Best Training Practices Within the Software Engineering Industry

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Executive Summary

This section provides a general summary of the findings from the benchmarking study, along with a brief description of the process used and the purpose of the study. Chapter 4 contains a more thorough discussion of the findings, and Chapter 5 provides the specific practices and enablers to those practices that we identified.

Background

This report documents the results of a benchmarking study to identify the best training practices and support training initiatives within the software engineering community. The study was divided into two phases. In the first phase, we collected and analyzed information from a number of organizations to create a broad picture of training as it currently exists in industry. In the second phase, we targeted three organizations for an in-depth study.

Phase One

We sent a survey to over 100 educators from industry, academia, and government in the United States and abroad. We received 24 responses.

Based on the findings of the survey, we did not believe that any one organization embodied the best practices in all the categories listed. Instead, we needed to look at several organizations to identify the best practices. We chose three companies based on the fact that (1) their responses indicated that training had a significant effect on software engineering within their organization, and (2) their training processes were evaluated to be very effective. See Chapter 2 of this report for more details.

Summary of Best Practices

The three organizations that were benchmarked had certain practices in common, which we viewed as indicators of why they could be considered the best. ¹

¹ The persons interviewed during phase 2 of this study represented select areas of the companies involved. Therefore, the practices and enablers reported here are not necessarily representative of the company’s practices as a whole.
These practices included
- a defined process for software engineering education
- a formal needs analysis activity
- availability of a wide variety of courses from different sources
- training by a local, respected organization

See Chapters 4 and 5 for more details.

Summary of Enablers to Best Practices

The enablers to best training practices generally included the following:
- process and quality improvement
- management involvement and support
- employee involvement
- timing of delivery compared to the identified need
- availability of training

See Chapters 4 and 5 for more details.

Areas of Improvement

Most organizations reported flat or declining training budgets. They had learned to do more with less. As a consequence, the number of hours available to each employee on an annual basis seemed low relative to what would be needed to keep up with the field.

Few organizations did return-on-investment analysis relative to training, and those that did could not readily attribute improvement to training. Usually the improvement was seen as part of a larger activity, such as software process improvement.
Best Training Practices Within the Software Engineering Industry

Abstract: This report provides the results of a benchmarking study to identify the best training practices within the software engineering community. We surveyed 24 organizations to create a broad picture of training as it currently exists in industry. We then chose three of these organizations for an in-depth study to identify the best training practices and enablers to those practices. This report summarizes the results of the survey and the in-depth study, and discusses the best practices and enablers that were identified.

1. Overview

1.1 Purpose

The purpose of this report is to document the results of a benchmarking study to identify the best training practices within the software engineering community. The report does not set forth a process to follow, rather it presents the way the benchmarking study was conducted and the results that it generated.

1.2 Intended Audience

The primary audience for this report is educators in industry who may want to use these best practices as reference points for establishing training programs within their own organizations. A secondary audience may be individuals doing Capability Maturity Model (CMM)-based process improvement, especially those trying to implement the Level 3 key process area “Training Program.”

1.3 Background

Problem statement


\(^{sm}\) CMM and Capability Maturity Model are service marks of Carnegie Mellon University.
information was discovered. Organizations were asking for best training practices information that did not exist in a usable form.

The benchmarking study was initiated to solve this problem. Our objective in performing this study was to identify the best training practices and support training initiatives within the software engineering community.

Structure of the Study

The study was divided into two phases. In the first phase, we sent a survey to a number of organizations to create a broad picture of training as it currently exists in industry. We collected the results and analyzed them. In the second phase, we identified three organizations to benchmark. Benchmarking teams led interviews, collected more findings, and identified specific best training practices and enablers.

The Teams

The first phase of the study was undertaken by the SEI, in conjunction with Lawrence Tobin Associates, Inc., a private consulting firm in Maryland.

The second phase of the study was led by a benchmarking team of five individuals: Larry Tobin, Lawrence Tobin Associates; Mary McComb, Lawrence Tobin Associates; Marsha Melkonian, Internal Revenue Service (IRS); Nancy Mead, SEI; and Maribeth Carpenter, SEI. This team was divided into subteams, each of which contacted one of the companies selected for further study.

1.4 Benchmarking

In general, the purpose of a benchmarking study is to uncover better ways of performing some activity—in this instance, training. The objective is to improve practices by looking to others for new approaches, new ideas, or entirely different management philosophies. In benchmarking, the best practices of industry leaders are adopted. The term “best practices” refers to the methods used in work processes whose outputs best meet customer requirements.

The focus is on industry leaders because they provide the best examples to emulate. For this study, industry leaders were defined as companies having the best training process. This focus on process allowed us to consider organizations regardless of their product or industry affiliation. Since it is not always possible or desirable to copy processes from one organization to another, we focused on practices and enablers. Practices and enablers are a way to look at the inner workings of a process independent of how the process is implemented in a particular organization. Practices are defined as what we have to do to achieve a result. Enablers are what we have to do to make the process work. Chapter 5 describes the practices and enablers used by the three industry leaders that we studied.
2. Phase One

2.1 Description of the Survey

We sent the survey to over 100 educators from industry, academia, and government in the United States and abroad. These educators were selected from an SEI database of people who had attended past education conferences and workshops conducted by the SEI. We chose people who we believed were responsible for education in their organizations.

The survey consisted of 37 multiple-choice questions organized into five sections. (A copy of the survey is provided in Appendix A.)

1. Introduction: questions about the existence of a software process improvement program and whether training resulted in improvements to software engineering within the organization

2. Staff development: questions about the level of support for training, the degree of satisfaction with the training, and whether training budgets were increasing, decreasing, or staying the same

3. Training process: questions about who provides training (e.g., a separate group within the organization, outside vendors, or universities); whether training procedures were documented; and whether they used computer-based training or instructor-led training

4. Measurement: questions about what data the organization collected to determine the value of training and who collected these data

5. Planning and requirements: questions on the use and maintenance of training plans, the existence of a mission/vision statement, the use of assessments to determine training needs, and the effectiveness of the training process

We received 24 responses to the survey. Most of the respondents were from the United States, with one response from a European organization. Organizations that responded to the survey included: GTE, Loral Federal Systems (now Lockheed Martin), Florida Atlantic University, IBM, TRW, Lockheed Martin, Philips/Research, Westinghouse, and Northrop Grumman.

2.2 Survey Results

We organized the survey results into the five categories that were described in section 2.1. The response percentages reported for each question were calculated from only the number of responses that we received for that question, not from the total number of
surveys that were completed. The actual data from the survey are contained in Appendix B.²

2.2.1 Summary of Findings

Based on the findings of this survey, we determined that no single organization embodied the best practices in all the categories we studied. Instead, we needed to look at several organizations to identify the best practices (this activity was done in Phase two of the study).

Although the small response to the survey limits its usefulness as a guide to organizational training, the results do lead to some valuable insights:

- For the respondents, return on investment was not an indicator of the value of training. Training is not seen as an instant money maker. Instead, management seems to see it as a means to achieve certain organizational goals.
- Planning is an important element in training. In addition, respondents seem to recognize that continuous improvement is required for a high-quality training program.
- Based on this group of respondents, it seems that training has not achieved the goals set out for it. With only 18% of the respondents indicating that training resulted in significant improvements in software engineering, there seems to be an opportunity for improvement in training.

The following sections provide the detailed results of this survey. If you are interested primarily in the general findings and best practices and enablers of the organizations we studied in depth, see Chapters 4 and 5.

2.2.2 Introduction

The first question of the survey asked whether training was provided to any members of the work force. The response was 100% yes. More specifically, all respondents reported that training was provided in software-related fields.

Of the 17 responses to the question about the existence of a software process improvement program, 100% of the respondents reported that they did have such a program.

The effect of training on software engineering is shown in Figure 1.

2.2.3 Staff Development

The average number of employees in software-related fields was 1,806. Responses to question 3 indicate widespread support for software engineering training: 79% of executives, 92% of middle managers, and 88% of supervisory or project-level management support training. Employees were encouraged by management to attend training (88%), and all respondent organizations allowed time for training during working hours. Data on employees’ degree of satisfaction with training were not so definite (see Figure 2).
Only 14% of respondents indicated that overall training budgets had increased, while 68% indicated that general training budgets were either decreasing or staying the same. A relatively large number of organizations (81%) reported that they had a separate overall training budget.

