2575 Lansing Avenue NE Salem, Oregon 97301 March 6, 2017

Mr. Jeffrey McAlpine Technical Writing Instructor Chemeketa Community College 4000 Lancaster Drive NE Salem, Oregon 97305

Dear Mr. McAlpine:

My analytical report, "The Advisability of and Considerations for Pursuing Higher-Level Degrees in Computer Sciences" is attached for your consideration.

There's no question that computer science has grown to the point that it's become an integral part of nearly every facet of our lives, personally and professionally. Computer science has been growing exponentially for years, and shows no sign of abating. It has been and will continue to be a high-demand and high-paying industry.

At issue is: "What is the optimum level of education necessary to be competitive in the computer science field, and to secure a satisfying and well-compensated job?"

The research required to prepare this report unveiled some new perspectives, interesting and valuable to me as a student in the midst of my own decision-making process on this matter.

If you have questions or would like to discuss this in more depth, I can be reached most easily via email at: stormcloud.enterprises@gmail.com

Sincerely,

Tricia L. Holman

Advisability of and Considerations for Pursuing Higher-Level Degrees in Computer Sciences

To the attention of: Mr. Jeffrey McAlpine Technical Writing Instructor Chemeketa Community College Salem, Oregon

> Prepared by: Tricia L. Holman Writing 227

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Abstract

When embarking on an academic journey into the computer sciences, it's important for students to decide on a primary field of interest among the many available choices. Once these decisions are made, an educational path can be developed, which will most expeditiously and thoroughly prepare the student to achieve their end goal.

The main question facing students is, "What level and type of education is needed to secure your dream job?" In some cases, a coding boot camp and/or online academies will be the perfect fit; for others, an associate degree is the most suitable option. Sometimes, a bachelor's or even master's degree is the only appropriate answer.

Although many well-paid and satisfying jobs are available upon successful completion of boot camp or earning an associate degree, the consensus appears to favor the bachelor's degree as the most versatile and valuable means to obtaining the most comprehensive education, maximizing graduates' ability to secure any of a wide variety of highly compensated jobs, as well as putting them in the best position for advancement.

The issue at hand is: "What is the optimum level of education necessary to be a competitive job candidate, and to secure a satisfying job in one's preferred branch of computer sciences?"

This report will analyze these key considerations:

- Financial and time investment for associate, bachelor's, and master's degrees;
- Missed earning opportunity factor when going for higher-level degrees;
- Entry-level career requirements and opportunities for holders of a particular degree;
- Immediate and long-term earning potential for holders of a particular degree;
- Prospects for advancement with or without a particular degree;
- Experience and ability versus education and degree; where is the balance.

Introduction

Over the last few decades, the business community has increasingly come to view a college degree as a requirement, or at the very least an attractive quality, even for entry-level positions. Degreed applicants often upstage experience-only candidates. Jobs previously obtainable with a certificate or associate degree now often require a bachelor's degree; in some cases requirements previously satisfied with a bachelor's now take a master's degree.

In response to these expectations, a four-year degree is now widely considered essential to making a good or even adequate living. It has become commonplace for

students to graduate with significant college loan debt. For computer sciences, even alternative degrees, such as coding boot camps, are surprisingly expensive.

Essentially, higher education should be regarded as a serious

"In 20 years, you'll need a Ph.D. to be a janitor." Richard K. Vedder Professor of Economics, Ohio University; Director, Center for College Affordability & Productivity

investment of both time and money. Most importantly, it should be viewed as a means to an end. To make a wise investment, first identify the goal, then chart the most advantageous path to get there.

The eventual end should justify the means. Projected income should adequately repay school debt in a timely manner while still affording a comfortable living. Honestly evaluate whether the time and expense invested in earning higher-level degrees will result in more versatile and satisfying opportunities and increased earning power.

Findings & Considerations

Financial & Time Investment

In general, an associate degree can be earned in two years, a bachelor's in four, and a master's degree typically requires one additional year for computer science.

