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Training Trends in the Oil and Gas and Petrochemical Industries

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Training Trends in the Oil and Gas and Petrochemical Industries

by

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Report

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Abstract

Training Trends in the Oil and Gas and Petrochemical Industries

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This purpose of this report is to gain insight into the current training trends for training new operations personnel within the oil and gas and petrochemical industries in the United States. Companies in these industries face an increasing number of training challenges presented by an array of factors including: regulatory compliance mandates, an aging workforce, training costs and the need to maintain or improve production rates while decreasing safety and environmental incidents. In response to these challenges Learning and Development (L&D) leaders and practitioners in these industries must provide sound instructional strategies that meet the learning needs of their employees while meeting the requirements of their employers and regulatory requirements. This report focuses on the design and delivery tools and methods, the training management tools, and the challenges faced by training professionals in this industry, including the gaps and areas of greatest training concern. The study also investigates the future plans to accommodate training methods and tools used to address younger employees.

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Chapter One: Introduction

Background

The working environment of the oil and gas and petrochemical industries is dangerous. Human error has proven to be a significant cause of industrial failures and accidents. These failures and accidents can have devastating, long-term effects on the company, its employees, the environment and the community. Clearly, human error will always occur, but training has a direct impact on reducing accidents in these industries (LeMay, 2009). Because of this, a significant amount of time is spent in these industries on safety training.

Purpose

The purpose of this research study is to investigate how oil and gas and petrochemical company trainers and training departments are balancing training requirements and training needs within the constraints of their training budgets. The study focuses on operators/processors within this industry as opposed to management and administrative employees. The operators/processors are those who control the plant equipment and processes. The present study looks at training topics, training methods and tools, and training design/development tools. In addition, the study attempts to discover what changes, if any, are being considered to address the needs of a younger incoming workforce within this industry.

Significance

Companies in the oil and gas and petrochemical industries face training challenges that are affected by various factors including: regulatory compliance mandates, an aging workforce, training costs and the need to maintain or improve production rates while decreasing safety accidents and environmental incidents. In response to these challenges, Learning and Development (L&D) leaders and practitioners in these industries need to provide sound instructional strategies that

meet the needs of their employees as well as factor in the competitive business and economic challenges faced by their employers.

Research Questions

There were three research questions that guided this study. These questions are:

1. What are the current training trends for operators and processors in the oil, gas and petroleum industries in the United States?
2. What challenges do trainers in these industries face in training new and experienced operators and processors who are the employees primarily responsible for the final product production?
3. How do trainers effectively address the training needs of an increasingly younger workforce in these industries?

Approach

This study will use a number of survey questions to determine the current trends for training operators and processors within the oil, gas and petroleum industries. These questions will be asked through two methods. The first method will be a set of questions asked in an online survey instrument. The second method will be through telephone interviews to ask questions that delve more deeply into some of the question topics.

This report will review current literature on the subject, a discussion on the research approach and instruments used in this research, and a discussion of the findings and their meanings.

Chapter Two: Literature Review

Introduction

Due to the nature of the oil and gas and petrochemical industries, employers and trainers face unique challenges regarding regulatory compliance and safety training. In addition, they must address other issues common to other industries. These issues include addressing an aging workforce and the costs associated with training development.

Training Challenges

There are a number of challenges associated with training in these industries. The first relates to the regulatory compliance and safety training requirements. In 1992, the Occupational Safety & Health Administration (OSHA) created the Process Safety Management mandate requiring all companies working with specified levels of chemicals that are deemed dangerous to adhere to new operating requirements. This mandate is called OSHA 1910.119. One of the directives in this mandate requires initial and refresher training for all employees who handle highly hazardous chemicals. While the very fact of this training and the required documentation is specified by OSHA, the training methods used to conduct training is not defined. This leaves the decision for how to perform initial and refresher training to the employer. Depending on the processes and products involved, oil/gas and petrochemical companies may also be required to provide additional training to adhere to regulations from the Environmental Protection Agency (EPA), The U.S. Coast Guard, and the Department of Transportation (DOT) among others. All of these regulations can greatly impact the training budget for these companies.

Oil and gas and petrochemical companies must address the issue of effectively balancing worker safety with downtime that occurs when employees are attending safety training. Clearly companies want to provide a safe working environment for their employees. Failure to do so can result in severe OSHA and

EPA fines and serious potential public relations issues, as seen following the Exxon Valdez oil spill in 1989, the British Petroleum oil spill in the Gulf of Mexico in 2010, and the explosion that occurred at the West Fertilizer Company plant in 2013. Safety training, while required by OSHA, can be expensive. Company management is challenged with balancing safe working environments with necessary profit margins in order to remain competitive.

Another challenge associated with training in this industry is that many employees are preparing for retirement. The issue of a graying workforce is not unique to these industries; however, the issue of how to address the loss of knowledge and expertise posed by an aging workforce is relevant to these industries. In 2007, surveys indicated that 15-20% of employees were already eligible for retirement. This problem will continue to grow as the "baby boomer" population continues to age and reach retirement age. Companies must find a way to retain the knowledge of the aging workers and transition this knowledge to the younger, less-experienced workers (Lave, 2007). When experienced employees retire, companies in most areas of the country are not having difficulty finding replacements. The difficulty that occurs is that the new employees are unable to replace the veteran employees at the same level of knowledge or skill (Fletcher, 2007). Therefore, there is a need for a systematic approach to capturing the knowledge and skill of the veterans and then transferring it to the replacements.

A third challenge is that the cost of training employees is rising (Society for Human Resource Management, 2006), and that can greatly impact the training programs that are implemented. In addition to the cost of developing the training materials and programs themselves, there are additional costs to be considered. These include implementation costs, such as the cost of technology, equipment, and training facilities, and indirect costs, such as the cost to replace employees in training, compensation to the training participants, and general and administrative costs associated with providing the training. While the potential benefits of quality training may not be in question by employers and managers, the direct and indirect

costs associated with quality training is a serious business consideration for most companies.

In the oil/gas and petrochemical industries, the supervisory personnel are often depended upon to make difficult decisions in emergency situations. Their ability to make these difficult decisions during a moment of crisis can often be the difference between life and death (Flin, 1996). The ability to make difficult decisions that can affect the entire company and its employees is one that must be learned through training.

Instructional designers and training specialists may argue that each of the challenges discussed can be met through effective training programs. In order to determine how the companies in this industry can design and deliver training, designed to provide effective learning to the employees, we must first look at what constitutes effective learning, which is the goal of the training.

Effective Learning

What is effective learning? There are many theories as to what makes effective learning. For the purposes of this discussion, a few of the more prominent and commonly used theories and principles related to effective learning are included.

Adult Learning Theory

Adult Learning Theory, first conceived by Malcolm Knowles, highlights several characteristics of the adult learner (Knowles, 1973). Knowles found that the adult learners want to take responsibility for their own learning, are self-directed, want to learn information that will help them perform the job, and can draw on resources of what they already know. The resources of younger adults is likely more limited than those of older, experienced adults. Instructional designers are challenged with designing strategies to help the younger adults gain the most significant learning experience from the resources that they possess.

Gagne's Steps to Learning

Many instructional designers consider Gagne's *The Conditions of Learning and the Theory of Instruction* a classic book. His theory includes nine events of instruction . Most instructional designers consider the importance of these steps when designing and developing training programs. These steps including gaining attention of the learner, discussing the learning objectives, helping learners recall prior knowledge through scaffolding, presenting the new material, providing guidance for learning, allowing the learner to practice the skill or knowledge, providing feedback, assessing performance and enhancing retention and transfer. Including all nine steps can seem daunting for the instructional designer who must work within a timeline and budget to deliver the training.

ADDIE Model

The Instructional Systems Design model that is often used in industry to develop training programs is called the ADDIE model. In this model, there are five phases: analysis, design, development, implementation and evaluation. The cost of training can be very high; therefore, it is a common business practice to follow this model due to its strong analysis phase, which affects the remainder of the project. During analysis, the characteristics of the learners are determined. In addition, project analysis considerations include budget, timeline, learning constraints, and desired pedagogy. Following the analysis stage, the training manager may determine that the costs outweigh the projected outcomes of the training. Budgets are reviewed annually, and unless the costs of the training can be clearly justified by potential employee performance outcomes, the manager may recommend a less expensive type of training or may cancel the training project altogether.

Current Training Trends and the Possible Future of Training in the Oil/Gas and Petrochemical Industries

According to findings at a recent conference for the American Society for Training and Development (ASTD), some specific training trends are emerging in the field of instructional design and development (Heathfield, 2010). These training trends include increasing use of multimedia, online and web based training.

Classroom Training

Classroom Training has historically been the method of training in the oil/gas and petrochemical industries. There are a number of reasons for this: perceived cost, culture, access to technology, etc. Organizations often look at the cost of the technology required to provide any training other than classroom and decide that a classroom scenario is the best method for training. While there is no argument that a good teacher can provide an excellent learning environment, there is the consistency factor that may interfere. Given the same set of training materials, one trainer/instructor may provide a better learning experience than another. For example, one trainer/instructor may have more experience with the topic. Unless the classroom materials are well developed and are completely adhered to from training class to training class, there will be an inconsistency in the knowledge and skills of attendees. According to the ASTD training trends discussion, traditional classroom training is no longer the only way employees should learn.

In an effort to reduce training time of industrial training, a client-specific program was designed and developed for an applied case study (Jacobs, 2012). This program was founded in the ADDIE model, and special emphasis was placed on the delivery method. Classroom training was found to be much less effective than on-job-training (OJT), which is the delivery method used in the new training program. Training time was reduced from an average of 53 months to 36 months through the use of the OJT materials, as opposed to the classroom training that had been delivered in the past.