A similar trend appears for organizations that maintain a separate budget for software engineering and related training. In these organizations, the budgets for software engineering and related training were increasing for 30% of the respondents, but decreasing or staying the same for 43%.

### 2.2.4 Training Process

Of the 24 respondents, 79% reported having a separate group responsible for software engineering and related training. The relatively low effectiveness of training (reported in the general section) may be partially explained by the fact that 57% of respondents reported that the training group was very knowledgeable of software engineering and related functions to begin with. The data shown in Figure 3 seem to indicate a robust training capability within organizations, supplemented when appropriate by outside vendors. They also indicate an increasing interest on the part of universities to engage in training, as well as education.

![Figure 3. Source of Training Development](chart)

While the data indicate that organizations want to retain an internal capability for training development, organizations appear more likely to consider outsourcing for delivery of training. Eighty-three percent of respondents reported partially outsourcing training delivery, compared to 13% who did not outsource at all. Only 4% (1 organization) outsourced all of their training.
Consistent with the low effectiveness rating reported earlier (18% reported a significant effect on engineering), only 17% of the respondents reported that their training process was very effective. However, as shown in Figure 4, 71% felt that their training process was effective.

![Figure 4. Effectiveness of Training](image)

2.2.5 Measurement

Seventy-one percent of the respondents reported that their organization measured the value of training. As shown in Figure 5, the value of training was measured in a variety of ways: learning, application on the job, return on investment, and customer satisfaction.

![Figure 5. Types of Measures](image)
While all respondents reported collecting metrics, only 88% reported keeping records of employee training.

Only 25% of the respondents reported that their organizations advertised the contribution of training to productivity. Perhaps this failure to advertise the value of training is related to the low rating for the effectiveness of training (see previous sections).

A significant number of respondents reported that training is independently evaluated by an outside group (46%), while 67% reported that senior management reviewed the training activities in accordance with a documented procedure. The responses to the question about the effectiveness of the measurement process are shown in Figure 6.

![Figure 6. Effectiveness of Measurement Process](image)

### 2.2.6 Planning and Requirements

Slightly over half of the respondents (58%) reported that their organization had a vision or mission statement for training. Even though 100% of the respondents reported that training existed in their organization, 21% said that there was no vision or mission statement for training and 21% did not know.

There seems to be considerable interaction between the training group and the operational managers (78%). This would suggest that the needs of the customer are at least partly heard by the training group. In addition, 75% of the respondents reported that assessments of training needs are performed always or sometimes.

The majority of respondents reported that training plans are prepared for individuals (54%) and organizational units (71%). The higher percentage for organizations suggests that training is seen as a means for achieving goals. The significant number of requests for training that is not documented in a plan (“off-the-plan” training) also suggests a
relationship between training and organizational goals. Figure 7 shows the percentage of operational managers, training managers, and employees that can request off-the-plan training.

![Figure 7. Requests for Off-the-Plan Training](image)

The survey results emphasize the importance attached to maintaining training plans. Eighty-eight percent of respondents reported that their training plans were maintained.

Although 87% of respondents reported that training needs were sometimes met, none reported that they were always met. Again, this seems consistent with the low ratings for the effectiveness of training. On a more positive note, organizations seem to be responding to the need for training very efficiently (see Figure 8).
The effectiveness of the planning and requirements process is shown in Figure 9. Note that none of the respondents reported that their training process was very effective.
3. Phase Two: The Interview Process

3.1 Target Companies

Based on the results of the survey in Phase One of the study, we identified three companies for a benchmarking study of their training practices: Motorola, McDonnell Douglas, and IBM. These companies were chosen because:

1. Their responses indicated that training had a significant effect on software engineering within their organization.
2. They evaluated their training processes to be very effective.

It is important to note that the persons interviewed represented select areas of the companies involved. Therefore, the practices and enablers reported here are not necessarily representative of the company’s practices as a whole.

3.2 Purpose of Interviews

The main purpose of the interviews was to identify practices and enablers of the companies being studied. The teams focused on identifying practices in the areas that the company had indicated as being positive or superior in the initial survey.

3.3 Data Collection

The benchmarking teams collected data primarily through telephone interviews, although they also reviewed some documents. During the phone interviews, the benchmarking teams used an open-ended interview technique to elicit more detailed information about the areas that we focused on in the survey. This process is not repeatable; that is, we would not expect that someone else could use the material provided in this report to get the exact same results. This material is provided for information only, so others can understand the process that we used to get the results.

Both the benchmarking subteams and the companies being studied used an interviewing guide that outlined the techniques and questions to be used to gain a better understanding of the three organizations’ training processes. Appendix C contains the suggested questions and tips from this interviewing guide that the teams used to collect data.

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4. Phase Two: General Summary of Findings

This chapter provides a general summary of the best training practices and enablers that we identified during our benchmarking study of the three industry leaders. Chapter 5 provides a more detailed description of the specific training practices and the enablers to those practices in the three organizations.

4.1 Summary of Best Practices

The three organizations that were benchmarked had certain practices in common, which we viewed as indicators of why they could be considered the best. These practices included

- a defined process for software engineering education
- a formal needs analysis activity
- availability of a wide variety of courses from different sources
- training by a local, respected organization

We will expand on each of these below.

Defined Process

The benchmarked organizations all had defined and documented processes for education.

New course development or acquisition was based on needs analysis and identification. New courses went through a quality control process to ensure that they were consistent with the stated needs. In addition, new instructors received appropriate instructor training, conducted dry runs, etc.

The organizations kept records of employee and project needs, as well as training completions. There generally was a feedback process that occurred both when a course was completed and again later to determine whether the employees thought the course had been effective. Some organizations also obtained feedback from the managers. This feedback enabled the organizations continuously to improve the quality of their training.

Needs Analysis

A formal needs analysis process was used to identify training needs. This was done by the managers, the employees, or both. In some cases a formal record of individual training needs was kept as a tracking mechanism. The most sophisticated process involved assessing gaps in skills and identifying the training needed to close the gap. Generally, needs analysis was done annually and became part of the overall training plan activity for the following year.
Course Availability

The organizations consistently had courses available from a wide variety of sources. Courses were available from in-house instructors, training vendors, and universities. Support existed for employees to take university courses for credit. In some organizations the courses had to be work related, but in other organizations any university course would be supported. Acquisition of training from vendors was generally done via a centralized process, so as to optimize use of training budgets.

Training by Local, Respected Organizations

Training was provided by local organizations that had the respect of the staff. University training was usually preferred over corporate training because it took only three to four hours a week, and the professor was local and available for help. Successful training focused on the interests and needs of the local people and was customized with examples from their environment [McCabe 96].

4.2 Summary of Enablers to Best Practices

The enablers to the best training practices included the following:

• process and quality improvement
• management involvement and support
• employee involvement
• timing of delivery compared to the identified need
• availability of training

Each of these enablers is explained in more detail below.

Process and Quality Improvement

All the organizations we benchmarked were engaged in software process improvement or quality improvement activities and were aiming for higher maturity levels and improved quality. This correlates well with the need for training, as well as the need for an established training process.

Management Involvement and Support

All the organizations reported involvement and support of all levels of management in the training process. It was felt that management support was essential to the success of the training program, particularly the support of middle management. In one organization, managers developed training plans for their areas based on the skills-gap assessments of individual employees. They then developed an action plan to close the gap.
Employee Involvement

When employees were involved in the training process and the associated needs analysis, they felt that they were getting skills improvement that would be beneficial to them in their careers. Employee involvement helped to overcome the resistance that sometimes occurred when training was viewed as a required addition to an already demanding job.

Timing of Delivery vs. Identified Need

All organizations focused on the importance of delivering the training at the right time relative to the need (i.e., not too early or too late), and they had tracking mechanisms to ensure that this took place. It is important that training be available soon before employees need to apply the skill, not soon after the need is identified.

Availability of Training

All of the benchmarked organizations reported that needed training was delivered even though budgets were flat or declining. They also reported that the availability of university courses for credit significantly helped employees to achieve their development goals.

4.3 Areas of Improvement

In the three organizations that we studied, there were some areas that could be improved upon. These included training budget and return on investment analysis.

Training Budget

Most organizations reported flat or declining training budgets. They had learned to do more with less. As a side effect, the number of hours available to each employee on an annual basis seemed low relative to what would be needed to keep up in the field. As a result, most employees spent some of their own time obtaining training and education outside the workplace.

