Maintaining Lifelong, Personal Global-Competitiveness

Charles H. Sobey
ChannelScience
7300 Cody CT, Plano, TX 75024-3837, USA
csobey@ChannelScience.com

Abstract

In August 2011, approximately 2.8% of US engineers and scientists were unemployed for more than 15 weeks. The corresponding percentage across all occupations was slightly over 5%. At the same time, almost 90% of recent engineering and science graduates from some top US research universities had job or school plans in place before graduation. The majority of these new-grads enter the workforce without years of industry experience. This paper presents five attributes of these new-grads that make them more hirable than some of the experienced technology workers they may be competing with. However, these attributes can be modified and adopted by the experienced workers themselves. Five actions are proposed for experienced engineers and scientists to take to recapture and maintain the global competitiveness that top US engineering and science new-grads have enjoyed, even during the recent difficult employment market.

1. Introduction

In 2011, the University of Leiden published a ranking of the scientific performance of 500 major universities. [1] 22 of the top 25 universities are American. Two universities from the top 10 of this list (see Table 1) are used herein as exemplars for the placement of new graduates in the engineering and science fields.

One is the University of California, Santa Barbara, a public institution in the western US, ranked 7th. The other is a private institution in the eastern US, Carnegie Mellon University (CMU), ranked 9th. CMU reports that for the class of 2011, 89% of the graduates from their engineering college, Carnegie Institute of Technology (CIT), had job offers or graduate school plans shortly after graduation. [2] For UCSB, the most recent data available are for the graduating class of 2011. This shows that just 12% of the computer engineering graduates were still seeking work after graduation. [3] Similar data for UC Berkeley is available on-line. [4]

Table 1. Top 10 of 500 Major Universities Ranked by the University of Leiden on Scientific Performance [1]

Rank	*University*
1	Massachusetts Institute of Technology (MIT)
2	Princeton University
3	Harvard University
4	Rice University
5	Stanford University
6	California Institute of Technology (Caltech)
7	University of California, Santa Barbara (UCSB)
8	University of California, Berkeley (Berkeley)
9	Carnegie Mellon University (CMU)
10	University of California, San Francisco

The transition from highly-employable new-grad to experienced, but unemployed, engineer or scientist can take many paths. Some of these transitions likely involve circumstances beyond an individual's control, such as a company's closing or personal health issues. Others may be directly caused by the individual's performance or attitude. Some may be a combination of both, accelerated by poor economic conditions. Regardless of the cause, extended periods of unemployment often exact a heavy toll – emotionally, financially, professionally, and personally.

This paper presents the idea that by modifying and adopting certain key attributes of the best new-grads from top science, technology, engineering, and math (STEM) departments, the condition of higher-employability can be regained and maintained throughout a career in engineering or science – even in the face of strong global competition.

This paper is arranged as follows. The next section provides statistics on education, unemployment, and the duration of unemployment. Then, five important attributes that contribute to the hirability of top new STEM graduates are identified. The changes in these attributes that may occur after several years of STEM employment are then examined. This is followed by a description of five specific actions experienced technologists can take to remedy these changes and potentially restore themselves to a hirability level on par with that of top new-grads. Then, comments on these ideas are shared from some soon-to-be-graduates and from experienced engineers who have heard them presented by the author through a lecture series entitled *Hirable for Life*™. [5] The paper concludes with a forward-looking description of what a workforce and a company might be like that apply the principles herein.

2. Education and Unemployment

In the 43 years from 1966 through 2008, the total number of all bachelor's degrees awarded in the US tripled from 524,008 to 1,580,036. Over the same period, the number of master's degrees awarded more than quadrupled from 140,772 to 631,608. Doctorates awarded rose from 17,949 in 1966 to 48,802 in 2008. Figure 1 shows the percentage of these degrees that were awarded in science and engineering (S&E) majors (left vertical axis). The total number of S&E degrees awarded is plotted on the right vertical axis. [6]

The data show that although the number of bachelor's degrees awarded in S&E has more than doubled over the period, the percentage they represent of all degrees awarded has been on a slight decline. Apparently the ratio of non-S&E to S&E master's degrees is rising. Also, the percentage of doctorates that are awarded in the S&E field has remained high and fairly steady around 60% for the 43 years plotted.