E-Learning

E-learning is the use of any electronic media or technology for the purpose of learning or teaching. There are many e-learning options, including training CDs, online learning, blended learning and even university degrees provided online (Heathfield, 2010). Articles and discussions on the return on investment (ROI) of classroom training compared to the costs of online training are rapidly increasing. Many of these studies, however, are conducted by consulting companies that provide e-learning solutions. Because of the personal interest of these companies, their findings that indicate that e-learning provides a greater ROI than classroom learning are subject to question. No significant educational research could be found on this topic to support that e-learning provides a better or worse ROI than classroom training.

Much research has been conducted on the benefits of using e-learning to train employees. While there may be debate in the industry as to whether e-Learning is the solution for all training challenges, more companies are beginning to agree that a blended approach is preferable (Becker, 2011). A blended approach is one in which various methods are used to train employees. These can be a combination of classroom, e-Learning, multi-media or CD-delivered courses, etc.

One qualitative, empirical case study in Australia researched the use of technology for compliance training in the rail industry. There are strong similarities to the rail industry demographics with those of oil/gas and petrochemical companies in the United States. The employees are primarily from a blue-collar background and training topics include occupational health and safety, security and environmental regulatory compliance issues. They find that compliance training is most successful when delivered via e-learning (Becker, 2011). In addition, they recommend that employee groups be considered when planning e-learning, rather than the entire workforce. A full analysis of the availability of technology and the application of that technology is recommended to ensure that the employee groups

have access to computers, that the appropriate technology, such as mobile devices, is applied appropriately, that e-learning will provide the solution to some training needs, and that other training methods may be more appropriate for other training needs.

Simulations

Simulations have been shown to be very effective learning methods for teaching emergency situations and critical thinking skills (Flin, 1996). Some operating facilities in the industry have adopted electronic simulators, which can replicate the plant processes and provide emergency situations without impacting health, safety, and environmental conditions. These simulators typically cost over one million dollars and are not used in most plant operating units because of the cost. Instead, a number of facilities have adopted simulations that are performed through "table-top drills." These drills, which involve everyone on shift, are verbal scenarios that simulate a problem. Each person on shift contributes ideas on how to solve the problem without an actual emergency condition present. The Flin qualitative study concluded that the team be trained in emergency procedures because of the importance of the team in an actual emergency. They also concluded that team skills training be provided as well. Le May's study also found that an essential contributor to industrial accidents is an employee or team's inability to perform their job tasks reliably when there is a potential safety risk. The study concluded that training on emergency conditions is key to helping prevent these accidents (Le May, 2009). Performance simulations can also help capture the experience of veteran employees and help transfer it to new employees (Fletcher, 2007).

The Adaptability of Training in Simulated Process Control research by Hockey provided a quantitative empirical study of systems approach versus procedural approach when training employees on emergency procedures in an industrial environment. Both study groups used simulations; however, one group

was trained to think of the entire process as a series of integrated systems. The other group was trained to follow procedures. During an emergency situation in which critical thinking is imperative, the systems-taught participants were more effective in controlling an emergency situation than the other group of participants (Hockey, 2007).

Participatory Training

Participatory training is researched in the study by Fam, et. al (2011). The researchers divided participants into two groups. Each group trained with discussion groups that were participatory in nature. While both groups used different types of participatory training over a two-year period, the researchers concluded that participatory training is more effective in improving the safety and health of the employees when compared to the historical data of training of employees without the use participatory training (Fam, 2011).

Conclusion

Companies in the oil and gas and petrochemical industries face multiple training challenges that are somewhat unique to their industry. They are required to provide regulatory compliance training while minimizing training costs to help ensure adequate profit margins. Accidents and incidents over the past 30 years have caused OSHA to initiate required training for most companies in this industry without providing the funding to pay for that training. Training managers are tasked to solve this problem.

The demographics of oil/gas and petrochemical workers is primarily blue-collar, aging employees who do not have access to or skills for extensive online or e-learning. Younger employees may bring more technology skills to the work environment; however, they still remain in the minority of those working in this position. The research shows, however, that e-learning, particularly for compliance training, is more effective than other methods. This creates an additional challenge

to the training managers, who are responsible for ensuring that the training they design and develop is effective while holding the costs at minimum.

Additional research is necessary to narrow the focus of current training within the oil/gas and petrochemical industries. Specifically, research is needed to determine the current training trends in this industry and to determine if these trends address the training challenges that the training professionals in this industry face. In addition, there is little data to determine if the training needs of a younger workforce are being addressed in this industry, thereby inferring the need for more research on the topic.

Chapter Three: Method

Research Design/Instruments

This study utilized the mixed-method approach of analysis, particularly the Explanatory Design. This design is one in which quantitative and qualitative data on the same topic were gathered to obtain a full picture of the research topic. The first phase of this design collected quantitative information that was analyzed through a quantitative method of analysis. The initial phase was followed by a qualitative phase that built upon the information gathered through the quantitative means.

Two instruments, found in the Appendix section, were used in this research. The first was comprised of nominal quantitative questions divided into two parts. The first part of the instrument asked general company demographics questions, such as company size, employee education levels, and annual training budgets. The second part of the instrument included specific questions over training methods and tools that trainers used, challenges they faced in training operators and processors, and innovations that they wanted to implement at their job sites. Research participants accessed the instrument online through the Survey Monkey program. The final question on this instrument asked respondents if they were willing to participate in a follow-up telephone interview.

The second instrument, completed through the telephone interviews, was used to derive qualitative information over the same topics as well as delving into the topic of younger employee training needs. This phase was completed through telephone interviews with those participants who were willing to volunteer information pertinent to research objectives.

Data Collection

Research participants were found through a variety of means. Members of the researcher's personal network of current and former clients were asked to participate. These were clients within the oil/gas and petrochemical industries, directly or indirectly involved with the training of operators and processors. Professional group members within Linked-In were also asked to participate. These

included Leaders in Oil & Gas Training and Development in Houston, TX and Instructional Design & E-Learning Professionals' Group. The researcher also contacted other educational/training groups and organizations (Louisiana Safety Council, Center for Workforce & Community Development at Lee College, Baytown and the East Harris County Manufacturing Association). Finally, emails were sent to instructors of process technology programs throughout the country. These instructors either worked directly for oil/gas or petrochemical companies or had client contacts within those organizations.

Emails were sent to interested participants, and they were given an overview on the purpose and scope of the research as well as a link to the online survey. Each participant completed the online portion of the survey, for a total of 24. One online survey was removed because of the lack of qualifications of the respondent. The responder was a retired attorney who was interested in the oil and gas fields from a political level but had no experience in the training of operators/processors. There were 23 remaining surveys. Of those 23, ten were willing to participate in the telephone interviews. Each of the ten was contacted and asked the questions from instrument number two (also located in the Appendix). The researcher took notes of the responses to each question and transcribed them onto a document that included all answers to each question.

Chapter Four: Analysis/Results

Overview

The first set of questions on the online survey helped categorize the participant company demographics, including size, service, and education level of their operators/processors. Of the 23 respondents, 3 were from the same company in three locations. These locations were all of different size and provided different services; therefore, all three responses were used in the analysis. Three of the remaining surveys were also from the same organization, and one of those three answered the survey two separate times. The data from these extra survey responses were not used in the analysis.

The remaining questions asked specific questions about the training methodology, tools, and challenges encountered by each of the responders.

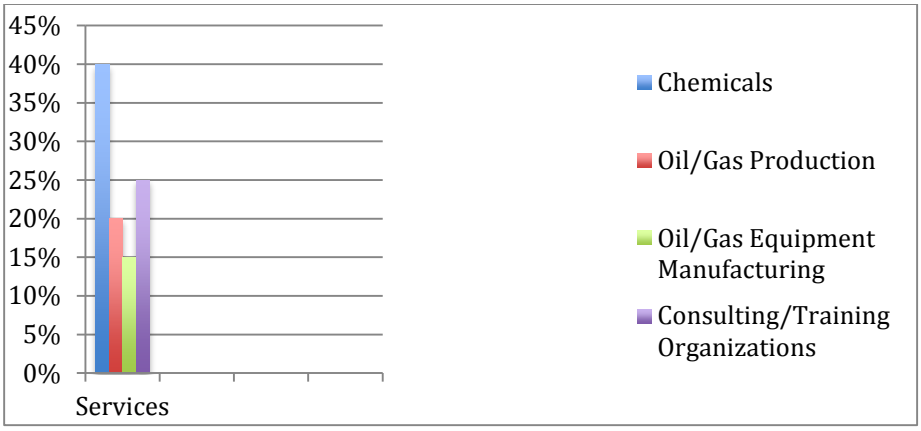
Demographics

The first question, illustrated in Figure 4.1, identified the type of company service provided by the responders. The original instrument provided the following categories:

- Refining
- Natural Gas
- Oil/Gas Production
- Chemicals
- Other (please specify)

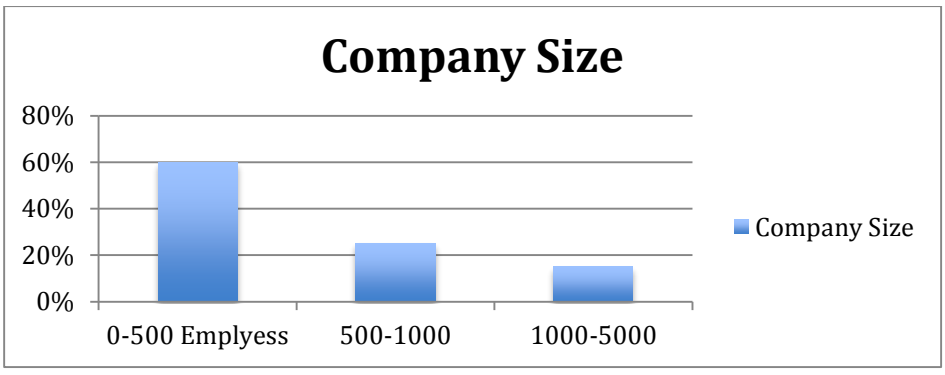
There were no companies represented from the refining or natural gas services, and eight of the responses were classified as "other." Therefore, the categories created for this report were changed to reflect those who responded to the online survey. These became the four categories: Chemicals, Oil/Gas Production, Oil/Gas Equipment Manufacturing, and Consulting/Training Organizations. Each of the consulting/training companies included in this report provided training for operators/processors within the oil/gas or petrochemical industries.