Return on Investment

Few organizations did return-on-investment analysis relative to training, and those that did could not readily attribute improvement to training. Usually the improvement was seen as part of a larger activity, such as software process improvement.
5. Phase Two: Specific Practices and Enablers

This chapter describes the specific practices and enablers at the three companies in our benchmarking study. We have identified the companies as A, B, and C to protect confidential information. Because the three companies were benchmarked by three different teams, the depth of the practices and enablers information within Sections 5.1-5.3 varies slightly.

Best practices are shown in italicized text. The enabler(s) to each best practice are listed directly below the practice.

5.1 Company A

5.1.1 Background

Company A is one installation of a large company operating from multiple sites. It is estimated that between 35 and 40% of the installation is directly involved in software engineering tasks. Our contact was responsible for the centralized site education department, working with vendors and management to supply the necessary training. There is also a corporate training function to which the sites can go to request training.

5.1.2 Best Practices and Enablers

We identified the following best practices and enablers during our review.

*Practice: A comprehensive skills-gap assessment is completed annually for both the individual and the organization*

Enabler: A focus on skills development, not training

Enabler: Training is viewed as essential for both management and staff.

The vision of the organization is "to enhance organizational performance by accelerating development of critical skills." A major part of the job is identifying those critical skills. This is a very dynamic process. The emphasis is not strictly on training, but on skills development. A skills-gap assessment is done once a year in each area (an area consists of approximately 100 people). Questions such as, "What skills are needed?", "Is there a gap between what is needed and what is available?", "What causes the gap?", and "Is a class necessary to close the gap?", are included in the skills-gap assessment. The assessment is self-administered by managers and staff and the results are reviewed annually. The assessment forms the basis for improving individual skills and organizational capabilities.
There is a continuous effort to improve the quality of training, although not necessarily through the use of quality teams or other structured quality processes. An evaluation process is used to continuously evaluate and verify the training. If the training manager at the centralized company site sees a need for new material to be included in training, the manager evaluates whether it is best included in an existing course or whether there is a need for a new course. The manager gives regular presentations on training to the management at Company A. The following information is included in the presentation:

- the skills-gap assessment results for that manager’s area
- training that has been held
- budget requested and changes
- budget status
- student days in class (past and proposed)
- metrics
- gap analysis (yearly)
- identification of critical skills coming up that will require training (e.g., JAVA)
- books that might augment the training
- question-and-answer session

These presentations are given up the entire line of management, and information is tailored to the responsibility areas of each level of management. Part of the goal of the meeting is to get managers to confirm this information.

Although there is awareness of and interest in process improvement, the focus is not primarily on the CMM. Representatives generally have very positive feelings about the training program. They feel there has been moderate improvement in software engineering due to the training program. This improvement is measured in the decrease in the number of defects per thousand lines of code. This has been a consistent reduction, from 4 or 5 defects per KLOC (thousand lines of code) 5-10 years ago to 0.5 defect per KLOC now.

**Practice:** Management is responsible for closing the skills gap.

**Enabler:** Management can employ a variety of enrichment activities, including training.

Managers are very involved in planning the training for their employees. Training plans are done by managers as part of the annual review process and can be raised to the organization level. Training plans for the areas are based on the skills gap assessment, translated by the manager into an action plan to close the gap. Managers can employ a variety of training experiences, from brown bag lunch sessions all the way to formal training. These plans are working documents since needs in this area frequently change. Off-plan training can also be requested by the manager and charged against the site education budget.
Management does support training. Training is provided for all positions, including managers, although sometimes the training for managers is more of an overview. Some of the training may be designed uniquely for managers (possibly a higher level overview of some of the more technical material). There is no predefined curriculum for the positions, but it is driven by the skills assessments done every year. Short-term curricula are developed by the areas, and the central training function tries to fill in areas where they foresee a need (e.g., object-oriented methods).

Practise: Two-tiered training planning allows for two simultaneous views of the needs of the organization: current project needs and future technology needs.

Enabler: Cross component/functional communications

Enabler: Strategic view of future technologies and needed skills

Training plans are developed by line managers and by staff within the central site training office. This complementary and supportive approach ensures the plan addresses current and future needs of employees and the organization. Training managers use the plan to promote the development of future skills. Line managers use the plan to close current skill gaps.

Employees are expected to participate actively in the planning process. The initial skills assessment is a self assessment. Much of the training that is provided will be on the employee’s time, so they have to commit to that time.

5.2 Company B

5.2.1 Background

Company B has undergone a number of CMM-based appraisals. Their goal is to achieve Level 5 across the organization in the near future. Company B is a major producer of commercial and government/space technology products and services. It has a major corporate software initiative to be a premier software company. The company has made significant commitment to high quality products and mature development processes, and is leading the industry in its focus on education.

Company B’s education staff is visible at the highest corporate levels and enjoys significant corporate support. Its educational resources are among the best in the industry.
5.2.2 Best Practices and Enablers

The best practices and enablers that we identified in this company are discussed below.

**Practice:** A quality software engineering process is incorporated into the organization’s infrastructure.

**Enabler:** Process quality metrics are reported to higher management.

Software process improvement (SPI) is implemented throughout the corporate structure. On the commercial side of the company, there is a software engineering process group (SEPG), which acts as a steering committee; a quality assurance organization; and process action teams. The quality organization does quarterly audits of process and product quality. In addition, the software engineering teams do self assessments to assure quality.

The company uses design assurance, a software engineering resource center for tools and process support, and a chief software engineer. The chief software engineer is responsible for the quality of the software engineering effort. This individual is a key leader with process responsibilities who ensures that proper software engineering processes are assigned to appropriate staff and adhered to by the development teams.

On the government services side of the company, each new project has a process champion with responsibilities similar to those of the chief software engineer.

An award system recognizing quality performance was instituted. Quality performance had been added to position descriptions. The need for quality is communicated throughout the company.

**Practice:** Middle management believes in and supports efforts to improve software process quality.

**Enabler:** Pressure was exerted from customers, technical staff, and upper management to improve the quality of the software process.

The hardest part of implementing quality was causing the behavioral change, especially for middle management. First, people within the company had to sell quality to higher level management. A corporate quality initiative was then instituted, and the need for quality training in software engineering naturally arose from this. A quality champion was appointed to bring the message to the middle levels of the company.

Getting buy-in from top management was key to getting middle management to buy into software process quality. Pressure for quality software engineering actually arose from the technical staff. It traveled up to the executive levels, then down to the middle and lower management levels. Educating the customers about the need for software engineering
quality also helped get middle management buy-in. From there, providing software
ing engineering training was the next natural step.

*Practice: Training is treated as a strategic investment*

Enabler: The organization creates an internal training capability.

Enabler: A minimum training requirement is imposed on the technical staff.

Enabler: A wide range of training opportunities is provided.

A group focused on software engineering was created within the training organization. This

group might be attached to the program area and supplement the training organization.

Trainers are very knowledgeable about software engineering and of immediate and

specific needs. New training may be developed by internal resources, including the training

organization. It may also be developed by external vendors including educational

institutions. Training delivery is outsourced according to who developed it.

There are 12,000 people throughout the corporation who are engaged in software

eering-related activities. All levels of the organization support software engineering

training. Employees have to take at least 40 hours of training each year, and managers are

evaluated on whether their employees meet this 40-hour requirement.

Most of the software engineering courses are technical. However, courses for managers

and support roles, such as configuration management and quality assurance, are being

added.

Training is provided during work hours. Employees are also allowed to take college

courses during working time up to 3 hours per week over and above the 40-hour minimum

requirement.

Training is evaluated immediately after each class. The training organization has recently

started doing follow-ups three to six months later to test for retention and use of the

training. This information is used to update training content.

*Practice: Training is connected with project and individual improvement needs*

Enabler: Individual and project training needs are assessed for new projects.

Enabler: Responsibility for training needs is shared between project management, training

managers, and the individual.

Training is brought into every project from the beginning. Project managers determine

project skill needs at the beginning of each project. Every project plan includes a training
plan. Employees create their own training plans, where they prioritize their training requirements according to the needs of the project and their own strengths and weaknesses. The training organization, project management, and individuals have joint responsibility for meeting training needs.

**Practice:** Statistical process controls applied to software engineering processes.

Enabler: Training is provided in statistical process control tools, especially control charts.

The company applies statistical process controls, especially control charts, to track their process performance. Out-of-control situations are explored for special causes. The company might find that inexperienced and untrained employees are the cause for the out-of-control situation.

**Practice:** Training is continuously improved to ensure it meets customer requirements

Enabler: Training feedback and follow-up are provided.