Accurate data for job placement in a student's chosen field of study is currently difficult to obtain from many institutions. On July 1, 2011, the US Department of Education began

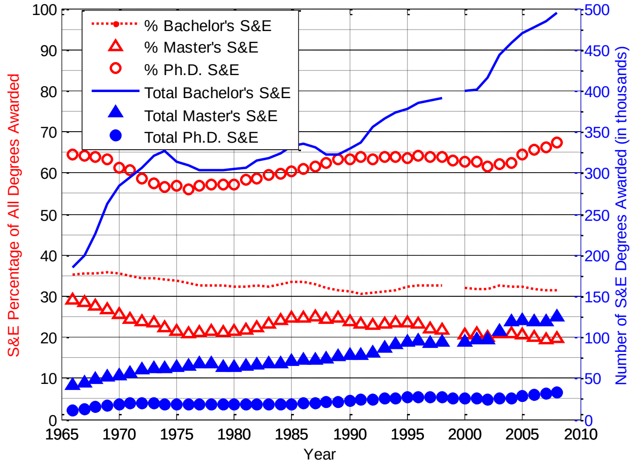

Figure 1. Number of US science and engineering (S&E) degrees awarded, and the percentage they represent of all degrees awarded. Note: 1999 data are incomplete. [6]

requiring private universities to provide "gainful employment" disclosures. [7] With this new reporting requirement, reliable data should be more widely available in the future. There are also calls to extend this requirement to public universities. [8]

It is well-known that obtaining a college degree correlates strongly with lower unemployment. The unemployment rates for all US workers during the 27 year period from 1984 through 2010 are shown in Figure 2. Also plotted in the figure are the unemployment rates for those with bachelor's degrees and for those working in S&E jobs. [9] In 2009, the rate of unemployment for workers in the S&E field was higher than anytime during the 27 years shown in Figure 2. Furthermore, the volatility of S&E unemployment increases across the period. The duration of unemployment for the latter portion of this period, the 17 years from 1994 to 2010, is plotted in Figure 3. [10]

The right vertical axis of Figure 3 plots the number of workers who transitioned from unemployed to employed each year. The left vertical axis plots the percentage of the unemployed who have been without a job for *N* weeks, where *N* is less than 5 weeks, 5-14 weeks, 15-26 weeks, 27-52 weeks, or more than one year. The data suggest that the rise in transitions to employment from about 2008 to 2010 has benefited those who have been unemployed less than four months more than those unemployed longer than six months. Furthermore, it appears that the unemployment rate for workers who have been jobless for more than four months has been on a rising trajectory since 2001.

Among these long-term unemployed there are undoubtedly many with college degrees. Some of these have degrees in the STEM fields. The author has spoken with long-term unemployed engineers who, years earlier were themselves sought-after new graduates from US technology schools. There are, of course, even unemployed STEM workers who are alumni from top-ranked research universities.

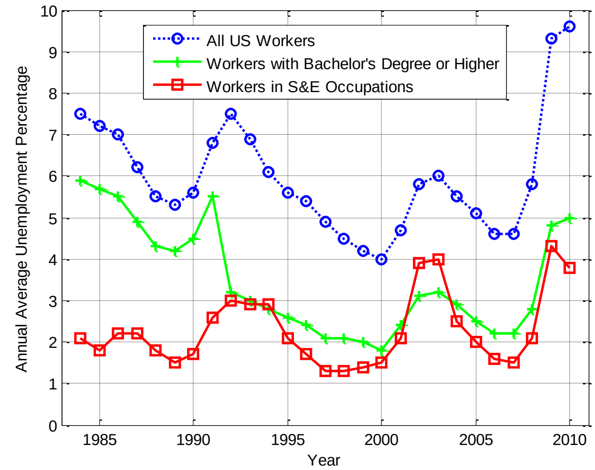

Figure 2. Annual unemployment rate (1984 – 2010), reflecting education and field. [9]

3. Five Key Attributes of Top New STEM Graduates

CMU's *Post Graduation Survey Results 2011*, lists post-graduation plans for 117 ECE BS graduates. [1] [2] Of the 116 who were seeking positions (employment, graduate school, military) 103 reported firm plans by the date of the survey (August 1, 2011). That is, 89% of new-graduates had positions within three months of graduation. This contrasts with the percentages of the unemployed that are unemployed longer than 14 weeks (about three months), see Figure 3.