Figure 4.1, Company Service



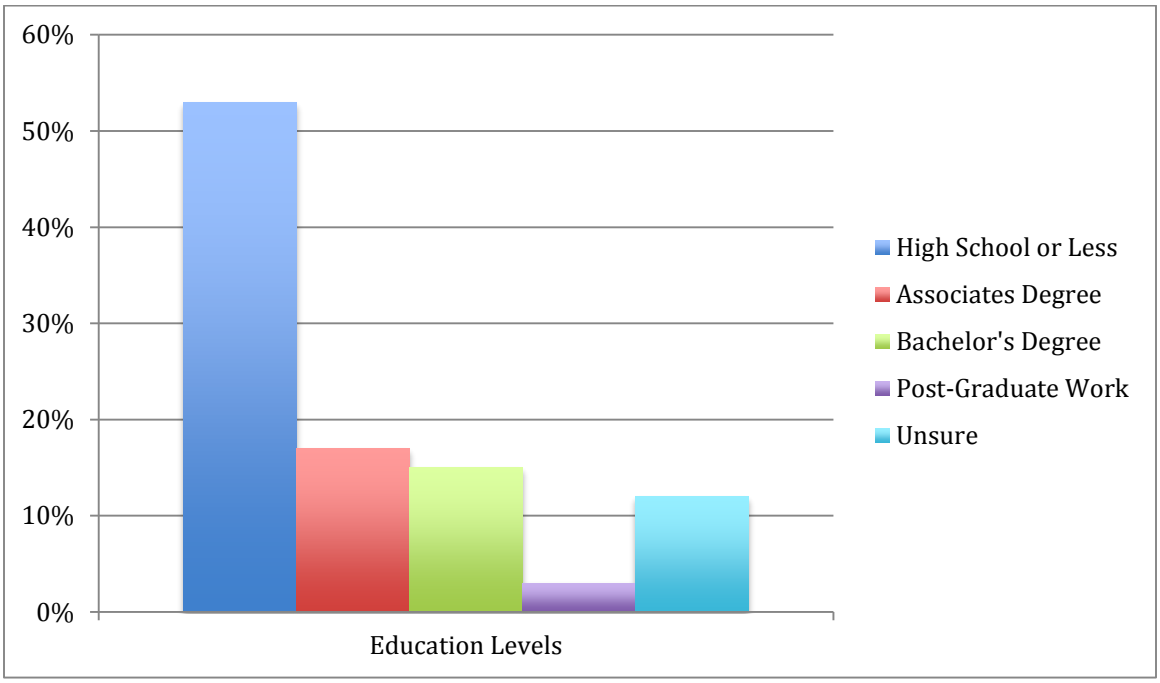
The second question, illustrated in Figure 4.2, identified the number of employees within the company. Of the original list of choices, the first two, less than 250 and 250 to 500, were combined. These made up 60% of the responders. All of the consulting/training companies fit into this category. There were 25% of responders in the 500-1000 category and 15% with over 1000 employees.

Figure 4.2, Company Size



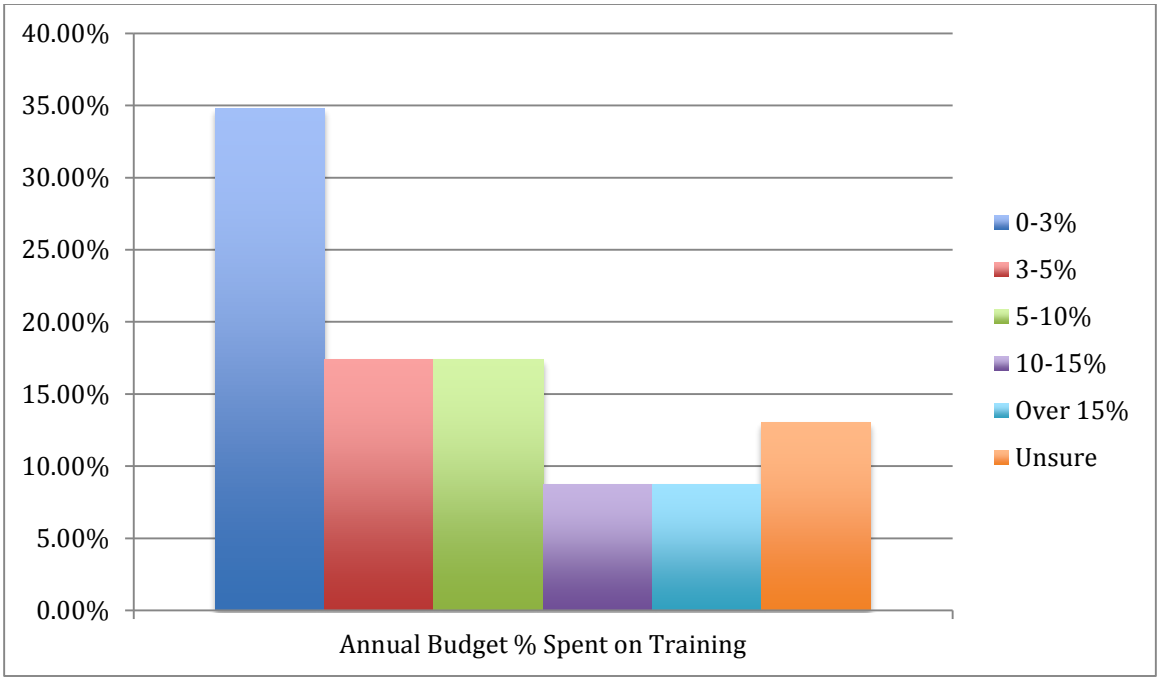
Estimated education levels of operators/processors were identified, as illustrated in Figure 4.3. As expected, the majority of operators/processors had an associate's (two-year) college degree education or less. Over 50% were identified as having only a high school education. There were some with a bachelor's degree and even post-graduate work. However, the researcher believed that this factor was due to the number of independent consultants/trainers who completed the survey. They may have been submitting their own education levels. Another interesting item to note was that some of this data may have been skewed due to errors in data reporting. For example, one responder indicated that 150% of the employees were high school or less and another 100% were listed as unsure. Two of the responders reported this way in error. It was still believed that the general education estimates represented in Figure 4.3 were relatively accurate.

Figure 4.3, Educations Levels of Operators/Processors



The next survey question asked about the percentage of overall annual budget that was dedicated to training. These percentages are represented in Figure 4.4.

Figure 4.4, Percentage of Annual Budget Dedicated to Training



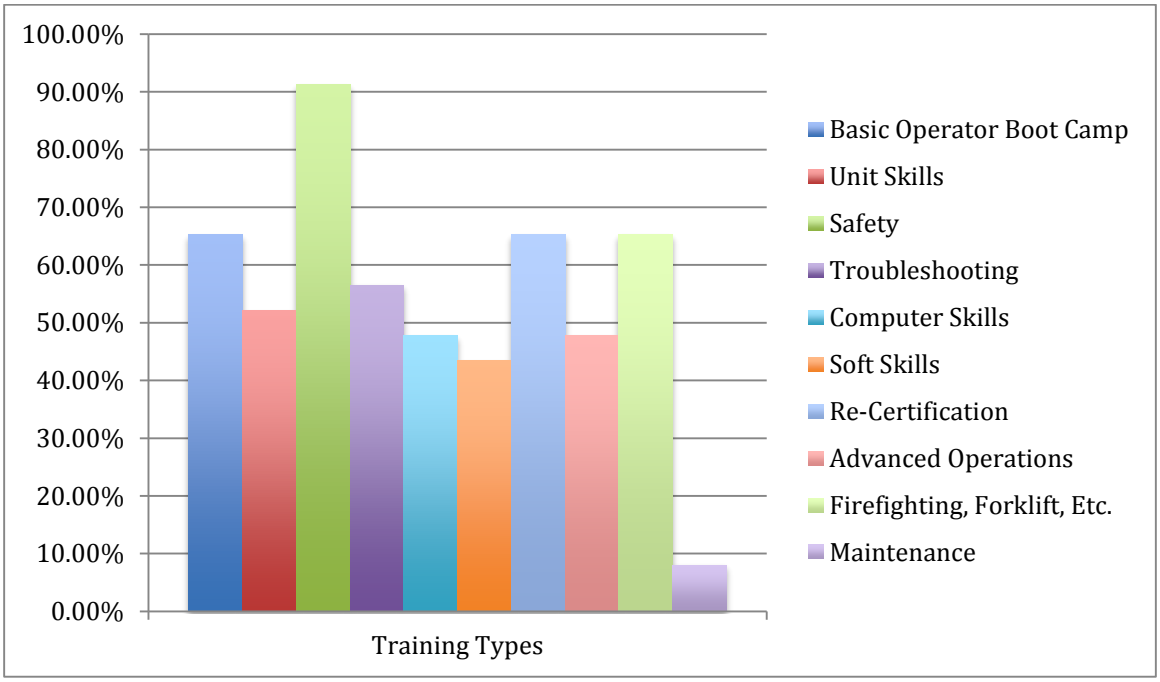
The next question about whether the facility was a union facility was originally included because of the implications in the industry. Union facilities have special requirements of training as well as other employment requirements. 100% of the responders indicated that they were not a union facility. Therefore, this data and its possible implications were not considered in this report.