The training process is subject to continuous improvement based on student feedback and instructor comments. The employees provide immediate feedback and a follow-on assessment three to six months after the training. At the project level, metrics record improvement although it is not always possible to attribute improvements entirely to training. New training courses go through a rigorous evaluation process. Courses are evaluated by corporate professionals and are upgraded based on the feedback from this process.

5.3 Company C

5.3.1 Background

Company C is a large company with a substantial training staff. The company has recently undergone some cutbacks, which have affected the training staff as well as other corporate functions. The organization served by this particular training function reports to an executive vice president. About 10% of the staff are directly involved in software engineering tasks. The software engineering training group is closely connected with software process improvement. Training is obtained from a variety of sources, including in-house courses, external courses, and university courses.
5.3.2 Best Practices and Enablers

The best practices and enablers for Company C are discussed below.

Practice: There are documented practices for training.

Enabler: There is an annual planning process for identifying training needs.

Enabler: Training is a continuous improvement activity. Kirkpatrick feedback methods are used to rank student satisfaction [Kirkpatrick 94]. Plus/minus analysis techniques are used to determine which classes should be changed.

Enabler: Training is an integral part of the software process improvement activity.

Enabler: Course completion information is maintained in training records, which are held by human resources for all employees.

Enabler: Step-by-step procedures exist, which must be followed. If these procedures are not to be followed, a waiver must be obtained.

The organization used Levels 1 through 3 of the Kirkpatrick model to evaluate student satisfaction with the training. Level 1 of the model measures student reaction to the course, Level 2 measures whether the learning objectives were met, and Level 3 measures whether the students used the newly acquired skills and behaviors on the job.

Practice: There is good management support for training

Enabler: Middle management provides excellent support.

Middle managers attend the executive overview course. Managers receive data on the SEPG, including training results, on an annual basis. Letters have been sent from executive management to the training department, thanking them for their participation in the achievement of a higher CMM level. Course completion certificates are given to the managers to distribute to their employees. This way the managers are in the loop and know which courses their employees have completed.

Practice: Courses are obtained from a variety of sources

Enabler: Employees receive a tuition refund for all university courses, regardless of subject matter.

The Kirkpatrick feedback method provided the means for evaluating, and eventually improving, in-house courses. The method determines whether training was effective based on a four-level model.
Enabler: A collaboration between industry and a university assists in obtaining outside courses.

Enabler: There is a catalog of in-house courses that are offered quarterly and on demand.

The organization uses both in-house and outsourced training in its software training program. Outside vendors are usually used for classes on particular technical topics needed by specific projects. Both in-house and outsourced training, however, have the following goals:

- comply with the CMM
- provide value for the training resources spent by projects
- be provided “just-in-time”
- fit course content to the company’s specific needs

The organization uses three parameters to decide whether to develop the training in house or procure the training from other sources:

- volume of training needed
- technical versus process content
- generic versus specific to the organization

In-house training is developed for all training needs that are specific to the organization and for training needs that are both high volume and process oriented. Consortium training is sought for training needs that are low volume, generic, and process oriented. The organization purchases the training from other sources (e.g., junior colleges and vendors) for generic and technically oriented training.

The organization’s goal is to provide 40 hours of training each year for each staff member. This training is to be provided on company time and must be directly relevant to the employee’s job and position.

*Practice: Training is delivered “just-in-time.”*

Enabler: The training organization is nimble enough to be able to adjust schedules so that courses can be offered “just in time.” This applies to in-house courses as well as external courses.

*Practice: The training process is continuously improved.*

Enabler: Kirkpatrick Level 2 or Level 3 feedback is used.
Enabler: Measurements are used to determine whether training is effective. There are standard evaluation forms for all classes. These are summarized in a monthly report for managers.

Enabler: Human Resources staff are involved in training, provide some instructor training, and observe classes.

Enabler: Training is an integral part of SPI and is included in the plan to reach the next CMM level.

Training in software engineering process is done by a separate group, whose members are knowledgeable in software engineering.

The software process training evolved over a number of years to accommodate the following tradeoffs:

• training on company time versus employee time
• training in basic software courses versus the full component of software process courses
• use of in-class training versus self-paced tutorials
• use of courses that are developed fully in house vs. a combination of both in-house and outsourced courses

In 1992, the basic set of training materials included a software project management course, an initial software engineering process course, a class on how to train review leaders, and an executive overview for all upper management. Since then, the organization has made changes to these basic courses based on the following factors:

• need for off-site training
• feedback from attendees (Kirkpatrick method)
• the need to limit in-class time
• availability of the CMM Version 1.1
• the requirement to cover different and additional training material

Management has required that the organization have a corporate roadmap to reach CMM Level 4.

Practice: Classes are effective.

Enabler: Classes are practical and hands on. For example, real student problems are used in teaching software project management. The students do cost estimating for their own projects.

Enabler: A variety of delivery mechanisms are used, such as video and other multimedia.
Enabler: Students are excited about the value of the classes.

Students completed a survey after each class to address Level 1 of the Kirkpatrick model. The survey presented a number of statements, to which students indicated their agreement or disagreement, in varying degrees. Examples of survey statements include

- The course materials were useful.
- The instructor’s presentation was effective.
- The instructor maintained my interest in the course.
- I can apply these ideas/techniques to my (or my team’s) work.
- The ideas/techniques presented will help me (or my team) better achieve my (our) goals.

The survey also provided space for students to comment on other topics such as what they liked best or least about the course and how the material presented in the course would apply to their jobs.
Appendix A: Initial Survey

Benchmarking Study to Identify Best Training Practices Within the Software Engineering Industry

Questionnaire

Please complete all applicable sections of the questionnaire. Please mail or fax the completed questionnaire to Larry Tobin at the above address. All data is confidential.

Name of person completing this questionnaire: ____________________________________________

Position title: ________________________________________________________________

Room number/mail stop: _______________________________________________________

Office telephone number: _______________________________________________________

Company name: _______________________________________________________________

Company address: _____________________________________________________________

________________________________________________________________________

Does your organization provide or make available training to any members of its workforce?
yes ___, no, organization-sponsored training is not available to employees ____.

(If you answer "No" to this question, do not complete the remaining questions. Please return the questionnaire.)

A. Introduction

1. Has a software capability assessment (SCE) been conducted in your organization?

   yes ____, no _____, don’t know ____

2. If yes, are you engaged in a Software Process Improvement Program? ____

3. In your opinion, has training affected software engineering within your organization?

   significant improvement: ____
   moderate improvement: ____
   some improvement: ____
   no improvement: ____

B. Staff Development Questions:

1. How many people in your organization are in software related fields?

   ____ employees, don’t know ____

2. Is software engineering and related training available?
3. Do you feel that management supports software engineering training?
   executive management: yes ___, no ___, no opinion ___
   middle management: yes ___, no ___, no opinion ___
   supervisory (project) management yes ___, no ___, no opinion ___

4. Is training provided for all software engineering-related job classification levels, including managers and support staff?
   yes ___, no ___, don’t know ____

5. Are employees encouraged by management to attend training classes?
   yes ___, no ___, don’t know ____

6. Is time allowed during work hours for training?
   yes ___, no ___, don’t know ____

7. Are people within the organization generally satisfied with the training they receive?
   yes ___, no ___, don’t know ____

8. In general, is the training budget:
   increasing ___, decreasing ___, same as last year ___, no separate budget ___
9. For software engineering and related disciplines, is the training budget:

    increasing ___, decreasing ___, same as last year ___, no separate budget ___

C. Training Process

1. Is there a separate group responsible for providing software engineering and related training?

    yes ____, no ____ , don’t know ____

2. Is this group knowledgeable of software engineering and related functions?

    very knowledgeable ____
    knowledgeable _____
    not knowledgeable ____
    don’t know ____

3. Are new training programs developed: (check all that apply)

    internally ____, by vendors/consultants ____, by university partners ____

4. Is training delivery out-sourced (vendors, consultants, university partners, etc.)

    training delivery is totally out-sourced ____
    training delivery is partially out-sourced ____ , approximate percentage ____
    training delivery is not out-sourced ____
5. Are training procedures documented?

creating training plans: yes ___, no ___, don’t know ___
performing training needs analyses: yes ___, no ___, don’t know ___
requesting training: yes ___, no ___, don’t know ___
training development: yes ___, no ___, don’t know ___
training procurement: yes ___, no ___, don’t know ___
registering for training: yes ___, no ___, don’t know ___
training delivery: yes ___, no ___, don’t know ___
training evaluation: yes ___, no ___, don’t know ___