For new-grads who do not quickly find employment, a common complaint is that employers require experience, but they cannot get experience without being hired. While common complaints of newly unemployed, experienced engineers are that they do not have the required skills, are

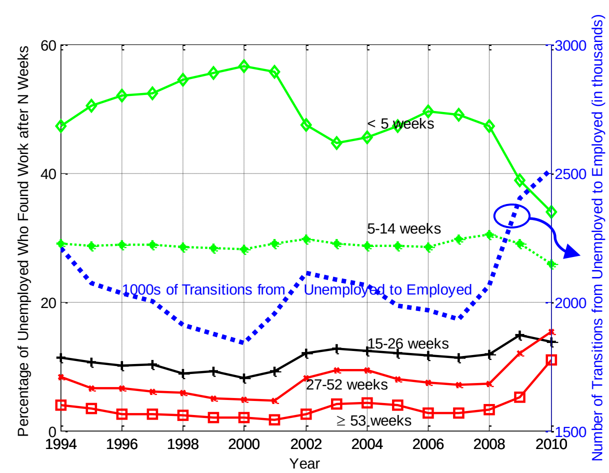

Figure 3. US workforce by year: Percentage of unemployed who have been unemployed for the specified duration (left axis). Number of transitions from unemployed to employed (right axis). [10]

[1] For full-disclosure, the author is a graduate of the electrical and computer engineering departments of CMU (BS ECE 1984) and UCSB (MS EE 1986).

"overqualified," or are too expensive.

Herein, it is proposed that engineers and scientists with at least a few years of experience in the workforce can inherently have the advantage in the competition for jobs. That is, if they can emulate the most desirable characteristics of new-grads from the technology and science departments of top research universities.

Specifically, it is asserted that five key attributes of these students are that 1) their skills are largely up-to-date, 2) they are recommended by a trusted source (through their continued acceptance in the university's degree program), 3) they have demonstrated results that are understandable to the employer (*i.e.* graduation and grade point average), 4) they are easy-to-find, and 5) they are a good value. Next, each of these new-grad attributes is described in more detail.

A typical science or technology program will present the subject major with the necessary breadth and depth; plus it will provide a solid foundation in fundamental math and science. At top universities, the instructors may even be the founders or innovators of the very topics they are teaching. In such classes, the latest techniques and research will also likely be presented. It is possible, however, that the industry's latest tools, such as software packages and laboratory equipment, will not be available at all institutions – even at the very top schools. Therefore, the students are likely to have a strong relevant background, with largely up-to-date skills, but may not have direct experience with the state-of-the-art technology.

Hiring managers often put candidates who have been recommended by a trusted source, such as a company employee, in a preferred pool of applicants. New grads from top universities have such a recommendation from the fact that they have been accepted and graduated from a university with a trusted reputation. The proven performance of that university's professors and alumni vouch for the future potential of its current students.

Successfully completing a degree objective in engineering or science at a top research university demonstrates results in accomplishing a task. Furthermore, this is a task that hiring managers understand is very difficult. Graduating from such programs requires sustained determination, self-sacrifice, and competition with some of the best students in the world. Graduating students have demonstrated successful global competitiveness.

Career centers at top universities have lasting relationships with many employers. They provide an established path for employers to find the best students from their institutions. These students are very easy for the employers to find. Furthermore, the students are even ranked by the university for the employers by grade point averages (GPAs) in their major, and overall. This makes the very best (at least as measured by GPA) even easier to find.