Training Types, Methods, and Tools

The remaining survey questions focused on specific training that the companies provide to their operators/processors as well as to contractors, the training methods employed, and the tools that trainers used to train operators/processors.

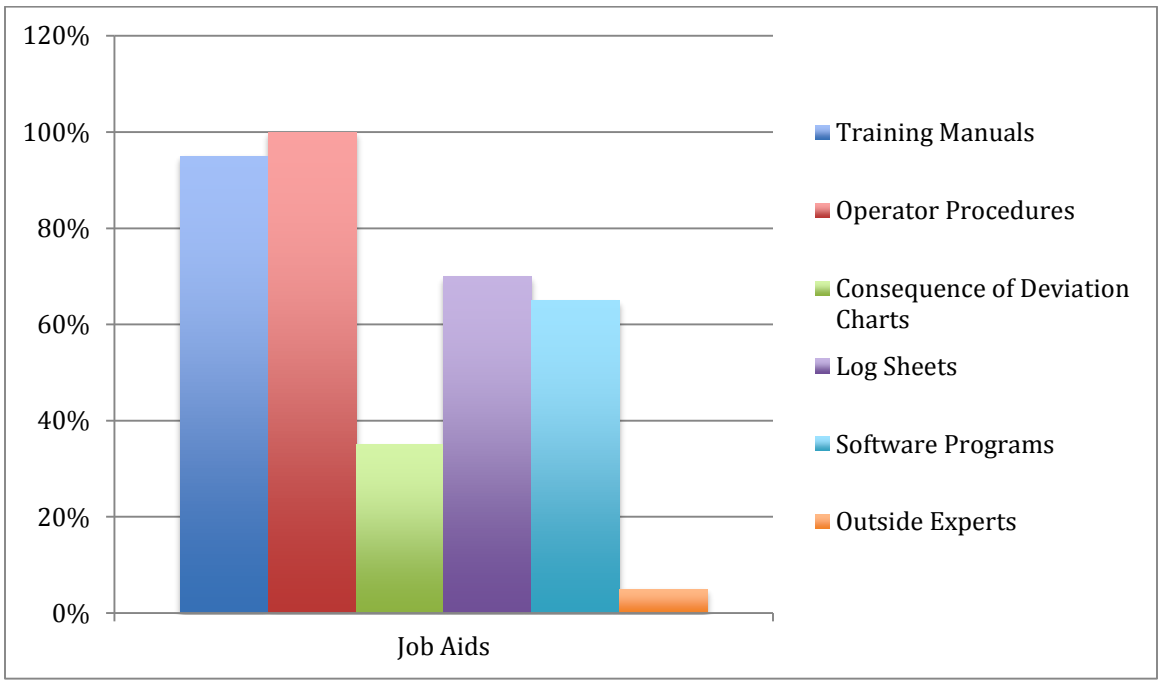
The first of these questions asked what training they provide for operators, illustrated in Figure 4.5. The percentages indicated that the percentage of all companies represented who offer that type of training. There was an option to select "other" and explain with other training they offered. Two of the responders selected that option, and both indicated that they provide maintenance training to their operators/processors.

Figure 4.5, Training Provided for Operators/Processors



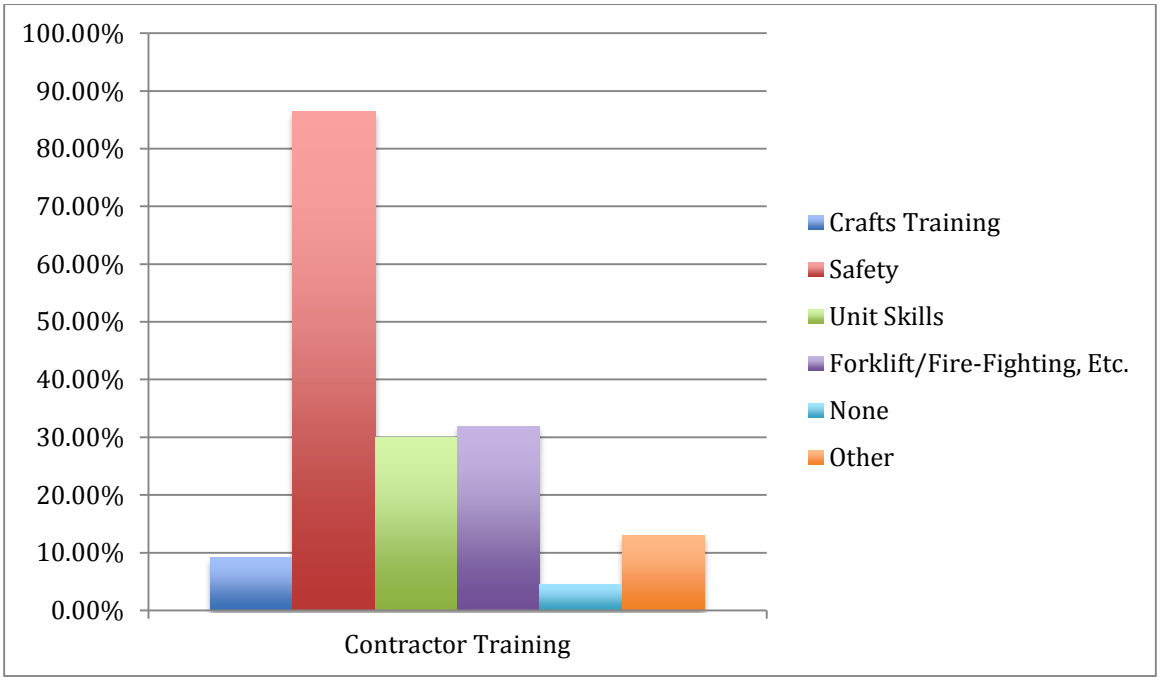
When asked what performance aids the operators/processors use on the job, they were given a list of choices and the option to select "other" and provide specifics, illustrated in Figure 4.6. The only "other" that was selected cited the use of outside experts. Most responders probably did not consider outside experts as job aids; however, it was included in the chart.

Figure 4.6, Performance Aids Used on the Job



Contractor workers were used extensively in this industry to support the existing trained operators and to work on special projects, such as a major turnaround during which equipment is repaired, cleaned, and sometimes replaced. Most contractors received their on-job training from their employers; however, safety and unit-specific training, even in the form of an overview, was typically required. The trainers were asked to identify the types of training that they provided to contractors. 13% of the responders selected "other." Their responses identified the other training provided as how to control the operation of a well, soft skills, and maintenance, illustrated in Figure 4.7.

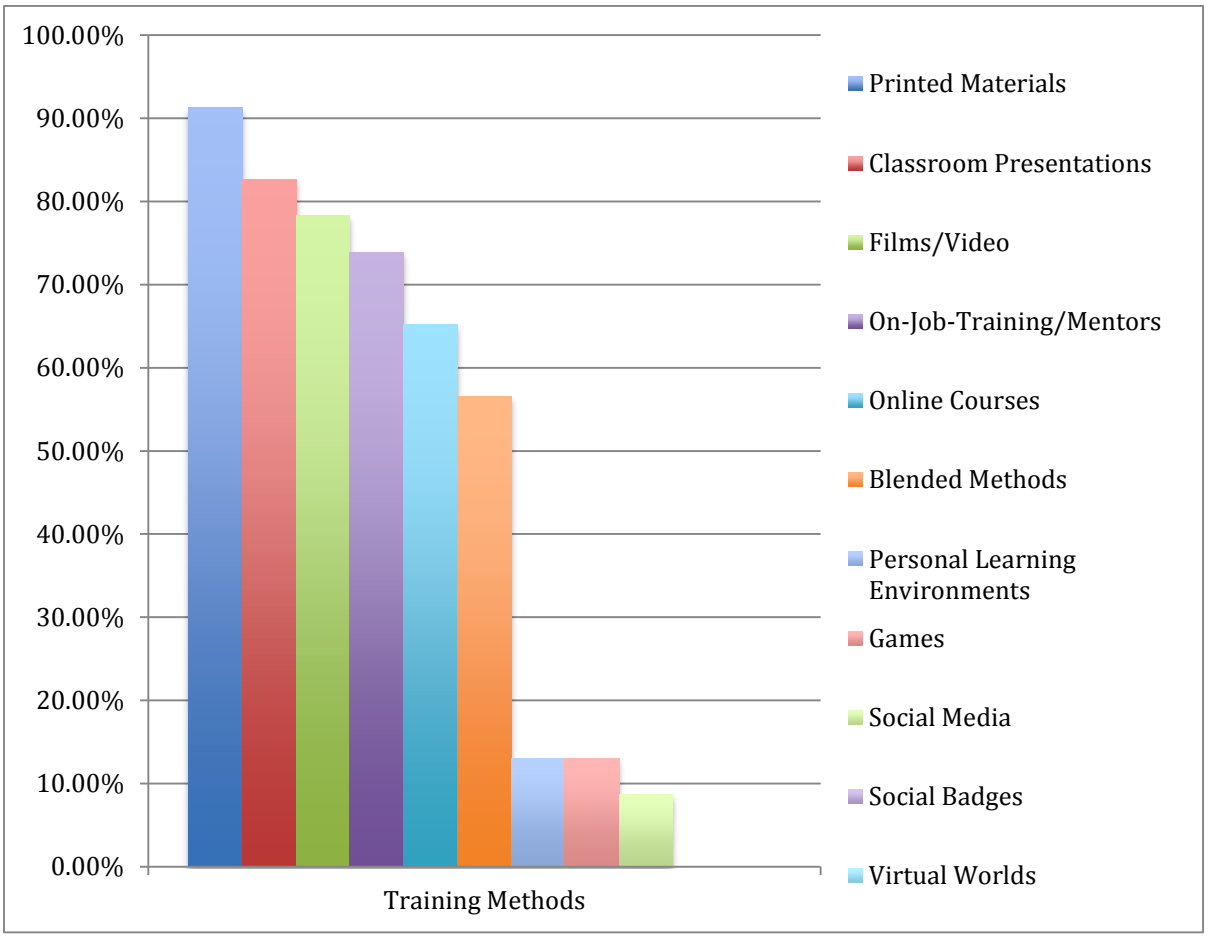
Figure 4.7, Training Provided to Contractors



