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Building a K-16-Industry Partnership to Train IT Professionals

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ABSTRACT

Building on the importance of experiential learning for early career success, this paper presents a blueprint for a multiple-tier co-op approach, where students as early as high school will be selected by employers, will learn skills relevant to the employer's needs, and will get hands-on experience while enrolled in a relevant educational program. This program is currently being developed by a partnership of industry professionals, university faculty, and local school district faculty and administrators in Anchorage, Alaska. After identifying a need for more and better qualified candidates for many unfilled IT positions, a consortium of hiring authorities in Anchorage initiated discussions with educators to better align curriculum with employers' needs and to establish a pipeline in the education system for better recruiting, growing, and retaining technology talent. Two high school courses have been developed as a result of this collaboration and are being offered with direct assistance and involvement from the business community. In the courses, students are evaluated against a series of 13 micro-credentials relevant for IT professionals. An articulated pathway into university degrees and an extension of the pipeline into middle school are under development.

Keywords: Experiential learning & education, Internships & co-ops, Partnerships, Curriculum alignment

1. INTRODUCTION

At a time when information technology (IT) permeates our daily lives, when businesses increasingly rely on IT-literate professionals, have increasing numbers of unfilled positions for those with IT skills, and pay IT staff ever-increasing salaries, it is surprising and frustrating to see ever-declining numbers of students pursuing higher education degrees necessary to meet the employers' needs. For decades, researchers have considered this problem as well as possible solutions, with no solution quite able to address the problem. Without claiming we have such an ultimate solution, nor even a radically new one, we revisit the idea of a partnership between employers and educators, not just from higher education, but a partnership reaching into much earlier educational establishments: high school, middle school, and possibly elementary school. With this proposal, we do not expect to fully solve the problem, but we hope we can at least move the needle in addressing the shortage of trained professionals. To use a homeowner's metaphor, this is not a turn-key home, ready to move in, but a sizable pile of construction materials that can help build the intended edifice.

2. IT JOB MARKETS: ALIGNING SUPPLY AND DEMAND

2.1 Where are all the IT Professionals?

What started in the late 1990s as an acute shortage of IT professionals in the frenzied preparations for the year 2000 transition has become a chronic shortage that continued unabated for the following two decades. The explosive growth of the Internet and the increased adoption of mobile technologies and of e-commerce has created an ever-expanding menu of jobs for those with IT skills.

For example, what used to be a relatively tiny field in the 1990s, information security, has grown both in size and in importance. Cybersecurity Ventures predicts that cybercrime costs will rise to $6 trillion by 2021, a doubling from 2015 (Morgan, 2019). The report finds that nearly half of the world's population used the Internet in 2018, again, a doubling from the figure in 2015, and that 75% of the world population will be online by 2022. The same report estimates that 6 million cybersecurity professionals will be needed by 2019, with 3.5 million of these jobs going unfilled by 2021. Others are more

conservative in their estimates, but still expect steep growth in the number of information security jobs, from 200,000 in 2016 to 1.5 million in 2019 (Knapp, Maurer, and Plachkinova, 2017). In an earlier estimate, the same 1.5 million jobs figure appears for 2020, with the caveat that two thirds of the jobs will not be filled, due to the lack of qualified applicants (White, Hewitt, and Kruck, 2013). Although there appears to be disagreement regarding the actual number of jobs, there is strong agreement that a large percentage of them are going to remain unfilled.

There are at least two main factors blamed for this shortage of IT professionals. First, enrollment in some IT related programs (Management Information Systems - MIS) has been on the decline, even as enrollment in Computer Science (CS) programs has tripled from 2006 to 2017 (Computing Research Association, 2017). The decline in enrollment in the face of low employment and high salaries for graduates is difficult to explain. Surveys have found a combination of factors, including inaccurate perceptions on the part of the students, lack of engaging content in introductory classes, and dislike of the technical nature of the profession (Scott et al., 2009).

The second suspected reason for the shortage of trained professionals is a skills gap between academic learning goals and industry expectations. As early as 1989, experts pointed out a difference between students' preparation and employers' expectations: "industry needs software engineers, but universities are supplying computer scientists" (Beckman et al., 1997). A comparison of academic and industry perspectives on IS education highlighted details of this skills gap across narrowly defined areas of the IT body of knowledge (Aasheim, Li, and Williams, 2009). In their responses, managers valued more hardware, operating systems, leadership, entrepreneurship and risk taking, software packages, high general GPA (grade point average), and any work experience. In contrast, faculty saw internships, database knowledge, and communications skills as more important. Fortunately, the degree of alignment between managers and faculty was somewhat higher when considering skill groups rather than the more narrowly defined skill areas. In overall rank order, these skill groups are interpersonal skills, personal skills, technical skills, organizational skills, experience, and GPA (in decreasing order of importance).