6. Is the training process subject to continuous improvement?

yes _____, no _____, don’t know _____

7. Is training: (check all that apply)

instructor led ___, computer-based ___

8. How effective is your training process?

very effective: ___
effective: ___
not effective: ___

D. Measurement
1. Does the organization measure the value of training provided?

   yes ____, no ____, don’t know ____

2. If yes, to what level?  ___ learning has occurred  
   ___ application on the job  
   ___ return on investment  
   ___ customer satisfaction indicators

3. Are metrics collected such as student days, enrollment vs. attendance, training planned vs. training provided?

   yes ____, no ____, don’t know ____

4. Are employee training records kept?

   yes ____, no ____, don’t know ____

5. Is training’s contribution to productivity improvement advertised throughout the software engineering organization?

   yes ____, no ____, don’t know ____

6. Is training independently evaluated by a qualified group outside the training organization?

   yes ____, no ____, don’t know ____

7. Are training activities regularly reported to senior management using a documented procedure?
8. How effective is your measurement process?

very effective: ____

effective: ____

not effective: ____

E. Planning & Requirements

1. Is there a vision/mission statement for training?

   yes ____, no ____, don’t know ____

2. Does the training group interact with operations managers to discuss training needs?

   yes ____, no ____, don’t know ____

3. Are training needs assessments conducted?

   always ____, sometimes ____, never ____, don’t know ____

4. Are training plans produced?

   for individuals: yes ____, no ____, don’t know ____

   for organizational units: yes ____, no ____, don’t know ____
5. If yes, can “off-the-plan” training be requested: (check all that apply)

   by operating managers  ____
   by training managers   ____
   directly by employees  ____
   not at all              ____

6. Are training plans maintained?

   maintained ___, ignored ___

7. Are training needs:

   always met___, sometimes met___, never met___, don’t know___

8. On average, how much time elapses between the identification of a training need and the delivery of training?

   when training is purchased  ____ days  don’t know ___
   when training exists in house  ____ days  don’t know ___
   when training must be developed  ____ days  don’t know ___

9. How effective is your planning and requirements process?

   very effective: ____
   effective:  ____
   not effective: ___
Appendix B: Initial Survey Results

Summary Data of Benchmark Study to Identify Best Training Practices Within the Software Engineering Industry 10/27/96

Total Number of People completing the Questionnaire: 24

Does your organization provide or make available training to any members of its work force?

# of YES responses 24 YES as a % of responses 100%
# of NO responses 0 NO as a % of responses 0%
# of responses to question 24 Responses as a % of total questionnaires 100%

A. Introduction

1. Has a CMM Based Appraisal (CBA) been conducted in your organization?

# of YES responses 17 YES as a % of responses 71%
# of NO responses 4 NO as a % of responses 17%
# of DON'T KNOW responses 3 DON'T KNOW as a % of responses 13%
Total # responding 24 Responses as a % of total questionnaires 100%

2. If yes, are you engaged in a Software Process Improvement Program?

# of YES responses 17 YES as a % of responses 100%
# of NO responses 0 NO as a % of responses 0%
# of DON'T KNOW responses 0 DON'T KNOW as a % of responses 0%
Total # responding 17 Responses as a % of total questionnaires 71%

3. In your opinion, has training affected software engineering within your organization?

# of SIGNIFICANT responses 4 SIGNIFICANT as a % of responses 18%
# of MODERATE responses 13 MODERATE as a % of responses 59%
# of SOME responses 5 SOME as a % of responses 23%
# of NO responses 0 NO as a % of total questionnaire 0%
Total # responding 22 Responses as a % of total questionnaires 92%

B. Staff Development Questions

1. How many people in your organization are in software related fields?

# of employee responses 21 Average of average employees given 1805.90476190476
# of DON'T KNOW responses 3
Total # responding 24 Responses as a % of total questionnaires 100%
2. Is software engineering and related training available?

- # of YES responses: 24, YES as a % of responses: 100%
- # of NO responses: 0, NO as a % of responses: 0%
- # of DON'T KNOW responses: 0, DON'T KNOW as a % of responses: 0%
- Total # responding: 24, Responses as a % of total questionnaires: 100%

3. Do you feel that management supports software engineering training?

**Executive Management:**

- # of YES responses: 19, YES as a % of responses: 79%
- # of NO responses: 3, NO as a % of responses: 13%
- # of NO OPINION responses: 2, NO OPINION as a % of responses: 8%
- Total # responding: 24, Responses as a % of total questionnaires: 100%

**Middle Management:**

- # of YES responses: 22, YES as a % of responses: 92%
- # of NO responses: 1, NO as a % of responses: 4%
- # of NO OPINION responses: 1, NO OPINION as a % of responses: 4%
- Total # responding: 24, Responses as a % of total questionnaires: 100%

**Supervisory (project) Management:**

- # of YES responses: 21, YES as a % of responses: 88%
- # of NO responses: 3, NO as a % of responses: 13%
- # of NO OPINION responses: 0, NO OPINION as a % of responses: 0%
- Total # responding: 24, Responses as a % of total questionnaires: 100%

4. Is training provided for all software engineering-related job classification levels, including managers and support staff?

- # of YES responses: 19, YES as a % of responses: 79%
- # of NO responses: 3, NO as a % of responses: 13%
- # of DON'T KNOW responses: 2, DON'T KNOW as a % of responses: 8%
- Total # responding: 24, Responses as a % of total questionnaires: 100%

5. Are employees encouraged by management to attend training classes?

- # of YES responses: 21, YES as a % of responses: 88%
- # of NO responses: 2, NO as a % of responses: 8%
- # of DON'T KNOW responses: 1, DON'T KNOW as a % of responses: 4%
- Total # responding: 24, Responses as a % of total questionnaires: 100%
### 6. Is time allowed during work hours for training?

<table>
<thead>
<tr>
<th>Response</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>24</td>
<td>100%</td>
</tr>
<tr>
<td>NO</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>DON'T KNOW</td>
<td>0</td>
<td>0%</td>
</tr>
</tbody>
</table>

**Total responding:** 24

**Responses as a % of total questionnaires:** 100%

### 7. Are people within the organization generally satisfied with the training they receive?

<table>
<thead>
<tr>
<th>Response</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>17</td>
<td>71%</td>
</tr>
<tr>
<td>NO</td>
<td>3</td>
<td>13%</td>
</tr>
<tr>
<td>DON'T KNOW</td>
<td>4</td>
<td>17%</td>
</tr>
</tbody>
</table>

**Total responding:** 24

**Responses as a % of total questionnaires:** 100%

### 8. In general, is the training budget:

<table>
<thead>
<tr>
<th>Change</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>INCREASING</td>
<td>3</td>
<td>14%</td>
</tr>
<tr>
<td>DECREASING</td>
<td>10</td>
<td>45%</td>
</tr>
<tr>
<td>SAME</td>
<td>5</td>
<td>23%</td>
</tr>
<tr>
<td>NO SEPARATE</td>
<td>4</td>
<td>18%</td>
</tr>
</tbody>
</table>

**Total responding:** 22

**Responses as a % of total questionnaire:** 92%

### 9. For software engineering and related disciplines, is the training budget:

<table>
<thead>
<tr>
<th>Change</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>INCREASING</td>
<td>7</td>
<td>30%</td>
</tr>
<tr>
<td>DECREASING</td>
<td>6</td>
<td>26%</td>
</tr>
<tr>
<td>SAME</td>
<td>4</td>
<td>17%</td>
</tr>
<tr>
<td>NO SEPARATE</td>
<td>6</td>
<td>26%</td>
</tr>
</tbody>
</table>

**Total responding:** 23

**Responses as a % of total questionnaire:** 96%

### C. Training Process

#### 1. Is there a separate group responsible for providing software engineering and related?

<table>
<thead>
<tr>
<th>Response</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>19</td>
<td>79%</td>
</tr>
<tr>
<td>NO</td>
<td>5</td>
<td>21%</td>
</tr>
<tr>
<td>DON'T KNOW</td>
<td>0</td>
<td>0%</td>
</tr>
</tbody>
</table>

