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Division 46

OBSOLESCENCE IN SOFTWARE ENGINEERING CAREERS

An Interactive Qualifying Project Report
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by

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Abstract

This seven-week long project looked at how real-life software engineers deal with the obsolescence of professional knowledge. We compared what effective methods practitioners in other fast-moving technical fields take in order to keep progressing. The project investigated what can be learned by software engineers both from other fields and from best practices within the field. The project team came up with recommendations for companies to adopt to help their software engineering employees stay up-to-date.

Executive Summary

This project examined software engineering obsolescence and the factors that can help software engineers address professional obsolescence.

This project looked at how real-life software engineers deal (or do not deal) with the obsolescence of professional knowledge. We compared what effective methods practitioners in other fast-moving technical fields take in order to keep progressing. The project investigated what can be learned by software engineers both from other fields and from best practices within the field. The industries we researched include game development, medical industry, chemical engineering and mechanical engineering and companies including EMC, Mass General Hospital, General Motor and Google provided support for the project conclusion. We conducted in-person and telephone interviews with professionals from a range of careers on the topic of professional obsolescence in their industries. We concluded our study with effective recommendations for the software engineering industry in order to assist the professional development of software engineers regarding their current professional obsolescence.

Results from the industry research, company study and interviews showed that the prevention of professional obsolescence requires a combination of individual effort and company assistance. Software engineers must have self-motivation in order to keep themselves updated with the technology development. Companies should provide the software engineers with as many resources as possible and certain personal development freedom in choosing professional activities. The project further showed that among the various resources that a company may provide, mentoring programs, tuition reimbursement, internal training programs, professional conferences, side projects, work challenge, informal talks on innovative topics and proper rotational programs appear to be most effective in helping software engineers grow in this industry and are highly recommended. In addition, having individual development plans, subscribing to job-related news and magazines for employees, encouraging

professional networking and posting internal jobs also helps prevent professional obsolescence to some extent. However, even though they are useful for some other industries, requiring professional certificates, reward systems, and mandatory training are not suggested for the software engineering industry.

The project resulted in a final written analysis on preventing the obsolescence of software engineering careers followed by a presentation conducted to some employees at Microsoft Cambridge. One of the outcomes from the project was recommendations about policies companies could adopt to ensure that their software engineering employees stay up to date. Software engineers in various companies may benefit from reading the suggested recommendations in helping them keep current.

This project contributes to an understanding of professional growth of software engineers. The study elaborated on the approaches summarized from the research with respect to what software engineers can adopt in order to avoid professional obsolescence.

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1. Project Description

Along with the development of software is the enhancement of computer programming, designing and architectural technology. As practitioners of this innovative industry, some software engineers, however, have been said that their technical knowledge, to some extent, becomes obsolete every five years.

Nobody can deny that this obsolescence exists in other fast developing fields as well; it is, however, possible to keep up with the pace of the development of technology. Doctors and nurses renew their licenses and certificates on a regular basis in order to work in the industry; game developers are sponsored to go to various conferences to learn the most recent trends of the gaming field; even auto mechanics must keep participating in continuous education to be able to use computers to diagnose issues with the newest car models.

This seven-week long project, known as a Worcester Polytechnic Institute (WPI) Interactive Qualifying Project (IQP), looked at how real-life software engineers deal (or do not deal) with the obsolescence of professional knowledge. We compared what effective methods practitioners in other fast-moving technical fields use in order to keep progressing. The project investigated what can be learned by software engineers both from other fields and from best practices within the field. One of the outcomes from the project was recommendations about policies companies could adopt to ensure that their software engineering employees stay up to date. The final project product was a written report along with a presentation.

2. Introduction

With the fast development of software engineering, it is said that the skill sets of software engineers get obsolete every three to five years. However, even though the technology has been changing, not all software engineers are capable of keeping themselves updated with the most recently developed technology that they need to be familiar with in order to perform high-quality work. This can result in the under performance of the software corporations and therefore the entire software industry.

This project looked at how real-life software engineers deal (or do not deal) with the obsolescence of professional knowledge. We compared what effective methods practitioners in other fast-moving technical fields take in order to keep progressing. The project investigated what can be learned by software engineers both from other fields and from best practices within the field. The research of industries including game development, medical industry, chemical engineering and mechanical engineering and companies including EMC, Mass General Hospital, General Motor and Google provided support for the project conclusion. We conducted in-person and telephone interviews with professionals from different careers on the topic of professional obsolescence in their industries. We came up with recommendations for the software industry in order to assist the professional development of software engineers regarding their current professional obsolescence.

The project resulted in a final written analysis paper on the obsolescence of software engineering careers followed by a presentation conducted at Microsoft to the employees at Microsoft New England Research and Development Center. One of the outcomes from the project was recommendations about policies companies could adopt to ensure that their software engineering employees stay up to date.

The report first introduces the background of this topic, with the research conclusions from previous papers on professional obsolescence. Then the report focuses on different industries to demonstrate how these fast

developing industries keep their professionals updated. Following that section are examples of successful company practices in various disciplines with detailed information on their support of employees' professional development. Finally we presented an evaluation of the methods that are adopted in different industries and companies, and therefore suggest the solutions to keep software engineers updated. The interview summary with professionals from different industries is attached in the appendix section.

3. Background Information

In this chapter, in Section 3.1, we provide a brief introduction of the previous research on the topic of professional obsolescence. In Section 3.2, we discuss the methodology used in the previous research. Finally, in Section 3.3, we discuss the conclusions we reached as a result of studying the previous research.

3.1. Introduction

In order to make sure our conclusions were accurate and our research topic had a base, we first performed background research for information gathered from previous research on related topics. We focused on not only the software engineering field, but various other professions that make use of or require some form of professional development. Through this research we came up with various books and articles related to our topic of professional obsolescence. The published material we reviewed typically addressed two primary issues: factors that affect an employee's obsolescence and methods to prevent or combat obsolescence.

The works discussing factors that affect an employee's obsolescence looked at these factors from different angles. The purpose of these articles is to look into the factors that can affect obsolescence, but in doing so, suggest ways to stay up to date. Rothman and Perrucci (1) looked at levels of vulnerability to obsolescence based mostly on career paths. They compared various different jobs and job aspects inside the engineering field to see which ones inherently kept the engineers up to date and which ones let the engineers fall behind if they did not pay attention to this aspect. They also looked into how an employee's actions related to his or her obsolescence.

Similarly, Blanton, Trimmer, and Schambach (2) did a study on obsolescence affecting information technology professionals (ITPs) in order to assess the "relationships between manageable work context factors and degree of professional competency". They researched

multiple factors affecting professional obsolescence, many of which were very similar, and in some cases the same, as the topics suggested in Rothman and Perrucci's article.

Authors Rong and Grover (3) also did a related study in which they tested a model of technological knowledge renewal effectiveness. They hypothesized that "renewal effectiveness was influenced by the IT professional's (ITP) career orientation, perceived IT dynamism, tolerance of ambiguity, and delegation" and that "this positively affected both intrinsic and extrinsic job satisfaction." They felt that ITPs need to stay up to date with technical knowledge in such a rapidly changing environment. While this type of research has been done quite frequently, they claim to go about it in a different way. While other articles study renewing activities, they study renewing itself, thus broadening their research. Unlike the previous two articles, this article also focused more on the individual and their actions and attitude and how that affected their obsolescence rather than focusing on their jobs aspects.

"Are you on the verge of obsolescence?" (4) sought to identify and understand the level of, causes responsible for, and consequences of managerial obsolescence. This article also identified several causes of professional obsolescence found within the work environment. All of these articles look at very similar factors and discuss how they may, or may not, affect professional obsolescence and go about doing so in various ways which will be discussed later. Despite publication dates ranging over the last 40 or so years, these four articles all came to very similar conclusions, which we discuss in Section 3.3.

As mentioned earlier, the other group of articles we encountered related to methods of staying up to date and combating professional obsolescence. As with the previous group, the articles in this group typically focused on one method of keeping employees up to date within the profession they chose to look at. This compilation focuses purely on ways of keeping the professionals up to date, assuming they have already

become obsolete in some way.

In one of the articles, authors Chun, Arling, and McQuaid (5) chose to follow a company, which is a case study research, in order to look at social networking technologies (SNT) and how they could be used to aid a company's efforts to create a "knowledge management (KM) and generative learning environment". They offer valuable information on using SNT to help keep employees up to date in a fast paced career. This is important research as SNT are relatively new tools and as such not much has been done in terms of discussing to use them as a learning environment.

An article written for the *Internet Journal if Allied Health Sciences and Practice* looks into creating a professional learning plan (PLP) designed to help athletic trainers with continuing education (6). While the profession is not related to our research, the concept of their research could be used. Creating an individualized learning plan could prove to be very useful for engineers.

3.2. Methodology

As survey is a common methodology for research, it is important for researchers to specify the proper sample to conduct the study. Researchers use field research, employing quantitative analysis of self-report questionnaire data as the primary method of research; qualitative interviews and data gathered from managers were sometimes used to supplement the primary quantitative analysis and evaluate potential common-method bias (2). Whereas surveying is not the only way to conduct the study, sometimes case study methodology was more appropriate, such as a single longitudinal case study, which can also provide a rich understanding and evaluation of the topic, as shown in Chun and Arling's (5) research on SNT's effect on KM. Multiple sources of historical data were used as the major resource. Similar to survey study, case study also was supported with formal interviews for data collection as well.

Besides getting proper samples, research surveys

were conducted under proper administration, with the measurement instrument pre-tested using an expert panel of academic and practitioner domain experts, to verify content validity and check for ambiguous measurement items. In case study, accuracy was sometimes ensured by having the case data reviewed and verified by key implementation actors for the analyzing product.

For the content of the survey, researchers usually brought up their hypothesis before settling down for a specific research design in order to have their ideas proved more thoroughly. Three broad factors, directly or indirectly pointed out in most research, are the primary causes for professional obsolescence: individual factors, organizational factors and nature of work. Each of these survey factors was measured with several items as subsets of factors. The specific professional facets being analyzed were usually drawn from previous studies to include the most important factors. For example, Trimmer, Blanton and Schambach (2) used the scaled items adapted from behavioral anchored rating scales (scales used to report performance) (7), which were professional knowledge, interpersonal communication skills, project management skills, problem analysis skills, conceptual design skills, system evaluation skills, and implementation skills.

In data analysis, validating questionnaires are selected from the surveys. Some studies selected random questionnaires from the survey pool for further research, whereas some would use the entire survey pool if the survey population is not significantly huge. The final samples were mostly very representative.

For further assurance, as mentioned earlier, an important factor in analyzing the data from the surveys is common method bias, which is one of the main sources of measurement error. For example, one of the common method biases is favoritism towards different social groups. It can threaten the validity of the conclusions about the relationships between measures (8). Most of the researches conducted single-factor tests, and all of the variables were loaded into an exploratory factor analysis and researchers examined the unrotated factor

solution, a solution based on all possible factors (9). Final conclusions were drawn that common method bias was not a significant factor in the results (3).

As shown in the previous research of Rothman and Perrucci (1), some conclusions were drawn from a national survey that was conducted during 1964 and 1965. A sample of 150 organizations was selected from 3,231 organizations; among these 150 organizations, approximately 4,000 engineers where polled. Of the 4,000, only engineers with B.S. degree were used because holding an advanced degree was highly correlated with the result, which resulted in 2,353 acceptable responses. In order to measure the amount of obsolescence, they used two scales: "current knowledge" and "emerging fields". The score of "current knowledge" came from summing respondents' self-evaluation of 29 technical areas. The resulting scores had a range of 100 to 200, and the higher the score the greater the reported knowledge. The other scale, "emerging fields", was based on 51 new and specialized areas of engineering knowledge. The resulting scores had a range of 51 to 102, and again, higher scores indicate greater knowledge. Rothman and Perrucci used the standard one-way analysis of variance and analyzed the data by examining one variable at a time. Some of the data that they used in their research are shown in Table 1.

Career Attribute		Obsolescence Score	
		Current Knowledge	Emerging Fields
Technical Responsibility	Limited	116.1	65.2
	Moderate	117.5	67.8
	Extensive	122.2	72.0
Engineering Function	Operations/Const./ Prod.	113.8	65.0
	Sales/Mgmt./Teaching	116.9	68.7
	Design	120.5	67.3
	Research/Development	122.0	70.3
Administrative Duties	Primarily Technical	120.5	68.6
	Both	118.0	68.2
	Primarily Administrative	113.4	66.5

Table 1. Variance between Career Attributes and Knowledge Obsolescence

A detailed explanation of data from this table can

be found at the beginning of Section 3.3. From the above table, we can see that extensive technical responsibility, research and development engineering function and primarily technical administrative duties can, to some extent, help professionals to avoid obsolescence from their professions (1).

3.3. Conclusions from Previous Research

In the article "Vulnerability to Knowledge Obsolescence among Professionals", the authors, Rothman and Perrucci (1), showed that vulnerability to obsolescence is a problem for professionals who possess certain professional characteristics, follow certain career paths, and perform in certain types of organizations. For example, Table 1 above showed that engineers with limited technical responsibility were more likely to become obsolete than engineers with extensive responsibility. Limited technical responsibility is expected to increase vulnerability to obsolescence by allowing the degeneration of existing knowledge through disuse, and failing to stimulate self-education because of the minimal requirements necessary to keep the job position. The authors also used another set of data on variance between professional characteristics and knowledge obsolescence to show that obsolescence decreases as the extent of involvement in professional activities increases.

By surveying 2,353 engineers, the authors found that the least vulnerable engineers are those who: 1) have pursued a broad technical career, worked in Research and Development, and performed technical tasks rather than administrative tasks; 2) have high achievement needs, engage in various professional activities, and have a more cosmopolitan orientation; and 3) work in companies that are technically dynamic, and where management is aware of professional value systems. (1)

Some other research made recommendations to employees and companies. "Are You on The Verge of Obsolescence" (4) is an article published by the Shri Ram Centre for Industrial Relations and Human Resources. The article appeared in *Indian Journal of Industrial*

Relations in the April of 2009. In this research article, the authors suggest that solving the problem of obsolescence was a shared effort between employees and their organization or companies. The problem can be tackled by a two approaches happening at the same time. The first one is to encourage the initiatives to be taken at the personal level for self enhancement and updating. On the other hand, interventions like continuing education and training to be taken at the organizational level are also essential to combat obsolescence. Incite initiative

As the article argued, at an individual level, developing both short and long term goals to expand skills and knowledge is essential. This approach is very crucial as it is possible it has been a long time since they received a formal education. Although taking extra coursework on a part-time basis requires additional time, energy and money, working on life-long learning may differentiate between you and your peers in your field at the time of a promotion. In second place, the article suggested the individuals to keep abreast with current developments in the field. "Know how far your function with your organization deviates from the mainstream in your field." Reading professional journals and participating in regional, national or international conferences when possible are also important to individual employee. It is also critical to know some other aspect of the company's work which might be related to your own. In order to do this, one needs to be willing to take some challenging tasks and do more than what on one's job description. One should regularly discuss with colleagues in another department and ask what they have been doing (4).

In the journal *Indian Journal of Industrial Relations*, at an organizational level, it is companies' responsibility to provide a "right work environment, sound human resources policies and practices with a focus on training, and deployment of personnel based on their competence are some of the initiatives that can be taken at the organization level" (4). Managers should assign jobs that are so structured that they are challenging. People with potential should move through a series of

challenging jobs. Trimmer, Blanton and Schambach (2) also claimed that their study showed that management should encourage updating activities in order to enhance intellectual capital within the firm in the article "An Evaluation of Factors Affecting Professional Obsolescence of Information Technology Professionals". In this article, it was also suggested that organizations should focus on the employee.

Mohan and Chauhan (10) showed that training helped in reducing obsolescence particularly on the facets like: 1) Self-initiated updating activities; 2) Attitude towards learning; 3) Professional knowledge/skills; and 4) Motivation to update. In Chauhan and Chauhan's later article (2008) "Human Obsolescence: A Wake-up Call to Avert a Crisis", they claimed that post-training assessment of the impacts is also a good way to make training more useful. (11)

4. Industry Analysis

In this chapter, we investigate a number of industries. For each industry, we first introduce the industry and present its rapid development. Then, we show some approaches each industry adopted to keep their professionals stay up-to-date. Finally, we summarize and evaluated these approaches based on our research and interviews.

4.1. Game Developers

4.1.1. Industry Introduction

Video game developers are those who not only truly love to play games, but also understand games and want to make and design their own games. There are various kinds of game developers such as programmers, artists, producers, and designers.

With the rapid growth of computer technology and audiences' increasing demand for diverse games, the video game industry has undergone a drastic revolution during the last twenty years. During this period of time we saw a transition from arcade games to home consoles and we witnessed the emergence of new genres such as real-time strategy and Massively Multiplayer Online (MMO) games.

Brian Moriarty (12), a professor of practice in the Interactive Media & Game Development program at Worcester Polytechnic Institute (WPI), explained the evolution and changes in various types of game developers. Professor Moriarty said that the artists need to keep up with the new tools, such as from 3D Studio to Maya, and then to Z-brush. Things are constantly changing. The designers need to play all the major new games to learn what is going on in the new games. Also, the producers need to know the software, both the administration tools and the management tools. These tools are changing fast, but not as fast as programming language and development software.

Creath Carter (13), who is a game developer and artist for Turbine Entertainment asserted that engineers must keep up with changes from hardware and API's.

Approximately every 3-5 years, a new console will come out and engineers need to work on games that are on those consoles.

4.1.2. In-Depth Industry Investigation

Continuing Education

Some companies are dedicated to their growth in abilities and creativity. For instance, according to *Nintendo Corporate Social Responsibility Report*, Nintendo of America Inc. listed "Employee Welfare and Wellbeing" as a core of this report, which clearly said, "*Nintendo of America offers employees various programs and opportunities to help promote healthy lifestyle choices, as well as continuing education and training*". (14) Nintendo offers tuition reimbursement for those seeking for further education or enhancement in the field related to their current job or perspective job.

Another example is that Ubisoft, a leading creator and publisher of video games, has a strategy called In House Development. Ubisoft is deeply convinced that internal development will be essential to their transition to next-gen consoles. In order to build up the creative talents and skills of their 24 studios consisting of more than 5,350 developers, Ubisoft promotes continuous professional training and international mobility thereby giving teams the necessary tools to excel in their fields. (15) In addition, Ubisoft started the Ubisoft Campus in Montreal, Canada; it offers various certificate programs, such as Design and Production Levels of Video Games, to future talents as well as the current employees in Ubisoft.

Professor Moriarty pointed out the same thing that companies, especially large companies, support continuing education. If the employees only want to attend one class, his/her company will pay for the class as well.

On the other hand, Mr. Carter pointed out that continuing education does not happen that much and it depends on companies. Mr. Carter felt that it is more budget-friendly to hire people who just graduated because new graduates who just finished their education would have the latest technologies.

Conferences

Professor Brian Moriarty suggested that for engineers, the companies often send them to conferences. There are console manufacturers elaborating on unique features about a particular console and teaching attendees how to use their consoles. There are also middleware companies, who develop robust software suites which include many elements a game developer may need to build a game. They hold sessions to give an interactive demonstration and tutorial to developers. Brian Moriarty said that conferences are extremely helpful and they are an important source of information.

There are a lot of conferences and community groups that people can choose to attend. One example is the Game Developers Conference (GDC). They hold their conferences several times a year in San Francisco, Texas and Europe (16). The GDC features over 400 lectures, panels, tutorials and round-table discussions on a comprehensive selection of game development topics taught by leading industry experts. Moreover, the GDC exposition exhibits all of the most innovative game development tools, platforms and services that are helping to drive the industry forward.

These conferences also happen locally on a regular basis. Mr. Carter told us more about several regional conventions and community groups that he usually goes to. For the Boston Area specifically there are also the Boston Indie Group and the Boston Post Mortem. The International Game Developers Association has chapters all over the world such as Los Angeles, Shanghai, Berlin and Melbourne (17). Some developers will pick something (that they are interested in or are working on) to talk about in these conferences and monthly meetings. Attendees also will get exposed to the latest and most advanced technologies and games. Developers are also free to choose from a series of Special Interest Groups (SIG), ranging from Casual Games, Flash, Online, and Visual Arts. Attending these meetings and joining theses interest groups is a key to stay up-to-date.

Magazines and Industry News

According to Professor Moriarty, most of the companies he worked for subscribed to major game magazines and put the latest issues in the lounge so that people could read and know more about industry news. Examples of the magazines that companies usually subscribe to are *Game Developer*, *Games for Windows* and *Game!*. By reading these magazines, employees can have a better understanding of the industry trend.

Professor Moriarty goes to websites that are created for developers, such as *Gamasutra*, *Gamedev.net and Game Developer.* Professor Moriarty also suggested that developers should always read these sites and know what is going on in the business because these websites have featured articles and tutorials about the most innovative technologies.

Mr. Carter also pointed out that the most influential periodical, Game Developer Magazine, is made available to all professional members of the industry.

Upgrade Software and Hardware

Two things are changing constantly in the game industry: hardware and software, as Mr. Carter expressed. Hardware, such as graphic cards and consoles, is improving very fast. Software tools and middleware are progressing even faster. Most companies know the importance of upgrading software and hardware and they do so regularly.

However, Professor Moriarty provided some rules that companies follow while upgrading their software and hardware. During a project it's not good to switch versions because some tools are designed specifically for one version, and if things change it may break. But between projects it's definitely good to move to the newer versions. This is true with hardware as well. It's a trade-off of time and money. The game companies update their hardware at a rate that makes sense. They try to update them once a year. They always update the hardware to the most updated version available in the market.

Other Approaches

One of the most essential points in game industry is

innovation. Great inventions may come from ideas that seemed to be naïve and even silly. Companies should create a healthy culture in which ideas are able to flourish. Companies such as Blizzard Entertainment, the developer of World of Warcraft, encourage every employee to speak up, listen, be respectful of other opinions, and embrace criticism as just another avenue for great ideas (18). Such a policy is explicitly explained in Blizzard's Mission Statement.

Mr. Carter pointed out that this industry is so young so that the growth of the industry as a whole is essential. Some companies will sponsor game development competitions in order to incite developers to create the most innovative games. Activision, publisher of the Call of Duty series and the Guitar Hero series, holds an Independent Game Competition to all developers, both individuals and teams (19). It is open to Activision's employees and employees from all over the United States. The first place contestant will receive $175,000 while the second place contestant will receive $75,000 in order to assist with the development of their games. Activision fully believes that great ideas and rising talents need support to reach their full potential. Activision's action is beneficial not only to the individuals but also to the industry as a whole.