In another study, a survey of judges and mentors for a high school cybersecurity competition, researchers asked respondents to consider several areas of IT preparation (Woszczynski and Green, 2017). For each area, respondents were asked to evaluate the level of preparation of the students as well as the importance of the area for three domains: importance in general, importance in a civilian IS career, and importance in a military IS career. Across all areas, the level of preparation of the students was generally low, an average of 2.7 on a scale of 4.0. This low level of preparation is a clear illustration of the skills gap where even the most dedicated and motivated students (those attending cybersecurity competitions) are not adequately prepared according to business professionals.

It is likely that the skills gap is caused at least in part by the misalignment of academic and industry expectations for the curriculum. For example, a survey (Saunders and Lockridge, 2011) found that MIS graduates have good employment prospects and are happy with the education they received, yet the same graduates saw a need for more business input into program development and a need for internships.

In turn, the need for more business input into curriculum design might come as a surprise, since MIS curriculum models have been developed for many decades as a partnership between industry and academia. Software and database curriculum models were introduced as early as the 1970s (Hirschheim and Klein, 2012). The first modern IS curriculum model, IS'97 (Couger et al., 1995), appeared more than twenty years later, and updates have been and continue to be developed collaboratively with input from several key professional organizations, including ACM, AIS, DPMA, and ICIS. Academics try hard to keep curriculum updated and anchored in business needs. For example, more than half of the core courses and almost all of the electives in the IS model curriculum have changed from IS'97 through the next two models, IS2002 and IS2010 (Apigian and Gambill, 2010). This change was driven by input from business professionals and in response to fast-paced technology development.

What might be the cause for the misalignment, despite these efforts to consider business input? First, employer needs are very diverse, and it is difficult to design a curriculum that would meet all the needs. Second, actual IS programs are also diverse, although generally following the most current model curriculum. Each post-secondary program customizes the course structure and the contents of each course to reflect its mission and target student population. The 240 programs surveyed in one publication (Apigian and Gambill, 2010) required 4 to 16 courses (9 on average), with 1-26 electives (7.9 on average).

Beyond the curriculum models, two other best practices are well known to lead to well qualified graduates. First, programs that incorporate experiential learning, be it internships or co-ops, allow students opportunities to apply their academic skills on real-life business problems. Second, partnerships between academic units and businesses go beyond aligning curriculum expectations: they combine experiential learning with classroom visits from business experts in both the development and the delivery of the curriculum. We review some of the main findings in both of these best practice areas in the next section.

2.2 Experiential Learning in the MIS Curriculum Models

Sadly, the previously-mentioned study on the breadth of MIS programs (Apigian and Gambill, 2010) did not provide any information on the extent of internships, practicums, or other experiential courses. What is clear, though, is that virtually all programs value and try to include experiential learning.

For example, Saltz, Serva, and Heckman (2013) provide an excellent review of pre-2005 studies on the importance of integrating work-based experience with academic preparation. One study (Fang et al., 2004) finds that internships lead to shorter job searches and to an average of $2,240 (9%) in higher salary offers, but those studies did not control for double majors, gender, timing of MIS degree declaration, GPA, or the nature of the internship. In another study, Wallace (2007) found that 25% of new college hires are sourced from employers' internship programs. Another finding was that 55% of employers report hiring new college graduates who had internships as part of their background. Wallace cites the same statistic, that new hires who have internship experience get offers 9% higher than those who do not. Even authors who

extoll the virtues of industry-relevant certifications will remind students not to pursue certifications at the expense of internships (Knapp, Maurer, and Plachkinova, 2017).

Current trends in experiential learning acknowledge that internships might be out of reach for some students: those lacking connections to secure an internship, lacking the flexibility to relocate to a new place to pursue an opportunity, or lacking the time to take what would amount to a second job (Blumenstyk, 2019). In such cases, micro-internships can still allow students to gain direct experience in jobs that can be done remotely yet pay reasonably well.

Even more impact on the outcomes and the skills of graduates arise when employers partner with educational institutions, as described in the next section.

2.3. Industry-Academic Partnerships

Partnerships have been around for a long time, but employers have recently taken a much more active role, in response to fast-changing technology, the difficulty in filling open positions, and the sometimes-slow pace of change in academic institutions.