Attending community college for the first two years, regardless of the ultimate degree, will definitely save money – tuition is about half that of a four-year school. Money, and time, could be saved by not requiring a move or reducing commute time. Most

community colleges offer 2-year Colleges **4-year Universities** many classes Public Colleges/Universities – Average Annual Cost online; many 2012 - 13 \$8,927 \$17,475 universities require 2013 – 14 \$18,100 \$9,281 in-class 2014 – 15 \$18,632 \$9,586 attendance. If Private College/Universities – Average Annual Cost continuing to a 2012 – 13 \$23,355 \$35,071 four-year degree, ensure that all 2013 - 14\$23,859 \$36,587 \$37,990 2014 - 15\$24,317 credits earned will transfer. FIGURE 1

Average total tuition, fees, room & board for full-time undergraduate students. EXCERPTED FROM: U.S. Department of Education, National Center for Education Statistics. (2016). Digest of Education Statistics, 2015 (NCES 2016-014), Chapter 3.

Know the costs:

tuition, mandatory

fees, plus specific class and/or lab fees. This can be found in college catalogs, plus estimates for required books and other supplies for your program – \$300 to \$600 per term or semester is not unusual. Account for dorm costs, if applicable; or travel expenses and parking permits if commuting. *Figure 1* gives national average costs for undergraduates living on-campus.

Lacking a well-funded college savings account, the Free Application for Federal Student Aid (FAFSA) must be filed several months in advance of starting classes. Financial aid eligibility is determined by financial need plus credit hours per term, with six being the minimum and twelve to be considered a full-time student. Scholarships abound, which can help defray costs as well.

Part of the time investment is on a granular level. Dedicate adequate time per week to genuinely learn course content, ensuring a well-earned degree. The general rule is to

multiply credit hours by three or four to arrive at an estimate of required weekly study time.

If moving on to a graduate program, it's important to be aware that tuition costs more per credit hour than for undergraduate programs; sometimes nearly double. The increased financial investment is mitigated by the fact that fewer hours are required to earn a master's; but this difference must be accounted for.

A recent and exceptionally viable undergraduate option offered by some universities is the applied baccalaureate degree. Available only for select majors, it more narrowly focuses on program-specific coursework; requiring fewer general education credits. While still relatively new, in many ways it's considered more valuable than the resumeequivalent traditional bachelor's degree, particularly for computer sciences.

To follow this path, first an associate of science degree in a computer major is earned at a community college. Previously considered a "terminal degree", it is now transferable to the four-year school offering the applied baccalaureate degree. It does not negatively affect later pursuit of a master's degree.

Missed Earnings Opportunity Factor

Each additional school year invested pursuing a higher-level degree is an additional year of incurred expense and debt, delaying the start of a potentially lucrative career.

Evaluate career statistics by level of degree for entry-level educational requirements as applicable to the preferred branch of computer science, plus potential earnings at entry level and with advancement. Geographical location can have an impact, so investigate regional opportunities.

Weigh pros and cons. A significant up-front investment may ultimately provide the best return, in the long run; both financially and in career enjoyment. Again, it's crucial to know financial aid eligibility, the percentage that will be grants, and to apply for scholarship funds.

Discern when it's prudent to conclude the college journey. In some cases, a master's degree may be overkill. Many in the computer science field believe they're most beneficial if a very specific goal is sought; but are unnecessary for general purposes. However, even leaders in the field disagree on this point, with just as many believing that a master's is the best and most versatile investment regardless.

If a master's is determined to be the ultimate goal, it's important to not be tempted by a "bird in the hand". A well-paid and interesting job may become available, only requiring a lesser degree; which may even contribute to continuing education, furthering the thought of putting off the attainment of a master's degree. However, as William L. Bain states in his Quartz magazine article, "Why All Programmers Should Earn Their Master's", "For a young adult with a computer science degree, having four years of college debt and a desire to eat something other than ramen noodles makes a salary tempting." (Bain).

Realistically, "later" may be more difficult than initially imagined. Bain continues, "During the years of student living, we become accustomed to its inherent financial limitations", describing how newly-affordable luxuries can make it "too difficult to return to student life." Family obligations and other life obstacles incurred along the way further hinder the goal. Despite best intentions to return for that master's, "In reality, few do." (Bain).

Entry-Level Requirements & Opportunities

It's true that there are good jobs to be had in the computer science field, upon earning an associate degree or completion of "traditional degree alternatives". It's also true that by and large, there's a far wider range of entry-level opportunities and far better starting salaries with a bachelor's degree or higher.

