218,500</td>
<td>613,000</td>
<td>752,900</td>
<td>$92,660</td>
</tr>
<tr>
<td>Computer systems analysts</td>
<td>209,600</td>
<td>520,600</td>
<td>648,400</td>
<td>81,190</td>
</tr>
<tr>
<td>Computer user support specialists</td>
<td>196,900</td>
<td>547,700</td>
<td>658,500</td>
<td>46,620</td>
</tr>
<tr>
<td>Software developers, systems software</td>
<td>134,700</td>
<td>405,000</td>
<td>487,800</td>
<td>101,410</td>
</tr>
<tr>
<td>Civil engineers</td>
<td>120,100</td>
<td>272,900</td>
<td>326,600</td>
<td>80,770</td>
</tr>
<tr>
<td>Computer programmers</td>
<td>118,100</td>
<td>343,700</td>
<td>372,100</td>
<td>76,140</td>
</tr>
</tbody>
</table>

STEM Pathways to College and Careers

STEM-PCC provides students with a high school-college-career continuum that helps them understand the direct links between what they are learning today and the worlds of college and work.

- **Focus on Early College**: a six-year scope and sequence of high school and college coursework
- **Focus on Careers**: an ongoing, sequenced Workplace Learning curriculum that includes career goals, mentoring, guest speakers, workplace visits and internships
- **Focus on Personal Pathways**: a personalized academic pathway monitored and based on individual needs and performance

Source: IBM STEM Pathways to College and Careers Schools: A Development Guide
Takeaways/“ASKs”

• Act with a **sense of urgency** to address unsustainable trends and exploit rare economic development opportunity to create hundreds of thousands of middle class jobs

• Develop industry/government/academic coalition led by industry to address cybersecurity **“skills gap”** and talent pipeline

• Take immediate steps to connect education directly to a job through a dual learn and earn **registered apprenticeship program**

• In your community, develop **skilled workforce** based on validated competencies and industry standard certifications

• Stay on the message: Apprenticeships are good for business with **positive return on investment**
Contact

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