At the lowest level of involvement, partnerships can mean simply getting together and outlining a joint plan of action. For example, the *Journal of Information Systems Education* has published several excellent articles written by joint teams of industry professionals and academics. The topics of these articles span a wide range, from what it means to be a white hat hacker and how to become one (Fulton, Lawrence, and Clouse, 2013) to advice from industry professionals for faculty on recruiting international students, enhancing the hands-on activities, and the importance of internships (Sauls and Gudigantala, 2013).

Beyond simply devising plans, a longer-term and more impactful type of partnership is one where students in a class get to work on actual business problems for an existing business partner, for example to conduct risk assessments for small and medium enterprises which could otherwise not afford to pay professionals for such assessments (Ilvonen, 2013). Most businesses have some level of concern about opening up certain information security projects to students, so projects can be structured with a range of options, some with more limited scope and limited outcomes for businesses that prefer not to open up too much, while other projects may allow businesses to open more of their infrastructure in exchange for more in-depth reports from students (Spears, 2018). Beyond the narrower scope of information security projects, senior projects allow students to carry out an even wider range of real-life work projects to gain hands-on experiences with solving actual business problems. In a project partnering the University of North Florida with Blue Cross Blue Shield of Florida, students worked on the Service Pricing Financial Model system (Seyed-Abbassi, King, and Wiseman, 2007). At the completion of the project, all students were either Extremely Satisfied (86%) or Very Satisfied (14%), none choosing any of the six lower ratings (including Not Sure/Can't Rate).

Even closer partnerships can involve curriculum design for an entire program, where industry professionals working with faculty start with the overall program learning goals, then proceed to derive a course structure with course-level learning goals, ultimately leading to the details of each course's definition (Tan, Nakata, and Paul, 2018). Although the paper focuses on the redesign of a particular course, the approach can also be used at the program level to integrate teaching and learning activities with assessment activities to achieve the learning outcomes.

The most comprehensive types of partnerships involve joint curriculum planning combined with experiential learning in internships at the business partner. An example of a particularly well-designed partnership program is the one between a consortium of universities (Syracuse University, the University of Delaware, Rutgers University, and The Ohio State University) and a large group of corporate employers, including JPMorgan Chase, IBM, Cisco, Ernst & Young, Nationwide Insurance, and GE (Saltz, Serva, and Heckman, 2013). The eight-month-long program (January through August), combines paid internships with blended-learning interdisciplinary coursework. Universities can recruit companies as long as the companies recruited are large and have a global presence. Students apply in the second half of their junior year. They can have technical majors or non-technical ones, but they are admitted to the program after a job interview and only if offered a position by a participating company. On average, 25% of the applicants are accepted into the program which has a 100% completion rate. Interns work full-time on real-life problems and are well compensated.

Unlike traditional co-op programs that alternate work and courses, this program integrates the two at the same time. Students learn through boundary-spanning activities at three boundary levels. In interactions with managers and faculty, students might get conflicting directions for presentations, experiencing and helping to bridge the skills gap between academia and business, the first boundary. The second boundary is between different business units, where students experience patterns of tension among subunits within a single company, good preparation for their future career experiences. Finally, the third boundary is that between different academic disciplines; students work in heterogeneous teams with disciplinary representation which discourages free riding and encourages cross-pollination among the academic disciplines.

Although most partnerships bring together industry and academia as equal partners, in some situations the academic component takes a distant second to the industry presence. For-profit schools like Foundry College focus on meeting the career change needs of adult learners, online and with a technology-driven approach (Blumenstyk, 2018). The curriculum is competency-based, with much focus on many of the employer-critical student outcomes: critical thinking, soft skills, and employer-aligned learning for middle management jobs in sales or IT. The school was started by Stephen M. Kosslyn, who previously served as dean of social science at Harvard University and as director of the Center for Advanced Study in the Behavioral Sciences at Stanford University. He is planning to recruit students through employers and professional organizations.

This section has shown that there is general agreement about the need for partnerships between business professionals and educators in developing and aligning IT curriculum. There is also strong agreement about the importance of experiential learning, whether internships or co-op programs. Nonetheless, while most of the partnerships discussed in the literature are between higher education and industry, they are missing out on

a key stakeholder: the K-12 education system as the originator of the student pool to feed the pipeline input.

In the next section of the paper, we discuss a partnership that extends the pipeline into the K-12 educational system, for now into the final two years of high school, but with plans of reaching into middle school and elementary school.