Even though the value of a master's degree in computer science is the subject of considerable debate among the experts, and may well depend on the intended area of specialty; statistics and consensus would seem to indicate that it does open more doors for those new to the workforce, and brings higher starting salaries.

According to the authors of the report "STEM: Good Jobs Now and for the Future", published by the U.S. Department of Commerce, "More than two-thirds (68 percent) of STEM (Science-Technology-Engineering-Mathematics) workers have a bachelor's degree or higher, compared to just under one-third (31 percent) of other workers." (Langdon et al, 6)

Figure 2 shows the percentages of those working in different branches of computer science by level of degree; by far, the most prevalent is bachelor's or higher. While not neatly broken down by percentages, the most recent edition of the Bureau of Labor Statistics Occupational Outlook Handbook shows that for most branches of computer science, a bachelor's degree is still required or preferred for entry; it also updates median salaries. (*Figure 3*)

Occupation	Net job openings for college graduates, projected 2004-14 (thousands)	Median annual earnings, 2004	Most significant source of postsecondary education or training	Percent of workers aged 25 to 44 with		
				High school diploma or less	Some college or associate degree	Bachelor's or higher degree
Computer software engineers, applications	268	\$74,980	Bachelor's degree	4%	13%	83%
Computer software engineers, systems software	180	79,740	Bachelor's degree	4	13	83
Computer systems analysts	151	66,460	Bachelor's degree	9	25	66
Network systems and data communications analysts	101	60,600	Bachelor's degree	9	31	60
Computer support specialists	90	40,430	Associate degree	17	42	41
Computer programmers	90	62,890	Bachelor's degree	6	22	72
Mechanical engineers	87	66,320	Bachelor's degree	4	16	80
Network and computer systems administrators	82	58,190	Bachelor's degree	13	35	51
Civil engineers	77	64,230	Bachelor's degree	3	9	87
Industrial engineers	54	65,020	Bachelor's degree	9	22	70

FIGURE 2

Source: Bureau of Labor Statistics: http://www.bls.gov/opub/ooq/2006/fall/art03.pdf

Regarding the last entry in *Figure 3*, in her article "Make \$30 an Hour, No Bachelor's Degree Required", Annalynn Kurtz reports "About 38% of web developers had less than a four-year college degree, according to Census data." (Kurtz) However, this means that about 62% <u>did</u> have a four-year or higher college degree. For jobs incorporating programming with web design & development, a four-year degree becomes more important; although this is one area where coding boot camp could neatly suffice.

	Typical Required	2015
Occupation	Entry-Level Education	Median Pay
Computer Network Architect	Bachelor's degree	\$100,240
Computer Programmer	Bachelor's degree	\$79,530
Computer Systems Analyst	Bachelor's degree	\$85 <i>,</i> 800
Database Administrator	Bachelor's degree	\$81,710
Information Security Analyst	Bachelor's degree	\$90,120
Network & Computer System Administrator	Bachelor's degree	\$77,810
Software Developer	Bachelor's degree	\$100,690
Web Developer	Associate's degree	\$64,970

FIGURE 3

Source: Bureau of Labor Statistics: https://www.bls.gov/ooh/computer-and-information-technology/home.htm Published December 17, 2015 According to many of the sources cited, having earned at least a bachelor's degree typically gives prospective employers a far better first impression, even in cases when the degree is *not* a requirement. Candidates are more likely to make the cut for interviews. If it comes down to two or three candidates with equivalent experience, and one is relatively as proficient as the others; often the edge goes to the candidate with the higher degree.

There *are* some more niche areas in the computer science field where that doesn't always hold true; and entry-level jobs exist where one can start out lower and work up, with experience gained over the course of several years. However, having at least a bachelor's degree could easily be the difference of securing a higher-level position – and higher salary – to begin with.

Immediate & Long-Term Earning Potential

While the purpose of the table shown in *Figure 4*, featured in the publication, "STEM: Good Jobs Now and in the Future", is to illustrate how STEM jobs pay better than non-STEM jobs; it also shows how a bachelor's degree makes a pretty big difference within the STEM field over an associate degree – a little over 34% higher. Adding a master's degree increases earnings by a little over 13% (Langdon et al, 3).