Responders were asked if they had completed any return-on-investment (ROI) studies to measure the effectiveness of training. As expected, the majority (86%) reported that they had not conducted ROI studies. Three of the responders, who were all consulting/training company representatives, reported that they had. This was not surprising because ROI studies are services often conducted by outside consultants and external training organizations. One responder skipped the question. These findings were not represented in a figure.

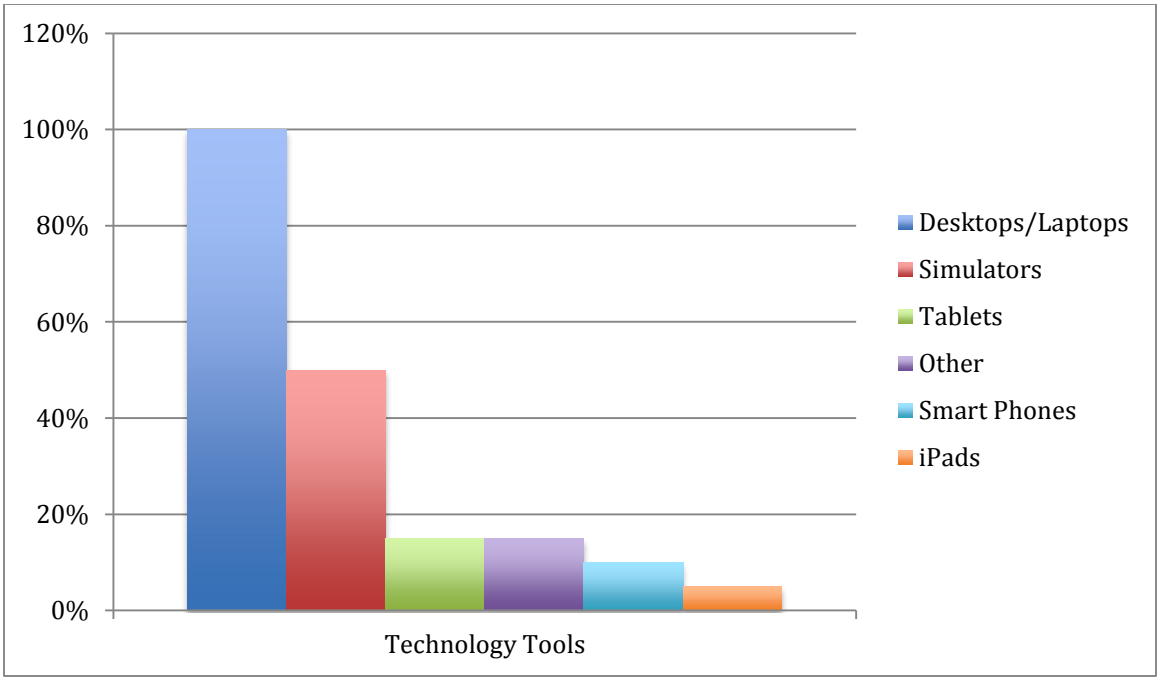
The next two questions, illustrated in Figures 4.8 and 4.9, asked the responders to identify the training methods and technology tools currently used to train operators/processors. Over 90% of those surveyed used printed materials to train. Over 80% used classroom presentations. Less than 15% of these organizations used technology-based methods, such as personal learning environments, games or social media.

Figure 4.8, Training Methods



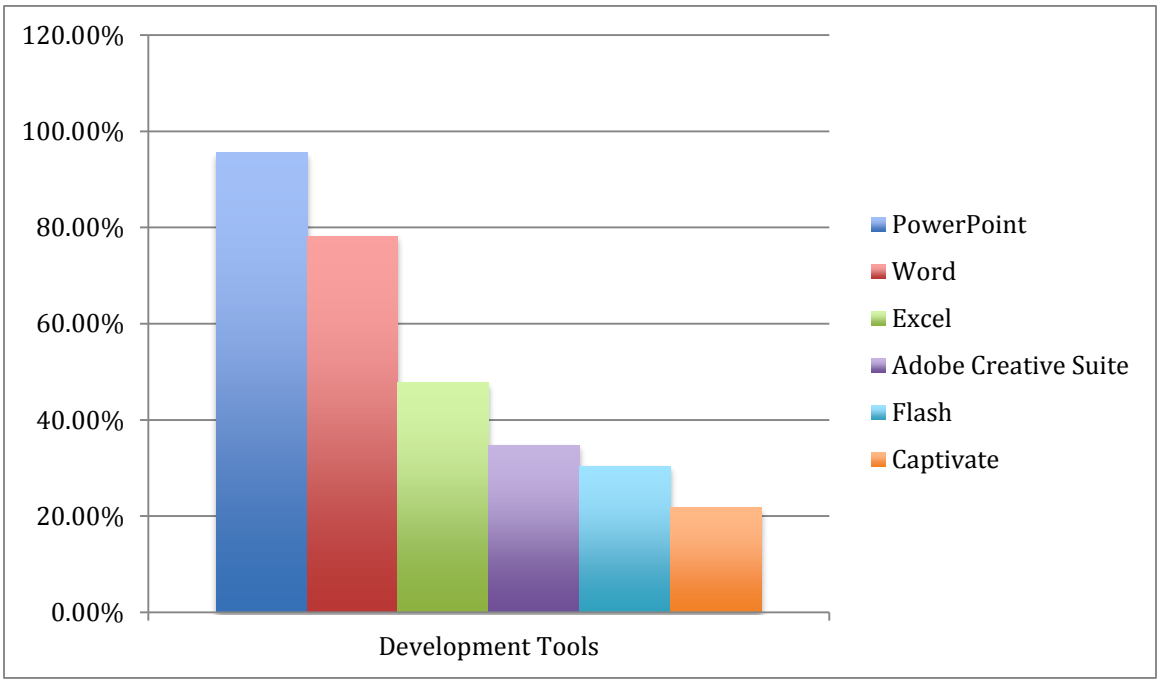
15% of responders selected “other” for the technology tools used. All of them indicated the use of computer-operated software for interactive presentations and/or computer-based training programs.

Figure 4.9, Technology Tools Used to Deliver Training



When asked what development tools they used to create training materials and programs, illustrated in Figure 4.10, there were no "other" options selected. Microsoft PowerPoint and Microsoft Word were the clear choices for most. This correlated with the high percentage of trainers who provide written training materials and classroom presentations to train operators/processors, so this response was not surprising.