3. BUILDING A PARTNERSHIP IN ALASKA

Alaska has a relatively vibrant IT employment market concentrated in the three main population centers: Anchorage (population 400,000 in 2016 including the neighboring Matanuska Susitna Borough), Fairbanks (population 100,000 including the surrounding Fairbanks North Star Borough), and Juneau, the state capital (population 30,000). Separate school districts serve the primary education needs of each of the metropolitan areas, with Anchorage and Matanuska Susitna in two separate school districts. The higher education in the state is dominated by the University of Alaska, which has separately accredited campuses in each of these three metropolitan areas.

Alaska suffers from the same low enrollment in MIS programs, and likely from a far greater shortage of IT professionals, as the rest of the nation. Of the relatively small number of students graduating with IT backgrounds in a given year, many choose to leave the state to pursue the numerous opportunities they find elsewhere; although Alaska is certainly not an island, the remoteness and isolation give many young professionals born and raised in Alaska some kind of "island fever," a desire to leave the state to go explore.

For Alaskan employers, the relatively isolated location makes it difficult to recruit qualified IT staff from outside the state. Of those recruited, often at a high cost, many discover they cannot handle the remoteness and the arctic climate. Even when employers train local natives with no plans to leave the state, the new skills make the employees more marketable. When employees receive attractive offers from firms outside the state, some can be recruited out of Alaska, leaving the local employers with unfilled positions.

Faced with these challenges, Ben Craig, Chief Information Officer at Northrim Bank, an Alaskan-based bank, decided to create a forum bringing together employers, vendors, and educators to increase the flow of qualified graduates for IT positions in Alaska, primarily in Anchorage. This is how the Anchorage Technology Forum (ATF) was born.

Mr. Craig started by reaching out to representatives from two industry giants, Cisco Systems and Dell Technologies, and proposed the formation of a recurring, vendor-agnostic forum without driving a sales agenda and with the goal of creating a thriving technology community. Mr. Craig then reached out to his local professional contacts across an array of commercial, non-profit, state, local, and federal organizations, inviting them to join the forum. The inaugural forum meeting was held in October 2017 and focused on a challenge that resonated across all organizations: how to better grow, recruit, and retain technology talent. In that meeting, several ambitious goals were adopted:

- Align the hiring needs of industry with the educational goals of educators.
- Increase technology recruiting at the junior-high and high school levels, while also encouraging more females into the industry.
- Establish well-advertised career paths for secondary, post-secondary, and graduate-level students, incorporating on-the-job experience, and accounting for students transitioning from other careers.

In the weeks to follow, Mr. Craig reached out to educators in town, in both the Anchorage School District (ASD) and at the University of Alaska-Anchorage (UAA).

For the ASD representatives, he contacted the highly entrepreneurial district superintendent, Dr. Deena Bishop; the ASD Chief Information Officer, Mike Fleckenstein; and the principal of the King Tech High School, Lou Pondolfino. Dr. Bishop refocused what used to be the King Career Center into the King Tech High School (KTHS), a full-time technical high school that enrolls students from throughout the district, offering a wide range of courses from advertising, to carpentry, to video production, and welding. Because of this strong focus on career development at KTHS, business professionals agreed this was the ideal location to create a pilot IT program: a pathway from high school directly into entry-level positions and post-secondary education (see Section 3.2.1 for timeline).

As part of his outreach to local educators, Craig also reached out to three deans at UAA, the leaders of the colleges that prepare IT professionals. The Career and Technical College offers two- and four-year degrees as well as occupational endorsement certificates in computer and networking technology. The College of Business and Public Policy offers an Associate's degree in business computer information systems as well as a Bachelor of Business Administration (BBA) in MIS. Finally, the College of Engineering offers Bachelor's degrees in computer science, computer systems engineering, and electrical engineering. Bluntly, Craig told the three deans that none of their programs were preparing the type of employee he and his peers were looking for; he would have to triangulate among the existing UAA programs to get the skills he was looking for. The three deans and the CIO agreed to continue the conversation and to explore ways to prepare students for the needs of local employers.

The remainder of this paper will focus on two issues. Section 3.1 will provide Mr. Craig's perspective as CIO and employer on the IT- and IS-related degrees and programs offered at UAA, a large public university. As currently designed, none of these degrees aligns with industry needs, but they are in the process of being redesigned for better alignment. Mr. Craig put forward a list of course offerings and student learning objectives that are driving this alignment process (see Appendix 1).

The following section, 3.2., will then focus on the process and the timeline of the alignment which has already taken place at the secondary (high school) level, and which is in process for the post-secondary education.

3.1 A CIO's Perspective on Higher Education Degrees

While this section is a personal perspective of CIO Craig, his perspective has been grounded in multiple conversations with other employers across a wide range of industries in Alaska and elsewhere. The personal perspective is nonetheless his personal

one. Mr. Craig evaluated the seven degrees and certificates offered at UAA and provided the following assessment.