Moreover, some companies offer free resources to public game developers. Popcap, who made the prominent Plants vs. Zombies, is committed to the game developer community by allowing free access to the programming framework that Popcap has successfully established (20). This framework contains plenty of libraries that provide commonly required functions and reusable components, which benefits developers to a great extent.

4.1.3. Industry Evaluation

There exist various methods that companies adopt in order to keep their developers fresh and updated, which are, indeed, valuable to the developer community as well as the gaming industry as a whole.

More importantly, as both Professor Moriarty and Mr. Carter suggested, self-motivation is definitely the No. 1

incentive that helps everyone stay up-to-date. “Games have always had roots in the hobbyist/DIY spaces, so many people stay on top of changing technologies and techniques purely driven by interest and enthusiasm for the medium”, said Mr. Carter.

Having the desire to learn and know more is critical for everyone. Learning from other people in the industry tends to help to a significant extent. This is especially true for designers and animators. “I'm in constant search of information on the new stuff a good animator should know. I love to read interviews with other animators so I can study their methods of working and the way they have of approaching different shots of animation. All animators have their own techniques,” says Patrick Beaulieu (21), an animation artistic director at Ubisoft Quebec. Moreover, it is crucial that a game developer is open to critiques. As a developer, one of the ways to examine your abilities is to post your work on an online forum or show it to the public and see how they react to it.

Mr. Carter mentioned that he had worked for several game companies up to now, and only one or two companies treated professional development seriously. Mr. Carter pointed out that most other companies thought that if something was not creating profit immediately, it was not worth doing it. He also conveyed that the game industry is immature and it is still finding its footing. “Every few years I make that statement, and every time I wonder how many more years it will continue to hold true. If more companies would be more serious about helping employees keep themselves updated, it would benefit everybody.”

4.2. Medical Industry

4.2.1. Industry Introduction

A physician, also known as a doctor of medicine, is someone that helps patients recover to full health through the study, diagnosis, and treatment of disease. Doctors are in charge of people's lives and are therefore held to an extremely high standard with their knowledge base. New hospital technology is coming out a fast pace and, while though in the long run it makes the doctors' lives easier, they must first learn how to use all of it safely and properly. Both of these factors make it extremely important for physicians to stay up to date.

According to the American Nurses Association, "nursing is the protection, promotion, and optimization of health and abilities; prevention of illness and injury; alleviation of suffering through the diagnosis and treatment of human responses; and advocacy in health care for individuals, families, communities, and populations" (22). Though the nursing industry is not the most high-tech field, it is still very competitive and very fast paced. Even though the basic nursing skills, such as the care giving to the patients, do not change the way to assess people by checking on the skin color and skin temperature, the clinical skills, the technology, the equipment and the tools are changing. Nursing is a very diverse profession. No matter in what area of nursing the nurses work, there is constantly new technology evolving. Procedure areas and critical care areas are likely to be the most impacted by the development of technology; emergency rooms, critical care, intensive care, and even endoscopy suites are fast developing as well, because they all involve the newest and latest equipment.

4.2.2. In-Depth Industry Investigation Certifications

One of the major motivations for physicians and nurses to stay current with their professional knowledge is that they are required to maintain certain certifications in order to work in the industry. Most certificates can be renewed by acquiring continuing education credits.

Physicians are required to get a full physician's license from their state medical boards to practice medicine (23). An application from the Board of Registration in Medicine's website (24) is required in order to obtain the full license. They need to renew the license every two years. In order to renew it they must acquire 100 Continuing Medical Education (CME) credits every two year cycle. There is a strict set of rules to follow in order to achieve the CME requirement; a doctor cannot just pick a bunch of different methods to get his or her CME credits. First, 40 credits must fall into Category 1. A Category 1 credit is generally sponsored by an institution or organization accredited to offer American Medical Association (AMA) Category 1 credit for CME activities. The other 60 credits may fall into Category 2. Category 2 may include: lectures/seminars that are not accredited, teaching of other health care professionals, publication of articles, and self-instruction such as reading an article or taking an online course.

More specifically, it is required that the majority (at least 51) of these credits must directly relate to the physician's primary area of practice. It is also required that ten credits of risk management study are obtained. At least four of these hours must be Category 1. The final requirement for CME credits is to include 2 credits studying the Massachusetts Board of Registration regulations.

In addition to CME credits, many physicians can get board certification (23) in their specialty areas by the particular board overseeing their specialty area which shows that the physician is a qualified practitioner of that specialty. In order to get this certification, physicians must meet extensive initial education requirements, participate in clinical practice, and take some form of test or tests. Every ten years retesting is required for physicians to maintain their board certification. This entire process however is not a requirement for physicians. Getting the certification may be highly encouraged and recommended by the hospital they work at but it is up to the physician to get it.

Whereas for nurses in the United States, after graduating from an accredited nursing school, they must partake in the National Council Licensure Examination (NCLEX). There are two versions of this test, the NCLEX-RN for registered nurses and the NCLEX-PN for practical nurses. The exam tests nurses on knowledge, skills, and abilities essential to the safe and effective practice of nursing at the entry-level. The content of each version varies but the general idea of the test remains the same. Upon completion of this test a nurse is issued his or her license by the state board, for Massachusetts, this is the Massachusetts Board of Registration in Nursing (25).

Once nurses have their licenses, they must renew them every two years. This is done through Continuing Education Units (CEUs). A nurse is required to obtain 15 CEUs before their license is to be renewed. There are a variety of methods to go about doing this. It is very common for a hospital to provide programs on different topics, which nurses can attend and earn CEU's for attending. Specific units inside the hospital may also offer more relevant programs to their nurses to help keep them from scrambling for CEUs when it is almost time to renew. Another option is reading a professional journal such as the *Journal of Nursing* which has articles on different topics. After reading the article the nurse must take a test and mail the test and, assuming the nurse passed, they will be awarded with some amount of CEUs. A third way is to attend a seminar which can be offered by the hospital or an outside source. There is not always a test involved and at the end of the seminar, a certain number of CEUs will be awarded. For example, last May Children’s Hospital Boston offered an all-day seminar on pain control. There was no test involved and at the end all of the attendees received a certificate for 6 CEUs.

Outside of CEUs it is highly encouraged, though not necessary, that a nurse gets certified in their specific area of care. Most acute care hospitals also want their nurses to be proficient in their chosen specialty area. For example, according to Judith Grindeland (25), a nurse from Children’s Hospital Boston, her hospital would

prefer that all of their gastroenterology nurses were certified in that area. Getting certified in this area requires taking the Certified Gastroenterology Nurse Exam (CGRN). In order to qualify for this exam, the nurse must have worked 1,000 hours in this specific field.

Hospitals generally support nurses pursuing the certificates and licenses. The certification tests can be expensive and hospitals will sometimes reimburse the nurses upon passing the exam. Passing gets the nurses certified for five years at which point they must renew it. Every specialty in nursing has a certification exam like that. The emergency room nurse exam is the CEN exam and the Operating Nurse exam is the CNOR exam. There are also certificates for orthopedics, neurology and even ambulatory nursing. Hospitals are under more and more scrutiny to be "excellent" and part of the way they do that is to tout how many of their nurses are certified. Hospitals also want to achieve Magnet status, and one of the things that distinguish them from the rest of the hospitals trying to achieve Magnet status is how many of their nurses are certified.

Continuing Education / Training

The first type of training is equipment-related. As mentioned in Section 4.2.1, nurses constantly deal with the newest medical equipment. When hospitals bring in new equipment, some of the companies that make the equipment hold classes to teach everyone how to use the equipment. Since there is no formal assessment to test the training result, further clarification on the usage of the equipment mainly depends on communication between co-workers.

According to Judith Grindeland from Children's Hospital Boston (Appendix A.7), the hospital offers refresher classes periodically for basic nursing knowledge. The education department comes in to teach and provide classes. Furthermore, the units that physicians and nurses work in usually provide some basic opportunities for continuing education, and the information being taught is usually pertinent to where the professionals work, which is always beneficial. In this way, physicians and nurses will also get the

opportunity to accumulate their CME and CEU hours so that they will not scramble at the last minute.

A computer-based learning system, called net learning, is also supported in Children's Hospital Boston. This hospital-wide learning occurs when a problem arises. Everyone is required to finish the net learning class on it to understand the problem and to prevent it from happening again. For these classes, everyone has to learn the presentations and pass a test at the end. The managers have access to their employees' net learning account. An employee's salary can be altered if they are not caught up on their net learning.

In addition to the three types of training mentioned above, My Yearly Report (MYR) at Children's Hospital, which includes all safety-related topics, is available for nursing training. The content of MYR does not change as often as the computer based learning system. One of the reasons that MYR is named this way is because it is one of the major parts that are discussed during the nurses' annual reviews.

Most hospitals support their employee's pursuit of a higher degree through part-time attendance of universities' masters or PhD programs that are job-related by providing full or partial tuition reimbursement. Unlike most professions, getting a master's degree in nursing generally will not bring the nurses higher salaries. It is, however, viewed as highly desirable if the nurses are interested in a management position in nursing. The focus then would not be clinical in nature but rather management and human resources.

Also, an advanced practice nurse (APN) is a nurse who has obtained master's degree in nursing to be a nurse practitioner in a certain specialty. They can see patients as an independent practitioner (although they work under an MD's supervision) and write prescriptions. The renewal of advanced practice nurses' licenses require more CEU's than that of regular nurses.

Other Approaches

In addition to obtaining and maintaining certain licenses and certificates and continuing education in forms of training, there are also many other approaches that help physicians and nurses to keep updating their professional knowledge. For example, most institutions expect the physicians to attend a number of conferences, meetings, lectures, some of which are related to medical practice and some of which are related to more business like aspects.

An important factor in achieving good performance for nurses is to learn from co-workers. There are always experienced nurses that are available to help the new and inexperienced nurses. Some hospitals also offer mentoring programs to pair up experienced and new nurses, in order to provide new nurses with the necessary resources and help that they may need. The experienced nurses have a lot of knowledge and this gives new nurses a chance to gain that knowledge.

Another way to learn about the new techniques in the medical industry is to watch representative surgery videos. These happen for surgeries both within the hospital and outside of the hospital. The surgery is not only shown to the physicians but to the nurses as well to let everyone have an understanding of some important topics and methods.

Physicians and nurses are often supported to go to conferences, which also counts towards their CMEs and CEUs to renew their license. The hospital encourages employees to go to the conferences and bring back what they learnt there. Medical innovation related topics are talked about in the conferences. Lectures and group discussions are the common forms of how information is spread during the conference.

4.2.3. Industry Evaluation

There is no blanket statement for which single method does the best to keep the medical industry up-to-date, but the combination of certifying, continuing education and all other approaches that push the industry forward help it to up with the pace of technology

development.

For the certification process, there is a fairly specific set of rules to go about doing this which must be followed to acquire 100 CME credits. The other option for physicians, which is not required, is to get board certified in their specialty area by showing and maintaining a great amount of knowledge and skill in their specialty area. The most basic thing that a nurse does to show that she or he is up-to-date is obtaining CEUs which allows the nurse to get their license renewed. However, this isn't a very difficult process and doesn't require much effort from the nurses. A nurse has two years to obtain 15 CEU's. Another option for nurses is to get certified in their specialized area of nursing. This shows that the nurse has a certain level of proficiency beyond a basic degree.

It is highly dependent upon the individual as to whether or not there are better methods for them to learn. In the end the more motivated the person is, the more likely they are to do better. A computer based learning system may be a good choice because it keeps providing new training courses and makes everyone notice what is going on in the industry. Having more skill sets may not have an immediate effect on the medical employees' jobs, but they look well on a resume. Employees can feel the prestige if they have more skills and knowledge. It cannot be denied that even though some people are self-motivated so that they want to learn more, there are also some nurses who just want to keep their job but not interested in learning more.

Managers play an important role for those who are not motivated. Managers usually want their department to develop continuously because hospitals always would like to attract more patients. Keeping each department up-to-date is definitely essential to each department, and is a component of the managers' review. They usually will encourage each nurse to learn more about newer equipment and skill sets.

Hands-on experience is one of the best methods to learn, said Judith Grindeland, a nurse from Children's

Hospital Boston. Ms. Grindeland discovered that good old fashioned experience was what makes the best nurse in any given specialty. She would prefer an experienced nurse over a certified nurse any day. She felt that nothing tops having an experienced nurse with you showing you what to do and then coaching you through it.

4.3. Chemical Engineering

4.3.1. Industry Introduction

Chemical engineering is the branch of engineering that deals with the application of physical science and life sciences with mathematics, to the process of converting raw materials or chemicals into more useful or valuable forms. In addition to producing useful materials, modern chemical engineering is also concerned with pioneering valuable new materials and techniques. It largely involves the design, improvement and maintenance of processes involving chemical or biological transformations for large-scale manufacturing. Chemical engineers ensure the processes are operated safely, sustainably and economically. It is a very broad and fast-developing industry that is worth of being looked into.

Chemical engineers focus on different sub-areas. As individuals, even though the basic concepts of chemical engineering do not change over the years, there are new technologies and software developed for different disciplines of chemical engineering all the time.

4.3.2. In-Depth Industry Investigation

Obsolescence of technical knowledge is a major problem in many engineering fields, including chemical engineering. The chemical engineering field has ways of keeping their engineers up to date but they are purely by choice and nothing is officially required of the engineers. The only requirement comes from a personal commitment to being a first rate engineer and not falling behind in their field.

Professional Engineer License

Most engineering fields have what is known as the Professional Engineer license which tests the applicants on their engineering knowledge and allows them to offer professional services directly to the public. The same applies to chemical engineering as well. The license demonstrates that the chemical engineers have certain knowledge about their professional area. Professor Thomas Starr (26), from the Chemical Engineering department of Worcester Polytechnic Institute, said that he always encourages his students to get the Professional

Engineer license if they have the opportunity to do so. Even though most companies do not require their chemical engineers to have the Professional Engineer license, it does give the engineers qualifications that not everyone has, and puts the engineers in a slightly different category.

The process for chemical engineers to attain the Professional Engineer license has no difference from other engineering fields (27). It can take a few years to accomplish and as such can be considered a way of keeping the engineers up to date. The first step is to complete the Fundamentals of Engineering test which is an exam that tests applicants on basic engineering knowledge. Completion of this test enters the engineer into the Engineer in Training phase. The applicant must remain in this stage for around four years (it is different from state to state) gaining experience. Once applicants have finished their training period they can take the Principles and Practice in Engineering test which tests them on knowledge more specific to their field. Upon passing this test, the applicant is awarded their license and the title of Professional Engineer.

The license does have to be renewed but the renewal process, at least in Massachusetts, involves simply asking for a new license. No test or refresher course is needed for a license renewal. Therefore for the first four years, a chemical engineer should stay up to date if they wish to pass the test but after that it's all left up to them. This is not the case with all states however. Currently, there are 29 states that require Professional Development Hours (PDH) to maintain licensure. PDH's are set up to encourage engineers to acquire Continuing Education Units (CEU) as one CEU is equivalent to 10 PDH's.

Professional Organization

As fast-developing as the chemical engineering industry is, there are several leading professional organizations, such as American Chemical Society (ACS), American Institute of Chemical Engineers (AIChE), American Hydrogen Association (AHA), etc., among which AIChE is the most widely recognized organization.

Professor Starr felt that it helps with technical education and learning the news and it serves for personal satisfaction as well.

AIChE (28) is the world's leading organization for chemical engineering professionals, with over 40,000 members from over 90 countries. AIChE has the breadth of resources and expertise you need whether you are in core process industries or emerging areas, such as nanobiotechnology. AIChE members can access information on recognized and promising chemical engineering processes and methods, connect with a global network of intelligent, resourceful colleagues and their shared wisdom, or find learning opportunities from recognized authorities. All of which can help the members move forward professionally and enrich the world we live in.

AIChE holds a lot of conferences that provide concentrated knowledge in specific areas and contain the most up-to-date information in these areas. Companies generally pay for the cost of attending conferences; however, due to the fact that most conferences are expensive, and employees need to leave work in order to attend the conferences, chemical engineers need to justify what they can bring back to the companies before they are allowed to attend the conferences. There are different conferences that can meet different chemical engineers' needs: the Spring Meeting is the year's key technical conference for practicing chemical engineers; the Annual Meeting is the premier educational forum for chemical engineers interested in innovation and professional growth; specialty conferences are where thousands of industry peers share the same interest; there are also co-sponsored conferences that cover a wide range of fields including instrumentation, energy, heat transfer and emerging technologies and materials.

There are also several other programs offered by AIChE that help members with their knowledge update. As the latest online benefit for AIChE members, ChemE on Demand is an electronic repository of chemical engineering content, both live and archived, drawn from AIChE, SBE, SEF, IFS, CCPS and many divisions, forums and local sections' programming and publications. Content is

added every day. The accessed content will always be accessible in the members' "My Content" tab. One feature of the ChemE on Demand content is the AIChE Webinars. This e-learning initiative covers current and informative topics of interest to all chemical engineers, including career building skills, technical instruction and state-of-industry overview, in an accessible at-your-desk format.

AIChE also provides valuable publications for chemical engineers in various disciplines, and the AIChE eLibrary which is free of charge for the organization members. It serves as a career center for chemical engineers who are looking for new jobs, and builds communities for local sections in order to meet the needs of chemical engineers locally. Beyond networking opportunities, it can give the chemical engineers the support that they need to grow professionally and personally.

Pharmaceutical Industry

As an important branch of chemical engineering, pharmaceutics can serve as an excellent industry example in keeping updated. There are many chemicals with known pharmacological properties but a raw chemical is of no use to a patient. Pharmaceutics deals with the formulation of a pure drug substance into a dosage form. The pharmaceutical industry is a very fast-developing industry that develops, produces, and markets drugs licensed for use as medications. Pharmaceutical companies can deal in generic and/or brand medications. They are subject to a variety of laws and regulations regarding the patenting, testing and marketing of drugs. Pharmaceutical Research and Manufacturers of America (PhRMA) is one of the main organizations that publish guidelines urging companies to report all findings and limit the financial involvement in drug companies of researchers.

In the pharmaceutical industry, innovative new medicines and treatment do not just happen. Potential new medicines pass through several crucial stages on their way from research laboratories to the pharmacy shelf. Scientific knowledge of disease and potential treatments

is growing rapidly. Scientists today are tackling more complex diseases than ever before. Once researchers identify a potential new treatment in the laboratory, years of testing begin. In order to determine whether a potential medicine can safely and effectively treat a targeted disease, teams of physicians, who work with the Pharmaceutical Research and Manufacturers of America companies, carry out a series of clinical trials. Once a potential medicine is shown to be both a safe and effective treatment, the U.S. Food and Drug Administration (29) reviews all of the studies and trials in order to determine whether a medicine can be approved for patient use (30).

America's pharmaceutical research and biotechnology companies understand that accurate information about disease and treatment options makes patients and doctors better partners (31). And getting that information to patients and consumers is the goal of direct-to-consumer (DTC) advertising about prescription medicines. DTC advertising increases people's awareness of disease and available treatments. Studies show DTC advertising brings patients into their doctors' offices and starts important doctor-patient conversations about health that might not take place otherwise. People sometimes have opinions about prescription medicine advertising.

As mentioned earlier in this section, an important organization in pharmaceutics is Pharmaceutical Research and Manufacturers of America (PhRMA). Various publications keep PhRMA companies up-to-date with the most developed technologies of the pharmaceutical industry. PhRMA publishes yearly industry reports to share with the public news about industry innovations, new medicines, and new discoveries (32). Pharmaceutical professionals can stay current with PhRMA news reading regular newsletters published by PhRMA on a variety of industry-specific and newsworthy items. PhRMA's principles and guidelines concerning Clinical Trials, Direct to Consumer Advertising, Health Outcomes Research, and the Pharmaceutical Supply Chain are available for viewing and/or download. Many testimonies before Congress are available for viewing through PhRMA publications. Various official submissions to Congress on a variety of

pharmaceutical-related topics are also available online.

Included in pharmaceutics is the cosmetics industry. The cosmetics industry is also very fast-developing and therefore cosmetics product development training is needed to help developers to stay up-to-date with the major changes in the cosmetics industry that are mainly driven by consumer demand, aggressive market claims, regulatory issues and scientific breakthrough discoveries. As the leader in continuing education and accredited technical training, the Center for Professional Advancement (CfPA) offers the most state-of-the-art cosmetic research and development training. Public and online training courses run from one to five days in length, include discussions, case studies, and group exercises and are taught by industry leaders who share their knowledge in an enthusiastic, interactive manner (33). Over ninety courses are offered online that cover almost every aspect of the cosmetic industry.

Other Approaches

While there are various different ways that the chemical engineers can take in order to keep themselves up-to-date with technology development, it is mainly the employees' own interest in taking on actions to learn more about their professional world. Different companies encourage their employees to different degrees; however, there is no strict requirement on what chemical engineers have to accomplish in updating their knowledge.

It is fairly important for chemical engineers to be interested in the industry news, read magazines about the businesses in this industry and focus on what is going on every day that includes new technologies that are coming out and events that are going on. Self-motivation and self-satisfaction are important since as long as the interest is there, the chemical engineers do take time to seek more knowledge either in their specialty fields or in the more broad chemical industry. When asked about what the most effective methods in updating the chemical engineers' knowledge were, Professor Starr answered that it would be to be aware of what's going on, stay on top of the news and engineering magazines. It's good for picking up specific knowledge and getting the best

overview.

Chemical engineering companies generally provide the necessary training for their employees. Presentations can be put on during lunch time for engineers to learn about the new technology and the new trends happening in the chemical industry. The necessary training is also brought up during the chemical engineers' annual reviews, which in turn provide the engineers the opportunities to state the conferences or external industry events that they would like to attend in order to learn more about the industry trends. Companies can support chemical engineers in reimbursing the Professional Engineer license fee and pay for the tuition for chemical engineers to pursue a higher degree in job-related programs. Chemical engineers who are obtaining a degree can help their companies because they get the opportunities to be specifically trained for their jobs, however they benefit themselves the most in the long run.

Research cooperation with universities happens at times. Universities provide excellent resources and knowledge for the research and development, but a close match between faculty members' research interest and the companies' product interest is usually hard to find. Geographical overlap between companies and universities also has to be taken into consideration.