Figure 4.10, Tools Used to Develop Training

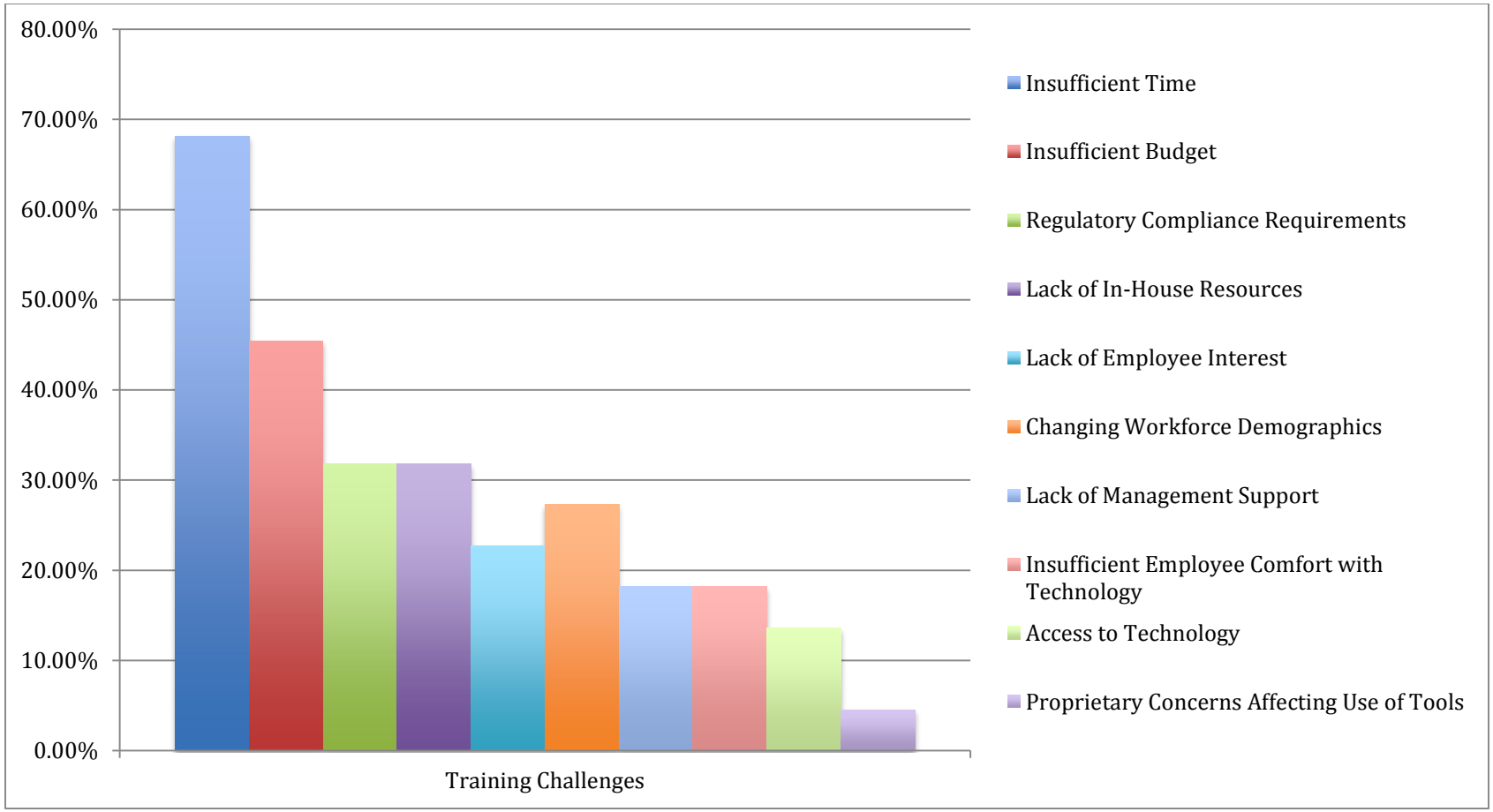


There were two questions concerning the use of Learning Management Systems (LMS). One asked if they used one to support training, and the other asked if the LMS they used was commercial or developed in-house. 80% used an LMS, which indicated that networking technology was available and being used, even if it was not used for training delivery. Most used a commercial LMS program. Although some were customizable, these programs typically were used to track training records and progress.

Training Challenges

Responders were asked to identify the challenges they encounter when training operators/processors in this industry. They were given a list of items from which to select and the option of "other." Those who selected "other" cited the lack of high-speed internet for web-based training, inconsistent mentors, too many training modules to complete for each employee, and language barriers. Challenges identified are illustrated in Figure 4.11. Not surprising, the two greatest challenges were insufficient time and insufficient training budgets.

Figure 4.11, Training Challenges



Interviews

Ten of those surveyed online were contacted by a phone interview to delve more deeply into the topics and themes that were identified on the interview instrument. 80% of those contacted were trainers working directly for one of the oil/gas or petrochemical companies or equipment manufacturers. 20% of the interviews were conducted with external consultants. The rationale behind the volunteers selected was to obtain a more in-depth analysis of what was occurring within these companies as opposed to the opinions of an outsider. In addition, external consultants often did not have the entire picture of what is happening across an entire organization. They were normally hired to work on a specific project, thereby limiting their scope of knowledge.

The areas covered in the telephone interviews included:

- Training Gaps/Plans
- Training Initiatives
- Training Younger Employees
- Overall Training Challenges

Training Gaps/Plans

The employees in this industry, particularly those who work as operators/processors, were required to complete a large number of regulatory-compliance training. In addition, they were required to complete new-employee training to learn the specific job skills that they use to perform their job tasks. As these regulatory and new employee training requirements used a significant amount of the training time and budget available, the interviewees cited a number of training needs or gaps. These gaps included advanced operator training, training for continuous improvement of skills, and critical thinking skills. The plans to address these needs ranged from using simulations or scenarios to drill and practice to help develop more advanced or critical thinking skills. In fact, 60 percent of the

interview responses included this strategy. If a simulator, which could be cost-prohibitive, was not available, these simulations were delivered through table-top drills. A table-top drill was described as a discussion with an entire shift in which the scenario was presented and shift members contributed appropriate actions for each job position as well as potential consequences of the scenario if not solved. This approach helped those trainers provide more advanced training to their operators without the high expense of a simulator.

A representative from Company A, a large chemical company with multiple sites and over 1000 employees, explained that there was a new initiative to apply a consistent training approach and methodology to train all operators/processors across all sites. Not all of the sites, however, were supportive of this endeavor. Another initiative was to support the programs of local community colleges to help harvest a higher baseline of industrial knowledge within the potential employee pool. Company H, a refining and chemicals engineering company that provided safety training to contractors, developed computer-based training modules for compliance-driven training that could be scheduled when convenient. They also provided a combination of classroom/on-job-training training when shorter response time was needed.

Training Initiatives

Interviewees were asked to cite examples of training initiatives that they had implemented that were supported by management as well as training initiatives they had suggested that were not supported by management.

Successful implementations included the use of new simulations, coaching programs, training for management to support the efforts of operations, safety training, and consistent training approaches across a facility as well as across a company. In the case of the purchase of new simulators, the operation of that process unit was complicated. The training coordinator for Company F, a chemical plant with 1000-5000 employees in the Gulf Coast Region, stated that he was able to

sell the initiative to management to purchase an expensive simulator by convincing them it would mitigate the potential cost of shutdowns. In other words, he believed the simulator would help the company avoid costly shutdowns and downtime due to employee mistakes. The chemical plant, a PSM-classified facility, would face high fines if specific employee mistakes led to environmental releases or employee injuries. Management agreed and purchased the simulator.

Safety initiatives were the number one cited initiative approved by management. This data is predictable and understandable due to the consequences of unsafe acts in this industry. A consultant for Company I, a safety training consulting firm, stated that it was relatively easy to sell safety training initiatives to clients due to the client's ability to understand the return on the training investment. One trainer cited an extension of the safety training to include the training of the supervisors and coaches/mentors of the operators/processors who performed the jobs. He believed that by ensuring the supervisors/management/ mentoring personnel were trained on the same safety policies and procedures, the likelihood of those policies and procedures being followed would increase.

Another initiative that had not been approved, but the trainer believed it would be, was based around a pre-hire program that simulated an operating process. Potential hires would go through the program, learn the system, and then be given a test to determine how well they could think on their feet and handle stressful conditions. These qualities were highly valuable in the job of operator/processor, particularly in smaller facilities where the employees were expected to qualify for the outside, manual jobs as well as the inside, computer-controlled jobs, which required a higher level of critical-thinking skills.

The interviewees also cited examples of initiatives that they proposed to management that were not approved by management. They were asked the reasons they were given for the failure of the incentive. Failed incentives included online training initiatives, the purchase of simulators, and soft skills (e.g., leadership training) training. Again, the training emphasis in this industry was on safety

training and regulatory compliance. Over half of the interviewees stated that management did not approve much training that was beyond the realm of safety/compliance training unless it was directly related to process improvement, which could positively affect the profit margin.

Regardless of the initiative type, the two most common reasons for failure to convince management were insufficient money for the initiative as well as the lack of time to implement it effectively. Training coordinator at Company F stated, "Scheduling has been an issue affecting the smoothness of prior implementations, causing resistance to additional implementations."

Training Younger Employees

100% of the interviewees that work directly for the industrial companies included in the study concluded that younger employees had a high level of satisfaction with the current training programs, which were highly dependent upon classroom and paper-based training materials. 100% of the interviewees who worked for external consulting/training firms expressed the exact opposite opinion. In discussing the current methods used to train operators/processors in this industry, one interviewee stated, "They (younger employees) do everything online and avoid anything printed. There will be six in a meeting, and all will be looking at their smart phones." Another consultant reiterated the same opinion, stating, "Technology is available and should be used. I recommend computer-based training modules and videos that are available online for safety training. They are more engaging to a younger audience than classroom training or written materials."

Another contracting company trainer continued this theme, recognizing that the historical culture in this industry was the use of traditional training methods and tools. He noted, however, that some of the more recently-promoted management personnel were "really young and interested in taking advantage of technology like cell phones and note pads" for training. He pointed out, however,

that a large majority of the managers "are older so they don't really want to change. It's an uphill battle to convince management to change the archaic approach."

A common theme concerning the future training of younger employees among the audience of in-house training professionals was a need for more soft skills and technical skills as well as a need to alter the culture among the target audience. When asked about the types of soft skills needed, a trainer for Company C, a small chemical company, stated, "Young people have a lax attitude. They do not understand that they must be on time and on point when they are at work." He proposed soft skills training on time management and leadership to help bring the younger workers up to the expectations of the work world.