3.1.1 B.S. degree in computer science. This sound regimen of courses appears designed to train well-rounded programmers. That said, given the soft and hard cost of tuition, and the growing trend of self-taught developers, Mr. Craig predicts that millennials and future generations will lean towards lower cost, à la carte online courses to accomplish their specific goals (build and sell an app), rather than elect to invest in a more comprehensive program geared toward working in a more traditional work culture (a program that includes fundamentals and useful but tangential topics, such as: ethics, professional writing, coding doctrine, etc.). At Northrim Bank, where Mr. Craig serves as CIO, this program does not directly translate into any existing technology positions. Not all enterprise/corporate IT departments have dedicated programmers, and there is a continued growing trend to outsource the majority of programming/development within most enterprise verticals. In the state of Alaska, there are probably fewer than two dozen large organizations, mostly state and federal, that do in-house development, because to do it right they need a relatively substantial workforce of developers/programmers, quality assurance testers, project managers, analysts, and technical managers. This level of staffing leads to expensive overhead, well-suited for software development in the Silicon Valley, Seattle, Portland, Salt Lake City, Phoenix, and Texas metropolitan areas, but not so much for more rural states. In fact, many, if not most, of the graduates of the B.S. in Computer Science end up relocating out of Alaska.

3.1.2 Electrical engineering. This is and will continue to be a hot degree program, particularly in a trade-based state. It is of no direct value to most corporate IT Departments, but of immense value to the Alaskan economy.

3.1.3 Computer engineering degree. Like the electrical engineering program, this is not applicable to most corporate IT needs, but is vital to the Alaskan economy. There are data that correlate higher-paying jobs and increased marketability with both of these engineering degrees.

3.1.4 Associate of applied science in business computer information systems. This program is somewhat relevant to what most enterprise IT departments classify as business analyst positions. While it provides foundational exposure to some of the concepts, vocabulary, and skills needed for a business analyst, it is unlikely Northrim Bank would hire an entry-level applicant with this degree without at least two years of work experience. For meeting the needs of employers, less coursework would be required in accounting and macroeconomics, along with more practical math courses, more business communications, human management, and project management courses – and it would need a strong capstone project.

With those changes, this program would yield students who could expect to start in the high $50,000 to mid-$60,000 range with no additional experience, and mid-$60,000 to high-$80,000 with four to five years of experience. That said, Northrim has two business analysts, a small fraction of their IT workforce, and these positions do not address Northrim's mainstream Enterprise IT staffing deficiency.

3.1.5 Bachelor of business administration in management information systems. This program could fulfill quite a few of the prerequisites for many enterprise IT business analyst positions without additional on-the-job experience. For those positions, graduates could expect to see salaries as described above. That said, the efficacy of this degree program could vary wildly based on the selected upper division electives – it could produce business analysts, web/light-app developers, or data analysts/report writers. And because of that flexibility, it would require that an interviewer drill into the specific course curriculum chosen by the applicant with a detailed conversation about the track they pursued and the experience they acquired. Frankly, most corporate interviewers are not that good at interviewing. Because this degree strives for breadth, rather than depth, it almost feels like a blunderbuss as opposed to a rifle. For the employer looking to hire a graduate of the program, the graduate could have gained many skills, or very few, depending on the choice of electives.

3.1.6 Occupational endorsement certificate in Cisco-Certified Network Associate (CCNA). Northrim Bank would typically hire a CCNA as an entry-level (upper-$30,000 to mid-$40,000/year) Tier-1 systems & network technician. Although this is a nationally recognized and vendor accredited program, Mr. Craig believes that it is missing two components invaluable to creating a well-rounded systems & networking candidate: understanding of client/server systems and the applications that run on them. Hence, his staff have turned away applicants that only have their CCNA with no systems experience. That said, there are some local small and medium-sized companies that would hire an entry-level CCNA with no other experience.

3.1.7 Associate of applied science in computer and networking technology. This slightly more well-rounded curriculum than a CCNA certification could substitute for more real-world experience, depending on what elective coursework was completed in conjunction with the core program requirements. That said, the descriptions of these courses seem to either undersell their complexity or imply the courses are not adequate to remove the need for practical work experience for a Tier-1 entry-level position.