4.3.3. Industry Evaluation

Chemical engineering is a very fast developing industry with new technologies from other sciences and engineering that can be integrated into this field. As most chemical engineering companies help their employees to achieve their best performance, it largely depends on the chemical engineers to have the self-motivation to learn more about what is going on in the industry, get the Professional Engineer license for professional capability demonstration, and join a professional organization for broader industry networking and activities involving more innovative knowledge.

As indicated from the pharmaceutical industry, cooperation between companies within an organization is good for the innovation and testing of new medicines.

Developing the relationship between patients and doctors also helps to improve the development of the pharmaceutical industry. Regular publications on the most recently developed technologies are another great way to help to keep the professionals updated with the trend of the industry. Specifically in the cosmetic discipline, courses are offered in order to keep professionals updated with the recently developed technologies, and research outcome can be gained by purchasing from research institutes rather than self-developing.

4.4. Mechanical Engineering

4.4.1. Industry Introduction

Mechanical Engineering is a division of engineering focused on motion, energy, and force through mechanical solutions. The field involves making mechanical devices that can help to solve problems in society. Being a broad field, a mechanical engineer can go into multiple different fields after learning the basics of mechanical engineering. If an engineer is willing, the can pursue a higher degree in a more specific are an open up new opportunities in the field.

Like almost all engineering fields, mechanical engineering updates very fast. Because the technology within this industry changes so rapidly, skills a student learns in college can become obsolete after only a few years and of course this applies to engineers already in the field as well. Because of this, mechanical engineers must have some sort of system in place, whether it is on the individual or company level, in order to stay up to date.

4.4.2. In-Depth Industry Investigation

Obsolescence of technical knowledge is a major problem in the mechanical engineering field. Technology is moving so quickly that mechanical engineers need to figure out a way to grasp incoming technology while balancing it against the current technology. There are various ways to do this in mechanical engineering, some examples are: continuing education, obtaining a license, and joining an organization. These are just a few of the ways a member of the mechanical engineering field can stay up to date.

Professional Organizations

There are a number of organizations a mechanical engineer can join to help combat professional obsolescence. These organizations can provide the engineers that belong to them with numerous tools to help in their professional development. Despite many smaller organizations, there are only a few major ones, one of which is the American Society of Mechanical Engineers (ASME).

Despite labeling themselves American, ASME promotes the practice of mechanical and multidisciplinary engineering around the world. ASME is one of the world's largest mechanical engineering societies with over 127,000 members (34). This organization helps its members with continuing education programs and developing their professional careers.

One of the major things that ASME does is to ensure that all members are accredited and have the proper licensing and certifications. The major license, which can be obtained through AMSE, is the Professional Engineer license. The specifics on this license, such as how to obtain and maintain it, can be found in Section 4.3.2. (35)

In addition to ensuring that their members receive accreditation, ASME tries to further each member's professional development by offering Training and Development sessions. These sessions are planned in advance and the dates are prominently displayed on the front page of the website. These sessions are key to helping members remain up to date in the latest technology and information. The sessions are authorized by the International Association for Continuing Education and Training (IACET) (35). The IACET authorization is the accepted standard for training programs worldwide, putting a heavier weight on the training learned from the sessions (35).

ASME also gives its members the option of organizing and teaching their own course provided they have proper expertise in that area. This is a great way for members to get involved in the organization. It also allows the spreading of shared knowledge among members. In addition to spreading the knowledge, the members also spread their name throughout the community which leads into another opportunity provided by ASME, networking. (35)

ASME is a good tool to use while trying to increase one's professional network. There are specific parts of their website designated to community bonding. They welcome mechanical engineers of all levels from those

still in school to the most experienced engineers. They allow for interactions that further their member's careers, no matter their professional level. Members can choose whether to interact with only their level of peers, or they can choose to venture into other groups. (35)

ASME also offers numerous conferences a month that members can participate in. Conferences are offered on various different mechanical topics and can be about a very technical topic such as a brand new technology or about something very non-technical such as making yourself stand in out in a crowd of potential employees. Also, depending on where an employee works, a company may pay for an employee to attend, provided they have the resources to pay and can spare a few employees. (35)

ASME even offers a mechanical engineering magazine called *ME Magazine* (36). The magazine "provides an interdisciplinary view of engineering and is a recognized sourcebook and tool for navigating today's engineering challenges as well as tomorrow's breakthrough technologies" (36).

Joining an organization such as ASME is imperative to a mechanical engineer if they do not want to become obsolete. It becomes even more necessary when working with a small company that cannot provide the resources for professional development that the larger companies can.

Continuing Education/Training

Continuing education is a major part of all fast paced industries. In a field is always growing and evolving, it is best to have employees that are always learning. Because mechanical engineering fits into this category, continuing education is a major part of company policies and the field in general.

Take, for example, General Motors, one of the largest car manufacturers and innovators in the world. They have two separate programs to aid in continuing education (Section 6.4). Both involve major company and university involvement in order to teach their employees

and allow them to get a higher degree while still on the job, and in most cases, without even leaving the building. GM pays all the fees for these programs to encourage their employees to keep learning and to pursue that higher degree. More can be found about these and other programs run by GM in Section 6.4.

GM is not the only company that offers this type of program, though they may be the only one that goes as far in depth with is as they do. In fact, just about every company that has the available resources is willing to offer some type of tuition reimbursement to employees for taking classes related to their current department. The only companies that might not offer a program like this are the ones that simply can't afford it, in which case they probably encourage it.

During our interview with Sivaprasad (37), he talked to us about his short time at Tata motors, an Indian car manufacturing company. He talked about a rotation program, a two year program, in which all engineers have the opportunity to participate in various departments of the company such as automobile maintenance and research and development. Each of these departments are very different from each other and they grant the engineers the opportunity to grow and learn in various areas.

Other Approaches

These of course are not the only ways to keep employees up to date in mechanical engineering. Companies such as DuPont, a large science based solutions company, offers similar programs. DuPont has a large variety of jobs within it including mechanical engineering. In addition to the continuing education courses offered, they also use a formal process which they call Targeted Development (38). This is an annual review type system in which the employee and their supervisor work together to plan the employee's future development and to create and meet goals.

Along with all these company based programs, there is also individual drive and self-motivation that helps to keep the engineers up to date. For example, Computer Aided Design (CAD) software gets updated very frequently.

With new versions coming out so fast, companies may not invest in creating a formal training program to teach all of them. As a result it is left up to the individual to learn the new versions in order to keep themselves up to date.

4.4.3. Industry Evaluation

As in most engineering and high-tech companies, mechanical engineering is a rapidly changing field. As a direct result of this, if an engineer does not keep himself up to date he will find himself obsolete in a very short amount of time. To avoid this problem, companies and individuals have come up with methods to keep them in a state of almost constant learning as this is the only way to properly combat the ever looming obsolescence.

Along with these methods comes self-motivation, perhaps the most important factor in professional development. If a mechanical engineer does not have the desire and drive to learn more he will soon fall behind in his career. If they find themselves uninterested in a course they are taking they will not take anything from that course and will have effectively wasted their time and possibly the company's money if they happen to be paying for it. It is all the drive to be better and to hold yourself to a higher standard that results in people joining organizations such as ASME. By no means is being a member of ASME required as a mechanical engineer, but if they want easy access to countless tools to keep themselves update, it would be a great idea for them to join.

Outside of self-motivation, it would be best for companies to provide as many resources as possible for their engineers to keep updated. The more resources a company has, the less likely their engineers are to become obsolete. Of course this is no easy task as providing resources such as tuition reimbursement, paying for conferences, and running online classes to name a few can get very expensive. Companies can also have annual review systems though this does not always work out as rewarding an employee for meeting the goals they set does not have a really significant effect on the amount of

effort the employee is willing to give as shown in Section 3. Therefore, self-motivation, and company provided continuing education and training are probably the best methods to keep an engineer up to date.

5. Companies Analysis

In this section we look into the methods of professional development for various companies in different fields. For each company, we provide a brief introduction to the company explaining who they are and what they do. Afterwards we look into their methods of keeping their employees up to date in the "company development" sections. Finally we provide a quick evaluation of the methods they use on whether they appear to be useful.

5.1. Massachusetts General Hospital

5.1.1. Hospital Overview

Massachusetts General Hospital (Mass General or MGH) is a teaching hospital of Harvard Medical School and a biomedical research facility in Boston, Massachusetts. It is the third oldest general hospital in the United States and the oldest and largest hospital in New England (39). Many of its specialties are ranked among the top five in the United States (40). It is owned and operated by Partners HealthCare (41). MGH is part of the consortium of hospitals which operates Boston MedFlight (42) and is a member of the Dana-Farber/Harvard Cancer Center (43). It offers world-class patient care for different types of patients, serves as a research powerhouse, provides an emphasis on teaching and sets the bar for quality and safety.

5.1.2. Hospital Development

Research and Development

As the medical industry is developing very fast, Mass General Hospital has long been a leader in successfully bridging innovative science with state-of-the-art clinical medicine. The support to research and development plays an important role in keeping the entire hospital at the leading position in the industry. With an annual research budget of nearly $550 million, Mass General conducts the largest hospital-based research program in the United States - a program that spans more than 20 clinical departments and centers across the hospital. This funding drives discoveries and

breakthroughs in basic and clinical research, which translate into new and better treatments that transform medical practice and patient care. (44)

Education and Training

Massachusetts General Hospital is affiliated with Harvard Medical School. It is the original and largest teaching hospital of Harvard Medical School, where nearly all of their staff physicians serve on the faculty. Together they form an academic health science center. More innovations are conducted in MGH due to the research and new technology used at Harvard. Since the hospital's founding, Mass General has been committed to training and mentoring the next generation of international leaders in science and medicine, providing a wealth of opportunities for physicians, nurses, allied health professionals, physical, occupational and speech and language therapists and other health professionals. Lots of lectures are held in the hospital; one picture shows that as early as in 1965, there was a lecture held in the hospital's iconic Ether Dome (45). These talented men and women, in turn, lend fresh and innovative perspective on how to treat and care for patients.

Education and training is a large part of the hospital's programs. MGH offers specialized residencies and fellowships in each of their multidisciplinary care centers and clinical departments, together with various other award programs and scholar programs (46). This helps students and faculty to be familiar with their specialized area with hands-on experience at the hospital, and the hospital also gets the opportunity to utilize the theories and ideas provided by the university.

Besides residency programs, MGH also has a commitment to furthering the education of health care professionals and the surrounding community (47). For example, MGH Institute of Health Professions offers graduate-level nursing programs. There are several master's degree programs that nurses can choose from, and it offers degrees and certificates in nursing study (48). As a provider of education to the rest of the community, MGH is capable of providing the leading knowledge and

technology to people in the medical industry, and as the biggest benefiter of this program, MGH offers a good opportunity for each of its employees to stay up-to-date.

In addition, Mass General Hospital is a participating institution in Harvard medical School's Department of Continuing Education. And MGH's partnership with HealthCare plays a leadership role in educating the nation's future health care professionals.

Employee Education

Besides being a teaching hospital, MGH focuses a lot on education of its employees as well. In addition to an annual college fair, career-development sessions and a tuition-assistance program that includes adult basic education and certificate programs, MGH offers a variety of other programs to help employees to the best degree. On the website, it says, "Massachusetts General Hospital's Training and Workforce Development program offers employees career-growth training and educational opportunities designed to attract and retain a highly skilled, diverse workforce" (46). MGH embraces diverse skills, perspectives and ideas.

As the world is getting more and more close to each other, the hospital shows its welcome to diverse employees and patients by offering language classes. The "English for Speakers of Other Languages" program offers classes to help non-native English-speaking employees improve their communications skills and promote continued learning. It largely helps the hospital to take advantage of employees with various culture backgrounds. In addition, beginner through intermediate level Spanish classes are offered to help employees enhance the experience of Spanish-speaking patients, their family members and visitors, and build up an even better reputation for the hospital.

MGH shows its support in employees' education by providing grants and scholarship. "Support Service Employee Grants" are offered to benefits-eligible hourly employees to apply as educational grants to advance their training and/or education. Each year members of the Association of Multicultural are eligible to apply for

Partners Scholarships to pursue undergraduate and graduate educational programs.

Also, MGH puts effort in promulgating different education for every single employee based on their needs. These classes are essential in helping the employees get involved in this environment and providing the immediate assistance to meet employees' needs. For example, medical terminology classes offer training to help non-medical employees understand medical terminology as related to the anatomy, physiology and pathology of the human body; HR course offerings give employees the opportunity to learn new or improve existing skills such as conflict communication, project management and organization, which in turn helps the community to better perform their daily jobs; and MGH Leadership Academy provides managers the information, resources and competencies to be effective leaders at Mass General Hospital. In this way, the hospital can grow in a very balanced direction because almost everyone working in the hospital gets the opportunity to enhance.

5.1.3. Hospital Evaluation

As a teaching hospital affiliated with Harvard Medical School, Massachusetts General Hospital leads the medical research. MGH offers various types of training and education which benefit the entire medical industry, and also help MGH stay current with medical technology. It embraces diversity, and provides education in multiple areas for its employees to help them achieve the best performance at work, as well as pursuing the higher education that they would like to obtain. With all of these aspects combined, Mass General Hospital stays as the leader in the industry, and keeps progressing with the development of medical technology.

5.2. EMC Corporation

5.2.1. Company Overview

EMC (49) is a Fortune 500 and Standard & Poor's (S&P) 500 company that is based in Hopkinton, Massachusetts. It is a leading enterprise in information storage that provides hardware, software and service to many large data centers such as Bank of America's data center and Microsoft's data center. It has more than 40,000 employees and 100 locations worldwide.

EMC's data storage products are built to store and protect information. Nowadays, information is expanding at a tremendous speed. Here are some interesting facts about information explosion: it is estimated that a week's worth of the New York Times contains more information than a person was likely to come across in a lifetime in the 18th century; Over 580,000 Facebook posts are generated by the time that someone finishes reading this sentence (50).

Nowadays, information is expanding at a tremendous speed, thus the demand of storing information securely and properly has been growing exponentially as well. Being in such a fast-developing industry, EMC, indeed, requires their employees to stay up-to-date.

5.2.2. Company Development

Education Services

Offering training and courses, both online and in-classroom, is one of EMC's most essential strategies to keep their employees up-to-date. The so-called "Education Service" offers wide choices of courses, ranging from EMC Technology Foundation to EMC Data Storage Security (51). In addition, EMC offers "Learning Paths" which are structured frameworks that use a building-block approach to learning. EMC's blended model begins with e-Learning, and progresses to more complicated and interactive classroom and lab experiences often culminating in an opportunity to get certified. In most cases, these courses are offered at no cost to the employees, which definitely encourages some employees to participate in such a selection of continuing education opportunities. Moreover, EMC offers a variety of

learning options: Instructor-Led Training (ILT), e-Learning, Video Instructor-Led Training (VILT) and Online Instructor-Led Training (Online ILT) (52). Moreover, e-Learning can be taken at any time and at a pace that is suitable to an employee's ability. Some on-site courses are also available online through e-Learning, which allows employees from other EMC sites to learn the same materials conveniently online without travel.

We interviewed Linda Kelleher (53), an EMC employee who manages the Education Services. Ms. Kelleher maintained that the initiative in taking a course comes from both the individual and his or her manager. Employees will sit down together with their managers to talk about what courses and trainings are need for the current and future job.

Individual Development Plan (IDP)

At EMC, individual's development is an ongoing, evolutionary process that identifies the strengths and gaps in everyone's capabilities. More importantly, it enables EMC to identify solutions that close these gaps. EMC employees work with their managers to establish an Individual Development Plan (IDP) (54), which records strategies to help them develop and grow. The development can be career-oriented or it can expand some aspects of an individual's skill sets related to a current or a future position. The IDP will "strike a balance between your career aspirations, your strengths and opportunities for improvement, and the needs of the business", as stated in the core value of IDP.

Individuals' IDP follows the EMC Development Model, a tool to simplify selection of development options when the employees and their managers are in development planning discussions. Ms. Kelleher told us that managers may discuss with employees the training they could take, some challenges that he/she could assign to employees and something they could learn on their own. Throughout the year, employee will discuss with manager to discuss the employee's progress and status on the IDP; they will maintain and update the IDP regularly.

In EMC, setting up a "stretch goal" for each employee

is common. The “stretch goal” has to be a development goal that is beyond one’s skill sets so that it can help the employees personally to develop some skills. Ms. Kelleher said that a “stretch goal” could be reading a book, attending a class or teaching a class.

Conference

Furthermore, EMC consistently encourages their employees to attend conferences and expositions in the information storage field. EMC usually offers partial to full reimbursement and allowance to those who attend conferences.

On May 10th to May 13th, 2010, the annual EMC World, an ultimate educational forum and technical exhibition (55) for EMC customers, partners and employees, was held in Boston, MA. Zhaochen Liu, one of the project members who used to work in EMC from January to August in 2010, said that EMC employees in all Massachusetts locations were encouraged to attend this exhibition at no cost: admission tickets, bus transportations and food were provided by EMC. During this event, employees could participate in over 500 breakout sessions, keynotes and live demonstrations to learn some advanced technologies from other EMC engineers, customers and partners. “By attending this conference, I am able to explore ‘Cloud Computing’ which is what EMC is focusing on in the next few years”, said Zhaochen (56). In the second day of the conference, Joe Tucci, the CEO of EMC, addressed the EMC employees with a presentation called “A Journey to the Private Cloud”. Zhaochen commented, “After listening to Mr. Tucci’s presentation, I became familiar with what different development branches in EMC have been working on. Their innovative ideas and initiatives gave me a useful lesson and opened up my horizons”.

EMC also sends employees to EMC’s partners’ conferences. Ms. Kelleher expressed that EMC has partnerships with Microsoft, Oracle and Cisco, and they all hold conferences regularly. Sometimes, managers hold meetings to decide which key employees should attend these conventions and bring back some valuable information to share with the whole group. Sometimes,

employees also have the opportunity to inform their managers that they want to attend.

Continuing Education

According to Ms. Kelleher, continuing education happens a lot as well. EMC always encourages employees to go for higher degrees and credited courses and EMC offers tuition reimbursement for them. Most of time, the employees come up the courses they want to take and the courses are usually related to current or future job. EMC also worked with Northeastern University, a private university in Boston, in the past and encouraged Northeastern to bring training to EMC.

Other Approaches

"On a regular basis, EMC is sending company and industry news, on EMC Corporation or EMC's partners, to employees via emails", said Zhaochen. For such a multi-million dollar company, it is difficult for each employee to know every aspect of the company. Therefore, a short summary of EMC's developing orientation or strategies on marketing is useful to employees who often work on their own department's technology. A wide range of knowledge and skills are always beneficial in such a fast-paced industry. *EMC.now* (57) is an EMC magazine, published quarterly, that delivers EMC news to the EMC community worldwide. There are some feature stories and pieces of industry news and EMC news in each issue. "Those magazines are free for employees and I can usually get them in the mail stop", Zhaochen stated, "People do pick some articles that they are interested in and read them. I have heard employees talk about the news and articles".

Formal certificates are required for some specific jobs in EMC. Holders of certain certificates must renew their certificates annually or bi-annually because the technology is always changing. At the executive level, managers decide how many employees need certificates and what kind of certificates they ought to have.

5.2.3. Company Evaluation

Ms. Kelleher felt that there is no single method that helped EMC to grow into a multi-billion company. They are all effective if all the programs are used. If a

manager and an employee work together for the employee's professional development, it will be very helpful.

Ms. Kelleher was especially illustrated the effectiveness of training and courses EMC provided. The Education Services department offers different levels of surveys. The first survey employees have to fill out is right after taking the classes. At this time, most employees don't really know what the effects of the classes are. They continued to send out surveys after 60 days and after 120 days of completing the class. A question a survey usually asks is "Have you already used the knowledge from the training to your work?" The results usually showed that at 60 days, 70% - 80% of the employees had used the knowledge, while at 120 days, nearly 95% employees had used the knowledge they learnt. The questions tend to drill down to determine the effectiveness of the training. Education Services customize the surveys based on the courses and use the responses to modify and improve its training system.

Ms. Kelleher finally talked about some of the incentives that incite employees to learn more: If the company gets involved in major initiatives in the industry, then the employees tend to learn more. Such as now, EMC is changing to cloud computing, and a lot of employees like to learn about cloud computing as well.

5.3. Google Inc.

5.3.1. Company Overview

Google Inc. started as a research project on search engines in January 1996. Google was founded by Larry Page and Sergey Brin. During the last 14 years, Google has developed a great number of internet-based products and services, among which the most famous are Gmail, AdWords, Google Maps and Google News (58). Google is ranked #1 in the world for having the most daily visitors according to the three-month Alexa traffic rankings (59).

It is suggested on Google's website (60) that innovation is Google's bloodline: "Even the best technology can be improved. We see endless opportunity to create even more relevant, more useful, and faster products for our users. Google is the technology leader in organizing the world's information." Therefore, Google demands their engineers to be creative and understand the latest technology in the field.

5.3.2. Company Development

20 Percent of Time

Google's concept of 20% of time has turned into millions of dollars' worth of profit. The idea is simple: employees are allowed to use 20% of their time to work on projects of their own choice. The concept gave birth to some of their more prominent products such as Google News. Google News is a computer-generated news site that aggregates headlines from news sources worldwide, groups similar stories together and displays them according to each reader's personalized interests (61). The idea of Google News came from Krishna Bhara (62), who has a habit of reading news on the same issue from different sources and newspapers. However, it was not that convenient for an Internet user to do so. Therefore, Bhara spent his own 20% of time researching this project and, a few months later, he established StoryRank, a theoretical algorithm derived from PageRank, an algorithm used by Google Search Engine. After few internal evaluations in Google, Google News was approved and Bhara's major work responsibility switched to Google News. Eventually, Bhara not only fulfilled his dream by

creating a Search Engine for News, but he also changed his career path and enhanced his personal technical skills and management abilities.

We interviewed a senior manager from Google (63). He told us a little more about the 20 percent of time. An employee is not only allowed to work on a specific product that Google may release in the future, but he/she can also work on anything in company's operation. A lot of the 20 percent of time projects are just about really making lives better within the company. The interviewee suggested that 20 percent of time can be spent by organizing a Tech Talk, managing the Human Resources offerings, or even helping with some training. Not everyone can have the 20% time to work on their interested side project. If the employees are not performing well in their jobs, then they will not be allowed to have the 20% time. Also, if the employees are working on something that's critical to the company, they may not have the 20% time either; under this situation, some employees may not want to have the 20% time either. Employees must get permission from their manager in order to be allowed to work on the 20% time project, but employees generally get this permission. For certain people this program has been extremely helpful.