The training coordinator for Company F noted that twenty years ago, the plants could find contractors with general knowledge, and understanding of the hazards and an ability to do the work. At the time of this study, the potential employee pool was different. "They (younger new-hires) are lacking the background knowledge and industrial experience" to do the job. "People in their twenties may have a process technology associate's degree but no plant experience or even general industry experience." He continued the discussion with an example of hand tool use. He explained that many young people did not have a basic understanding of how to use hand tools that are used daily on the job. His concern was not only of the increase of lost time accidents due to this factor but that it affected how fellow shift workers felt about the younger employees' ability to perform the job safely and correctly. His suggestion for a solution was to ask for basic hand tools training to be added to the curriculum at the local college program, which was used by his company to help narrow the pool of potential workers. In addition, he was reviewing his next entry-level "boot camp" objectives and activities to determine if he could find the delivery time to add a section on hand tools as a more immediate solution.

To address this same problem, a trainer from Company A, a mid-sized chemical company with multiple locations in the southeast, was working with local

high schools and community colleges to create programs to teach younger potential employees the basic manufacturing skills that they needed to be successful in this industry. These programs were not intended to replace the training offered by individual industrial companies but to serve as a supplement to help close the gap on the knowledge and skills of potential employees.

When asked about concerns for future training of young people, a trainer for Company M, a drilling services company, said, "In general, they (younger employees) get it (the knowledge and skills) because our training is repetitious. The hard part is convincing them that we mean what we say, particularly on safety. They believe they are bullet proof."

Overall Training Challenges

The quantitative data on training challenges suggested that insufficient time and lack of training budget were the two most common concerns. During the interviews, these themes also recurred, but one other did as well. That was a challenge of existing attitudes and cultural environment.

The challenge of adequate training time was repeated by most of the interviewees. Three interviewees specifically cited the issue of multiple training initiatives at their sites, making an employee a "jack of all trades, master of none." (Company P representative). A training coordinator across multiple sites said, "There is not enough help, and I am spread too thin" to do anything more than the minimum training that is required for operators/processors.

Company A trainer explained that much of the training that is scheduled occurred during overtime because of the inability to train people effectively while they are on shift. Management discouraged overtime, creating a no-win situation for training initiatives above and beyond regulatory compliance.

Another trainer (Company E, a Drilling Equipment Manufacturer) emphasized that training budgets were the first budgets to be reduced during an economic downturn. Many in middle- and upper-management did not see the

impact that this could have on incidents and accidents until it was too late. Too often these incidents and accidents were linked to a lack of adequate training. Unfortunately, management seemed to have a "short memory for these lessons learned."

One interviewee suggested that a solution for the lack of training time/budget was to effectively use evening and weekend shifts to provide training. There was normally more activity on weekday shifts. The shift workers worked 15 days each calendar month. Of those 15 days, nine are on nights and weekends, providing an opportunity to present training during less active shifts. "More training could happen if operations leadership would take advantage of that time."

50% of those interviewed stated a cultural or attitudinal challenge. "It is a challenge to make sure that the message sent out is the one they received." This message concerned safety and the importance of following policies and procedures. An independent consultant stated that may of these companies are focused on banners that say, "Safety First" but then ignore that message on the job. He attributed this to the working culture. "These are macho men. Macho men don't have to wear gloves or safety glasses." This culture was supported by these organizations, proclaiming their dedication to the standards while ignoring safety infractions.

Discussion/Implications

The data from the quantitative portion of the research instrument clearly indicated several characteristics about the community of learners and trainers investigated in this research. Most operators/processors had a high-school level education with some having had an associates' degree. The qualitative data indicated that those entering the workforce had inadequate industrial experience or knowledge and skills fundamental for working in this industry.

Training personnel and consultants delivered an extensive amount of training to employees while operating within modest budgets and limited training schedules. The training topics included everything from basic operator skills to

safety, troubleshooting, computer skills, soft skills and even advanced operations. In addition, over 80% provided at least safety training to outside contractors, thereby using additional monetary resources and time/personnel availability.

In spite of recent research indicating the high use of multimedia, online and web based training in other industries (Heathfield, 2010), most trainers in the oil/gas and petrochemical industry did not use these training delivery methods. With all of the demands placed on the training personnel to provide a large amount of training over a wide variety of topics, it was not surprising that the majority of trainers used classroom presentations, printed materials, films/video, and on-the-job training (OJT) to provide a majority of their training materials. Classroom presentations, which could be delivered to a large number of employees synchronously, were the least expensive delivery method. In addition, printed materials and films/videos, once created, could be delivered an unlimited number of times for no additional development costs. Finally, OJT could be delivered at no extra costs as the trainer trained the trainee while performing his/her normal job tasks. Most OJT activities used procedures and checklists that already existed.

The technology tools used to deliver training were relatively limited to desktops/laptops, which were commonplace to most businesses, and to simulators, which were expensive, but once implemented, could be a very effective training tool for new and experienced operators. Although electronic learning management systems were commonplace, there was no other significant use of technology to deliver training.

Trainers used low-level technology, particularly Microsoft PowerPoint, Word, and Excel, to develop training materials. These programs were prevalent within most businesses; therefore, they could be used to create the majority of training materials. Less than 38% of those interviewed used any of the Adobe products, Flash, or Captivate, even though these were commonly used to develop training materials in other industries and in educational settings. The selection of development tools may have been a direct result of maintaining low development

costs or may have been due to the typical training delivery methods selected by the trainers.

The training challenges in this industry were many. Multiple regulatory agencies (OSHA, DOT, EPA, among many) required regulatory training to personnel in this industry. Due to these requirements, there was little time to dedicate to other non-regulatory compliance training needs. The frustration level of trainers in this industry seemed high, although the research questions did not ask participants to rank frustration levels. Trainers expressed their frustrations through the course of the interviews. They wanted to provide training in other areas of importance (e.g., leadership, critical thinking) that they believed would help operators/processors perform their jobs better, which could ultimately have a positive impact on company profits. They found this difficult to do in light of the lack of time, budget, in-house resources, and management support.

Although 2007 research indicated that 15-20% of employees were eligible for retirement (Lave, 2007), little consideration was being given to the learning needs of the younger employees in the companies included in this report. Trainers discussed the lack of general knowledge and soft skills in many of these younger new hires; however, little consideration was given to changing the training methods and tools to address the technology skills of these younger employees. Those from within the organizations did not view this as a potential problem; however, the external consultants interviewed felt that this was a significant issue for younger employees.

Limitations/Additional Research

There were a number of limitations to this research and what can be derived from the findings. The most significant limitation was the limited number of participants used in this research. Less than 25 participants completed the online surveys, and only ten were willing to participate in the follow-up interview. There were several reasons that the research numbers were limited. Approximately ten people who were interested in and willing to participate in the initial study felt that

they were not qualified to answer the questions effectively once they learned more about the research. They did forward the information to colleagues that they felt could provide valuable input; however, only one subsequent colleague participated in the survey. Another problem that affected participants was that a large number of potential participants stated that it was against company policy to complete surveys that provided information about their training activities. They were assured of the confidentiality of the study; however, they could not break company policy.

A second limitation was the depth of information obtained from the research questions. For example, respondents were asked about the training methods and tools that they used to train operators/processors. The analysis indicated that more low-tech training methods and tools were being used, but there were no questions to determine why this was the trend when other industries and educational institutions used much more technology to deliver training/learning. There could have been a number of factors contributing to the use of more low-tech methods and tools. These factors may have included budgets, education level of the trainees, comfort level of the trainers, accessibility, and job culture. The research design did not use a qualitative method that was dependent on all of the quantitative questions. A separate study should be conducted to determine the correlation between the use of low-tech training methods and tools and the contributing factors as well as any other causes of this phenomenon.

Further research should also be conducted to determine how often trainers used each of the training methods. For example, 90% reported using printed materials; over 60% reported using online courses; over 50% reported using blended materials. These topics should be more closely investigated to determine the percentage of time that the trainers used printed materials and classroom delivery versus the percentage of time that the trainers used online courses.

An additional study of the development tools could be completed to determine the reason for those development tools. There could be a number of factors contributing to the choices of tools made by the trainers. One factor could be

the chosen delivery method. If the delivery method selected by the trainer was classroom, it is reasonable that the development tool for materials would be PowerPoint for classroom slides or Microsoft Word for printed training materials to be distributed in classroom training. Another potential factor may be the comfort level/competence of the trainer. If a trainer lacked high-tech skills, he or she might be less likely to try to develop materials in a program such as Flash or Captivate.

Another limitation of this study was the failure to involve the younger employees in the research. Trainers were the representative survey group. To determine more information about the satisfaction level of younger employees with the current training methods and tools, it would be necessary to obtain data from the younger employees. Their direct input would be more reliable and enlightening than the opinion of the trainers, which was how this survey question was approached. Related to that topic is the inclusion of a demographic question on the first instrument to determine the current average age of operators/processors. By including this information in the original survey, it could be determined if an influx of younger employees was actually imminent or if it has already occurred.

Another interesting possibility, related to the educational level of operations personnel, would be to look at the types of training currently delivered to non-operations personnel (for example, management) and determine if the training methodology is different from one type of job or educational level to the next.

Although much valuable information on current training trends was gathered in this study, due to the number of limitations, there is clearly need for further research.

Chapter Five: Conclusions

Summary

This study focuses on answering three research questions concerning the training of operators and processors in the oil, gas and petrochemical industries in the United States. It first asks the current training trends, including methods and tools used for design, development, and delivery of training. It then focuses on the challenges that trainers in these industry face. The final question focuses on how trainers can effectively address the training needs of an increasingly younger workforce.

The majority of trainers who were involved in this research indicated that there is a limited use of multimedia, online and web based training that is often used in other industries. The training delivery tools are mostly limited to desktops and laptops as well as simulators. Development tools that are used most often among this audience are limited to Microsoft Office programs, such as PowerPoint and Word. The most common training delivery methods used are classroom presentations, films, on-job training programs and online/blended courses. It is not possible to conclude from the research how often each of these methods is used or if the current delivery methods have changed with the emergence of new technology.