A lifetime of annual wage increases is far from guaranteed. However, as shown in Figure 4, it is common that a new-grad's starting salary is the lowest salary he or she will ever receive – barring a long period of unemployment later in their career. As such, they can be a good value compared to some experienced domestic technologists. However, when compared with some experienced off-shore engineers and

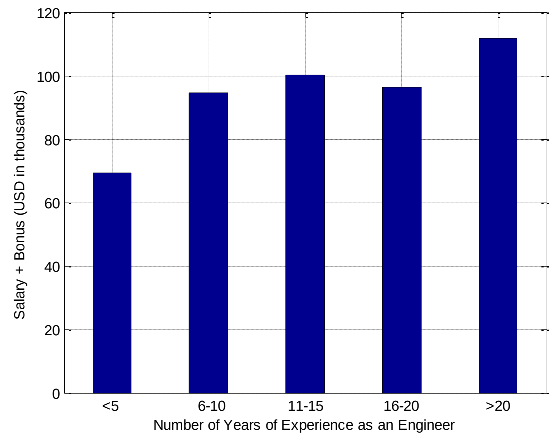

Figure 4. Annual salary + bonus for experienced engineers (2011). [11]

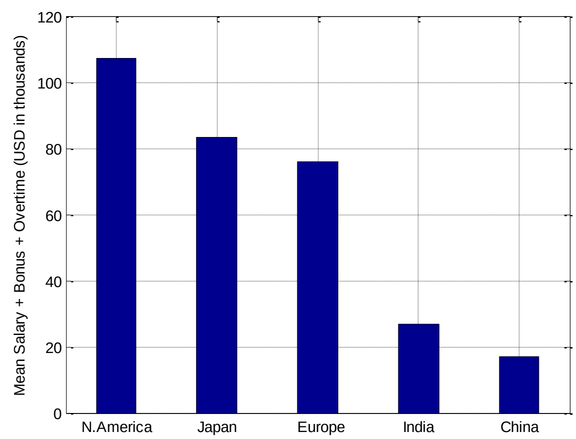

Figure 5. Annual salary + bonus + overtime for all engineers surveyed (2010). [12]

scientists, as in Figure 5, domestic workers must demonstrate a high level of value – even new-grads.

4. Differences Develop: From "New-Grad" to "Experienced"

While most engineers and scientists continue to grow throughout their careers, it is not uncommon that the *rate* of growth slows over time. Part of this is attributable to the fact that as one accumulates more knowledge and skills, incremental additions are a smaller portion of the whole, hence the rate reduces naturally. Indeed, the rate of growth of knowledge and skills during the college years is likely to be the highest, and longest sustained, of most employees' professional lives.

However measured, when the rate of acquisition of relevant new skills and knowledge does not keep pace with what is required for the job at hand, the value of the employee to the company decreases. If unchecked, that level of skill and knowledge can degrade to a point where they provide less value to their employer than is available on the open market from off-shoring, out-sourcing, a new-graduate, or a less experienced, less costly, new-hire. In the not-too-distant future, automation will also compete for increasingly more sophisticated knowledge-worker jobs.

Both the employee and the employer can contribute to maintaining worker hirability. The employer can provide training, support conference participation, purchase the latest tools, partner with the best suppliers and customers, hire talented co-workers across all positions, and free the employee from unnecessary tasks that take up productive time without producing learning or saleable services or products. Five specific actions the employee can take to maintain hirability are detailed after the next section.

5. New Graduates from Top Research Universities as a Worked-Example of Hirability

There are many actions and attitudes that contribute to keeping a STEM professional employed. In this paper, the five attributes listed earlier of recent graduates from top US research universities are modified and applied to working engineers and scientists. The graduating classes of top research universities must find employment, usually with little on-the-job experience, year-after-year. The five attributes of these graduating classes, listed above, are presented herein as a non-trivial, reproducible, worked-example of how to remain hirable throughout a career in the STEM field. Furthermore, these attributes are inherently familiar to almost all experienced STEM workers. This is because they were most likely members of the class of graduating technology or science majors themselves.