3.1.8 Toward the ideal degree. Following this detailed analysis, Mr. Craig concluded that that much of the state's brain drain is the result of a misalignment between hiring managers and educators. In his view, university IT programs are geared for positions that are more commonly found in major metropolitan centers, even though Alaska and other similar states have numerous open IT positions that remain unfilled for months. To help bridge this misalignment, he identified a list of knowledge areas in which graduates of four-year programs should be proficient (see Appendix 1). Using this list as a map, members of the Anchorage Technology Forum, including employers, educators, and other IT professionals are working on aligning the university curriculum with the industry needs. As detailed in the next section, this alignment has already taken place for a pilot course at King Tech High School and is underway for the University of Alaska-Anchorage programs.

3.2 A Phased Approach to the K-16 Partnership

Taking advantage of the wholehearted support of the superintendent of the Anchorage School District, who is focused on career development for high school students, the partnership moved fast in aligning the secondary curriculum with industry needs. The alignment of university curriculum with industry needs and with high school preparation will follow as a second phase.

3.2.1 Phase 1: Secondary IT. With the support of ASD Superintendent Dr. Deena Bishop and KTHS Principal Lou Pondolfino, KTHS Curriculum and Instructional Designer Missy Fraze convened Anchorage Technology Forum industry participants and KTHS teachers to develop and launch two new IT courses aimed at aligning common industry expectations with fundamental coursework and learning objectives. The two courses were chosen to cover computer concepts and communications, to be developed in this order. The courses were part of a larger learning roadmap, intended to align industry needs with the outcomes of K-12 and post-secondary education in Alaska.

Over the course of several weeks, the working group formulated curricula for the computer concepts course based on the most ubiquitous job duties and responsibilities found in the Anchorage market, then consolidated the curricula into common blocks of instruction designed to accommodate diverse learning styles. To ensure the courses met the criteria established on the learning roadmap, consideration was given to course articulation between industry specific certifications and post-secondary institutions. Once a consensus was reached within the working group, the learning objectives were translated into "micro-credentials" intended to demonstrate the student's proficiency and practical understanding of the coursework. These micro-credentials were then voted on and validated by the industry experts within the Anchorage Technology Forum.

The final layout included 13 micro-credentials:

1. Career & Goal Planning
2. Job Searching
3. Professional Ethics
4. Customer Service & Support
5. Industry-specific Math
6. Technical Writing & Documentation
7. Industry-specific Workplace Safety
8. Small Computers
9. Operating Systems
10. Networking
11. Applications
12. Servers
13. Information Security

The skills required to master each of these blocks of instruction could be individually validated, earning "badges" that collectively comprise a technology credential. Although all thirteen micro-credentials are included as part of the KTHS course curriculum, only students who attain proficiency in a given area will be granted that micro-credential. For a student who gets an A in the course, it is likely that the student has mastered all micro-credentials, but for a student who receives a C grade, the micro-credentialing will allow an employer to understand the student's areas of strength and weakness across each of the 13 micro-credentials.

Once the course was approved, business professionals from the Anchorage Technology Forum volunteered as guest instructors and speakers, assisting with practical labs and facilitating on-the-job training within their organizations.

Several members of the Anchorage Technology Forum have also volunteered to be a part of grass roots advisory boards focused on recruiting women into IT, encouraging participation in national technology competitions and summer camps, and establishing internship/work-study programs with local hiring managers. ATF members also approved the communications course which will be offered in the 2019-2020 academic year.

3.2.2 Phase 2: Post-Secondary IT. Currently, Mr. Craig and other members of the Anchorage Technology Forum are working with the Computer and Networking Technology Advisory Board at the UAA Career and Technical College and with the faculty of the UAA College of Business and Public Policy to align curricula at the university level. The ultimate goal is to expand the learning roadmap to allow students educational paths to careers in technology, whether starting at the primary, secondary, post-secondary, or graduate level.

Mr. Craig believes many of these curriculum design initiatives have gained traction over the past year because the state of Alaska is at an inflection point: technology, analytics, and agile development have matured to the point where the Alaska workforce must pivot from its primary dependency on natural resource extraction without abandoning the opportunities of that mature industry. To drive this initiative, Anchorage Technology Forum members are working with the Alaska Association for Careers and Technical Education with the same goals of aligning industry with educators and ultimately increasing technology opportunities for Alaskans.

3.2.3 Long-Term goals: A tiered system of co-op levels. Although the bulk of this section has focused on the process of alignment between educational programs and industry needs, the true issue goes deeper. Even with the relatively low curriculum alignment currently in place, technology-minded students graduate from the many secondary and post-secondary programs and get IT jobs in the state. The real problem is that there are not enough graduates: although some leave the state, not enough qualified students graduate to fill the needs of local businesses, even if they were all to remain in Alaska.