**Total responding:** 24

**Responses as a % of total questionnaires:** 100%

#### 2. Is this group knowledgeable of software engineering and related functions?

<table>
<thead>
<tr>
<th>Response</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>VERY</td>
<td>12</td>
<td>57%</td>
</tr>
<tr>
<td>KNOWLEDGEABLE</td>
<td>7</td>
<td>33%</td>
</tr>
<tr>
<td>NOT</td>
<td>2</td>
<td>10%</td>
</tr>
<tr>
<td>DON'T KNOW</td>
<td>0</td>
<td>0%</td>
</tr>
</tbody>
</table>

**Total responding:** 24

**Responses as a % of total questionnaire:** 100%
Total # responding 21  Responses as a % of total questionnaire 88%

3. Are new training programs developed:

<table>
<thead>
<tr>
<th>responses</th>
<th>22</th>
<th>INTERNALLY as a % of responses 92%</th>
</tr>
</thead>
<tbody>
<tr>
<td>VENDORS/CONS responses</td>
<td>20</td>
<td>VENDORS as a % of responses 83%</td>
</tr>
<tr>
<td>UNIVERSITY responses</td>
<td>12</td>
<td>UNIVERSITY as a % of responses 50%</td>
</tr>
<tr>
<td>Total # responding</td>
<td>24</td>
<td>Responses as a % of total questionnaires 100%</td>
</tr>
</tbody>
</table>

4. Is training delivery out-sourced (vendors, consultants, university partners, etc.)?

<table>
<thead>
<tr>
<th>responses</th>
<th>1</th>
<th>TOTALLY as a % of responses 4%</th>
</tr>
</thead>
<tbody>
<tr>
<td>PARTIALLY responses</td>
<td>19</td>
<td>PARTIALLY as a % of responses 83%</td>
</tr>
<tr>
<td>NOT responses</td>
<td>3</td>
<td>NOT as a % of responses 13%</td>
</tr>
<tr>
<td>Total # responding</td>
<td>23</td>
<td>Responses as a % of total questionnaires 96%</td>
</tr>
</tbody>
</table>

Average of % PARTIALLY out-sourced 40%

5. Are training procedures documented?

Creating Training Plans:

<table>
<thead>
<tr>
<th>responses</th>
<th>14</th>
<th>YES as a % of responses 58%</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO responses</td>
<td>7</td>
<td>NO as a % of responses 29%</td>
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<tr>
<td>DON'T KNOW responses</td>
<td>3</td>
<td>DON'T KNOW as a % of responses 13%</td>
</tr>
<tr>
<td>Total # responding</td>
<td>24</td>
<td>Responses as a % of total questionnaires 100%</td>
</tr>
</tbody>
</table>

Performing training needs analyses:

<table>
<thead>
<tr>
<th>responses</th>
<th>16</th>
<th>YES as a % of responses 67%</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO responses</td>
<td>5</td>
<td>NO as a % of responses 21%</td>
</tr>
<tr>
<td>DON'T KNOW responses</td>
<td>3</td>
<td>DON'T KNOW as a % of responses 13%</td>
</tr>
<tr>
<td>Total # responding</td>
<td>24</td>
<td>Responses as a % of total questionnaires 100%</td>
</tr>
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</table>

Requesting training:

<table>
<thead>
<tr>
<th>responses</th>
<th>18</th>
<th>YES as a % of responses 75%</th>
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</thead>
<tbody>
<tr>
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<td>4</td>
<td>NO as a % of responses 17%</td>
</tr>
<tr>
<td>DON'T KNOW responses</td>
<td>2</td>
<td>DON'T KNOW as a % of responses 8%</td>
</tr>
<tr>
<td>Total # responding</td>
<td>24</td>
<td>Responses as a % of total questionnaires 100%</td>
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Training development:

<table>
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<th>responses</th>
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<th>YES as a % of responses 75%</th>
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</thead>
<tbody>
<tr>
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<td>5</td>
<td>NO as a % of responses 21%</td>
</tr>
<tr>
<td>DON'T KNOW responses</td>
<td>1</td>
<td>DON'T KNOW as a % of responses 4%</td>
</tr>
<tr>
<td>Total # responding</td>
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<td>Responses as a % of total questionnaires 100%</td>
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Training Procurement:

<table>
<thead>
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<th>YES as a % of responses</th>
<th># of NO responses</th>
<th>NO as a % of responses</th>
<th># of DON'T KNOW responses</th>
<th>DON'T KNOW as a % of responses</th>
<th>Total # responding</th>
<th>Responses as a % of total questionnaires</th>
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<tbody>
<tr>
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<td>67%</td>
<td>6</td>
<td>25%</td>
<td>2</td>
<td>8%</td>
<td>24</td>
<td>100%</td>
</tr>
<tr>
<td># of NO responses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of DON'T KNOW responses</td>
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<td></td>
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<td>Total # responding</td>
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Registering for training:

<table>
<thead>
<tr>
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<th>YES as a % of responses</th>
<th># of NO responses</th>
<th>NO as a % of responses</th>
<th># of DON'T KNOW responses</th>
<th>DON'T KNOW as a % of responses</th>
<th>Total # responding</th>
<th>Responses as a % of total questionnaires</th>
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<tbody>
<tr>
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<td>88%</td>
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<td>8%</td>
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<td>4%</td>
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<td>100%</td>
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<td></td>
<td></td>
<td></td>
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Training delivery:

<table>
<thead>
<tr>
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<th>YES as a % of responses</th>
<th># of NO responses</th>
<th>NO as a % of responses</th>
<th># of DON'T KNOW responses</th>
<th>DON'T KNOW as a % of responses</th>
<th>Total # responding</th>
<th>Responses as a % of total questionnaires</th>
</tr>
</thead>
<tbody>
<tr>
<td># of YES responses</td>
<td>19</td>
<td>79%</td>
<td>2</td>
<td>8%</td>
<td>3</td>
<td>13%</td>
<td>24</td>
<td>100%</td>
</tr>
<tr>
<td># of NO responses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of DON'T KNOW responses</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total # responding</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Training evaluation:

<table>
<thead>
<tr>
<th></th>
<th># of YES responses</th>
<th>YES as a % of responses</th>
<th># of NO responses</th>
<th>NO as a % of responses</th>
<th># of DON'T KNOW responses</th>
<th>DON'T KNOW as a % of responses</th>
<th>Total # responding</th>
<th>Responses as a % of total questionnaires</th>
</tr>
</thead>
<tbody>
<tr>
<td># of YES responses</td>
<td>20</td>
<td>83%</td>
<td>2</td>
<td>8%</td>
<td>2</td>
<td>8%</td>
<td>24</td>
<td>100%</td>
</tr>
<tr>
<td># of NO responses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of DON'T KNOW responses</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Total # responding</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

6. Is the training process subject to continuous improvement?

<table>
<thead>
<tr>
<th></th>
<th># of YES responses</th>
<th>YES as a % of responses</th>
<th># of NO responses</th>
<th>NO as a % of responses</th>
<th># of DON'T KNOW responses</th>
<th>DON'T KNOW as a % of responses</th>
<th>Total # responding</th>
<th>Responses as a % of total questionnaires</th>
</tr>
</thead>
<tbody>
<tr>
<td># of YES responses</td>
<td>21</td>
<td>88%</td>
<td>1</td>
<td>4%</td>
<td>2</td>
<td>8%</td>
<td>24</td>
<td>100%</td>
</tr>
<tr>
<td># of NO responses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of DON'T KNOW responses</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total # responding</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. Is training:

<table>
<thead>
<tr>
<th></th>
<th># of INSTRUCTOR LED responses</th>
<th>INSTRUCTOR LED as a % of responses</th>
<th># of COMPUTER-BASED responses</th>
<th>COMPUTER-BASED as a % of responses</th>
<th>Total # responding</th>
<th>Responses as a % of total questionnaires</th>
</tr>
</thead>
<tbody>
<tr>
<td># of INSTRUCTOR LED responses</td>
<td>24</td>
<td>100%</td>
<td>12</td>
<td>50%</td>
<td>24</td>
<td>100%</td>
</tr>
<tr>
<td># of COMPUTER-BASED responses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total # responding</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
8. How effective is your training process?