The five actions for experienced STEM professionals to take that correspond to the five attributes listed for new graduates of top research universities are described in the following section.

5.1 Five Actions to Take to Remain Hirable

The first new-graduate attribute listed above is that their skills are largely up-to-date. For an experienced engineer or scientist to remain employed long-term, it is expected that they will continue to learn the latest techniques and tools. This rate of learning is faster or slower depending on the individual, the company, and the industry. However, for hirability, it is proposed that the engineer or scientist strives to become an *expert* in a particular aspect of their chosen field.

It is important to recognize that there can be more than one expert on any topic. “Expert” does not mean the best, nor does it mean that the person knows every detail on a topic. In the author’s experience, an expert has three key characteristics: 1) their range of knowledge of their field is complete (they know what is part of the field, and what is not), 2) they remain current with recent developments in their field and in competing fields, 3) they can explain complicated aspects of their field clearly and understandably to laypeople. It is this last characteristic that is a hallmark of the best *expert witnesses* in court cases.

Expertise implies a level of specialization. Unfortunatley, this can lead to obsolescence if one specializes in a field that is no longer needed. This can be avoided by monitoring the developments in competing fields that may eventually replace one’s chosen field and taking appropriate action – including aggressively developing expertise in the competing field.

Another tactic for avoiding obsolescence of one’s hard-won expertise is to find broad areas where it can be applied. For example, an expert in paint adhesion can strive to apply their skills to adhering paint to boats, airplanes, homes, commercial structures, cars, space craft, heavy equipment, toys, etc.

The second new-graduate attribute is that they are recommended by a trusted source: the university. For the experienced STEM worker, this is similar to having a network of contacts that know your work and can recommend you to the people who could hire you.

Often job-seekers are given the advice to network all the time, everywhere, with everyone. This may be effective for being hired to fill a well-known role, such as dentist, contractor, hair stylist, waiter, etc. However, for a STEM worker whose expertise is, for example, maximum *a posteriori* probability detection, this wide-net networking is largely a waste of time. The expert is highly unlikely, through accidental contact, to meet someone able to hire him/her. The expert should instead seek out the *right* contacts purposefully.

In particular, experts should look for people that could genuinely be helped by tiny expenditures of their expertise. Useful places to search for these networking opportunities include within your company, at your customers, at your suppliers, in special-interest on-line forums and blogs, in response to news and trade journal articles, in response to technical journal articles, webinars, and conference or tradeshow presentations.

Another powerful networking technique is to search these same places for people of whom the networker can ask one short question. A general approach to forming the question is to *succinctly* and clearly propose how one aspect of the networker’s area of expertise could be applied to the new contact’s particular field and ask what main drawbacks they see to the approach. Thank them, ask a follow-up question if appropriate, but do not argue with them.

A strong professional network, maintained throughout a career, is a valuable asset. Reid Hoffman, founder of LinkedIn, writes, “Professional loyalty now flows ‘horizontally’ to and from your network rather than ‘vertically’ to your boss, as Dan Pink has noted.” [13, 14] Fortunately, websites such as LinkedIn make maintaining, expanding, and utilizing such networks less onerous. [15]

The third attribute is that new-grads have demonstrated understandable results – they have graduated from a difficult program. The student is obviously a customer of the university, and has paid for the privilege of graduation. However, they have also earned the graduation through their work during their pursuit of the university degree. Therefore, in a different sense, the process of graduating is the *student’s* “customer.”

That is, the student demonstrates adequate results (*e.g.*, GPA) to the graduating process (the customer) and the customer “pays” for the student for the results by awarding the degree. The student needs to deliver exactly what this customer requires, and may be rewarded for delivering more. These extra rewards might be honors, or offers of further study for an advanced degree.

For the experienced STEM worker, the corresponding trait is a constant focus on the customer's needs. In particular, constant priority should be given to efforts that directly help the customer. Often employees learn that other people in their department, or in other departments, are their "customers." This way of thinking has its benefits. However, herein it is strongly recommended that every expert finds ways that his expertise can directly benefit external, paying customers.