The challenges faced by trainers were clear: lack of time and lack of budget to provide the most effective training possible. In addition, due to the regulatory compliance training requirements, there is little time or training budget remaining for non-compliance training. These training topics (e.g., leadership, critical thinking, etc.), which could help improve employee performance, are not being delivered very often.

According to the research findings, little consideration is given to changing the training methods and tools to address the technology skills of younger new-hires. The in-house trainers did not feel that this was a problem; however, the consultants involved in the study felt that it was a significant problem.

Further Research

Additional research is needed to determine several factors. First, because of the limited number of respondents/interviewees, it is not possible to determine if the findings of this research are the same as they would be if a much larger target audience was included. A second factor is the depth of information that was garnered through this study. Further research should focus not only on the methods and tools used to design, develop, and deliver training, but also to research why those methods are employed. The reasons could be anything from lack of resources to the target training audience to the comfort level of the trainers themselves. Another needed area of additional research relates to the employees (trainees) rather than the trainers. The trainers interviewed believed that the methods and tools of training delivery were satisfactory to the younger new-hires. The independent training consultants expressed the opposite opinion. Including the trainees in the survey would help determine their actual satisfactory level.

Appendix: Interview Questions

Online Survey Questions

1. What is your company product or service?

   refining _____ chemicals _____

   natural gas _____ oil/gas production _____

   other (specify) _____

2. How many employees do you have?

   Less than 250_____ 250 – 500 _____

   500 – 1000 _____ 1000-5000 _____

   Over 5000 _____

3. Estimate the percentage of Operators/Processors in the following educational levels:

High School or Less _____ Associate's Degree _____

Bachelor's Degree _____ Post-Graduate Work _____

Unsure _____

4. Approximately what percent of your overall annual budget is spent on training?

   0-3% ____ 3-5% ____ 5-10%____

   10-15%___ over 15%___ Unsure ____

5. Is your facility union? Yes ____ No _____

6. What training does your company provide for operators/processors? (Select all that apply.)
   - basic operator training
   - unit skills training
   - safety training
   - troubleshooting training
   - computer skills training
   - soft skills training (for example, diversity, conflict resolution, etc.)
   - operator re-certification

- advanced operator training
- specific skills training (for example, forklift, fire fighting, etc.)
- other (please specify) _____

7. What performance aids do your operators/processors use on the job? (Select all that apply.)
   - training manuals/guides
   - operating procedures/consequence of deviation charts
   - log sheets
   - software programs (please specify) _____
   - other (please specify) _____
8. What training does your company provide for contractors? (Select all that apply.
   - crafts training (welding, pipe fitting, etc.)
   - safety training
   - unit skills training (operations)
   - specific skills training (for example, forklift, fire fighting, etc.)
   - other (please specify) _____
9. Have you completed any return-on-investments studies to measure training effectiveness? (Yes/No)
10. Identify training methods you currently use in training operators/processors. (Mark all that apply.)
    - films/video
    - classroom
    - printed training manuals
    - social media
    - social badging
    - on-job training with a mentor
    - on-line courses/training
    - combined face-to-face and online training (blended)

- personal learning environments (customized employee training resources based on knowledge, skills and interests)
- learning games
- Second Life/virtual worlds
- other (please specify) _____

11. Identify technology tools you currently use to train operators/processors. (Select all that apply.)
    - simulators
    - desktops/laptops
    - tablets
    - smart phones
    - iPads
    - other (please specify) _____
12. What development tools do you use to create training materials/programs? (Select all that apply.)
    - Adobe Creative Suite
    - Flash
    - Captivate
    - PowerPoint
    - Microsoft Word
    - Microsoft Excel
    - other (please specify) _____
13. Do you use an LMS to track training? (Yes/No)
14. If you use an LMS, indicate if it is a commercial or company-developed LMS below.

    commercial (provide name)_____ company-developed ___
15. How many different LMS programs do you use at your site? _____

16. What challenges do you encounter as a training professional associated with training your operators/processors? (Select all that apply.)
    - Too many regulatory compliance requirements to focus on other types of training
    - Insufficient training budgets
    - Insufficient time for employees to train
    - Insufficient employee comfort with technology
    - Lack of access to technology
    - Lack of in-house training resources
    - Lack of employee interest in training
    - Changing workforce demographics
    - Union constraints
    - Proprietary concerns affecting training delivery methods (such as mobile learning)
    - Lack of corporate support of/interest in training issues
    - Other (please specify)

      _____
17. Briefly describe any training innovations you would like to implement at your site for operators/processors.
18. Briefly describe your biggest training concern associated with operators/processors.
19. Are you willing to participate in a brief telephone interview on this topic? (Yes/No)

If your answer to #19 is yes, please provide your name and contact number.

Phone Interview Questions

1. Describe any regulatory compliance training that you provide for your employees that exceeds the minimum OSHA PSM requirements.
2. Describe any return-on-investment studies you have performed to measure training effectiveness.
3. Describe your attempts to close any training gaps in your area/unit/site.
4. If you have multiple company sites, is there an attempt to address consistency in operator/processor training across those sites? If so, briefly describe the approach.
5. What training initiatives have you recommended that have been supported by management? (e.g., computer-based training, collaborative learning, etc.)
    - How did you "sell" the initiative to management?
6. What training initiatives have you recommended that have NOT been supported by management?
    - What reason(s) did management give for their decision?
7. What is the satisfaction level for training of younger employees using the methods and tools you currently have in place?
8. What concerns do you have concerning the future training of younger employees?
9. What plans, if any, are there to modify your current training methods and tools to address younger employees?
10. Discuss the most significant challenges you face as a trainer in addressing the training needs of your organization.

Bibliography

Al-Falah, E., & Al-Shuaib, A. (2000). Impact of On-Site Training on Performance of MSF Plants: A Case Study, *Desalination, 141*,129-143.

Becker, K., Fleming, J., & Keijsers, W. (2011). E-Learning: Ageing Workforce Versus Technology-Savvy Generation, *Education + Training, Vol. 54, No. 5,* 385-400.

Cullen, E. (2011). Effective Training: A Case Study from the Oil & Gas Industry, *Professional Safety*, *March 2011*, 40-47.

Fam, M., Nikoomaram, H., & Soltanian, A. (2011). Comparative Analysis of Creative and Classic Training Methods in Health, Safety and Environment (HSE) Participation Improvement, *Journal of Loss Prevention in the Process Industries 25*, 250-253.

Fletcher, S. (2007). Consultant Sees Surplus of Oil, Gas Workers in 5 Years, *Oil & Gas Journal*, 28.

Flin, R., Slaven, G., & Stewart, K. (1996). Emergency Decision Making in the Offshore Oil and Gas Industry, *Human Factors, 38(2),* 262-277.

Gagné, R. (1985). *The Conditions of Learning and the Theory of Instruction* (4th ed.), New York, NY, Holt, Rinehart, and Winston.

Harward, D. (2012). *Key Trends for 2012: New Era of Personal Learning is Transforming the Training Industry*, Retrieved February 20, 2013 from www.trainingindustry.com/articles.

Heathfield, S. (2010). *The 12 Best Ways to Do On-the-Job Training*, Retrieved February 20, 2013 from About.com.

Heathfield, S. (2010). *Training Trends*, Retrieved February 20, 2013 from About.com.

Hockey, G. Sauer, J., & Wastell, D. (2007). Adaptability of Training in Simulated Process Control: Knowledge-Versus Rule-Based Guidance Under Task Changes and Environmental Stress, *Human Factors*, *Volume 49*, No. 1, 158-174.

Jacobs, R., & Bu-Rahmah, M. (2012). Developing Employee Expertise Through Structured On-the-job Training (S-OJT): an introduction to this training

approach and the KNPC experience, *Industrial and Commercial Training, Vol. 44, No. 2*, 75-84.

Knowles, M. (1970). *The Modern Practice of Adult Education: Andragogy versus Pedagogy*, New York, NY, Association Press.

Knowles, M. (1973), *The Adult Learner: A Neglected Species*, Houston, TX, Gulf Publishing Company.

Lave, L., Ashworth, M., & Gellings, C. (2007). The Aging Workforce: Electricity Industry Challenges and Solutions, *The Electricity Journal, Vol. 20, Issue 2*, 71-80.

Le May, E. (2009). Reducing the Risk of Failure by Better Training and Education, *Engineering Failure Analysis*, 1153-1162.

Occupational Safety and Health Administration (1992), *29CFR1910.119, Process Safety Management of Highly Hazardous Chemicals – Compliance Guidelines and Enforcement Procedures*, Retrieved October 13, 2013 from www.osha.gov.

Punch, K. (2009), *Introduction to Research Methods in Education*, Los Angeles, CA, Sage Publications Ltd.

Rogers, E., & Miller, D. (2008). *Crafting a Blended Learning Strategy*, Retrieved September 15, 2013 from www.gpworldwide.com.

Society for Human Resource Management (2006), *Training Cost Per Employee*, Retrieved October 13, 2013 from www.shrm.org.

True, W. (2011), Learning about Learning, *Oil & Gas Journal*, 11.

Wikipedia, Deepwater Horizon Oil Spill, Retrieved October 13, 2013 from Wikipedia.org.

Woodward, C. (2007). Using Adult Learning Theory for New-Hire Training, *MPAEA Journal of Adult Education*, *Volume XXXVI*, *Number 1*, 44-47.

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