	Average hourly earnings		Difference	
	STEM	Non-STEM	Dollars	Percent
High school diploma or less	\$24.82	\$15.55	\$9.27	59.6%
Some college or associate degree	\$26.63	\$19.02	\$7.61	40.0%
Bachelor's degree only	\$35.81	\$28.27	\$7.54	26.7%
Graduate degree	\$40.69	\$36.22	\$4.47	12.3%

FIGURE 4

Source: Economics & Statistics Administration calculations using Current Population Survey public-use microdata and estimates from the Employment Projections Program of Bureau of Labor Statistics

PayScale.com provides even more specific information – see *Figures 5a* and *5b*. These tables show median earnings for various branches of the computer science field, for holders of each of the three degrees, at entry-level; and at the five to ten year range. The drawback with PayScale's data is that it's drawn from a relatively small survey collection; however, the results are generally in line with the less specific data from government sources; so it does provide some additional insight.

The infographic provided in *Figure 6*, compiled from data collected by the U.S. Census Bureau, the

American Community Survey, and the Department of Commerce; shows that those holding a master's degree in computer science earn about half a million dollars more over their career life, than those holding a bachelor's degree.

	Median Pay –Zero to Five Year		
Major	Associate's	Bachelor's	Master's
Computer Engineering	\$41,000	\$69,600	\$86,700
Computer Science	\$40,400	\$65,300	\$84,800
Software Engineering		\$64,700	\$83,900
Computer Programming	\$42,900	\$50,500	
Web Design & Multimedia	\$36,200	\$42,300	
Computer Information Systems	\$40,100	\$54,300	\$70,700
Information Technology	\$39,400	\$53,000	\$66,000
Information Technology & Systems		\$52,800	
Computer & Network Administration	\$40,200	\$50,800	
Computer Networking Systems	\$40,600	\$46,900	
Network Administration	\$39,100		
Network Technology	\$40,500		
Computer Technology	\$38,900		
Information Security		\$58,300	\$74,100
Information Systems Security		\$57,1 <u></u> 00	
Cybersecurity			\$67,800

Figure 5a

Source for both tables: http://www.payscale.com/college-salary-report/majors-that-pay-you-back, and http://www.payscale.com/college-salary-report/degrees-and-majors-lifetime-earnings

	Median Pay –Five to Ten Years		
Major	Associate's	Bachelor's	Master's
Computer Engineering	\$77,300	\$113,000	\$125,000
Computer Science	\$67,300	\$107,000	\$125,000
Software Engineering		\$98,100	\$119,000
Computer Programming	\$68,800	\$82,600	
Web Design & Multimedia	\$56,200	\$66,500	
Computer Information Systems	\$60,500	\$89,500	\$110,000
Information Technology	\$59,500	\$84,300	\$102,000
Information Technology & Systems		\$87,100	
Computer & Network Administration	\$58,500	\$66,900	
Computer Networking Systems	\$56,400	\$71,900	
Network Administration	\$60,400		
Network Technology	\$57,000		
Computer Technology	\$54,800		
Information Security		\$85,600	\$108,000
Information Systems Security		\$74,200	
Cybersecurity			\$101,000



Prospects for Advancement

A bachelor's degree or higher can also pay off further down the career path. While skill, experience, and reputation may easily be enough for advancement within an organization, without holding a higher-level degree; that may not suffice when it comes to vying for a new and improved job at a different organization. Sometimes, initial screening is based solely on whether an applicant has a four-year or higher degree, regardless of whether the job is entry-level or a senior position.

It *is* true that in the computer science field, it's not just about the degree, but also confirmed skill, experience, versatility, and accomplishments. An impressive portfolio may be enough for advancement without a higher-level degree, with the right employer – and there are many inspiring accounts of people doing just that.

So, while an individual's proven proficiency may sometimes stand in for a bachelor's or master's degree; keep in mind that some jobs outright require one degree or the other, and can be very reluctant to make the substitution. When just starting out or when trying to advance, having that degree can make the difference in opening the door.