An especially useful goal is to personally provide services that the external customer would be willing to pay for *again*. An expert with a reliable history of delivering this type of result may be less likely to be on the short list for layoffs during bad times.

The fourth new-grad attribute is that they are easy-to-find. For example, a hiring manager knows to contact key universities to *compete* for their reliable source of talent. Experienced engineers and scientists can emulate this by making people want to find them. This is different from networking. The networking recommended above is outward from the expert directly to individuals who could benefit from their expertise. Instead, the STEM worker can make people want to find *them* by widely sharing their expertise.

The STEM professional should strive to let the world know that they are an expert in a particular subject area. The goal is that when someone is searching for a particular expertise, solution, or capability, they quickly locate the experienced STEM worker. Having an internet presence is imperative. Ideally, it would be one's own website, but presence on social media sites and contributions to online magazines, journals, and blogs are also very helpful.

Items to include are standalone pieces of helpful information. These can be technical papers, webinars, YouTube-style videos, interviews, or MP3 audios. If you are fluent in a second language, present selected material in that language, as well as English. If a starting point is needed, consider writing a detailed step-by-step example of something that is very common in your field, but can be tricky the first time through. To have the mark of coming from a true expert (one who can explain things clearly) such an example must be directly reproducible by a newcomer to the field, using only the worked example. A collection of these worked-examples translated and provided in PDF, webinar, and video formats, will make for a satisfying endpoint for a potential web search on the topic.

Another related technique to illustrate expertise is to take a commonly used tool or skill from your current industry and write about how to use it in a different industry. For example, one could write about how advanced data detection algorithms used in hard disk drives could be cost-effectively applied to sensors used for physiological monitoring.

The fifth attribute of new-grads may be the hardest for the experienced engineer or scientist to adopt. Graduates typically get a significantly lower salary than those with years of experience in the same industry. Sometimes a hiring decision must be made in the face of a firm budget limit, which simply puts some candidates out of consideration. However, there are many other times that candidates are considered based on the value they can bring to a position.

In a nutshell, if an experienced engineer costs double what a new-grad costs, the experienced worker must deliver at least twice the productivity. The equation is less straightforward, of course. In addition, it can be quite lopsided when off-shore engineering salaries are compared to those in the US. Recall, for example, the salary comparisons in Figure 4 and Figure 5.

It is not suggested that the experienced engineer should lower her rates and settle for less financial reward over the long-term. However, continuous employment versus extended periods of unemployment can lead to better long-term success. What is recommended for experienced STEM professionals is to strive to scale *required* monthly fixed living expenses down to about 50% of their take-home pay.

The rest of the money should be first devoted to building an emergency fund, saving for retirement, and paying off debt. Any remaining funds can be used for discretionary spending. Ideally, a portion of the discretionary spending will be earmarked for network building and for increasing one's expertise.

The benefits of this financial discipline are two-fold. First, if faced with unemployment, they are financially prepared and know that they can live off of a smaller income. Second, because they do not require a pay raise to keep making ends meet, they can accept a lower paying job if they believe it will eventually lead to better long-term opportunities.

For the STEM student about to graduate, the financial recommendation is to continue to live the frugal life of a student for as long as possible after being hired at a well-paying job. This financial control and resultant pool of savings can pay rewards for a lifetime.

In summary, the five actions are 1) become an expert whose deep expertise can be broadly applied, 2) network effectively by specifically seeking people who can benefit from your expertise, 3) focus on the customer by delivering results they would pay for again, 4) make people want to find you by sharing your expertise publically, and 5) be financially flexible in order to take advantage of a wider range of opportunities.

5.2 Employable vs. Hirable

Many of the newly unemployed can point to plant closings, product cancellations, or business bankruptcies as the reason for their job loss. However, some view their unemployment as a personal failing: "Others were chosen to stay, but this employer believes they can do better without me." This is a very hard view, and it is not helpful to dwell on the past in this way. It is helpful for them to take a clear-eyed look at what they can personally do differently in a new job or new career. The goal is to increase the chances of remaining employed, in a good position, for the rest of their working life.