- # of VERY responses: 4, VERY EFFECTIVE as a % of responses: 17%
- # of EFFECTIVE responses: 17, EFFECTIVE as a % of responses: 71%
- # of NOT responses: 3, NOT EFFECTIVE as a % of responses: 13%
- Total # responding: 24, Responses as a % of total questionnaires: 100%

D. Measurement

1. Does the organization measure the value of training provided?

- # of YES responses: 17, YES as a % of responses: 71%
- # of NO responses: 7, NO as a % of responses: 29%
- # of DON'T KNOW responses: 0, DON'T KNOW as a % of responses: 0%
- Total # responding: 24, Responses as a % of total questionnaires: 100%

2. If yes, to what level?

- # of LEARNING HAS OCCURRED responses: 8, LEARNING as a % of responses: 50%
- # of APPLICATION ON THE JOB responses: 8, APPLICATION as a % of responses: 50%
- # of RETURN ON INVESTMENT responses: 1, ROI as a % of responses: 6%
- # of CUSTOMER SATISFACTION responses: 8, CUSTOMER as a % of responses: 50%
- Total # responding: 16, Responses as a % of total questionnaires: 67%

3. Are metrics collected such as student days, enrollment vs. attendance, training planned vs. training provided?

- # of YES responses: 24, YES as a % of responses: 100%
- # of NO responses: 0, NO as a % of responses: 0%
- # of DON'T KNOW responses: 0, DON'T KNOW as a % of responses: 0%
- Total # responding: 24, Responses as a % of total questionnaires: 100%

4. Are employee training records kept?

- # of YES responses: 21, YES as a % of responses: 88%
- # of NO responses: 2, NO as a % of responses: 8%
- # of DON'T KNOW responses: 1, DON'T KNOW as a % of responses: 4%
- Total # responding: 24, Responses as a % of total questionnaires: 100%

5. Is training’s contribution to productivity improvement advertised throughout the software engineering organization?

- # of YES responses: 6, YES as a % of responses: 25%
- # of NO responses: 15, NO as a % of responses: 63%
- # of DON'T KNOW responses: 3, DON'T KNOW as a % of responses: 13%
- Total # responding: 24, Responses as a % of total questionnaires: 100%
6. Is training independently evaluated by a qualified group outside the training organization?

<table>
<thead>
<tr>
<th>Response</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>11</td>
<td>46%</td>
</tr>
<tr>
<td>NO</td>
<td>12</td>
<td>50%</td>
</tr>
<tr>
<td>DON'T KNOW</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>100%</td>
</tr>
</tbody>
</table>

7. Are training activities regularly reported to senior management using a documented procedure?

<table>
<thead>
<tr>
<th>Response</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>16</td>
<td>67%</td>
</tr>
<tr>
<td>NO</td>
<td>6</td>
<td>25%</td>
</tr>
<tr>
<td>DON'T KNOW</td>
<td>2</td>
<td>8%</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>100%</td>
</tr>
</tbody>
</table>

8. How effective is your measurement process?

<table>
<thead>
<tr>
<th>Response</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>VERY</td>
<td>2</td>
<td>9%</td>
</tr>
<tr>
<td>EFFECTIVE</td>
<td>14</td>
<td>61%</td>
</tr>
<tr>
<td>NOT</td>
<td>7</td>
<td>30%</td>
</tr>
<tr>
<td>Total</td>
<td>23</td>
<td>96%</td>
</tr>
</tbody>
</table>

E. Planning and Requirements

1. Is there a vision/mission statement for training?

<table>
<thead>
<tr>
<th>Response</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>14</td>
<td>58%</td>
</tr>
<tr>
<td>NO</td>
<td>5</td>
<td>21%</td>
</tr>
<tr>
<td>DON'T KNOW</td>
<td>5</td>
<td>21%</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>100%</td>
</tr>
</tbody>
</table>

2. Does the training group interact with operations managers to discuss training needs?

<table>
<thead>
<tr>
<th>Response</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>18</td>
<td>78%</td>
</tr>
<tr>
<td>NO</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td>DON'T KNOW</td>
<td>4</td>
<td>17%</td>
</tr>
<tr>
<td>Total</td>
<td>23</td>
<td>96%</td>
</tr>
</tbody>
</table>

3. Are training needs assessments conducted?

<table>
<thead>
<tr>
<th>Response</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALWAYS</td>
<td>5</td>
<td>21%</td>
</tr>
<tr>
<td>SOMETIME</td>
<td>13</td>
<td>54%</td>
</tr>
<tr>
<td>NEVER</td>
<td>2</td>
<td>8%</td>
</tr>
<tr>
<td>DON'T KNOW</td>
<td>4</td>
<td>17%</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>100%</td>
</tr>
</tbody>
</table>
4. Are training plans produced?

For individuals:

<table>
<thead>
<tr>
<th>Response</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>13</td>
<td>54%</td>
</tr>
<tr>
<td>NO</td>
<td>6</td>
<td>25%</td>
</tr>
<tr>
<td>DON'T KNOW</td>
<td>5</td>
<td>21%</td>
</tr>
<tr>
<td>Total # responding</td>
<td>24</td>
<td>100%</td>
</tr>
</tbody>
</table>

For organizational units:

<table>
<thead>
<tr>
<th>Response</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>17</td>
<td>71%</td>
</tr>
<tr>
<td>NO</td>
<td>4</td>
<td>17%</td>
</tr>
<tr>
<td>DON'T KNOW</td>
<td>3</td>
<td>13%</td>
</tr>
<tr>
<td>Total # responding</td>
<td>24</td>
<td>100%</td>
</tr>
</tbody>
</table>

5. If yes, can “off-the-plan” training be requested:

<table>
<thead>
<tr>
<th>Response</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPS MGR</td>
<td>18</td>
<td>95%</td>
</tr>
<tr>
<td>TRAINING MGR</td>
<td>15</td>
<td>79%</td>
</tr>
<tr>
<td>DIRECT</td>
<td>16</td>
<td>84%</td>
</tr>
<tr>
<td>NOT AT ALL</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Total # responding</td>
<td>19</td>
<td>79%</td>
</tr>
</tbody>
</table>

6. Are training plans maintained?

<table>
<thead>
<tr>
<th>Response</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAINTAINED</td>
<td>14</td>
<td>88%</td>
</tr>
<tr>
<td>IGNORED</td>
<td>2</td>
<td>13%</td>
</tr>
<tr>
<td>Total # responding</td>
<td>16</td>
<td>67%</td>
</tr>
</tbody>
</table>

7. Are training needs:

<table>
<thead>
<tr>
<th>Response</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALWAYS MET</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>SOMETIMES MET</td>
<td>20</td>
<td>87%</td>
</tr>
<tr>
<td>NEVER MET</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>DON'T KNOW</td>
<td>3</td>
<td>13%</td>
</tr>
<tr>
<td>Total # responding</td>
<td>23</td>
<td>96%</td>
</tr>
</tbody>
</table>

8. On average, how much time elapses between the identification of a training need and the delivery of training?

When training is purchased:

<table>
<thead>
<tr>
<th>Response</th>
<th>Count</th>
<th>Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>PURCHASED</td>
<td>15</td>
<td>47.46</td>
</tr>
<tr>
<td>DON'T KNOW</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Total # responding</td>
<td>21</td>
<td>88%</td>
</tr>
</tbody>
</table>
When training exists in house:

<table>
<thead>
<tr>
<th>Response Type</th>
<th>Count</th>
<th>Description</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td># of EXISTS responses</td>
<td>15</td>
<td>Average of average days given</td>
<td>39</td>
</tr>
<tr>
<td># of DON'T KNOW responses</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total # responding</td>
<td>20</td>
<td>Responses as a % of total questionnaires</td>
<td>83%</td>
</tr>
</tbody>
</table>

When training must be developed:

<table>
<thead>
<tr>
<th>Response Type</th>
<th>Count</th>
<th>Description</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td># of DEVELOP responses</td>
<td>12</td>
<td>Average of average days given</td>
<td>120</td>
</tr>
<tr>
<td># of DON'T KNOW responses</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total # responding</td>
<td>18</td>
<td>Responses as a % of total questionnaires</td>
<td>75%</td>
</tr>
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</table>

9. How effective is your planning and requirements process?

<table>
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<tr>
<th>Response Type</th>
<th>Count</th>
<th>Description</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td># of VERY responses</td>
<td>0</td>
<td>VERY EFFECTIVE as a % of responses</td>
<td>0%</td>
</tr>
<tr>
<td># of EFFECTIVE responses</td>
<td>17</td>
<td>EFFECTIVE as a % of responses</td>
<td>77%</td>
</tr>
<tr>
<td># of NOT responses</td>
<td>5</td>
<td>NOT EFFECTIVE as a % of responses</td>
<td>23%</td>
</tr>
<tr>
<td>Total # responding</td>
<td>22</td>
<td>Responses as a % of total questionnaires</td>
<td>92%</td>
</tr>
</tbody>
</table>
Appendix C: Interview Questions

Section A. Introduction

Question A-1: If a CMM-Based Appraisal (CBA) has been conducted, inquire into the findings.