Tech Talks

According to the manager from Google that we interviewed, in Google, "Tech Talks" are common and are happening every day. Engineers, people from inside or outside the industry, authors of books, neighbors, entrepreneurs or employees' friends come in to Google's office and share what is changing and evolving in various environments. The manager elaborated on "Tech Talks", saying that there are usually three or four "Tech Talks" per day that people can attend them if they have time. Almost in every major building of the company there is a large area where the "Tech Talks" occur. Google also reaches out to those people who have published some interesting articles and invite them to talk to specific groups of people, such as the search team and the operation team, or talk to the general body. A "Tech Talk" may involve from two people to hundreds of people.

There is a group of people who organize the "Tech Talks" and work on logistics. There is a website for these "Tech Talks" so employees can find out what topic "Tech Talks" will be held on. They will also record most of the "Tech Talks" and put the videos online for those employees who did not have time to participate but wanted to know more.

Vote on Projects, Change Projects

Unlike most of the companies we've looked at, rotation programs happen in Google every few years. Around every 3 years, Google usually encourages their employees to move on to a different project. The manager from Google maintained that Google doesn't want people to get too comfortable in their roles and stop thinking about learning. There is an internal placement system in Google where each employee can vote on projects that he or she is interested in. The more engineers are attracted to a project, the more engineers are funded to work on that project. For example, recently, a number of employees became interested in working on Chrome OS; Google recognized employees' enthusiasm and funded more on the project. Eventually, the team could bring more people to work on Chrome OS. The interviewee from Google described the model and stated that picking projects was like picking classes: if one's first choice ran out, he/she could go for your second or third choice. Usually, an employee is able to find a project that is appealing because Google is involved in various types of development.

Other Approaches

In Google, new ideas, if it is worth trying, can always gain support from colleagues and managers. Joseph O'Sullivan, a senior staff engineer at Google, mentioned that his workmate Paul Buchheit believed that he could make a better email client (64). At first Paul worked on it on his 20% work time. Soon, he convinced more people such as Joseph that this idea was worth developing and deserved more time and effort to be spent on it, and later the small group of people convinced more people such as Larry Page and Sergey Brin, the founders of Google. Google provided the team, known as the Gmail Team, with financial resources and human resources.

Finally, Gmail succeeded and gained enormous popularity among the whole world. Another example of Google supporting engineers' ideas is with Jennifer Sager, a software engineer at Google Santa Monica (65). Jennifer and some other engineers wanted to find a project to work on; they brainstormed an idea that they wanted to add a new feature to Gmail. They contacted the Gmail Team with their idea, but they were not sure if they would hear back with any reply because they were some recent graduates from college. However, the Gmail Team was thrilled and was delighted to see more people work on Gmail. So, the Gmail team provided all the resources and assistance to the engineers and the Gmail team and the engineers learned a lot from each other. Jennifer said that in Google, "you can just be interested in something and you can just go and make a change."

Like other multi-million dollar companies, Google is able to provide various resources to employees such as supporting employees to go to conferences, internal training and continuing education. The manager from Google we interviewed said that it is required for each employee in Google to attend conferences at least once a year. An employee is free to pick any conference or convention that is related to his/her job. Google has a large budget for supporting employees to go to conferences.

There is a number of training and courses that employees can take online or in a classroom. Every Google's new employee must attend Noogler training, which covers the history of Google, the working environment and a broad overview. The interviewee himself was in one of the Python classes and he thought the class was extremely useful; the teacher was a professor from Stanford University. The interviewee stated that most of the classes that he took are very helpful.

5.3.3. Company Evaluation

Google's 20% time is more of a philosophy than a rule. The engineers are free to be interested in anything and seek resources and support in order to attain that goal. Thus, in Google, the engineers are always learning new knowledge they are interested in and apply the knowledge they learned to real projects.

Google tends to hire candidates who have great self-motivation and the desire to learn. The Google interviewee claimed that Google tried to hire people who crave for learning, so that they could keep learning. Google is looking for people who enjoy what they do, having the curiosity and yearning for learning more. Innovation is the core value of Google and Google tries its best to broaden its employees' knowledge and horizons.

5.4. General Motors

5.4.1. Company Overview

General Motors (GM) is one of the world's largest car manufacturers. They are a global company with headquarters in Detroit, MI. However, United States is only their second largest market; China being their largest market. GM sells cars ranging in class through eleven different brands. The brands target different consumer groups, ensuring that people from all economic and demographic classes buy their products. Some of GM's better known brands are Buick, Chevrolet, and Cadillac. (66)

GM is also the owner of OnStar, the innovative road side assistance program that can provide immediate assistance if a customer gets in a car crash. OnStar is a subsidiary company. GM as a whole employs over 205,000 people worldwide in approximately 157 countries. Being a company that always has to stay on the cutting edge to do well, and given such a large employee base, GM must maintain a solid professional development program in order to keep all of their employees up to date with all of the rapid changes going on. (66)

5.4.2. Company Development

In order to lead the car market a company must stay up to date on all of the latest technologies. In order to do this, the company's employees also need to be trained on up to date. Because of this GM has set up a fairly large professional development program which consists of three main programs: the Jumpstart program, Technical Education Program, and GM Learning program.

Networking

Jumpstart is program set up for new hires to allow them to initiate and maintain inter-company relations. The employees enter the program as a new hire and get to make connections, making networking inside the company easier. Jumpstart helps new hires feel more secure about their presence in the company. It also allows GM to ensure that each of their employees fit into the company, in addition to setting up a platform of communication where innovative ideas can be shared freely. (67)

The new employees can join up to five different Jumpstart committees, each with a different focus on company culture. Some of the committees include: the marketing initiatives committee, which focuses on growing GMs market share; the professional development committee, which holds book club meetings with GM business leaders and senior executives about career growth; and the social committee which participates in group activities such as sports. The wide varieties of programs ensure that all employees will find their own niche while learning skills that help the company evolve. The committees are run by members of Jumpstart who have already been on the program for a few years and have some experience with how it runs. In 2006, over 70% of new employees participated in the program in the Michigan area with a total of 800 employees in the program. (68)

Continuing Education

Created in 1984, the Technical Education program allows employees to continue their education in developing fields through GM. The idea of the program is to create an increase in competitive advantage with other companies (69). The program provides flexible hours and accessibility to universities. It provides both online classes and lectures (67). Using a combination of company and personal time, engineers and manufacturers at GM can pursue an associate's, bachelors, masters, or doctorate degree (70). These courses are designed for the automotive industries needs and GM will pay the tuition and all other fees that go along with the courses (67).

This program includes formal classes as well as hands on training. Students learn and create new techniques and ideas while working for GM. However, the benefits that arise from this program are not limited to the employees. GM is able to capture innovative ideas as soon as they are formed. Over a five year span ('99 – '04) the students of the program saved GM over $130 million (71).

The third program GM offers in called GM Learning. While the Technical Education program is mostly geared towards the engineers and manufacturers of GM, the GML

learning program is open to almost every profession within GM. This program is also largely run through online courses, though it is possible to take live lectures as well. (67)

Currently, the program has 14 colleges involved in GM that are given the task of creating unique curricula based on the challenges that GMs business division encounters (67). Some of these colleges include: Communications, Engineering, Finance, Human Resources, and Public Policy (67). In order to get involved in the program, GM employees must first consult with a supervisor about potential career paths and the course work. The employee must also complete all of the courses within a certain time window to avoid extending the process beyond what is necessary (72). This program gives employees an opportunity to pursue a more advanced degree without going to formal classes.

Other Approaches

Along with these programs GM also helps reach out into the community. They run a program called Automotive Service Educational Program (ASEP) in which they train auto mechanics how to repair GM vehicles (73). They also have a program in which they allow the public to submit new ideas and inventions for the company (74). Though these are not directly related to the company's professional development, it shows their dedication to educating as many people as possible.

5.4.3. Company Evaluation

Because GM is a major innovator their industry, it is imperative that they keep their employees update. Failing to do some would result in them falling behind in their fields. As a result they have set up three major programs to help combat this ever threatening obsolescence. These programs, some of the best in the industry, allow GM employees to pursue higher degrees while still getting work done for GM as the curriculum integrates GM projects. It also allows new employees to spread out and learn about their new company and co-workers. They even have a program set up for the business side of the company as they need it just as much as the engineers do. With these three programs, GM has

managed to maintain its high level of innovation and continues to learn and grow with the rapid development of new technologies.

6. Evaluation & Recommendations

After a wide range of research was done on different professions, companies and interviews, we found that professional development relies on cooperation between companies and individual. Companies and industries should have policies that support professional development of their employees and make as many resources available as possible; the employees, who serve as the major force and active participants of the development activities, need to motivate themselves to take advantage of these professional development opportunities and keep themselves updated with technology development. Self-motivation is mentioned as the most important aspect to keep professionals out of professional obsolescence.

Below are lists of professional activities and policies that our research found are taking place in various industries. First we give a brief description of the activities employees can partake in on their own. In Section 6.2, we review the policies we encountered that companies offer to help keep their employees up-to-date. In 6.3 we give our recommendations for the policies sorted by highly recommended, recommended, and not recommended explaining the usefulness, or non-usefulness, of each. In each section the policies and activities are sorted roughly by helpfulness as well, the first ones are the most helpful and the last ones the least.

6.1. List of Activities

During our research we learned about many different activities that employees make use of to keep themselves up to date. These activities, though they can be aided by company policy, are more about self-motivation and the employee participating on their own.

6.1.1. Attend Conferences

Attending presentations and conferences is another great way for engineers to keep themselves up to date. Conferences and presentations often contain the latest information on new technology presented by an expert on the subject matter.

The other option they have, instead of attending a presentation, is to be the presenter. Teaching others on a new topic is generally also a great way for presenters to make sure that they know a topic extremely well.

6.1.2. Read News

One of the activities that can be used to keep employees updated we learned about was reading news articles via magazines, websites, and even forums dedicated to your field. Both game developers we interviewed, Creath Carter (Appendix A.11) and Brian Moriarty (Appendix A.9), talked about how subscribing major development magazines such as *Game Developer* magazine and reading major websites such as *Gamasutra* everyday can be extremely useful in staying up to date.

6.1.3. Learn from Colleagues

Learning from co-workers is a natural way for engineers to stay up to date. This can come through in many ways. The first, and most common, way would be to just ask a co-worker for help on a particular problem. This is probably one of the easiest ways for an engineer to learn.

The other option would be to become a mentor or mentee. In this scenario the engineer would maintain contact with the same person for the help that is needed. This is generally more of a company program and will be discussed further in Section 6.2.

6.1.4. Pursue Higher Degrees

Engineers can also combat obsolescence through continuing education. This is one of the most common methods for an engineer to stay up to date. It generally involves the engineer taking classes related to their field part time, such as night classes, in pursuit of a higher degree.

Taking classes not only combats obsolescence, but it also opens up new job opportunities, allowing more room for the employee to grow. Unfortunately, this can be difficult for someone to do on their own as they have to balance work and class time and pay for everything themselves.

6.1.5. Set Personal Goals

Setting personal goals is helpful for an engineer because they are the only one that really knows what he/she is capable of. Setting goals gives the engineer something to reach for and accomplish. If done properly, it also puts the engineers in a situation where they have to learn more to achieve their goal. Engineers that don't set goals for themselves run the risk of never expanding and falling behind.

6.1.6. Establish Networks

While networking does not directly update an engineer, it can be used indirectly to do so. For example, an engineer that knows a lot of other engineers has more resources than one who doesn't. The engineer that uses networking can then reach out to those contacts when in need of help. Networking can also make the engineer aware of new job opportunities that they might be interested in. If they feel that their current job has become stale, having these connections can provide the engineer with a new, more interesting, job.

6.1.7. Join Professional Organizations

Joining professional organizations, for example ASME (Section 4.4.2) or IEEE, can be very useful for engineers. Upon joining such an organization engineers are immediately allowed access to numerous tools and methods to help keep them up to date. These can include classes, presentations, conferences, and training programs. Joining a professional organization can also help with networking which can open up more options for learning.

6.1.8. Participate in Side Projects

Many companies have their employees working either on the same product for a long time or on a project that doesn't really interest them. If this is the case, engineers can work on a side project in their free time. Side projects give engineers a chance for innovation and get them thinking about things they normally wouldn't do at their job. Also, because they are working on something they don't normally work on, they are learning this new topic and thus combating obsolescence in a way

that interests them.

6.1.9. Attain Certifications

Another option for engineers to stay up to date is to obtain certificates. The process of getting a certificate can help to update engineers because they must be experts on the subject matter to pass the test for the certificate. Upon passing the exam, the engineer has proof that he/she is highly competent in certain subject areas. Getting a certification may also open up new job opportunities for the engineer as some jobs require certifications. These new job opportunities can allow the engineer to grow in a way that they might not have without the certification.

6.1.10. Cooperate with University Research

Another way engineers can keep themselves up to date is to cooperate with universities on research. Though it is rare for this to occur, if a university happens to be running research on a topic that relates to the engineer, it can be very helpful as it is another way for the engineer to learn about and pursue something that they are interested in.

6.2. List of Policies

During our research we learned about many different policies that companies use in order to help their employees stay up-to-date. These policies are applied to different degrees in various industries and companies.

6.2.1. Offer Internal Training

Nearly all companies, especially mid-size to large companies, offer various types of training programs to their employees.

As Mr. Padisetty and Mr. Bilodeau indicated, Microsoft offers an internal learning site, My Learning (Appendix A.4 & Appendix A.3). Every active member in Microsoft is allowed, and encouraged, to attend internal training though it is not officially required by Microsoft. Employees are able to look up the courses that are available, build a learning plan and register for courses. Both Mr. Padisetty and Mr. Bilodeau

recommended this way for updating knowledge.

In EMC (Section 5.2), offering training and courses, both online and in-classroom, is one of company's most essential strategies to keep their employees up-to-date. The Education Services Department at EMC offers a wide range of courses, ranging from EMC Technology Foundation to EMC Data Storage Security.

In the medical industry (Section 4.2), hospitals often provide training to their nurses and doctors. For example, when a hospital brings in new equipment, hospitals or vendors who make the equipment hold classes to teach everyone how to use the equipment.

6.2.2. Encourage Conference Attendance

Most corporations expect their employees to attend numerous conferences, meetings, and conventions, most of which are related to their industry practice and some of which are related to more business like aspects. Companies encourage employees to go to conferences and bring back what they learnt there. According to several interviewees' past experience, a majority of big companies have a large budget for supporting employees' attendance of conferences, while smaller companies often pick key people to attend conferences due to budget concern.

For example, physicians and nurses are often supported to go to conference, which also counts towards their CMEs and CEUs to renew their license. The hospital encourages employees to go to conferences and bring back what they learnt there (Section 4.2).

Moreover, it is even required for each employee in Google to attend a conference at least once a year (Appendix A.12). A senior manager from Google maintained that the employee was free to pick any conference or convention that was related to his/her job.

6.2.3. Facilitate Informal Presentations

Companies generally have internal, informal talks on technology development. Most interviewees responded that they attend these types of events very often, and they

feel that they can get some useful or interesting knowledge from these talks. In Microsoft, there is a "brown bag" event (Appendix A.3) that people in Microsoft schedule lectures on some topics, and employees who are interested in the topic can bring their lunch to the event and learn about the topic. Sometimes buildings host events too.

Similarly, Professor Starr from WPI (Appendix A.10) also mentioned that the companies he worked for provide some programs, such as "Lunch and Learn", where people put on presentations and talk about technology and what's happening in the industry.

Mentioned by the senior manager from Google (Appendix A.12), Tech Talks, a kind of informal training, are meetings and presentations that usually happen three times every day. People from both Google and outside Google can come to give a talk and presentation that they find interesting. These people can be neighbors, authors of books, entrepreneurs or employees' friends. There is a website for these Tech Talks so employees can find out what Tech Talks will be held. Most of the Tech Talks are video-recorded so that employees can watch a few whenever they have time.

6.2.4. Create Challenging Work

Nature of work is an important factor in improving employees' work quality. A lot of companies have rotational programs for employees to switch their positions. If people get too familiar with what they are doing and get comfortable with it, it is harder for them to feel the necessity to enhance themselves. As Mr. Bilodeau (Appendix A.3), a software engineer at Microsoft, mentioned, when he got an assignment that he did not know how to approach at all, he had more incentive to learn more; and by the time he finished the work, he felt that he learnt a lot more about what he did not know before through working.

Also supported by several research articles (Section 3.3), challenging work has direct relationship with professional obsolescence. In *Are You on the Verge of Obsolescence?* (4), it is mentioned that "jobs should

provide a range of challenges" as one of the ways to keep the professionals up-to-date. *An Evaluation Of Factors Affecting Professional Obsolescence of Information Technology Professionals* (2)supports this by showing that job challenge helps people stay out of obsolescence.

6.2.6. Reimburse Tuition

Tuition reimbursement usually happens in companies throughout all industries. For example, most hospitals provide full or partial tuition reimbursement for their employees pursuing a higher degree part-time (Section 4.2).

Using a combination of company and personal time, engineers and manufacturers at General Motors can pursue an associate's, bachelors, masters, or doctorate degree (Section 5.4). These courses are designed for the automotive industries needs and GM will pay the tuition and all other fees that go along with the courses.

Similarly, chemical engineering companies generally provide tuition-assistance to employees (Section 4.3). Chemical engineers who are obtaining higher degrees can help their companies because they get the opportunity to be specifically trained for their jobs, and also benefit themselves the most in the long run.

6.2.7. Recognize Individual Initiatives

Most companies give employees the chance to express their ideas for their own professional development. During employees' annual reviews, employees have the opportunity to discuss with their managers what type of professional development training they would like to take, and if there are any conferences that they would like to attend. Managers listen to these proposals and discuss their ideas or suggestions with the employees. Even though most of these opinions will be taken, it needs to be considered together with companies' budget for professional development activities.

It is fairly important for employees to know about the company policies on supporting and listening to individuals' initiatives. Only with this knowledge can employees make use of the companies' resources and the

opportunity to learn more professionally.

6.2.8. Organize Mentoring Program

As indicated by Mr. Bilodeau, a software engineer who works for Microsoft, the Mentoring Program helped him to a great extent (Appendix A.3). Microsoft looks for volunteers for the program as mentors, and put the mentors' information on the program's website. Other employees can look for these people's information, and set up the mentor-mentee relationship with them.

Mr. Bilodeau also pointed out some flaws he felt that the mentoring program had and gave some suggestions to enhance the program. Mr. Bilodeau argued that he sometimes did not get what he was looking for from the mentors. He thought that it would be better to find a mentor through friends or colleagues who already knew him because they might know exactly what he was looking for. The company Mr. Bilodeau worked before had a better mentoring program than Microsoft because that one was more mentor-driven which Michael preferred. Mr. Bilodeau's mentor always pointed him in a direction instead of letting him explore on his own.

6.2.9. Provide Rotational Program

A Rotational program is a system in which employees are required to change their roles every so often. This rotation cycle could last anywhere from a few months to a few years.

Mr. Padisetty (Appendix A.4), who used to work for Tata Motors based in India, mentioned that there was a rotational program which lasted two years for engineers. All engineers were required to change their departments every three months. Some engineers might do automotive maintenance for three months and switch to research and development department after that. They have very little formal training or teaching, but they are assigned to a manager to guide them through their work.

In Google, rotations happen every few years (Appendix A.12). Around every 3 years, Google usually encourages their employees to move on to a different project. A manager from Google maintained that Google

doesn’t want people to get too comfortable in their roles and stop thinking about learning.

6.2.10. Organize Side Projects

Some companies encourage their employees to have projects of their own choice to work on besides their regular daily work. This can allow employees to pursue their personal interests, which in turn may benefit the companies.

Based in Redmond, WA, Microsoft has its “The Garage” Program where employees can find teams and work on some side projects they can choose from (Appendix A.5). This program is solely on employees’ free time rather than during work time. It’s a community with over 1800 members and is growing very fast. It encourages innovation in the company. This program is highly encouraged by the company.

Similarly, as mentioned in Section 5.4.2, at Google, employees are allowed to use 20% of their work time every day to work on the projects of their own choice. The available choices for the employees can be organizing a Tech Talk, managing the HR offerings, or even helping with Noogler training. Not everyone can have the 20% time to work on a side project (Appendix A.12). If the employees are not performing well in their jobs, then they will not be allowed to have the 20% time. Also, if the employees are working on something that’s critical to the company, they may not have the 20% time either; under this situation, some employees may not want to have the 20% time either. This program has been extremely helpful for certain people, and has turned into millions of dollars of profits with products like new Gmail features and Google News, etc.

6.2.11. Encourage Networking

Companies often encourage and support employees to go out to professional conferences, which, in some aspect, give employees the opportunity to build up professional networks. These networks can help the employees greatly in their professional development and offer the employees a broader view of the rest of the professional world.

Some conferences and professional organizations also have local communities to allow professionals to communicate better and meet local needs. And sometimes these networks can turn into recruiting opportunities, which to some extent discourages employers' support of conference attendance by their employees.

Companies also organize internal programs to let employees mingle and chat, to know more about each other through some activities. This makes the employees more familiar with their co-workers, and will encourage communication during work so that employees can help and support each other better.

6.2.5. Give Freedom to Explore

Some companies, especially those who put much weight on innovation and creativity, usually give their employees freedom to explore on their own. For example, Mr. Schwartz, a manager from Microsoft, indicated that Microsoft allows employees to pursue their own interests (Appendix A.6).

Employees may provide a series of commitments, including professional commitments, and then they may share their goals with others. Employees can discuss the commitment they came up with, with their manager.

The Google manager suggested that any Google employee is free to pick any conference or convention that appeals to him/her or is related to his/her job. In the 20% of time project, the Google engineers are free to be interested in anything and seek resources and support in order to accomplish the project.

6.2.12. Subscribe to Industry News

Some companies subscribe to industry-related newspapers and magazines, send out company and industry news via emails and buy books to help their employees stay updated.

According to Professor Moriarty (Appendix A.9), most of the companies he worked for subscribed to major game magazines and put the latest issues in the lounge so that

people could read them and know more about industry news. Mr. Bilodeau's bookshelf has a collection of programming books related to his job and Microsoft bought most of the books for him.