Experience & Ability versus Education

The 2015 edition of the annual survey by Stack Overflow, a major online forum for programmers and software developers, revealed that 48% of respondents working in those fields had never earned <u>any</u> degree in computer science (Stack Overflow). According to their 2016 survey, only 43% <u>do</u> have a four-year computer science degree (Stack Overflow). Discussions on Stack Overflow present widely varying opinions on the value of formal degrees, let alone higher-level ones. However, this debate is far more applicable to programming/coding and web development, than to other areas of computer science.

No matter the words on the degree, skills and proficiency must be demonstrated. Plenty of online, low- or no-cost academies exist to practice and reinforce existing knowledge, and even to learn additional computer science topics. Develop and perfect skills, perhaps even contribute to open-source projects to gain experience and credibility. Some online academies award certificates of completion, and are considered highly reputable in the field; so this can help build a portfolio that matters to

"It's something like every college basketball player thinking that they were going to play in the NBA."

Ran Libeskind-Hadas Harvey Mudd College Computer Science Chair potential employers, enhancing a traditional degree.

Taking self-guided courses and earning certificates of completion have been some people's sole means of landing well-paying and enjoyable computer science jobs. Openings do exist where the only requirement is proving one's

skill and proficiency in certain areas, but this applies almost exclusively to programming/coding and web design. For most other branches of computer science, some level of formal degree is non-negotiable.

An increasingly popular option is coding boot camps – again, this primarily applies to programming and, well, coding; although some include courses on algorithms and database (Meyerson). While boot camps have indeed taught people to code, and to code exceptionally well in most of the current top programming languages; and many of them have incredibly high job placement rates; they can be very expensive.

Costs range from \$12,000 to \$18,000, for programs typically only lasting from twelve weeks to six months (Meyerson). Throughout that shorter duration, these truly are boot camps, with all-day (up to 90 hours a week) intensive learning and application, working with instructors and fellow students. Although a handful of boot camps have recently been approved to accept financial aid, most do not.

Although boot camp education limits career opportunities to coding, even Caroline King, Chief Policy Officer for Washington STEM, emphasizes the relevance of coding. In Taylor Soper's article "The Exploding Demand For Computer Science Education, and Why America Needs To Keep Up", she's quoted, "Computer science jobs are growing and pay well. Students who know how to code will have access to the best paying and fastest growing jobs in the nation."

While many have been successful with these alternative options, be aware of their limitations, especially online academies. In Soper's article, Kristin Smith, CEO of Seattle-based trade school Code Fellows, points out the inefficiencies with online education: "Learning to code on your own is frustrating and lonely. Graduation rates from full online courses are in the single digits generally." (Soper).

Some industry leaders in computer science – especially those running start-ups or smaller, more "boutique" companies – brush aside the importance of traditional college degrees in favor of proving skills and proficiency. The inherent value of traditional, higher-level degrees is a hotly debated topic.

Regarding the value of a master's degree, in her article for Forbes, Aline Lerner, a software engineer and recruiter, says, "In my experience, an MS degree has been one of the strongest indicators of poor performance...Part of the problem is that CS fundamentals instruction tends to happen in undergrad...courses...if you already have an undergrad CS degree, employers may wonder why you chose to go back to school rather than working." (Lerner). The flaw in this reasoning would be that Lerner seems to be referring to those who earn a bachelor's in one field, then a master's in computer science. While apparently this happens, in our scenario, we're examining following up a bachelor's in computer science with a master's in computer science.

In his column *Software Engineering Daily* for GeekWire, Jeff Meyerson reports, "One consequence of this academic focus on theory is that many computer science students leave college incapable of programming." (Meyerson). He notes that Daniel Gelernter, CEO of tech company Dittach, doesn't hire computer science majors. Quoting Gelernter, "If a college graduate has the coding skills that tech startups need, he most likely learned them on his own, in between problem sets. As one of my developers told me: 'The people who were good at the school part of computer science – just weren't good developers.' My experience in hiring shows exactly that." (Meyerson).

In the article "This App Guy Thinks Computer Science Degrees Are a Waste of Money", Jeff John Roberts responds, "Gelernter's dismissive view of the academic approach to computer science risks glorifying minor technical talent at the expense of understanding computers' relation to science and humanity. An Android developer is no more of an authority on computers than a copy editor is on Shakespeare or Keats." (Roberts)

Also taking the opposing view in his article "Why All Programmers Should Earn Their Master's", William Bain states, "Silicon Valley is paved with the myth of the software engineering wunderkind, a programming genius who reaches heights of success without a graduate degree or maybe even an undergrad degree. In reality, this wunderkind is rare. A far better choice for most people is to obtain the foundational knowledge and design skills required for sustained career growth." (Bain).