The real challenge is not just to align the pieces of the pipeline – K-12, university, and employer – but also to fill the pipeline at its very beginning and to plug its leaks. For the input of the pipeline, not enough students are interested in technology careers early on, at a time when they still have the opportunity to choose coursework that will develop the relevant skills. For the leaks in the pipeline, the pull of industry is so strong that many students get hired away from academic programs after taking only a few courses that give them relevant skills. This leaves fewer students in the educational programs that can develop a more advanced portfolio of skills

Given the importance of experiential learning and the plumbing problems listed above, a long-term goal of the partnership is to develop a tiered system of co-op levels. Rather than looking for candidates only at the output of the educational system, employers will commit to be involved in the

educational process end-to-end. Not only will they help ensure curriculum alignment, but they will help select candidates and commit to fund them through co-op opportunities through several educational tiers.

While enrolled in the King Tech High School course, students will work a small number of hours in entry-level positions. As in the successful consortium reported in Saltz, Serva, and Heckman (2013), employers will screen applicants and will commit to employing them for the duration of their high school preparation. At the completion of the high school education phase, both students and employers will be free to pursue separate paths. Some students will choose to continue only in professional roles, with their current employer or with another employer, while other students will have the aptitude, the motivation, and the employer support to continue with a post-secondary education. When they enroll in a two-year or in a four-year program, students will likely be promoted into more challenging jobs where the new skills they are accumulating will be most relevant. Instead of simply providing a part-time job to the student, the employer will commit to ensuring that the job aligns with the curriculum and that the student's skills can be applied for maximum educational benefit.

Ideally, at the output of the pipeline, all parties will have achieved their goals. Employers will have gotten to know and trust the student who will have developed both academically and on the job. Graduates will have earned academic credit, on-the-job experience, and a living wage; they will have gotten to know their employer, but they will be available as free agents to seek other employment if they so desire. If students can graduate with job experience, with skills that match industry needs, and possibly even debt-free, this might help to attract more and younger students into the program, priming the input to the pipeline. The pipeline could extend into middle school or even into elementary school, although the co-op model will of course have to be modified for the younger-age students.

4. CONCLUSIONS

Developing IS professionals requires a partnership between educators and employers. Beyond aligning curriculum, attracting more students into the profession requires reaching out to younger learners with information about career choices, with hands-on activities that will engage them, and with a compelling learning roadmap that offers multiple options for every learner's interests, abilities, and aptitudes. Building on the importance of experiential learning, this paper has presented a blueprint for a multiple-tier co-op approach, where students as early as high school are selected by employers, learn skills relevant to employer needs, and get hands-on experience. It is likely that such a program will result in better student engagement, in better matching of employer needs, and in more and better trained IT professionals.

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Appendix 1. Knowledge Areas for IT Jobs

Section 3.1 of this paper presented CIO Craig's perspective on the range of IT-related degrees offered in a public university. None of the programs was a good match for the employers' needs, so the university and the local employers are working on aligning the curriculum. To facilitate this alignment, Mr. Craig proposed the following knowledge areas in which any graduate from a four year program should be proficient.

Systems and Networking

- A+ certification or equivalent (computers, printers/copiers, peripherals)
- Structured Cabling proficiency (more than just making cables)
- CCNP certification or equivalent (Layer 2, VLANs, LACP, 802.1x, 802.3ad, wireless mesh deployments, AAA, Layer 3, EIGRP, RIPv2, VRFs, Trunk and Span ports, stateful packet and application aware firewalls, content management, caching proxies, site-to-site and on-demand IPSEC and SSL VPNs, QoS (and federation with service provider QoS), traffic shaping, traffic capturing and analysis, L2TP, LEAP)
- Advanced Storage Design (host-based caching, iSCSI, NFS, SAN, NAS, NVME/flash/hybrid/spindles, container design and administration, throughput/latency/queue depth performance monitoring, backups and archives, data deduplication)
- Virtualization (VMware/Citrix/HyperV/KVM topologies, understanding of hypervisors, virtual desktop infrastructure, advanced security concepts (two-factor authentication, micro-segmentation, network integration, storage integration), client optimization and deployment considerations)
- Server/Client Engineering (Windows/Linux topologies, permissions, user rights assignments, inheritance, security baselining and hardening, patch management, Windows specific: Group Policy Objects and Templates, Active Directory, Network Access Control, IIS Administration, Dynamic DNS, High-availability DHCP, Domain/Forrest topologies, PowerShell scripting; Linux specific Apache, Samba, distribution management, compiling and dependencies)
- Messaging and Collaboration (Exchange on premise servers, roles, permissions, data management, high-availability, resource management, VoIP/Collaboration integration, Unified Communications integration)
- VoIP (Call Managers, Contact Center, SIP/H.323 federation with outside entities, codec provisioning, multi-party video/audio conferencing, SIP registration, call quality monitoring, templates and provisioning, high-availability, voicemail integration, encryption impact, trunk/tree/call design and topologies)
- Security (penetration testing, vulnerability management systems, network monitoring and alerting, disaster recovery and business continuity planning, buffer and stack overflows, privilege escalation, social engineering, mapping and exploiting unknown networks, remediation management)
- Administration (report writing, budgeting, social intelligence training, project management, introductory accounting, vendor management and due-diligence, conflict resolution, tactical planning and execution)