When asked about what would be the most effective methods in updating a chemical engineers' knowledge, Professor Starr from WPI answered that it would be to be aware of what is going on, to stay on top of the news and engineering magazines (Appendix A.10).

6.2.13. Conduct Annual Reviews

During an annual review, which happens in most companies, managers and employees can discuss and identify the strengths and weaknesses in employees' capabilities, which definitely helps them to enhance their abilities.

As mentioned in Section 5.2.2, employees will work with their managers to establish an Individual Development Plan (IDP). The development plan can be career-oriented or it can expand upon some aspects of an individual's skill sets related to a current or future position. Ms. Kelleher, who manages Education Services in EMC, implied that IDP was helpful and she told us that throughout the year, employees would discuss their progress on the IDP with their manager.

In the chemical engineering industry, necessary training is brought up during the chemical engineers' annual reviews, which in turn provide the engineers with opportunities to state the conferences or external industry events that they would like to attend in order to learn more about the industry trends (Section 4.3).

6.2.14. Post Internal Jobs

Mentioned by Mr. Padisetty (Appendix A.4) from Microsoft, there is a central, internal site where every position is listed. The employees can look for the positions that they are interested in, and contact their potential new manager to begin a conversation with them to see if the new position is a fit. If an interview is set up, it gives the employees the opportunity to change jobs within Microsoft to something they are currently

more interested in.

The manager from Google (Appendix A.12), mentioned that the internal job posting is also available for employees who wish to rotate jobs. Every around three years, engineers are supposed to move to different roles. People can vote on the projects they want to participate for the next few years. This internal job posting program can also assist to enhance the job challenge to some extent.

6.2.15. Provide System Upgrade

Nowadays computers are a necessity for most working environments. Upgrading computers is therefore an important factor in assisting employees' daily work. Especially in most game development companies, the upgrading frequency can be as high as at least once a year (Appendix A.11). The more advanced computer hardware provides support for developers programming needs, and more advanced software can offer a better chance to place the products of the companies among the cutting-edge of the industry. With the upgraded equipment, employees generally need to learn on their own about how to use the new hardware and software.

Mentioned by Judith Grindeland (Appendix A.7), some hospitals let the equipment vendors come in and teach tutorials on the equipment operations, but this does not happen often in software industry.

6.2.16. Require Licenses

Some of the professions we investigated require licensing or certification. For instance, Physicians are required to get a full physician's license from their state medical boards to practice medicine (Section 4.2). A nurse is issued his/her license by the state board upon completion of National Council Licensure Examination (NCLEX).

Renewal of these licenses or certificates is usually a must in professions that require them. A nurse is required to obtain 15 Continuing Education Units (CEUs) before their license is to be renewed (Section 4.2). In several engineering fields, the renewal process, at least

in Massachusetts, involves simply asking for a new license. No test or refresher course is needed for a license renewal.

On the other hand, in the software engineering field, no one we interviewed indicated that his/her company required a certificate or license. Also, most of the interviewees from this industry do not hold any certificate or license.

6.2.17. Reward Professional Development

One of the interviewees (Appendix A.5) mentioned that he felt that a financial reward is one of the biggest incentives to encourage employees to learn more, but the rest of the interviewees thought that rewards were not as important as the other incentives, and companies do not usually give promotions or bonuses to employees for professional development.

As shown in several research papers (Section 3.3), reward for professional development is one of the components that researchers looked into for a relationship regarding knowledge obsolescence. *Knowledge Obsolescence Among Professionals* shows that "frequency of rewarding professional activity" has no direct relationship with obsolescence score in both current knowledge and emerging fields; *An Evaluation Of Factors Affecting Professional Obsolescence of Information Technology Professionals* (2)also indicates that there is no proof that a "rewarding policy" can help employees stay updated with their professional knowledge.

6.2.18. Require Mandatory Training

Some companies have certain training that is required for employees to finish, and is recorded for employees' performance. Companies prefer mandatory training on certain topics to ensure that everyone who needs the knowledge can get informed. Most of the interviewees that we talked with indicated that mandatory training does not happen often in companies, and they do not think mandatory training helps professional development. When training is required, it discourages people's interest in taking the course, and the effect of the training is significantly lowered.

6.3. Recommended Solutions

6.3.1. Highly Recommended Policies

This section contains the programs that we would like to recommend for the software engineering industry. Based on our research and interviews, these are the programs and ideas that are widely recognized and have been providing significant effects to the companies.

Offer Internal Training

Nearly all companies, especially middle to large companies, offer various types of training programs to their employees. For example, EMC's Educational Services Department offers wide choices of courses; hospitals often provide training to their nurses and doctors.

Most of the interviewees liked this way of learning because it is convenient that they are able to take the courses in front of their desks or inside the company. Furthermore, there are a variety of courses they can choose from so there is usually one that is closely related to individuals' current or future jobs. In addition, the training courses can satisfy the software engineers' immediate needs for certain knowledge instead of waiting for the opportunity of exploring it through continuing education.

Some previous research suggested the same concept. For instance, "Are You on The Verge of Obsolescence" is an article in *Indian Journal of Industrial Relations* (Section 3.3). It suggested interventions like continuing education and training to be taken at the organizational level are also essential to combat the obsolescence. In Chauhan and Chauhan's later article (2008) "Human Obsolescence: A Wake-up Call to Avert a Crisis", they claimed that post-training assessment of the impacts is also a good way to make training more useful.

Ms. Kelleher (Section 5.2.3), who manages Education Services in EMC, especially illustrated the effectiveness of training and courses by identifying some statistical analysis: the survey result usually showed that at 60

days, 70% - 80% of the employees had used the knowledge, while at 120 days, nearly 95% employees had used the knowledge they learnt.

Encourage Conference Attendance

Most corporations expect their employees to attend numerous conferences, meetings and conventions, most of which are related to their industry practice and some of which are related to more business like aspects.

Recent research articles indicated that attending conferences helps employees keep themselves updated. In "Are You on The Verge of Obsolescence" (Section 3.3), it is said that participating in regional, national or international conferences when possible are very important to individual employees. In the article "Vulnerability to Knowledge Obsolescence among Professionals" showed some statistics that "obsolescence decreases as the extent of involvement in professional activities".

Creath Carter (Section 4.1.2, Appendix A.11) stated that the gaining support from the game community group and organizations is essential because he learned a lot by attending professional conferences such as Boston Indie Group and Boston Post Mortem. Mr. Carter implied that he was able to get exposed to the most innovative ideas and most advanced technologies.

Facilitate Informal Presentations

Informal training sessions and presentations are also very helpful for keeping software engineers up to date, such as Microsoft's "Brown Bag" events and Google's Tech Talks. These types of presentations are great ways for software engineers to get an introduction to topics either they are interested in or they are not familiar with so that they can broaden their horizon. Since these events often take place during lunch time, software engineers are more willing to go. The evaluation after the talk session from the participants can also give suggestions on how the companies can improve this program and how speakers can improve the contents. Because these are such a great way for engineers to learn more, we highly recommend companies implement similar policies.

Create Challenging Work

Challenging work is extremely beneficial when it comes to staying up to date in software engineering. By giving an engineer a project that they do not fully know how to do, the company is creating an opportunity for the engineer to grow and learn. Michael Bilodeau (Appendix A.3) talked to us about how he has been asking for challenging projects that he is not going to know how to do because he wants that extra opportunity to learn more.

Several research papers we read confirmed, through various means, that engineers that worked in technical areas that were constantly challenging them were much less likely to become obsolete than those that were in more administrative or less technical roles (Section 3.3).

Reimburse Tuition

Software engineering companies generally have a program to support employees' further education in pursuing a higher degree in job-related fields by providing tuition reimbursement. The education is mostly part-time in addition to the regular job at the companies. Even though most of the time it is the employees' initiative to pursuing a higher degree, employers can always get the employees trained professionally in the companies' interest. Universities are where innovation takes place. When employees discover what they specifically need to improve in order to have a better performance at work, high level classes in universities can provide them a systematic and comprehensive understanding in the topic.

On the other hand, many employees choose to take these classes also because higher degrees can benefit themselves in the end. When time comes for a software engineer to switch jobs, a higher degree makes him or her more competitive than the other applicants to some degree.

Recognize Individual Initiatives

When it comes to professional development, self-motivated software engineers will always know what they

are looking for in the near future. It is very important for companies to listen to employees' ideas of what they would like to do in order to accomplish their personal development goals. This may include attending conferences, participating in certain trainings or pursuing higher degrees, etc. A lot of these contents may be discussed during employees' annual reviews.

In addition, making company policies known to the employees that what can be supported by the companies is essential in getting software engineers to utilize as many resources as possible in bringing up professional development ideas.

Organize Mentoring Program

A lot of interviewees mentioned the mentoring program that they have participated in during their work. The nurse, Judith Grindeland from Boston Children's Hospital, said that it is very helpful to pair up experienced and new nurses, in order to provide new nurses the necessary resources and help that they may need. The experienced nurses have a lot of knowledge and this gives new nurses a chance to be a part of that knowledge. Similar program is also offered in Mass General Hospital.

In software engineering industry, Microsoft currently offers a mentee-driven type of mentoring program, where employees can find the help that they need from a central program website. This has provided employees who need help in certain disciplines great assistance. Sometimes online training courses can only provide information on a basic level due to the fact that they focus more on variety; the mentoring program gives people a chance to communicate with and learn from experts in certain fields that they are interested in but feel hard to find educational resources to further explore.

However, Michael Bilodeau from Microsoft also mentioned that it might be more beneficial if the program can be mentor-driven since mentors can always point out the direction for the mentees instead of let the mentees explore on their own.

Provide Rotational Program

Mr. Padisetty (Appendix A.4) from Microsoft talked to us about his time at Tata Motors and how they implemented a rotational program in which the engineers rotated every three months for two years to different job roles. Three months in the software engineering world would probably be too fast and wouldn't provide enough time for the engineers to really learn. The interviewee from Google (Appendix A.12) talked to us about how it is strongly encouraged that Google employees switch to a new project about every 3 years. This length of time is much more appropriate because it actually allows the engineer time to really get to know the project he is working on, making his work much more valuable.

This rotational program prevents software engineers from being too familiar with one type of jobs and therefore stopping learning new technology. This also gives software engineers an opportunity to be involved in different types of development environment and assists the engineers to be more fully developed. It gives the employees something new to look at and forces them to learn new things that they may actually want to learn but might not have had the chance to learn otherwise.

Organize Side Projects

Side project reflects engineers' personal interests. They are what the employees work on besides their regular jobs. Some software companies make it a requirement for the software engineers to work on some side projects besides their daily job and the side projects take up part of the regular working hours. Sandy Gotlib from Microsoft mentioned that the overall effect of this policy may or may not be beneficial because it is hard to determine whether the time spent on the side projects is worthwhile to the company.

However, another approach to this idea is that the company should encourage the software engineers to work on side projects and support the program by providing communication methods and tools, which is similar to Microsoft's "The Garage" program. This may not take up the regular working hours, and software engineers can

contact each other on setting up the projects during their free time, which is completely out of self-interest. The company can support the successful side projects from the employees and turn them into products. In this way, the overall performance of an employee for his or her regular job is not affected, and their personal interest can also be developed into innovative ideas.

6.3.2. Recommended Policies

The policies covered in this section are not as useful as those of the previous section. However, after our research and analysis we felt that these policies could still be useful to software engineering companies. Companies can adopt these policies, depending on their own needs and situations.

Encourage Networking

The first topic in this section is to encourage networking both internally and externally. Both game developers we interviewed talked about the usefulness of networking. Mr. Carter (Appendix A.11) told that the gaming industry is very community driven and as such a lot of networking is involved. Game developers, particularly the artists, can share their work within the community and get feedback and advice on how to better their work. Brian Moriarty (Appendix A.9) told us that networking can lead to new jobs for game developers, which also holds true in just about every industry. In order to get the new jobs however, the applicant must prove to the company that they are proficient in all the areas required for the job and is willing to put in the work to stay that way. As a result, the applicant must keep themselves up to date. Internal networking is also very useful. Getting to know co-workers can make it easier for an engineer to ask one of them for help on a problem they are having. If an engineer does not know their co-workers well, it can be difficult for them to find someone that can actually help them. Because networking can lead to professional development but does not directly cause it, we recommend that companies encourage it but it is not imperative for an employee to stay up to date though it can make it easier.

Give Freedom to Explore

Some companies tend to give their employees a degree of freedom in choosing what they want to do. A manager from Microsoft argued that when it comes to innovation, giving people the freedom to explore is the core philosophy. He said that employees can be easily attracted to advanced technologies if they have time, resources and freedom to investigate them more.

Mr. Schwartz, from Microsoft, also thought that this is a great way to incite employees because employees can usually decide what they want to learn and what they want to do in the future. As a manager, Mr. Schwartz encourages his employees to come up with their own plans and give them guidance to help them attain their goals.

Subscribe To Industry News

Another policy we ran into was subscribing to news sources (Section 4.1.2). This can include news, magazines, websites, and books. Both Brian Moriarty (Appendix A.9) and Creath Carter (Appendix A.11) spoke highly of using such mediums to stay up to date. However, both of them are in the game development industry and are not software engineers. Gary Pollice (Appendix A.2) also spoke of a few websites he used to keep himself up to date, but that was more on his own than company policy. Because it was spoken of so highly by the two game developers and it can be applied to software engineering we felt that it was useful for the engineers but perhaps not as useful as some other policies.

A third company strategy we felt could be useful, which is somewhat related to the above policy, was to send out company news internally. We actually learned about this not through interviews or research but from team member Zhaochen Liu who interned at EMC over the summer (Section 5.2.2). Essentially, it involves emailing employees in your company about major company news, such as the invention of a new product in another department. This is a good way of sparking interest within the company which can lead to more learning but doesn’t do so directly. Because it does not directly result in engineers learning, we felt that this would be

a good idea to implement but it is not completely necessary to do so.

However, this policy can be easily executed. Companies can adopt this policy at a low cost because subscribing magazines and sending news via emails do not cost too much money.

Conduct Annual Reviews

The next one of these recommended policies is having an Individual Development Plan (IDP) (Section 5.2.2) or similar review system. These most commonly show up during annual reviews but some companies refer to them more frequently. Responses on annual reviews were mixed when we asked about them during our interviews. Gary Pollice (Appendix A.2) talked to us about how he thought that such policies actually hurt more than helped. He told us about IBM's "stretch" goals in which an employee creates goals for themselves for the year that they should do their best to accomplish but might not be able to. Then, the next year these "stretch" goals would become just goals and they would create new "stretch" goals. After a few years of constantly stretching themselves, engineers would reach a point where they just can't do it anymore. Despite all of this, no one else we interviewed really mentioned this type of situation leading us to believe it is either isolated or not as bad as Prof Pollice seemed to make it sound. As a result, we feel that an IDP can still be a useful tool for a software engineer to stay up to date.

Post Internal Jobs

Internal job posting was also a very common policy we encountered during our research. We first learned about this procedure during our interview with Siva Padisetty (Appendix A.4). He told us that in Microsoft, they post jobs internally on a central website and all the employees can look through to see what openings there are in all of the departments in Microsoft. The manager from Google (Appendix A.12) told us about a similar system in Google in which employees can actually vote on projects that they are interested in and, provided there is an opening in that project, switch to different projects.

This program can help employees get the positions that they would like to work for; on the other hand, our research did not show direct correlation with professional development.

6.3.3. Not Recommended Policies

There exist other approaches in the industries we investigated. However, our research indicated none significant evidence that upon using these means would do to help software engineering employees stay up-to-date.

Require Licenses

Unlike professions that are related to medicine and public health, such as doctors, nurses and Emergency Medical Technician (EMT) (Section 4.2), software engineers usually do not hold any licenses or certificates. We do not recommend that software companies require their employees to have license and certificates.

Professor Pollice (Appendix A.2) maintained that society doesn't really pay a lot of attention to certification. Mr. Bilodeau (Appendix A.3), a software engineer from Microsoft, suggested that no certification is required in Microsoft at all. Mr. Bilodeau made a good point that spending too much time on passing the test is a waste, although the content of the test might be useful. Another Microsoft employee Mr. Padisetty (Section A.4) implied the same idea that certificates mean nothing is Microsoft. This is especially true for software developers because certificates prove the ability to use the product, but the skills required to develop the product are very different from using it.

Reward Professional Development

Most of the interviewees thought that rewards are not as important as the other incentives that encourage employees to learn more and enhance. Also, as shown in several research papers, there is a weak relationship between knowledge obsolescence and rewards. For example, as mentioned in Section 3.3, *"Knowledge Obsolescence among Professionals"* shows that "frequency of rewarding professional activity" has no direct relationship with obsolescence score in both current knowledge and emerging

fields; “An Evaluation of Factors Affecting Professional Obsolescence of Information Technology Professionals” also indicates no proof that “rewarding policy” can help employees stay updated with their professional knowledge.

Require Mandatory Training

Most of the interviewees that we talked with indicated that mandatory training does not happen often in the companies, and they do not think the mandatory training helps professional development. One of the Microsoft employees (Appendix A.5) stated that training only worked if 1) he needed it and 2) the training could be applied to what he was currently doing. When irrelevant training is required, it discourages people’s interest in taking the course, and the effect of the training is significantly lower.

7. Conclusion

This project report contains background information on research on professional obsolescence, industry studies on game development, the medical industry, chemical engineering and mechanical engineering, company studies on Mass General Hospital, EMC, Google and General Motors and finally evaluations on recommendations we drew from the above research. Interview summaries with professionals from different industries are attached in the appendix section.

Starting with background of this topic, we looked at the research conclusions from previous papers on professional obsolescence which were studied and analyzed to assist the research process. Following the background section, we took a look at various fast developing professions and evaluated the different approaches that each industry shows. We finally narrowed down the research focus to four industries in order to further investigate to draw conclusions on helping software engineers stay current. The analysis of different industries demonstrated how these fast-developing industries keep their professionals updated. We then provide examples within the industries of successful company practices in various disciplines with detailed information on their support on employees' professional development. Finally we came to the evaluation of the methods that are taking place in different industries and companies, and therefore suggest the best solutions to keep software engineers updated. During the research process, we also conducted a number of interviews with people from different professions on how they, and other employees in their discipline, avoided professional obsolescence.

Results from the industry research, company study and interview summaries showed that the prevention of professional obsolescence is a combination of individual effort and company assistance. Software engineers must have self-motivation in order to keep themselves updated with technology development. Companies should provide the software engineers with as many resources as possible and certain personal development freedom in choosing

professional activities. Results further showed that among the various resources that a company may provide, mentoring programs, tuition reimbursement, internal training programs, professional conferences, side projects, work challenge, informal talks on innovative topics and proper rotational programs appear to have outstanding effect in helping software engineers grow in this industry and are highly recommended. In addition, having individual development plans, subscribing to job-related news and magazines for employees, encouraging professional networking and posting internal jobs also gives assistance to professional obsolescence prevention to some extent. However, even though they are useful for some other industries, requirements on professional certificates, reward systems, and mandatory training are not suggested for the software engineering industry. Explanations for all of these conclusions can be found in section 6.3

The study steps shown through the project demonstrate clear project planning, and therefore the report can serve as an example for future Worcester Polytechnic Institute Interactive Qualifying Project students to conduct successful projects with external sponsoring companies.

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Appendix

Appendix A. Interview Records

We conducted several interviews with people from different professions. The interview records are attached in the file.

Note: The following interviews summaries are paraphrased from the interviews; they are not the transcripts or direct quotes from the interviewees.

A.1. Sandy Gotlib

Interviewee: Sandy Gotlib
Interviewer: Adam Driscoll, Han Li, Zhaochen "JJ" Liu
Interview Date: September 14, 2010
Interview Time: 10:00am – 11:00am
Location: Mr. Gotlib's Office

Interviewee Background Information:

Mr. Gotlib is the Sustained Engineering Manager of App-V SE.

Interviewee Past Experience:

- Director of Engineering, Softricity, Inc.
- Director of Software Engineering, Xevo
- Senior Development Manager, Lotus Development
- Department Manager, Section Manager, Prime Computer

1. Do you think obsolescence of knowledge in software engineering and Microsoft is very fast?*(If so, how fast?)*

Mr. Gotlib thought that this was too broad a question. For example, the fundamental of algorithms, data structures, programming concept haven't changed yet, but the web technologies, new programming languages and the pattern of new technology have been developing. And sometimes there is resurgence for some languages and technologies based on the market demand, for example COBOL. Mr. Gotlib mentioned that it was a language which was developed in 1960s, but the demand for expertise in this language saw a bit of resurgence usage of this language was widely required again around 2000 for solving the Y2K problem. Technology usually has a long life time, but the life cycle evolves based on the demand, Mr. Gotlib concluded.

2. What kind of knowledge needs to be updated regularly?

(Answered together with the previous question)

3. What has Microsoft been doing to keep the employees updated? Is it required/recommended for all/some employees?

For example,

- *Conference | Pay in full + allowance?*
- *Continuing Education | Cover full tuition?*
- *Competition | What award?*
- *Annual Review*
- *University Cooperation*

Mr. Gotlib pointed out that in most companies, nothing is required. He also introduced that, however, Microsoft offer internal courses taught by internal folks. These classes are job related; the list of courses includes engineering field, technology, management, etc. The only mandatory training is that Software Engineers must take classes about software security, secure development. Microsoft offers tuition reimbursement for pursuing a higher degree in universities. When asked if there are any universities that employees are limited to, Mr.

Gotlib said there wasn't any, but the degree to pursue should be job related as well. The degree program is generally part-time degree; full-time study opportunities are very rare. When asked about if the employees of Microsoft were encouraged to go to conferences, Mr. Gotlib answered that most conferences that the employees go to are technology-specific and often features internal products and third-party products. When asked about the competitions, Mr. Gotlib pointed that Microsoft sponsors some competitions, either internal competitions or those held at colleges. Microsoft has mid-year reviews and annual performance reviews. The annual reviews focus mainly on the feedback on what has been done for the year. The mid-year reviews are a combination of review of the feedback of the past and talking about career objectives. Sometimes they talk about advice on how to achieve the goals. For example, some people would set the objective for the year to be that they would spend forty hours this year on training. Mr. Gotlib also said that Microsoft has partnerships with some universities and sponsors research as well. Sometimes they have faculty members from universities to come to speak about some technologies. The concern that Mr. Gotlib expressed was that the advanced research doesn't have immediate effect, but it is good to have some new concept introduced.

4. Are those methods effective? How effective?

Mr. Gotlib thought that the courses satisfying immediate needs are the best.