In this paper, a collection of attributes of new graduates from top US research universities is posited as a possible role model for STEM professionals to emulate to remain hirable throughout their working life. Being "hirable" does not mean constantly looking for a new job or changing companies. Indeed a STEM expert may stay in a particular company, or even a particular department, for their entire working lives. However, they are evidently very hirable because they are continually being invited (hired) to contribute to new products, projects, teams, or initiatives within their current company.

Hirability is used herein instead of "employability" to emphasize that the concepts presented are not exclusive to the corporate or institutional STEM employee. In particular, they apply to entrepreneurs as well. For example, a venture capitalist may "hire" an engineer by investing in her new business idea. Or, a scientist may "hire" himself by investing his life-savings, nights, and weekends into starting his own business.

Another distinction is that "employable" may connote that one has the required skills and capabilities for a particular job, but unless the person is *hired* for the job they remain unemployed. This is not intended to emphasize semantics. The term hirability is used to imply that, in addition to being employable, the hirable individual can connect with a company that has an employment opportunity and can successfully compete to win the job. It is hirability that moves individuals from unemployed to employed.

6. *Hirable for Life*™: Reactions from Students and Experienced Engineers

On October 30, 2009, the author publicly presented the first version of the ideas described herein. The talk was optimistically entitled *Hirable for Life*™. The audience was made up of predominantly electrical and computer engineering (ECE) undergraduates and graduate students attending Carnegie Mellon University in Pittsburgh, PA. After that, the ideas were expanded and refined and then presented to CMU's entire 2010 graduating ECE class on May 12, 2010. [16]

Since then, the talk has evolved and has been presented to student and professional groups in the US and Europe. In addition, a professional training seminar has been developed for experienced engineers and scientists that teaches practical techniques for maintaining and enhancing the five key attributes identified in this paper. [5]

The question and answer periods following these talks have illuminated current concerns for soon-to-be-grads and experienced engineers and scientists. A sampling of the concerns voiced includes the following. Fear that becoming an expert and constantly keeping current in an advanced field will be too difficult to achieve. Belief that as people age they become less mentally quick, which when combined with more family and community responsibilities will not leave sufficient time for maintaining expertise in their field. Confusion that increasing hirability directly entitles them to salary increases.

The undergraduate and graduate students that have attended the *Hirable for Life*™ presentations at top universities are very impressive. A striking characteristic is their apparent ability to handle more simultaneous activities while pursuing their degrees. When these recent new-grads get 5 to 10 years of experience, they will likely continue to be very globally competitive. Because of their presence alone, the global market for talent is likely to get even more competitive in the coming years. It is with this understanding that the actions herein for maintaining personal global competitiveness are proposed.

After one particular discussion of these ideas, an especially actionable observation was made by a veteran data storage engineer. It is paraphrased in the following proposed rule-of-thumb.

Rule-of-Thumb: If your current job no longer provides enough opportunity and resources to build new skills, connections, and knowledge that increase your hirability for your next job (including those within the same department or company), then it is time to take the next job.

7. Conclusion

To thrive in the modern STEM workforce, develop deep expertise that can be broadly applied, maintain a robust professional network, and be financially disciplined so that new career opportunities can be pursued for reasons beyond salary alone. It is proposed that these goals can be accomplished by emulating the attributes of graduating STEM students from top US research universities. With the proper, sustained use of these attributes it is believed that experienced engineers and scientists can navigate an increasingly competitive global marketplace for STEM employment opportunities and withstand the possibility of longer periods of unemployment.

As a thought experiment, consider a company in which every employee is "hirable for life." That means that every employee remains in their job *by choice*, not because of necessity, circumstance, or lack of options. These employees could theoretically be hired away at any time, so the company must continuously strive to remain their employer of choice. A company with such a workforce and way of operating is poised to provide world-class products and services and remain globally competitive – that *company* will be "hirable for life."

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