Question A-2: If the phase one answer to this question is “yes,” ask how the software process improvement (SPI) has been implemented in the organization. Ask whether it is based on the CMM, or another model. Try to understand how the organization has changed to implement SPI, the tactical strategies employed to facilitate behavioral change, and how changes are controlled from the management perspective. Although more detailed questions follow, determine whether training is considered to be a formal part of the SPI program. Develop a complete picture of the implementation approach. Consider developing a flow chart as a means for displaying the implementation process. This question has the potential for gathering a large amount of data.

If the phase one answer to this question is “no,” ask why not? Explore reasons against SPI especially in terms of cost, perceived need, organizational size and structure, and culture.

Question A-3: Ask the basis for the answer given for this question. The answer should clearly indicate objective versus subjective bases. If the answer was based on subjective factors, inquire what those factors are.

Section B. Staff Development Questions

Question B-1: Attempt to determine the percentage of personnel directly involved in software engineering tasks. Include managers, developers and other professional staff in the count.

Question B-2: Obtain a list of available software engineering-related training classes.

Question B-3: Determine the bases for these answers. How is this support expressed?
**Question B-4:** If not revealed in Question B-2, determine whether curricula exist for software engineering-related positions. Determine the basis for the curricula; e.g. CMM-based, University developed, etc.

**Question B-5:** If the answer is “yes,” determine how this encouragement is expressed. If the answer is “no” or “don’t know,” determine why not.

**Question B-6:** If the answer is “yes,” determine whether this policy causes hardship to the organization. If yes, identify the strategies employed to overcome these negative impacts. If the answer is “no” or “don’t know,” ask when training is provided, and whether employee reactions to this scheduling have been tracked. Determine the nature of these reactions, and the degree to which employees support the training program.

**Question B-7:** If the answer is “yes,” determine how the benchmarking partner knows that people are satisfied with the training. Also, determine why they are satisfied. If the answer is “no”, determine how the benchmarking partner knows this, and why students are not satisfied.

**Question B-8:** Actual dollars spent on training is not important. Determine the percentage change in the training budget since the last budget year. Determine why there has been a change, and the impacts of the change on training.

**Question B-9:** Actual dollars spent on training is not important. Determine the percentage change in the software engineering training budget since the last budget year. Determine why there has been a change, and the impacts of the change on software engineering training.

**Section C. Training Process**

**Question C-1:** If the answer is “yes,” ask for the name of the group, and the number of staff assigned. If the answer is “no” or “don’t know,” ask how software engineering training is handled organizationally. Skip to question C-3.

**Question C-2:** If the answer is “knowledgeable or very knowledgeable,” ask how staff are selected and trained. Are there technical requirements for training positions? Also, ask
how the knowledge of the software engineering training staff is assessed, and whether there is a mechanism for continually upgrading the knowledge base of the software engineering training group. In addition, determine whether the software engineering training group receives instruction on developing and/or delivering training materials.

If the answer is “not knowledgeable,” determine how the benchmarking partner makes up for this lack of knowledge, if at all. In addition, determine the impact on software engineering training overall by the lack of a knowledgeable training group.

**Question C-3:** If multiple sources are used, determine the basis for dividing the development work.

**Question C-4:** If multiple sources are used, determine the basis for dividing the delivery work.

**Question C-5:** For “yes” answers in the categories listed under this question, determine whether the procedures are available. If available, request copies. Otherwise, determine the content of the procedures. For “no” answers in the categories listed under this question, determine what, if anything, is done in these areas.

**Question C-6:** If the answer is “yes,” determine how continuous improvement is applied to training. Are quality improvement teams employed? Are decisions which change the training process based on data? If appropriate, prepare a flow chart or diagram of the continuous improvement process. If the answer is “no” or “don’t know,” ask if there is a process for insuring that customer training requirements are met. If so, identify the process.

**Question C-7:** If multiple answers are indicated, determine how the decision is made whether to use an instructor and/or computer-based training.

**Question C-8:** Determine why the training process is either very effective, effective, or not effective. Determine if there are critical success factors for software engineering training (or training in general), and what they are. If you don’t understand the training process, ask for clarification and create a new flowchart or correct a flowchart already prepared. Finally, understand whether the answer is based on empirical or subjective data.

**Section D. Measurement**
Question D-1: If the answer is “yes,” determine how training value is defined. If reports are prepared, request copies. If the answer is “no” or “don’t know,” skip to question D-3.

Question D-2: Identify the procedures used to evaluate training. Obtain copies of any forms, questionnaires, and reports related to measuring the value of training. Understand the entire measurement and evaluation process. If appropriate, prepare a flowchart or other diagram to illustrate the process.

Question D-3: If the answer is “yes,” identify all the metrics used to analyze and evaluate training data. Also, determine how and when these metrics are used, and the significance of each metric. If the answer is “no” or “don’t know,” ask whether reports are produced that provide measures that can be related to the value of training. Obtain examples of any such measures.

Question D-4: If the answer is “yes,” identify the data elements stored in these training records. If the answer is “no” or “don’t know,” ask if it is important to the organization what training courses an employee has completed. Determine if promotions or work awards take training into account. If training is taken into account, determine how the organization knows what training was taken by the employee.

Question D-5: If the answer is “yes,” determine the communication methods and strategies used. If the answer is “no” or “don’t know,” determine if information on contract awards, software engineering project successes, or related information is distributed, and how it is disseminated.

Question D-6: If the answer is “yes,” determine if this is done periodically. Also, identify the information gathered, and the results of the latest survey. If the answer is “no” or “don’t know,” determine if any audits of the training department are conducted; by whom, what data are collected, and how often.

Question D-7: If the answer is “yes,” obtain a copy of the procedure. Determine how often the reports are made, and the information typically provided. If the answer is “no” or “don’t know,” determine if management has any concerns about training, and what they are.

Question D-8: Determine why the measurement process is either very effective, effective, or not effective. If you don’t understand the measurement process, ask for clarification and...
create a new flowchart or correct a flowchart already prepared. Finally, understand whether the answer is based on empirical or subjective data.

Section E. Planning and Requirements

Question E-1: If the answer is “yes,” obtain a copy of the vision and/or mission statement. Determine how the vision/mission is communicated to the training units. Identify the training objectives and goals that are associated with the vision/mission, and how the organization knows these objectives and goals are accomplished. If appropriate, illustrate the vision and/mission deployment strategy in chart or flow diagram form. Conclude by determining how aware the training staff is of the vision/mission and their role in its implementation. If the answer is “no” or “don’t know,” determine if training objectives and goals exist, and if they do, what they are and how they are formulated.

Question E-2: If the answer is “yes,” describe the process. If the answer is “no” or “don’t know,” determine how or if manager input is factored into training decisions.

Question E-3: If the answer is “always” or “sometimes” determine if there is a standard format for needs assessments, and obtain a copy of that format. If the answer is “sometimes,” “never,” or “don’t know,” determine how decisions on course requirements are made, who makes them, and their accuracy in selecting course content.

Question E-4: If the answer is “yes,” obtain an example of a sample plan. If the answer is “no” or “don’t know,” ask how training courses are selected, and what factors influence scheduling.

Question E-5: If blocks are checked, determine if special procedures are required to select off-the-plan courses. Obtain a copy of these procedures.

Question E-6: If the answer is “maintained,” determine who maintains the records. What data are updated to the records. If the answer is “ignored,” determine why this happens.

Question E-7: Determine how the benchmarking partner knows for sure that the response to this question is accurate.
Question E-8: If days-data are shown, determine whether these values are acceptable to the organization. Is anything being done to shorten cycle times? If so, what?

Question E-9: Determine why the planning and requirements process is either very effective, effective, or not effective. If you don’t understand the planning and requirements process, ask for clarification. Create a new flowchart or correct a flowchart already prepared. Finally, understand whether the answer is based on empirical data or subjective data.
References


[APQC 96] American Productivity and Quality Centre, International Benchmarking Clearinghouse, can be found at http://www.apqc.org/
This report provides the results of a benchmarking study to identify the best training practices within the software Engineering Community. We surveyed 24 organizations to create a broad picture of training as it currently exists in industry. We then chose three of these organizations for an in-depth study to identify the best training practices and enablers to those practices. This report summarizes the results of the survey and the in-depth study, and discusses the best practices and enablers that were identified.