5. How about other companies you worked before?

Mr. Gotlib said that there are no radically different approaches among those companies. He gave one example, Lotus, a company that he worked at before and later on was bought by IBM. When object-oriented programming was first introduced, many of the engineers were put into classes to learn OOP. And when Windows system was introduced and developed in the 90s, the company also hired the trainers to teach the employees about the system. Mr. Gotlib concluded that this was an

example when employee self-interest and the company's interest combined together to come up to speed on new technology.

6. Is there any method that you think would be effective yet is not take place in Microsoft/Software Engineering?

Mr. Gotlib did not think so.

7. What are the initiatives that encourage employees to learn more?

(Some possibilities: financially, self-motivation, self-enhancement, job security, social status, networking, etc.)

From individual motivation, Mr. Gotlib mostly hired people who are eager to learn. *(Q: does the company need an extra push?)* Mr. Gotlib said that the company encourages the employees to grow, Employees are expected to keep learning. Also they want to keep the job, so that they need to keep learning. Moreover, Mr. Gotlib said that for the larger market, they need to consider economic or financial issues. They also need to consider the skills that are in demand in the market so that they can find a job.

8. You are a manager now, and you were a software engineer before. From two perspectives, how do you think the obsolescence has changed?

Mr. Gotlib thought that it isn't that much different. For example, early in his career he wrote in assembly language. For the languages, he changed from assembly to FORTRAN, to PL1, to C, and then to C++, Java. These languages were not mutually exclusive; Mr. Gotlib said that some folks were still using C, for example. But people need to keep learning. If Mr. Gotlib only knew assembly now, he said there wouldn't be much job opportunity for him. So he concluded having the skills to adapt to the changes of the market is very important.

A.2. Gary Pollice

Interviewee: Gary Pollice
Interviewer: Adam Driscoll, Han Li, Zhaochen "JJ" Liu
Interview Date: September 14, 2010
Interview Time: 5:00 – 6:00pm
Location: Prof Pollice's Office at WPI

Interviewee Background Information:

Prof Pollice is the professor of practice at Worcester Polytechnic Institute Computer Science Department. He has rich experience in software development and software industry.

Interviewee Past Experience:

- Rational Software, Lexington, MA (1996 – 2003)
- Centerline Software, Cambridge, MA (1991 – 1996)
- Digital Equipment Corp., Nashua, NH (1987 – 1991)
- Sun Microsystems, Billerica, MA (1958 – 1987)
- SofTech, Waltham, MA (1985)
- Datapoint Technology Center, San Antonio, TX (1983 – 1985)

1. What kind of knowledge needs to be updated regularly? About how fast do you think it needs to be updated? Is there anything that hasn't really changed much?

Professor Pollice thought that the programming languages changed very fast. The software development practice also changed a lot. For example, 20 years ago, people used waterfall design concept. Then about 10 years ago iterative development came out. Later on people focused on how to design and represent their software, use flowchart. And now the agile development concept is very popular. In all, Professor Pollice concluded that specific technology changed fast, but concept, such as algorithms, didn't change much.

2. What have the companies you've worked for done to keep the employees updated? Is it required/recommended for all/some employees?

For example,

Conference | Pay in full + allowance?
Continuing Education | Cover full tuition?
Competition | What award?
Annual Review
University Cooperation
Licensing, Certificates

Professor Pollice categorized three main forms that companies generally take in order to keep employees up to date. The first one is tuition reimbursement. They encourage employees to take classes in universities in their free time. The courses or degree that the employees pursue should be job related. The second method is to offer internal courses, or so call trade courses. This is the most common way that companies take. They sometimes offer the classes in the company or go to another company to take the classes. A lot of industrial courses and training are offered this way. These classes teach the practice rather than theories. IBM does a lot of this type of training. Some companies hire them to teach their employees on certain concepts. The last one would be sponsoring employees to go to conferences, for example, ICSE (International Conference on Software Engineering) which introduces new software, or SPLASH which focuses on

the new technology and how to use it. There is a book called “Advanced Software Testing” that lists all the standard exams that software engineers can take.

In addition, Professor Pollice said that sometimes employees take online courses, and companies pay the employees for their certificates. ACM and IEEE sponsor some certificates, but the society doesn’t really pay a lot of attention to it. No software industry currently that Professor Pollice could think of that requires certificates in order to work. He said that the debate about certificates has been going on since 1960s. There are some certificates that some companies are looking for, but they are generally not for the industry. For example, Microsoft issues system administrator certificates, and it is required for some companies.

For competitions, Professor Pollice thought that they are not that common, because now companies mostly encourage collaboration. It’s not like in school students are encouraged to compete and win awards.

Regarding to annual reviews, Professor Pollice mentioned that they hurt more than help. He said that companies have been thinking about people as people nowadays; before some companies thought people as resources. They brought up “stretch goals” at IBM, which means that it’s something you can achieve if you really stretch yourself. If you achieve this stretch goal this year, it would be considered standard for you to achieve your stretch goal; next time you would be required to stretch more in order to take the higher stretch goal. Finally people will break like a string due to too much stretch. In high-tech companies, if you have incentives it goes away very fast. For example, some companies will provide lunch during development phase for a product. Some people think that this is a good thing; however, the employees will not go out to eat and work even harder. Some companies will provide stock options in order to keep employees. In all the annual reviews have nothing to do with technology but all about money.

Talking about self-motivation, Professor Pollice said that employees definitely have self-motivation. For conferences, it’s more likely to be that the employees found the conferences that they are interested in and then talk to managers for sponsorship to go to the conferences. This is more than 50% of the cases. Now some

good managers will also bring in trainers. But mostly it's bottom-up. Self-motivation is very important. Companies can try to hire more motivated people, but you never know whether this person is actually highly motivated or not. There are some policies of how to select people to go to the conferences too, but some good companies, like IBM, encourage as many people to go as possible.

Also, Professor Pollice said that most universities have corporate relationships. They do training for the companies. For example, he was going to BAE next spring to teach a development team who are not that good at testing. Companies bring in faculty if they have some tools that they are not good at using. Mostly it's for applications rather than for advanced research topics.

3. When new concepts in software engineering come out, how do people know about these concepts such as cloud computing, agile developing? Do people know these concepts through conferences, products or other ways?

Professor Pollice mentioned that for example, the agile developing started in 2001, there were 17 consultants who were trying to get a bigger market share. Several people started a document called "Manifesto for Agile Software Development". They went to the conference for software engineers and talked about their ideas. For example, there are conferences such as Agile 2010, Splash 2010, ICSE 2010 and Ecoop. There are a lot of vendors to give out information in these conferences to tell people about these new concepts. JavaOne is a conference that attracts more than 2500.

4. Are those methods effective? How effective?

Professor Pollice said conferences and internal courses would more likely have short-term effectives, but tuition reimbursement would have benefits in the long term.

5. How about WPI? What kind of thins does WPI do to

keep professors updated?

Professor Pollice introduced that there are two different kinds of professors. Tenured professors focus more on the research and theory of their field. Professors of Practice focus more on the practice of their field. Professors of practice must stay current on their own. WPI usually supports him to write books and go to conferences.

6. What are the initiatives that encourage employees to learn more?

(Some possibilities: financially, self-motivation, self-enhancement, job security, social status, networking, etc.)

Professor Pollice said that incentives for companies included food, stock options, and raises, but these were not for the employee to learn more. These were just to keep them in the company.

Some companies have policies to let their employees take time off for conferences and similar events. Many of these companies either ignore the policies or don't make them very public so that the employees will not take time off. The good companies encourage this, however, said Professor Pollice.

7. Is there any method that you think would be effective yet is not take place in software engineering companies?

Professor Pollice suggested that software engineers can use useful websites and programs to stay updated. For example, the "refcardz" site on Dzone.com, the IBM Development Works, and StackOverflow, etc.

When asked about whether Google's 20% of time was a good idea to invent new products, he agreed, but mentioned that it also can be a waste since it used a lot of resources. 20% was a good idea for some companies but not for others. For innovative companies it worked well, but not necessarily for others. He said that he was surprised that Google still kept its culture well. For a

lot of small companies, after they grew bigger, they lost their culture.

A.3. Michael Bilodeau

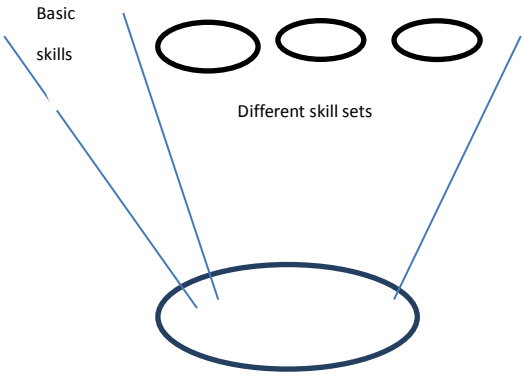
Interviewee: Michael Bilodeau
Interviewer: Adam Driscoll, Han Li, Zhaochen "JJ" Liu
Interview Date: September 17, 2010
Interview Time: 10:00am – 11:00am
Location: Mr. Bilodeau's Office

Interviewee Background Information:

Mr. Bilodeau is currently leading the security efforts on the Application Virtualization projects that are going on in Cambridge, MA. Prior to this role he has worked as a PM on App-V and also led/managed various Development and Test teams on App-V. Prior to Softricity (acquired by Microsoft in 2006) he worked in various IT consulting companies doing application development and systems integration for various large organizations in C++, PowerBuilder, and SQL.

1. You have been in software engineering field for more than twenty years now. What kind of knowledge needs to be updated regularly? About how fast do you think it needs to be updated? Is there anything that doesn't really change much?

Mr. Bilodeau said that a lot of the technologies do change much, but people never know how long the software technologies can last. Mr. Bilodeau gave the example that tools and some languages we have used for a while are gone. However, some other skills and concepts, namely data structure, algorithms and SQL, and some core languages, did not change much.



Mr. Bilodeau pointed out the question that if a person picked up a skill set that would not be out-of-date in the next few years. He said that at the beginning you learnt a little thing that everyone knows, and then you learnt more and more, and focused on one specific area. Some basic skills and core technologies don't change over the times. But if the high level area that you picked gets obsolete, then there will be a big trouble because you cannot find a job.

He said that it is also important for employees to deal with the technology shifts. For example, iPad and other tablet computer came out, but he still preferred reading paper. How to deal with paradigm shifts is something to consider. Mr. Bilodeau said that he might not want to do something that he was not comfortable doing.

2. What has Microsoft been doing to keep the employees updated?

Is it required/recommended for all/some employees?

For example,

Conference | Pay in full + allowance?
Continuing Education | Cover full tuition?
Competition | What award?
Annual Review
University Cooperation

Mr. Bilodeau said that Microsoft offers some learning sites. Most employees use mylearning.com. It's an internal site, and they post a lot of training courses on various topics. He also said that there's another site called channel9.msdn.com, which is external site that everyone can use. Employees post questions and videos on new technologies related with Microsoft products. There is a "brown bag" event that people in Microsoft schedule lectures and speaking on some topics, and employees who are interested in the topic can bring their lunch to the event and learn the knowledge. Mr. Bilodeau said that he went to these classes or lectures very often, at least several times a week, and he felt that they were very useful. He said that one thing to notice is that since they only offer very good introduction courses, it's hard to find people to teach you or guide you for more advanced information. Maybe they can offer some more advanced courses, or let people post the topics that they would like to learn about so that it would be more focused when they organize the courses. And employees can give feedback on the courses or lectures they attended, so that the speakers can improve. Mr. Bilodeau gave one lecture here several weeks ago, which was excellent, but the one he gave in San Francisco before was not that great, so he also learnt from these feedbacks and improved himself. And looking at the books on Mr. Bilodeau's bookshelf, they are all from Microsoft. Microsoft buys books for employees on their job related topics.

Mr. Bilodeau said that Microsoft doesn't really force employees to go to conferences, but they highly encourage employees to go to the customer visit events. Most employees find the conference that they would like to attend, and then go talk to their managers about it. Most managers would allow the attendance of a conference. Sometimes the company will encourage the employees to go to some conferences by giving a potential promotion or

some recognition.

Another program that's worth mentioning during the talk with Mr. Bilodeau is the mentoring program. He said that the company looks for volunteers for the program as mentors, and put the mentors' information on the program website. Other employees can look for these people's information, and set up the mentor-mentee relationship with them. From Mr. Bilodeau's point of view this program is nice to have, but a lot of the times it doesn't work the way it should. People are not getting what they are looking for from the mentors. And Mr. Bilodeau thought it works better to find someone through friends or colleagues who already know you. He would ping someone online to ask them if they knew anyone who knew the knowledge that he was looking for, and they would ask around their friends and finally found the person who could help him. He thought in this way the target was more specific because they knew exactly what he was looking for.

Mr. Bilodeau said that there are very few competitions held in Microsoft, those internal competitions. Because these competitions are not related with work, and therefore people don't really pay attention. Some competitions give out awards too, for example, the gold star awards. Some employees have a marble ball if their jobs got patented. The bonuses are connected to these awards too.

One thing that Mr. Bilodeau thought Microsoft does is that it lets the employees to seek for the information and help with what they need. Mr. Bilodeau thought it would be better if the managers can help the employees with what the employees need and how to find the resources. Nothing is forced; everything is self-driven. The best way to learn is to learn at the job and do what you don't know how to do before. You learn a lot through the process. This gives the people the opportunity to learn, but the company needs to give the employees the challenges. Now for a company, it's more important to figure out what to learn for the employees, and to pick and buy the right courses and trainings. And it's important to teach the employees how to keep their skills, how to learn and how to keep their mindset open for new things.

Mr. Bilodeau said that Microsoft doesn't really have

any special relationship with universities, besides that they sometimes may have speakers or researchers over from universities. Microsoft also pays for the tuition of grad school, supporting part-time education and allowing flexible working hours.

Also Mr. Bilodeau mentioned that the annual reviews are employee driven. The employees list what their goals are and what they need to do in order to achieve that. Then they share the goals with their managers and the managers will try to help them achieve it.

3. Are those methods effective? How effective?

(included in the second question)

4. Some people say that for IT-Security people, it might be a good idea for them to have certificates and update their certificates in a regular basis. How do you feel about it? Is it useful? Is it necessary?

Mr. Bilodeau said that in Microsoft, no certification is required at all. It is more common for people who use Microsoft's products to hold such certificates. In Microsoft, people put no weight on certificates in any area. No one pays attention to certificates. It's a decent way of picking up skills but no matter whether you have the skills or not, during interviews you will still be asked about all the questions that we need you to know.

Mr. Bilodeau also mentioned that some people are suggesting that security people should hold certificates. However, he felt that taking the certificates test is not worth it. It's good in some aspect because it legitimates security as a separate discipline rather than now in software industry there are only three roles: developers, test engineers, and project managers. Although the content of the test is good, too much time spent on passing the test is definitely a waste. Nobody pays attention to it, so it doesn't help with finding a job. And it's too slow; all the standard learning is the same thing.

5. You have been working for companies other than Microsoft. What is the difference in terms of companies' actions on professional development? Is it related to the size or culture of the companies?

Definitely, Microsoft puts a huge investment on training and professional development, said Mr. Bilodeau. Some small companies cannot do it at all. Some of the companies' professional education or training is less frequent and less formal than bigger companies'.

But a company Mr. Bilodeau worked before actually had a better mentoring program than here. Their mentoring program was more mentor-driven which was more useful to me. Mr. Bilodeau had a couple of mentors in that company and they always pointed something to him instead of let him explore by his own. Sometimes, it is good that if a third person can put more perspective. However, self-motivation still plays an important role in all of these.

6. Is there any method that you think would be effective yet is not take place in Microsoft/Software Engineering?

Mr. Bilodeau said that colleges need to teach students how to learn and adapt to new information rather than just teaching specific things that will become obsolete. There needs to be constant learning taught throughout the school years so students will be prepared when they make the move into the career world. This needs to be continued in the career world with things like adult learning centers and online course. Mr. Bilodeau believed that the education organization, not some company or industry, is best suited to accomplish this.

The universities focused on the core skills before, said Mr. Bilodeau, but now they tend to teach the new technologies to make the classes more interesting. But the students graduated from the colleges may not have the basic skills the industry is looking for. Students need to keep constant learning, from elementary school to college; they need to learn rapidly.

Mr. Bilodeau also pointed out that the professional organizations always focus on standards, but the

standards in information technology change very fast, so it doesn't apply. The best place to provide the help is educational institutions. Some universities, like MIT, post the course videos online so that the public can access the materials and learn what they would like to learn about.

7. What are the initiatives that encourage employees to learn more?

(Some possibilities: financially, self-motivation, self-enhancement, job security, social status, networking, etc.)

Mr. Bilodeau said that for an employee to learn more, it almost always relies on self-motivation though there are a few other things that help encourage the employee to learn. One example at Microsoft is called accountability. Employees are encouraged to give frequent and immediate feedback to their coworkers. This lets the employee know what they need to work on. Microsoft is also challenging employees to learn new things. Managers sometimes give projects to employees that don't know how to complete them but have the ability to learn how to do so. It is then up to the employee to find ways to learn how to complete this project. Employees should also be aware of obsolescence. Knowing that becoming obsolete could result in no advancement in your career and even job loss would definitely help keep employees motivated to stay up to date.

A.4. Sivaprasad Padisetty

Interviewee: Sivaprasad Padisetty
Interviewer: Adam Driscoll, Han Li, Zhaochen "JJ" Liu
Interview Date: September 17, 2010
Interview Time: 2:00-3:00pm
Location: This is a phone interview.

Interviewee Background Information:

Mr. Padisetty is the director of SDE of Windows Manageability – Development team.

Interviewee Past Experience:

- Director of Development, Microsoft Corporation (Currently holding)
- Test Manager, Microsoft Corporation (Jan 2000 – Jan 2002)
- Engineer, Tata Motors, (Jul 1990 – Jun 1991)

1. What kind of knowledge needs to be updated regularly? About how fast do you think it needs to be updated? Is there anything that doesn't really change much?

Mr. Padisetty believed that the basic concepts and fundamentals stayed the same but the technologies change very fast. Major computing paradigms shifts that he saw were Mainframe to client server to Web to Service Oriented Architecture to Cloud computing. Roughly it takes about a decade or so to start seeing paradigm shift. However technologies to support paradigm shift evolves at a faster rate say about three years. When he said "technologies" he meant in a very broad sense; this included language evolutions, shifts from unmanaged code (c/c++) to managed code (like Java/C#) to dynamic languages (Javascript, PHP, Ruby). He also included specific libraries like (ODBC, ADO.NET, WCF, etc.). The language progression generally results in a reduction of actual code and an increase in functionality which in turn leads to an increase in productivity.

2. What has Microsoft been doing to keep the employees updated?
Is it required/recommended for all/some employees?

Mr. Padisetty mentioned that there were a diverse set of skills involved with working at Microsoft. Microsoft hired employees based on the raw potential, having good understanding of the software fundamental concepts. He said that they always believe and encourage learning new technologies that are required for specific jobs. Having the raw set of skills allows employees to move between teams, which creates the opportunity for the employees to learn new skills. To aide this process, there is a central site where every position is listed. Employees can contact their potential new managers and begin a conversation with them to see if the new position is a fit. If it is an interview is set up, it gives the employees the opportunity to change jobs within Microsoft to something they are currently more interested in. All the jobs are posted on a website, so that people can choose what they are interested in and contact the manager directly with the position that they are

interested in for an interview.

Mr. Padisetty said that Microsoft also hosts numerous presentations usually on developing technologies. Some of the presentations are non-technical like precision questions, how to have tough conversations etc. Most of these presentations are recorded and can be found, listed on the Microsoft internal site "mylearning". Everyone in Microsoft is allowed, and encouraged, to attend though it is not officially required by Microsoft. Employees are not forced to learn unless they are underperformed, and their managers will require them to learn the knowledge.

Mr. Padisetty also introduced that Microsoft has discussion distribution lists which can be compared to news groups. Each product had its internal discussion distribution list, like a group. People who are interested in this topic are there to discuss the product and post questions. A lot of people join this program, and Mr. Padisetty is also in several groups. Mr. Padisetty said that it was very useful. Employees joined groups based on their interests and can post questions, answers, and anything else related to the topic of the discussion distribution list that they are a part of. Most people joined multiple and diverse groups and not just groups that are related to their area of practice.

Funding for employees to attend conference is one more way to learn, said Mr. Padisetty. Yet another way of encouraging learning is by reimbursing the tuition fee if the employee attended a class in the local university.

Mr. Padisetty thought that certifications inside Microsoft mean nothing. Certificates prove the ability to use the product, but the skills required to develop the product are very different from using it.

3. When new concepts in software engineering come out, how do people know about these concepts such as cloud computing, agile developing? Do people know these concepts through conferences, products or other ways?

(Answer to this question is included in the second question.)

4. Are those methods effective? How effective?

Mr. Padisetty personally found that the online recordings that can be found on "mylearning" to be the most effective. He can download them and watch them while on the treadmill in the morning. He also found the discussion distribution lists to be very effective especially when he got stuck with specific deep technical problems. On the job learning is a great way to ramp up on new technology and products. The working culture at Microsoft strongly supports on-the-job training; this is where Microsoft employees get about 80% of their continuing learning, said Mr. Padisetty.

5. How about other companies you worked before?

Mr. Padisetty worked at Tata before, which is an auto manufacturer with about 20,000 employees. They had the rotation program, which was a two-year program for engineers, and all engineers had the opportunity to participate in various departments. These departments included automobile maintenance, research and development of new automobiles and in the assembly where automobiles were built. Each department was very different. For example in the automobile maintenance employees got their hands dirty to fix automobiles, on the other hand research and development was an air conditioned office primarily doing designs in computers. Engineers in this program were rotated every three months. They might do automotive maintenance and get their hands dirty. They had very little formal training or teaching, but they were assigned to a manager to guide them through their work.

6. What are the initiatives that encourage employees to learn more? *(Some possibilities: financially, self-motivation, self-enhancement, job security, social status, networking, etc.)*

Mr. Padisetty thought that building the culture to learn is important. Employees always have pressure to finish the daily work but they also should find opportunities to update their skills. The managers should also emphasize the importance in learning new stuff. Mr.

Padisetty always told his employees that if they do not learn, they will become irrelevant in three years. And if at any time the team is overly busy, it cripples innovation. So, if Mr. Padisetty wanted innovation, the starting point is to have realistic schedules. People who are self-driven tend to be more successful. He told the people in his team that they are the driver and the managers are just there to help them. They control their own destiny.