Applications

- CCNA certification or equivalency (Layer 2, VLANs, 802.1x, Layer 3, stateful packet and application aware firewalls, content management, caching proxies, QoS (and federation with service provider QoS), traffic shaping, traffic capturing and analysis)
- Intermediate Storage Design (host-based caching, iSCSI, NFS, SAN, NAS, container design and administration, throughput/latency/queue depth performance monitoring, backups and archives, data deduplication)
- Virtualization (VMware/Citrix/HyperV/KVM topologies, understanding of hypervisors, client optimization and deployment considerations, Docker)
- Server/Client Engineering (Windows/Linux topologies, permissions, user rights assignments, inheritance, security baselining and hardening, patch management, Windows specific: Group Policy Objects and Templates, Active Directory, IIS Administration; Linux specific Apache, Samba, distribution management, compiling and dependencies)
- Security (penetration testing, vulnerability management systems, network monitoring and alerting, disaster recovery and business continuity planning, buffer and stack overflows, privilege escalation, social engineering, mapping and exploiting unknown networks, remediation management)
- Databases (MSSQL, PostgreSQL, MySQL, Oracle database engine installation, configuration, optimization, backup and high availability, logging, security hardening, troubleshooting, sizing, maintenance automation)
- Intranet Administration (SharePoint installation, administration, high-availability, data migration, workflow design, Web Part installation and administration, collaboration engine design)
- Administration (report writing, budgeting, social intelligence training, project management, introductory accounting, vendor management and due-diligence, conflict resolution, tactical planning and execution)

Data Analytics

- Intermediate Storage Design (host-based caching, iSCSI, NFS, SAN, NAS, container design and administration, throughput/latency/queue depth performance monitoring, backups and archives, data deduplication)
- Virtualization (VMware/Citrix/HyperV/KVM topologies, understanding of hypervisors, client optimization and deployment considerations)

- Server/Client Engineering (Windows/Linux topologies, permissions, user rights assignments, inheritance, security baselining and hardening, patch management, Windows specific: Group Policy Objects and Templates, Active Directory, IIS Administration; Linux specific Apache, Samba, distribution management, compiling and dependencies)
- Security (penetration testing, vulnerability management systems, network monitoring and alerting, disaster recovery and business continuity planning, buffer and stack overflows, privilege escalation, social engineering, mapping and exploiting unknown networks, remediation management)
- Databases (MSSQL, PostgreSQL, MySQL, Oracle database engine installation, configuration, optimization, backup and high availability, logging, security hardening, troubleshooting, sizing, maintenance automation)
- Data Warehousing installation, configuration, optimization. Hadoop clustering, R analytics, SAP Business Objects, PeopleSoft, Crystal Reports, and SQL Server Reporting Services (SSRS) with Visual Basic Expressions. Assist in defining reporting standards, and selection of reporting and analysis tools)
- Reporting authoring (e.g. Business Objects Intelligence, Qlik, Tableau, abstracted analytics, XML and API mapping)
- Structure Query Languages (advanced queries against star-schema and normalized data warehouses, OLTP, and OLAP cubes using ANSI SQL, T-SQL, PL/SQL, and MDX)
- Administration (report writing, budgeting, social intelligence training, project management, introductory accounting, vendor management and due-diligence, conflict resolution, tactical planning and execution)

Information Systems & Computing
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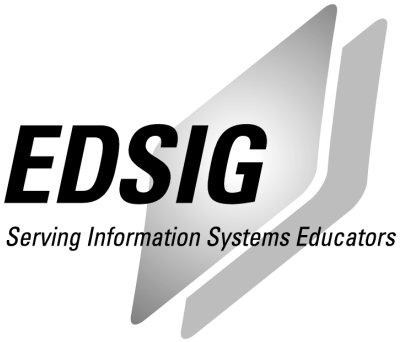

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