University of Washington computer science professor Ed Lazowska wrote a response to Meyerson's GeekWire column titled "A Coding Bootcamp Is Not a Replacement for a Computer Science Degree". Lazowska states, "Regardless of what *Software Engineering Daily* would have you believe about boot camps, leading-edge tech companies of all sizes focus on recruiting the top bachelor's, master's, and doctoral graduates from the top computer science programs." (Lazowska).

Elsewhere in Soper's GeekWire article, he writes, "Lazowska warned that computer science education without face-to-face interaction is simply not good enough... the lessons...students learn while working in small teams in upper-level classes is invaluable." (Soper).

Also quoted in Soper's article is Hakon Verespej, who holds a master's in computer science, has previously worked at Microsoft and a startup, and is an advisor with techinclined Madrona Venture Group. Verespej says, "No matter how smart you are, there is no way to get the breadth and depth from a four-year education... than you would at something like a boot camp. It's just not possible." (Soper).

Conclusion

Summary

It goes without saying: college degrees are expensive. They're also a lot of hard work, especially to become truly skilled and well-versed in computer sciences; rather than simply garnering a degree just for the prestige of having a piece of paper declaring that "[name here] has a degree".

Statistics bear out: The higher the college degree earned, the higher median earnings are from first job until retirement. The biggest jump in median earnings is between the associate degree (or certificates of completion) to bachelor's. The relatively new applied baccalaureate degree may well be the most effective four-year degree.

Although statistics show that master's degree holders do have higher median earnings, there is some merit to the debate over the necessity and return on investment in computer science.

For some, coding boot camps and/or online academies can be a serious and viable alternative to traditional college degrees. Prospective students need to investigate and evaluate course content to know if this will be a workable option for their ultimate goal.

Interpretation

Although there are some legitimate exceptions, the road to the best paying, most versatile and satisfying careers in computer sciences, appears to be earning at least a bachelor's degree.

Despite stories of landing six-figure dream jobs without the benefit of a four-year degree, or in some cases *any* formal higher education; statistics confirm the majority of those working in the various branches of computer science – and earning the most money – hold a bachelor's degree or higher. The bachelor's also lends greater flexibility so far as eligibility for a wider variety of jobs, and advantages for advancement.

While "college degree alternatives" do indeed have their place in the greater scheme of things within computer science, they aren't appropriate for everyone's scheme. If writing code, or perhaps web design, is the primary goal; they may well be ideal. Affordability becomes a factor, though, without benefit of financial aid, which can include grants and deferred repayment; and/or scholarships.

To achieve the greatest depth and breadth of knowledge and understanding of computer sciences, to ensure the option of greater versatility, and to open the most doors throughout one's career; the traditional college path and a bachelor's degree would seem to remain the soundest investment.

Recommendations

<u>Research and Network:</u> Evaluate all relevant facts along with educated opinions from those already in the industry and in the academic environment. Weigh this information to determine the most viable and efficient path to the final goal and answer the core question: "What level of education is required to achieve success?"

<u>Set a Final Goal:</u> A useful question to assist in identifying "the perfect job" is, "What makes me happy and what would I enjoy doing so much, I would be willing to do it for free?" Decide if a master's is worth it to achieve the goal.

<u>Develop a Plan:</u> Account for all college-related expenses and compile the data into a spreadsheet, updating it with year-to-year fluctuations. Take advantage of all legitimate financial resources. Budget time resources just as wisely as financial resources.

<u>Remain Focused on the Final Goal:</u> That would be knowledge, skills, versatility, career enjoyment, security that a higher income provides, and avenues for advancement. Resist the temptation to leave school early, as "later" doesn't always work out for finishing a degree. Establish an end game and stick with it.

<u>Remember the True Definition of Success</u>: It's not *just* earning enormous sums of money, although that certainly is part of it. It's also being happy and fulfilled in one's career, truly enjoying going to work every day, and being content with choices made.

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