7. Is there any method that you think would be effective, yet is not taking place in Microsoft/Software Engineering?

Mr. Padisetty mentioned that when the company is big, it is impossible to come with a single initiative and would work for all. So the problem is how to come up with methodology that is effective. The good managers would be able to form a good team spirit and encourage the employees to work hard and drive self-improvement, but how about those managers who are not as good?

He said that Microsoft also has reviews twice a year. The first one of the year spends 20% of the time evaluating performance, and the rest 80% of time they talk about career development. The career development includes discussing the skill set gaps to get to next level and coming up with concrete development plan to address the gaps. The second one, which happened in August, primarily targets performance evaluation. In addition to different manager feedback, they incorporate peer feedback and manager feedback.

8. You are a director now, and you were a test manager before. From two perspectives, how do you think the obsolescence has changed?

Mr. Padisetty didn't think it has changed much, from a technical perspective. In Microsoft even the test disciple is expected to be equally technical and challenging. If an employee doesn't keep up with the technology, it is hard to succeed at Microsoft over the long run.

A.5. Interview V

Interviewee: Program manager of Microsoft
Interviewer: Adam Driscoll, Han Li, Zhaochen "JJ" Liu
Interview Date: September 17, 2010
Interview Time: 3:30-4:30pm
Location: Microsoft NERD Center 16th Floor Style Conference Room

Interviewee Background Information:

The interviewee has over 20 years of experience working in the software industry.

1. What kind of knowledge needs to be updated regularly? About how fast do you think it needs to be updated? Is there anything that hasn't really changed much?

The interviewee said that software engineering knowledge needs to be updated about every three years. As for what type of knowledge needs to be updated, it is more along the lines of ways to approach a specific problem rather than the core knowledge. Also, technology shifts results in developer shifts as they must learn and adapt to the new technology.

2. What has Microsoft been doing to keep the employees updated?

Is it required/recommended for all/some employees?

For example:

Conference | Pay in full + allowance?
Continuing Education | Cover full tuition?
Competition | What award?
Annual Review
University Cooperation

The interviewee said that Microsoft's main technique is to hire really smart people who may not necessarily have the knowledge they currently need, but will be able to learn it quickly on the job. Microsoft also granted incentives for good performance. Performance is evaluated through annual reviews in which the employees create commitments for the next year. If the employees reach these commitments then they have done a good job. If they go above and beyond, or set very high commitments and reach them, then they get rewarded, often with bonuses.

The interviewee introduced that another option Microsoft offers is training, though in his opinion this does not work too well. The training only worked if the employees need it and it can be applied to what they are doing at that time. For example, if a person is a Java developer but wants to take a course in C# he is allowed to do that. However, once he has completed the course, he goes back to programming in Java and uses nothing he just learned. The training would only work, and make sense, if he is making the move from developing in Java to C#.

Microsoft also encourages employees to take real

life problems and to try and work on those as that helps expand their knowledge because it is not something they would normally be working on, said the interviewee.

3. Are those methods effective? How effective?

(Answered above)

4. How about other companies you worked before?

The interviewee said that he has been working with Microsoft for a very long time so it was hard for him to remember exactly what the other companies did. From what he could remember it was not too different.

5. Is there any method that you think would be effective yet is not take place in Microsoft/Software Engineering?

The interviewee thought that side projects encouraged people to learn. Also, companies' acknowledge of learning innovative technology was also essential to employees.

The interviewee mentioned that employees should have two kinds of commitment at job, both personal and non-personal.

He said that there is a program in Redmond called "The Garage": the developers get together once per week to work on a project that they are interested in. They develop application outside their job description.

6. What are the initiatives that encourage employees to learn more?

(Some possibilities: financially, self-motivation, self-enhancement, job security, social status, networking, etc.)

The interviewee thought that financial factor is an important point here. He pointed out that people do their job well, partially because they want to get promotions and bonuses.

The interviewee agreed that self-motivation is also essential. Microsoft always hires smart people and they usually have ambitions to seek for better technologies.

But in all, he thought financial factors can incite self-motivation.

7. You are a manager now, and you were a software engineer before. From two perspectives, how do you think the obsolescence has changed?

The interviewee said that as people went in to higher positions, skills and technology are easily transferred. Managers need to know more about soft skills such as public speaking, overseeing people and managing projects. At managing level, managers need to break business problems down and make the organization run more efficiently. Good managers also ought to clear the obstacles for their employees. He concluded that, in general, business skills do not change as fast as technical skills.

A.6. JP Schwartz

Interviewee: JP Schwartz
Interviewer: Adam Driscoll, Han Li, Zhaochen "JJ" Liu
Interview Date: September 20, 2010
Interview Time: 1:00 – 2:00pm
Location: Microsoft NERD Center 16th Floor Control Conference Room

Interviewee Background Information:

Mr. Schwartz is currently the senior technical lead of server engineering for the TV Media group for Microsoft's Waltham site. He directly manages fourteen software engineers.

Interviewee Past Experience:

- Senior Technical Lead, Microsoft (Aug 2000 – Present)
- Systems Engineer, Sun Microsystems (Dec 1999 – Aug 2000)
- Systems Engineer, Forte Software (Sep 1997 – Aug 2000)
- Software Engineer, Stratus Computer (Jul 1988 – Jul 1997)

Interview Questions

1. You have been in software engineering field for more than twenty years now. What kind of knowledge needs to be updated regularly? About how fast do you think it needs to be updated? Is there anything that doesn't really change much?

Mr. Schwartz said that he was not sure if he completely agreed with the premise. He said that it is true that technologies changed, but the fundamentals of computer science do not. They are established in the 1960s and still used by people now. The essence of building efficient, scalable systems has not changed in decades. Thread management, data structure locking, network usage etc. issues have not changed. The technologies used to "describe/define" these systems have evolved. He mentioned that even the concepts of object-oriented programming are note really new. Back in the mid-80s, he would argue that they were being taught object-oriented programming using C. Also sometimes using more advanced tools doesn't help. People have to understand the basis.

2. What has Microsoft been doing to keep the employees updated?

Is it required/recommended for all/some employees?

For example,

Conference | Pay in full + allowance?
Continuing Education | Cover full tuition?
Competition | What award?
Annual Review
University Cooperation

Mr. Schwartz mentioned that he worked at a start-up before, and they used Java. When they were acquired by Microsoft, they were thin on Microsoft's technology. The company didn't do anything specific but provided a lot of help and support. They didn't provide strict plans for employees. The online courses were provided in Redmond, and had different levels. They had the introduction courses, which was about two to three hours and there

were follow-up courses with homework on it. Microsoft allows employees to pursue their own interests. Employees must provide a series of commitments, including professional commitments, and then they share their goals with others. And they have on-going discussions with what is going on with the professional and personal development goals of the employees. Employees have a lot of freedom in deciding what they are doing. Mr. Schwartz said that employees come up with the commitment on their own, and then they discuss with their manager about their plan.

3. Are those methods effective? How effective?

Mr. Schwartz thought that the most effective one is that not having a particular requirement and let people take the directions in what they would like to do for themselves.

4. You mentioned that you worked at a start-up before you joined Microsoft. What is the difference in terms of companies' actions on professional development? Is it related to the size or culture of the companies?

Mr. Schwartz said for the start-ups, it was all up to the employees what they would like to learn. There were no set courses or materials. For example, they chose what languages they used, what direction the development should go. It was totally up to the developers to decide what they would like to learn. The decision on the direction of where technology grew was based on what people had done in the past or what other people were talking about.

5. Is there any method that you think would be effective yet is not take place in Microsoft/Software Engineering?

Mr. Schwartz said there was not really any. He mentioned that there is always some natural discussion on technology, to learn what they needed to do on a daily basis. People can learn and understand the current

industry standards through these discussions.

6. Do you think it would be better if the courses and trainings are required for the employees so that they can have a better understanding of the technology?

Mr. Schwartz said that he didn't think so. Even though now it was voluntary, he didn't feel anyone was dropped behind, at least in his team.

7. What are the initiatives that encourage employees to learn more?

(Some possibilities: financially, self-motivation, self-enhancement, job security, social status, networking, etc.)

Mr. Schwartz thought that engineers have a natural desire in knowing what other people are doing. They, as engineers, have a natural desire to learn technologies. And, from a career perspective, Mr. Schwartz thought it is always good to keep up to date with the latest technologies. He didn't think monetary awards or promotions would help that much.

8. You are a manager now, and you were a software engineer before. From these two perspectives, how do you think the obsolescence has changed?

Mr. Schwartz was a technical lead, so he dealt with the development of systems. As such, there is not a significant difference between managers and employees with respect to technology use. The basic design of a system can be done without consideration of the technology used to develop it, so obsolescence does not really come into play there. When taking the design to the level of implementation technology, he mentioned that they are back to the same basic question of how often the means to express a system changed. And also some public speaking, communication, interpersonal skills do not change either.

9. What do you think the professional organizations, like ACM, IEEE, can do to help the software engineers?

Mr. Schwartz said the standards differ among professions, but software engineers stay outside of that structure. The certificates indicate understanding of some specific knowledge. He mentioned that some companies are interested in this, but some are not.

A.7. Judith Grindeland

Interviewee: Judith Grindeland
Interviewer: Adam Driscoll, Han Li, Zhaochen "JJ" Liu
Interview Date: September 22, 2010
Interview Time: 7:30 – 8:00pm
Location: Microsoft NERD Center 16th Floor Style Conference Room

Interviewee Background Information:

Ms. Grindeland is currently a nurse in the procedure unit of Children's Hospital at Boston.

Interviewee Past Experience:

Ms. Grindeland has been working as a nurse for fifteen years. She worked at the ER for a hospital in Framingham for twelve years, and then in the clinic of Children's Hospital for two years before she joined the Gastroenterology department of procedure unit.

Interview Questions

1. We assume that you have been in nursing industry for more than twenty years now. What kind of knowledge do you think in the nursing industry needs to be updated regularly? About how fast do you think it needs to be updated? Is there anything that doesn't really change much?

Ms. Grindeland felt that the basic nursing skills didn't change, such as the care giving to the patients, the way to assess people by checking on the skin color and skin temperature, the clinical skills. But the technology, the equipment and the tools were changing, so the nurses needed to keep learning.

2. We know that you are working at Children's Hospital now. What has the hospital been doing to keep the employees, at least the doctors and nurse updated? Is it required or recommended for all/some employees?

For example,

Conference | Pay in full + allowance?
Continuing Education | Cover full tuition?
Competition | What award?
Annual Review
University Cooperation
Long distance surgery video

When the hospital brought in new equipment, the companies who made the equipment would hold classes to teach everyone how to use the equipment. And it was a lot better if we can learn by doing. After the training, there was no assessment to test the training result. It was up to you to ask other people if you have questions or things that were not clarified. It was important to learn from co-workers. For example, when Ms. Grindeland came to the new job, there were different monitors in this hospital than the hospital that she worked at before, so she just asked other nurses what she should do with this equipment.

The hospital offered refresher classes periodically for the basic nursing knowledge. The education department came in to teach and provided classes. There was also a

computer-based learning system. The hospital-wide learning happened when a problem came up, and the net learning system was required for everyone to finish in order to understand the problem and to prevent it from happening again. For the net learning classes, everyone had to learn the presentations and pass a test at the end. The managers had access to their employees' net learning account. This was also related with the salary.

Another thing is MYR, which was My Yearly Report, which includes all safety-related topics. The content of MYR did not change at least for the past three years when Ms. Grindeland was here in this hospital, but the net learning stuff was changing all the time.

For annual reviews, nurses and managers mostly talked about licenses, TB tests that they had to take 30 days before the review, the MYRs they had to take, which Ms. Grindeland thought was 14 of them in total, and the other net learning classes.

For long distance surgery videos, it happened for surgeries within the hospital or outside of the hospital. The surgery was not only shown to the doctors, but the nurses as well to let everyone have an understanding of some important topics and methods.

The hospital supported continuing education in degree pursuing as well. They provided tuition reimbursement for both doctors and nurses who would like to pursue a higher degree. And hospital provided money for certificate exams as well, but for Ms. Grindeland's job, certifications did not mean recognitions or a raise, only to look good on her resume.

The nurses were supported to go to conference all the time, and this could help them earn CEUs. Both doctors and nurses needed CEUs to renew their license. The hospital encouraged people to go to the conferences and bring back what they had learnt there. In the conference, they often talked about the innovative things. There were speeches, presentations, lectures, and group discussions.

3. Are those methods effective? How effective?

Ms. Grindeland had to keep up-to-date and these programs helped her to do that. Hands-on experience was one of the best methods to learn. Also, nothing topped

having an experienced nurse with you showing you what to do and then coaching you through it. The experienced nurses had a lot of knowledge and this gave you a chance to be a part of that knowledge. The net learning system was built on top of the mentoring program. The net learning system is good because it keeps coming out, and makes people always thinking about new things. It's not too hard either. Ms. Grindeland felt that there was nothing that's especially good, but everything together definitely helped.

4. Did you work at other hospitals or institution before you work at Children's Hospital? What is the difference in terms of companies' actions on professional development? Is it related to the size or culture of the hospitals?

Ms. Grindeland had been in the Gastroenterology department for about a year now. Before that Ms. Grindeland worked in the clinic for about 2 years (same hospital). Before that she worked in the ER in Framingham for about 12 years. There was definitely a difference in the programs provided because Children's was a teaching school, not to mention much bigger, they had access to a lot more resources than they did in Framingham. In Framingham, all they could really offer were the basic courses like CPR due to their limited resources. The hospital education department was also much smaller. However, managers did hire educational staff to help out. The difference was that they were also nurses, who worked part time, to educate the other nurses in their department on important topics. It was related with the managers' assessment for their performance in some community hospitals.

5. Is there any method that you think would be effective yet is not take place in the industry yet?

There was no blanket statement that really covers this question. Ms. Grindeland thought it was dependent upon the individual as to whether or not there are better methods for them to learn. In the end the more motivated

the person was, the more likely they were to do better. And maybe the honesty in issuing the certificates also helped.

6. Do you think it would be better if the courses and trainings are required for the employees so that they can have a better understanding of the technology?

Usually, nurses just sign some papers, saying that they have already done the training or hours of continuing education units. Then, they can get their certification renewed. In most cases, no one will check if the nurses have really done their annual training because it will be a huge amount of resources to check all of them. In reality, only few people are selected and checked.

Most of people around Ms. Grindeland really do the training every year. This really depends on individual's honesty. Usually, nurses are dedicated to save people live.

7. What are the initiatives that encourage the employees in you hospital to learn more?

(Some possibilities: financially, self-motivation, self-enhancement, job security, social status, networking, etc.)

Managers usually want to their department develop regularly because hospital always want to attract more patients. Keeping each department up-to-date is definitely essential to each department. Managers usually will encourage each nurse to learn more about newer equipment and skill sets.

Also, having more skills set looks well on resume. You can feel the prestige if you have more skills and knowledge.

No need to mention, some people are self-motivated so that they want to learn more. But there are also some nurses who just want to keep their job but not interested in learning more.

8. Are there any professional organizations for nurses and doctors? If so, what do you think these professional organizations can do or have been doing to help the nurses and doctors?

There are some organizations: for example, American Nurse Association, Massachusetts Nurse Association and National Association of Pediatric Nurse Practitioners. There hold conferences annually. However, most of them charge a lot for the membership and going to the conference. Ms. Grindeland felt that they are not worth it. Ms. Grindeland was not in any of the association. Some of people Ms. Grindeland knew had them.

9. How do you think the certifications and licenses have been helping the industry? Do you think they have effective improvement on professional performance?

Certification and licenses are fine. As long as people are honest and really perform the annual learning, they are helpful. For some nurses and doctors, certifications are required.

A.8. Interview VIII

Interviewee: President of a medical education company
Interviewer: Adam Driscoll, Han Li, Zhaochen "JJ" Liu
Interview Date: September 23, 2010
Interview Time: 2:15 – 2:45pm
Location: Microsoft NERD Center 16th Floor Style Conference Room

Interviewee Background Information:

The interviewee has rich experience in continuing education of the medical industry.

1. ***How to you evaluate the importance of continuing education in medical area? Do you think professional obsolescence exists in medical industry?***

The interviewee felt that medical is unique in how to keeping people up to date. The instruments get outdated, but he was more concerned of software security industry. The need is really keen. The continuing education for doctors is required by each state. Different state has different requirements on the hours for training, and some states even have more specific requirement for the hours spent on different subject or area of the training. This CME system helps people to catch the pace of change and remain up to date with the development.

2. ***How do they check the hours of the training that each doctor took? Do the doctors just fill out a form with the hours or is there a system to check the fact?***

The interviewee said that there are regular standards to govern the completion of the requirements. There is an organization called ACCME which created the guidelines. They identify the formats for the training, make sure that the education is delivered, and evaluate the impact of the education's knowledge, confidence and performance. The knowledge refers to the fact, the confidence refers to the application, and the performance refers to putting the action in reality.

3. ***You mentioned that "doctors have lost confidence in [continuing medical education] and the public has lost confidence". Why do you think that happened?***

The interviewee felt that it doesn't mean that they are not in need in continuing education. The need needs to be independence in learning. Now some content are a company's product-related if the training is sponsored by this company. The continuing education should take on a broader range of knowledge. Perhaps this may happen in software engineering industry as well. A big company may take lead in the content of the continuing education or

training for software engineers, and make them to learn their product.

4. ***The article also mentioned that a doctor said "commercial support created an unacceptable conflict". Where do you think the conflict lies in?***

The interviewee thought that this is related with the companies' involvement in the continuing education. ACCME posts steps in place so that education is as free from biased as possible.

5. ***What make courses provided by your institute from courses offered by other organizations/companies? What distinguish your courses?***

The interviewee felt that his institute provided classes that are uniquely targeted towards specialists and generalists.

6. ***What other things are done besides training in order to help people stay up-to-date in this industry?***

The interviewee felt that it is also important for the medical professionals to learn by simulating.

A.9. Brian Moriarty

Interviewee: Brian Moriarty
Interviewer: Adam Driscoll, Han Li, Zhaochen "JJ" Liu
Interview Date: September 23, 2010
Interview Time: 3:15 – 4:00pm
Location: Microsoft NERD Center 16th Floor Style Conference Room

Interviewee Background Information:

Brian Moriarty is current a professor of practice in Interactive Media & Game Development department in Worcester Polytechnic Institute.

Interviewee Past Experience:

- Editor, Analog Computing Magazine
- Game Developer, Infocom
- Game Developer, Lucas Arts, made famous game "Loom"
- Senior Producer, ImaginEngine

In July 2009, Brian Moriarty was appointed Professor of Practice in Game Design in the Interactive Media and Game Development program at Worcester Polytechnic Institute, thus returning to the city where his career began. He is currently completing an MEd in English at Framingham State.

Interview Questions

1. You have been involved in game industry for nearly 30 years now. Game industry is very fast-paced. As a game developer, he/she must update his/her knowledge and skill sets to keep up the pace. What knowledge and skill sets need to be updated regularly? What kind of knowledge did not change much?

The interviewee said what's changing is the software development kits and the platforms. Many platforms are changing and there are many tools available nowadays.

The interviewee also thought that the thing that doesn't change that much is the language. He is still using C++. Even though there are some new dialects, like Objective C and some newer scripting languages. Oh and Microsoft Word doesn't change that much either.

2. There are different roles in Game Industry, such as programmer, artist, designer and producer. Do they require different skill sets? Are they all fast-paced?

The professor felt that the artists need to keep up with the new tools, such as from 3D Studio to Maya, and then to Z-brush. Things are constantly changing.

The interviewee argued that the web developers need to know the web technology knowledge, such as the new versions of flash.

The professor said that the designers need to play all the major new games to learn what is going on in the new games. Everyone should know the independent games. As a professor he needs to know those too so that he can talk about this in class.

The interviewee suggested that the producers need to know the tools. The administration tool and the management tools are changing fast, but not as bad as others.

3. You worked for several companies. What have the companies (for example, Infocom, Lucasfilm and ImaginEngine) you've worked for done to keep the employees updated? Is it required/recommended for

all/some employees?

How to support?

Conference | Pay in full + allowance?

Continuing Education | Cover full tuition?

Competition | What award?

Annual Review

University Cooperation

Licensing, Certificates

The professor said a lot of companies subscribe to major game magazines and put the latest version in the lounge so that people can read and update themselves.

He said that the major sites can also help to keep people updated. Developers should read these sites every day and know what's going on in the business.

The interviewee felt that for the engineers, the companies often send them to conferences. Or there are console manufacturers teaching how to use their consoles. There are also other middleware companies teach tutorials. Conferences are extremely helpful, the important source of information. Brian Moriarty suggested that it's also possible that people get a new job on the conferences so that some companies decide not to send their employees. Smart engineers will keep this to themselves rather than depending on the companies to do this for them.

Brian Moriarty said networking events help too. It's good to know what people are talking about and what people are doing at this time.

The interviewee felt that the annual review is not very technical, but it's a way to know if the employees are up-to-date. It's easier to get the contracts if employees know the skill sets that they are looking for.

The interviewee felt that there are a lot of game festivals, art competitions, etc. the landscape keeps changing. This helps the people who participate to stay current. Sometimes there are technical speeches, and vendors even pay to get a table in the competitions.

The interviewee said that, some companies, actually most of the large companies, support continuing education, and they support pursuing a job-related higher degree as well. If the employees only want to attend one class, they pay for the class as well.

The professor said that for engineering area, in order

to get certain job, engineers have to get certain certifications. So some companies send their employees to be trained for the certifications. But Brian Moriarty did not think there's anything specifically for gaming industry. For the artists, companies mainly hire them based on their portfolios.

4. Are those methods effective? How effective?

The professor said that all those methods are important, such as going to conferences, building up the network, and reading magazine. He thought it's most important to check the websites daily and read magazines. Gamasutra.com is a website that every game developer should go to. It's important to have the daily interest, and know what's going on in the industry and what new games are coming out. The companies should encourage the employees to do so.

5. There are some independent developers and animators out there. How do they keep themselves updated?

Brian Moriarty said that they have the same responsibilities. They should go to conferences, but some conferences are expensive, but it's worth it and they can meet people there and stay connected. It's really important to sit down with someone and have a drink. It's all about meeting people. It's more important for them to update themselves.

6. The development kit and animation software are having newer versions regularly. How important it is for developers to use the relatively new version of the software? Do they usually just learn by themselves?

The professor maintained that during a project it's not good to switch versions because some tools are designed specifically for one version, and if things change it may break. But between projects definitely it's good to move to the newer versions. It's always good to stay with the newest version of the software.

Brian Moriarty thought that it is true with hardware as well. It's a transfer of time and money. The game companies update their hardware mostly once a year, or at least at the rate that makes sense. They always update the hardware to the most updated version available in the market.

7. How about WPI? What kind of things does WPI do to keep professors updated?

WPI expects professors to keep updated, especially for professor of practice, like Professor Moriarty. WPI sends Professor Moriarty to go to conference, and evaluates him on those things. He is going to speak on a panel in Boston. He also works on developing games, real games, at the same time too.

8. What are the initiatives that encourage employees to learn more?

(Some possibilities: financially, self-motivation, self-enhancement, job security, social status, networking, etc.)

Professor Moriarty said that smart companies offer to send people to conferences and they keep investing in their employees. For those bad companies that don't do these, they lose their employees. Besides self-motivation, Professor Moriarty thought it's because that this is part of the yearly review. People change jobs constantly. Professor Moriarty said that it was necessary to let one's new employers know how updated one is. One's self-interest can make you more marketable.

9. Is there any method that you think would be effective yet is not taking place in game companies? Or, can you think of something that would be useful for software engineering companies and their employees?

Professor Moriarty thought that professional organizations can help people stay in current, like ACM and IEEE. It would be nice if there are specific

organizations for designers, artists, producers, etc. they can offer conferences, local meet-ups, and network events. But currently there’s no central game organization.

10. Does the size of the companies have anything to do with the approaches companies use? What difference?

The interviewee argued that small companies don’t send employees to conferences that much, mostly because they can’t afford it. But most big companies can. Small companies do whatever they can afford, maybe some short conferences, and offering magazines. And sometimes they only pick one guy to go and let that person bring back the knowledge from the conference.

A.10. Thomas Starr

Interviewee: Thomas Starr
Interviewer: Adam Driscoll, Han Li, Zhaochen "JJ" Liu
Interview Date: September 27, 2010
Interview Time: 2:00 – 3:00pm
Location: Microsoft NERD Center 16th floor Trouble conference room

Interviewee Background Information:

Professor Starr has been an adjunct professor for WPI chemical engineering department since 1983. His study focuses on chemical process systems analysis, plant and equipment design, and project management.

Interviewee Past Experience:

- Exxon Company USA; 1969-1973
- Artisan Industries; 1973-1976
- Koch Process Systems; 1976-1999
- Helix Technology; 1999-2001
- Babcock Power Environmental; 2001-

Interview Questions

1. What kind of knowledge in chemical engineering area needs to be updated regularly? About how fast do you think it needs to be updated? Is there anything that hasn't really changed much?

Professor Starr said that chemical engineers focus on different sub-areas. There are different sub-technologies in chemical engineering and the sciences, and you don't really have time or the capacity to care about the general knowledge of the industry. Computer software and hardware are changing quickly, but the basic technologies don't change fast. The basic concepts of chemical engineering have been there for many years, and maybe only have some small improvements. For example Professor Starr was working in the energy discipline. One of the key topics was mercury control. Things there were happening fairly quickly. Also in power generation, CO_2 removal was a big thing. But since it's expensive and not very widely applied yet, things were happening less quickly there.

2. Are there any certifications that are required for chemical engineering industry?

Professor Starr said that he had always encouraged my students to get the professional engineers (PE) license if they had the opportunity to do so. Most companies don't require the PE license, but if you are doing work for someone else, PE gives you qualifications that not everyone has, and put you in a slightly different category.

He said that he personally didn't have certificates or licenses. Professor Starr said that they are worthwhile and they are something that one can put on your resume. Companies sometimes also pay partially for the license fee.

Professor Starr said that he didn't know of any certifications that are specifically for chemical engineers. There are some other certificates besides PE, such as project management certification. But licenses definitely have their value.

3. What have the companies you've worked for done to keep the employees updated? Is it required/recommended for all/some employees?

For example,

Conference | Pay in full + allowance?
Continuing Education | Cover full tuition?
Competition | What award?
Annual Review
University Cooperation
Licensing, Certificates

The companies that he worked for don't have that much training on general knowledge. There are some programs, such as "Lunch and Learn", that people put on presentations and talk about the technology and what's happening in the industry.

Professor Starr said that it's up to the employees to read the magazines, and nowadays there are some e-magazines as well. Various companies encourage this to different degrees.

AIChE holds a lot of conferences. Companies generally pay for conferences in full and pay the membership fee for AIChE. Since attending conferences is expensive and employees need to leave work, it needs to be justified about the knowledge that they can bring back. But even small companies have budgets set aside for these types of activities.

Regarding university co-operation, there are some but to find the overlapping interests between companies and research professors are rare. It's unusual to have a close match, geographically also. Research is very specific and companies are interested in results that can benefit the product rather than scholarly research.

Professor Starr argued that in annual reviews, it's good to have the training and everything planned. One can bring up the events that you would like to attend. It's related to the company's budget.

He also maintained that besides paying for the certificates fee, the companies also pay for advanced degree tuition as well. These things benefit the company because they want the employees to be specifically trained, but they will benefit the employees most.

4. Are those methods effective? How effective?

Professor Starr thought it's important to be aware of what's going on, stay on top of the news, engineering magazines. It's good for both picking up specific knowledge and for getting the best overview. If people would like to have some concentrated learning, then conferences would be a better choice because conferences have the most up-to-date, brand-new information on specific topics.

5. How about WPI? What kind of thins does WPI do to keep professors updated?

Professor Starr said that there are some graduate students' papers and news about what's going on, but these are very specific. If you are focused in that area, then it would be very useful; otherwise it's still good to be aware that things are going on. It's fairly important to know what's new in the industry.

6. What are the initiatives that encourage people, or employees in the companies that you worked for before, to learn more?

(Some possibilities: financially, self-motivation, self-enhancement, job security, social status, networking, etc.)

Professor Starr especially argued that it's all about self-motivation, and self-satisfaction. A lot of things are interesting. As long as the interest is there, then you do take time to do it. For example, WPI's "Transformations" Magazine is a journal that's sent out to WPI engineering alumni. It includes some in-depth articles about the significant things that are happening on campus. The professor thought that it has to be personally interesting, however, for you to read the articles and know about what's going on.

7. Are there any professional organizations for chemical engineers? I know there is one called AIChE. How do you think the organizations have been helping the engineers?

Professor Starr said that it mainly helps technical education and learning the news. If you participate in these organizations, it serves for personal satisfaction as well. The major benefits include networking, awareness of the names and who's doing what, and the opportunities to be with engineers in your profession with similar interests. It's also a chance to find out the hiring opportunities.

8. Is there any method that you think would be effective yet is not take place in chemical engineering companies with respect to keep people updated?

Professor Starr thought the methods do change, and it will be good if we can have more extensive use of new services. The technology is there.

A.11. Creath Carter

Interviewee: Creath Carter
Interviewer: Adam Driscoll, Han Li, Zhaochen "JJ" Liu
Interview Date: September 27, 2010
Interview Time:4:00 – 4:45pm
Location: Microsoft NERD Center 16th Floor Trouble Conference Room

Interviewee Background Information:
Turbine Entertainment - Sept 2008 - Present
World Builder/Environment Artist ***Lord of the Rings Online***
(Lotro) *(PC)*

Interviewee Past Experience:
InXile Entertainment Apr 2006 - Sept 2007
Environment Artist/Environment Designer *Heist*
Electronic Arts Apr 2005 – Dec2005
3D Artist ***Godfather***
Vidiator Technology Feb 2005 – Apr 2005
Creative Artist
Atomic Blue 2004 – 2005
2D/3D Artist ***PlaneShift***
Enemy Technology 2002 – 2003
2D/3D Artist & Environment Designer ***I of the Enemy***
Sony Electronics 2000 – 2002
Creative Engineer ***CLIE Handheld Project***

Interview Questions

1. You have been involved in game industry for nearly 10 years now. Game industry is very fast-paced. As a game developer, he/she must update his/her knowledge and skill sets to keep up the pace. What knowledge and skill sets need to be updated regularly? What kind of knowledge did not change much? There are different roles in Game Industry, such as programmer, artist, designer and producer. Do they require different skill sets? Are they all fast-paced?

Mr. Carter said that game development has three major disciplines: artists, designers and engineers.

Mr. Carter said that artists' knowledge is needed to be updated the most, almost yearly. Both the technical and art environment can change pretty regularly. For the designers, there is not a lot of change to the approach because they are a theory-based discipline that's a bit more tech-agnostic. Engineers must keep up with changes from hardware and API's. Approximately every 3-5 years, new console will come out and we need to work on games that are on those consoles.

He also suggested that two things are changing constantly in the game industry: hardware and software. Hardware, such as graphic card and console, is improving very fast. As developers, you need to know their capabilities and limitations. New versions of software are releasing regularly as well.

3. You worked for several companies. What have the companies (for example Turbine, InXile and EA) you've worked for done to keep the employees updated? Is it required/recommended for all/some employees?

How to support?

- Conference | Pay in full + allowance?
- Continuing Education | Cover full tuition?
- Competition | What award?
- Annual Review
- University Cooperation
- Licensing, Certificates

Community group:

He thought that artists usually do not get too much support from companies. So the effort is usually community-driven under the pressure of personal obsolescence. There are a lot of community groups that people can choose to go to. One of the examples is Game Developer Conference (GDC). They hold their conferences several times a year in San Francisco, Texas and Europe. For the Boston Area specifically there are also Boston Indie Group and Boston Post Mortem. International Game Developers Association has chapters all over the world such as Los Angeles, Europe and Asia. Some developers will pick something that they are interested in or are working on to talk about in these conferences. Attendees also will get exposed to the latest and most advanced technologies and games.

Magazines:

Mr. Carter suggested that there are periodicals, monthly or bi-monthly, and magazines for game developers. There are some featured articles and tutorials about the most innovative technologies. However, for the companies he worked for, they offered little official support for subscribing the magazines. Mr. Carter also noted that the most influential periodical, Game Developer Magazine, is made free to all professional members of the industry.

Online forum:

Mr. Carter felt that online forums are usually good places to go to for employees. For artists, you can go there to appreciate others' work just to gain some inspiration, find some new ideas and learn some new techniques.

Continuing education:

Mr. Carter said that continuing education depends on the companies. But it does not usually happen. It is more budget-friendly to hire people who just graduated because new graduates who just finished their education would have the latest technologies. In this way, new employees and former employees can exchange information and skills and help each other. Everything he has described about employee knowledge retention really *is* largely motivated by personal or community interest and

fear of obsolescence, while the closest thing to an official, industry-supported "plan" is to lay-off more experienced, and higher paid employees, and hire a cheaper, more up-to-date labor force every few years.

4. Are those methods effective? How effective

Mr. Carter said that attending conferences is the most effective. You can learn information outside of formal school education. Most of the stuff you can see in a conference or convention is new technology and ideas. Other approaches are not as useful as going to conferences.

5. What are the initiatives that encourage employees to learn more?

(Some possibilities: financially, self-motivation, self-enhancement, job security, social status, networking, etc.)

Mr. Carter also argued that personal interest and self-motivation are huge. Games have always had roots in the hobbyist/DIY spaces, so many people stay on top of changing technologies and techniques purely driven by interest and enthusiasm for the medium. Self-motivation, the desire of knowing more knowledge, technologies and skill sets, is very important.

Mr. Carter felt that job security is also one of the initiatives. People need to have the enough knowledge to get the job done.

6. You mentioned that companies right now generally do not have formal approaches to help their employees to fight against obsolescence. Do you think it will be better if they companies do things such as support people to go to conferences and giving them more resources?

Mr. Carter has worked for several game companies up to now, and only one or two companies treated professional development seriously. On the other hand,

most other companies thought that if something was not creating profit immediately, it was not worth doing it.

Mr. Carter was disappointed that the industry is still finding its footing. It is really immature. Every few years he makes that statement, and every time he wonders how many more years it will continue to hold true. Mr. Carter asserted that if more companies would take more serious in helping employees keep themselves updated, it would have benefited everybody.

A.12. Interview XII

Interviewee: A senior manager from Google
Interviewer: Adam Driscoll, Han Li, Zhaochen "JJ" Liu
Interview Date: September 28, 2010
Interview Time: 4:30pm – 5:30pm
Location: Microsoft NERD Center 16th floor Trouble Conference Room

Interviewee Background Information:

He is a senior manager from Google.

Interview Questions

1. You have been in software engineering field for about fifteen years now. What kind of knowledge needs to be updated regularly? About how fast do you think it needs to be updated? Is there anything that doesn't really change much?

He said that the development platforms changed. Also the development languages changed. For example, Basic was changed to Java, C evolved to C++. Long time ago in AltaVista, no one worked for the Internet. But now, most of the services and products are internet-oriented.

While building the search engine for eBay, he and his team need to enhance the performance of the search by adding new features and changing new indexes. The data structure must be changed in order to work together with the new search engine.

2. What has Google been doing to keep the employees updated?

Is it required/recommended for all/some employees?

For example,

Conference | Pay in full + allowance?
Continuing Education | Cover full tuition?
Competition | What award?
Annual Review
University Cooperation

Internal training

He said that there are tons of training and courses that employees can take online or in a classroom. Every Google's new employee must attend Noogler training, which covers the history of Google, the working environment and a broad overview. He was in one of the Python classes and the class was extremely useful. The teacher was a professor from Stanford University. In addition, he felt that most of the classes he took were very helpful.

Tech Talks

He said that Tech Talks are meetings and presentations that usually happen three times every day. People from both Google and outside Google can come to give a talk and presentation that they find interesting. These people can be neighbors, authors of books, entrepreneurs or employees' friends. There is a website for these Tech Talks so employees can find out what Tech Talks will be held. Most of the Tech Talks will be video-recorded so that employees can watch a few whenever they have time.

Vote on Projects, Change Projects

He suggested that in Google, every few years, maybe around three years, engineers are supposed to move to different roles. People can vote on the projects they want to participate for the next few years. He also said that the internal job posting is also available for employees who wish to rotate jobs.

Conference

He indicated that Google encourages and sponsors employees to go to conferences. Google provides large budget for this. Actually, it is required for each employee to attend conferences for at least one time a year. Employee is free to pick any conference or convention that is related to his/her job.

Continuing Education

He said that Google supports employees to go for continuing education and Google will cover partial to full tuition. Usually, employees do this in their part-time.

Interesting Environments

He maintained that Google provides very good working environment for their employees. For example, massage is the one that he likes the most. For people who live in San Francisco, Google provides shuttle services and they can come in earlier to have breakfast. All the shuttles are equipped with Wi-Fi so employees can even work on the buses. Google is trying to offer a pleasant, comfortable, relaxing work space to help their employees balance their life at work.

3. Are those methods effective? How effective?

He thought that it varied by individuals and it was engineers' personal choice.

4. How do think of Google's 20% time policy? How do most employees think about it?

He explained that it can be spent by organizing the Tech Talk, managing the HR offerings, or even help the Noogler training. Not everyone can have the 20% time to work on their interested side project. If the employees are not performing well in their jobs, then they will not be allowed to have the 20% time. Also, if the employees are working on something that's critical to the company, they may not have the 20% time either; under this situation, some employees may not want to have the 20% time either. Employees can get the permissions from their manager in order to be allowed to work on the 20% time project, but employees generally get this permission. He argued that for certain people this program has been extremely helpful.

5. Is there any method that you think would be effective yet is not take place either in Google or in the entire Software Engineering profession?

He thought it is the freedom given to people to explore; this is the core philosophy. There should be a reason to attract people to use the new technology.

6. What are the initiatives that encourage employees to learn more?

(Some possibilities: financially, self-motivation, self-enhancement, job security, social status, networking, etc.)

He explained that Google tried to hire people who crave for learning, so that they can keep learning. They enjoy what they do, having the curiosity and yearning for

learning more.

7. As a manager at Google, do you require your team/employees to do anything specific in order to stay up-to-date? How have they been reacting regarding to technology development?

He worked at the operations department so it's slightly different from the development department. He would encourage them to take some classes, but does not really require that.

8. You are a manager now, and you were a software engineer before. From two perspectives, how do you think the obsolescence has changed?

He said that at Google, engineering managers and directors are very technical. For example, as a director, he still writes code. He felt that keeping up-to-date is very important. Managers need to make decisions based on the new technologies, so they need to stay cutting-edge and find out what's going on in the industry.

A.13. Linda Kelleher

Interviewee: Linda Kelleher
Interviewer: Adam Driscoll, Han Li, Zhaochen "JJ" Liu
Interview Date: September 24, 2010
Interview Time: 9:45 – 10:30am
Location: Microsoft NERD Center 16th Floor Style Conference Room

Interviewee Background Information:

Linda Kelleher currently manages Education Services for Global Service department in EMC Corporation. She doesn't support SW engineering, but she's a highly regarded professional who works the same issues that you're asking about: how do you keep new technology from distancing itself from your current workers, how do you keep them current with what's new.

Interviewee Past Experience:

Education Services, Prime Computer (16 years)

Interview Questions

1. George introduced you as the manager of the Education Services. We are not too sure what specifically your job is. Would you please explain that?

In the 80s, Linda Kelleher worked for a company and she did Educational Services for about 15 years. Then, she came to EMC and she has been in EMC for 15 years. In EMC, Linda Kelleher and her colleagues do training for engineering, sales, post-installation, remote support and customer services. They work with engineers to learn the products both inside and outside the company in order to understand what knowledge need to be taught. They also design the courses according to the need and teach the courses.

2. What kind of knowledge do the employees need to keep updated? What knowledge or skill sets tend to obsolete fast? What knowledge does not change?

The products change regularly. Newer products, both EMC products and products from other companies, come out and new features have been added to these products. So the knowledge and skill sets of new products are changing constantly. EMC's courseware is update at least 3 times per year.

Some soft skills do not change much. For engineers, some basic skills such as how to do things don't change much. For software engineers, the type of code does change but the way to write code does not change much. EMC is a storage company so the basic understanding of what storage is doesn't change. For customer services and sales people, the phone manner and the sales skills do not change much.

3. What have you/EMC done to keep the employees updated? Is it required/recommended for all/some employees?

Linda Kelleher said that EMC sends people to conferences. EMC has partnership with Microsoft, Oracle and Cisco, and they all hold conferences often. Managers

hold meetings to decide some key employees to attend these conferences and bring back some valuable information. Also, it is a share effort between managers and employees to decide who best fit these conferences and who should attend. For example, in Atlanta, there is a Microsoft team in EMC, the team can go to Microsoft's conference to learn more about Microsoft's products.

Linda Kelleher also maintained that Quarterly training is another way. Usually in this training, EMC employees and managers will go over what the industry is doing and what we can learn from them. Some groups even have mandatory group quarterly training.

According to Linda Kelleher, continuing education happens a lot as well. EMC always encourage employees to go for higher degrees and some credited courses. EMC will offer tuition reimbursement for them. For the most of time, the employees came up the courses they want to take and the courses are usually job-related. EMC worked with Northeastern University in the past and encouraged Northeastern to bring training to EMC.

Linda Kelleher argued that in EMC, there is something called Individual Development Plan. Annually, employees need to sit down with their managers to talk about what have they accomplished in the past year, what are their goals for the incoming year and what training are needed. Throughout the year, the development plan is updated and revised. Every employee's IDP is a formal process and it is documented in the system. It does not have negative impact if one did not finish his IDP.

Ms. Kelleher mentioned a program called "Management by Objective": managers and employees sit together to talk about a priority goal and a "stretch goal" for employees. The "stretch goal" has to be a development goal that is beyond your skills so that it can help you personally to develop some skills. For example, these goals include reading a book, attending a class or teaching a class.

Ms. Kelleher suggested that at executive level, managers would discuss and decide how many people should

take certificates exam. Then, the managers will talk to the employees and encourage them to take these exams.

4. Are those methods effective? How effective?

Linda Kelleher indicated that they are all effective if all the programs are used. Not a single program is especially useful. If a manager and an employee work together, it will be very helpful. Not a program but the approach to the program is effective.

5. You are in charge of the Education Services. Do you hear any feedback from the employees that how effective are those?

Linda Kelleher said that Education Services offers different levels of surveys. When employees finish the online classes, Education Services offers evaluation for the employees to fill out. At this time, most employees don't really know what the effects of the classes are. After 60 days after the course, Education Services sends out another evaluation. The first question this survey asks is that "How do you use the knowledge after the training", and if people reply that they haven't used the knowledge yet, we won't ask any further questions; if they reply that they have used the knowledge, then Education Services would ask more questions about the training. The majority of the people who reply back to this evaluation have already used the knowledge from the training to their work. Linda Kelleher thought the percentage is around 70% - 80%. After 120 days, Education Services send out the survey again. This time only very few people who haven't used the knowledge yet. The questions Education Services asks tend to drill down to determine the effectiveness of the training. For example, whether they understood the training very well, and in what disciplines has the training helped them. EMC Education Services customizes the surveys based on the courses and uses the response to modify and improve its training system.

6. What are the initiatives that encourage employees to learn more?

(Some possibilities: financially, self-motivation, self-enhancement, job security, social status, networking, etc.)

Linda Kelleher suggested that if the company involves in major initiatives in the industry, then the employees tend to learn more. Such as now EMC is changing to cloud computing, and a lot of employees like to learn about cloud computing as well. Self-motivation is definitely a big one. Job security is a huge thing. It's also important for people to like to work at EMC and like their jobs. EMC does not really award people to learn more, but the bad economy has kept the employees to make themselves valuable to the company.

7. Is there any method that you think would be effective yet is not take place in EMC? Or, can you think of something that would be useful for software engineering companies and their employees?

Linda Kelleher thought that sometimes information only flows down to a certain level and it just flows so far and not any more. If EMC can figure out how to communicate better, it would be beneficial. But EMC has not come up with a good solution yet. Linda Kelleher suggested creating a social media community because she felt that the young generation is very interested in this.

8. You have worked for Prime Computer for more than 15 years. How do you feel the difference regarding their approaches on employee training and education? Is the difference related to the size of the company?

Linda Kelleher felt that it is not just about the content, but the methods are different today. In the companies that she worked at before, employees came to classes to learn, and then they left the classroom. Today there are more innovative ways to do trainings. She has always worked for big companies, so she is not sure how small companies are. But bigger companies definitely have more resources. But for small companies, she felt

that they have fewer employees, but they tend to invest high dollars in fewer individuals.