SEMATECH

# PERFORMANCE-BASED EQUIPMENT TRAINING

**A Performance Improvement Program Developed by the SEMATECH**
**Organizational Learning and Performance Technology Department**

# INSTRUCTOR GUIDE

**October 1, 1995**

# Performance-Based Equipment Training (PBET) Instructor Guide

**SEMATECH** Technology Transfer
95102996A-TRG

# Performance-Based Equipment Training (PBET) Instructor Guide

Technology Transfer # **95102996A-TRG**
**SEMATECH**
*January 31, 1996*

**Abstract:** This document provides the course materials that are designed to assist instructors in the delivery of an entry-level course in the concepts of Performance-Based Equipment Training (PBET), a workshop developed by SEMATECH's Organizational Learning and Performance Technology Department. The course is designed for persons who are responsible for training others in the operation, maintenance, and/or repair of process equipment and is best suited for equipment trainers, technical trainers, and technical training developers. This document helps the instructor teach the basic steps for designing and developing effective training courses, with emphasis on the instructional development process. Its eight modules provide an introduction and modules teaching how to identify, analyze, design, develop, pilot, deliver, and evaluate training courses. It is supplemented by three companion documents: *Performance Based Equipment Training (PBET) Participant Guide* , Technology Transfer #95102995A-TRG; *Performance-Based Equipment Training (PBET) Transparency Masters*, Technology Transfer #95103004A-TRG; and *Performance-Based Equipment Training (PBET) Templates*, Technology Transfer #95103011A-TRG.

**Keywords:** Training, Instructor Guide, Equipment, Quality Management, Manufacturing Technicians

**Approvals:** Julian Serda, Author/Project Manager
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## Table of Contents

## 1 EXECUTIVE SUMMARY

This document provides instructor's materials for leading (teaching) the delivery of the Performance-Based Equipment Training (PBET) course. It explains the basic steps for designing and developing effective training courses, with emphasis on the instructional module development process. The vision behind these materials is to improve corporate training practices while raising the skill level of the U.S. semiconductor workforce.

The PBET course outlined in this document is designed for persons who are responsible for training others in the operation, maintenance, and/or repair of process equipment. To benefit from this material, a participant need not have a degree in education or engineering, nor have training experience. However, the course is best suited for equipment trainers, technical trainers, and technical training developers.

The course includes eight modules covering the following topics:

- Introduction: Course orientation and characteristics and design phases of PBET
- Identify Module: Perform needs analysis
- Analyze Module: Perform task analysis, write performance objectives, and develop a skills hierarchy
- Design Module: Develop skills tests, describe relevant practice, analyze materials, select delivery method, summarize a PBET lesson, and complete a second PBET lesson plan
- Develop Module: Develop instructional materials
- Pilot Module: Describe trainer characteristics and pilot a short PBET lesson
- Deliver Module: Describe trainer responsibilities, prepare a training curriculum checklist, create an action plan for PBET implementation
- Evaluate Module: Describe evaluation levels

Note: The Instructor Guide is formatted in a two-page manner wherein the page on the right is exactly the same as what the participant would see in his book. The left side page provides a guide to assist the course instructor in the delivery of the information that appears on the participant's page.

Also, appendixes include course-related forms, lists, and bibliography.

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# PERFORMANCE-BASED EQUIPMENT TRAINING

**a Performance Improvement Program developed by the SEMATECH Organizational Learning and Performance Technology Department**

Your comments and recommendations for continuous improvement of this program are sincerely appreciated. For more information regarding the PBET program and training schedules, contact the Organizational Learning and Performance Technology Department.

SEMATECH and SEMI/SEMATECH member companies may obtain copies of this training manual by contacting the SEMATECH Technology Transfer Department. Refer to Appendix F for information regarding this PBET course and other courses that are available through Tech Transfer.


*SEMATECH*

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The Organizational Learning and Performance Technology Department would like to extend its appreciation to all SEMATECH employees, SEMATECH and SEMI/SEMATECH members, and consultants who contributed to the development of this training program.

**ACKNOWLEDGEMENTS**

**Organizational Learning and Performance Technology**

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**Content Expertise and Technical Editing**

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SEMATECH Supplier Development Department

SEMATECH Technician Training Council

SEMATECH Technology Transfer Department

## NOTES TO THE INSTRUCTOR

**Materials/Equipment:**

- Instructor guide (SEMATECH #95102996A-TRG), Participant guides and PBET lesson planning templates (SEMATECH #95102995A-TRG) , transparency foils (SEMATECH #95103004A-XFR)
- Task Analysis video (SEMATECH # 95052836A-TRG)
- VCR and TV -- for use with Task Analysis video
- Overhead projector, pointer, markers for transparency foils
- Flipchart pad -- one or two for instructor and one for each table of participants
- 3M Post-it pads or index cards (3x5) -- one set per table
- Pens, pencils, flipchart markers and transparency markers, masking tape
- Name tents, note pads -- one per participant
- Legos -- enough so each pair of participants shares one box
- Envelope with enabling objectives for skills hierarchy practice exercise -- one per pair
- Basket of assorted candies in pairs with total number equal to class size (optional)
- Cleanroom garb (hairnet, gloves, booties) for Honeymooners skit (optional)
- Music playback system for Classical and Baroque recorded music (optional)
- Posters to decorate room and for instructional purposes (list of posters)
- Blank lesson planning forms -- two per participant
- Course evaluation forms -- one per participant
- Attendance sheet -- one for each day
- Mager Six Pack and or Robert Mager book list (optional)

- Provide breakfast and lunch catering (optional, but recommended to conserve time)

**Instructor's Notes:**

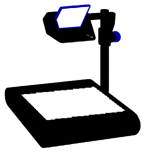
Always read the foils aloud to the class.  Make sure all of your materials are collected and ready.  Have name tents for each participant.  Remember to pass out the course evaluation forms before the end of the third day.

The modules in this course are numbered and follow the sequence of PBET phases.  It's at the discretion of the instructor to use the modules in a sequence that seems best suited for the circumstances.  Refer to the course map accompanying this guide, located on page IN-1-6.  This course map describes the most logical sequencing of each unit of instruction.

***NOTES:***

# Introduction

## (IN-1) COURSE ORIENTATION



**Performance-Based Equipment Training**

- This course introduces the concepts of PBET
- We will cover basic steps of designing and developing PBET
- You will complete two PBET lesson plans
  - one lesson will be assigned to you
  - one lesson in an area of your choice

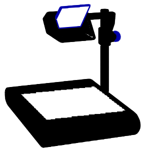
**IN-1**

## PERFORMANCE-BASED EQUIPMENT TRAINING

**PURPOSE:**

- **Learn Methods for Effective Equipment Training**
- **Learn or Improve Skills for Performing Task Analysis**
- **Perform Skills Analysis and Develop Training Checklists**
- **Learn an Easy Way to Develop Effective Lesson Plans**
- **Develop PBET Materials for a Specific Equipment Training Application**
- **Practice Communication Skills**

This course introduces concepts of Performance-Based Equipment Training (PBET). The basic steps in designing and developing effective training courses will be explained. Most of the time will be spent on the instructional module development process. A simple template (job aid) will be provided to help simplify and accelerate the process of learning how to prepare an effective lesson in PBET for application in your training facility (see Appendix A).

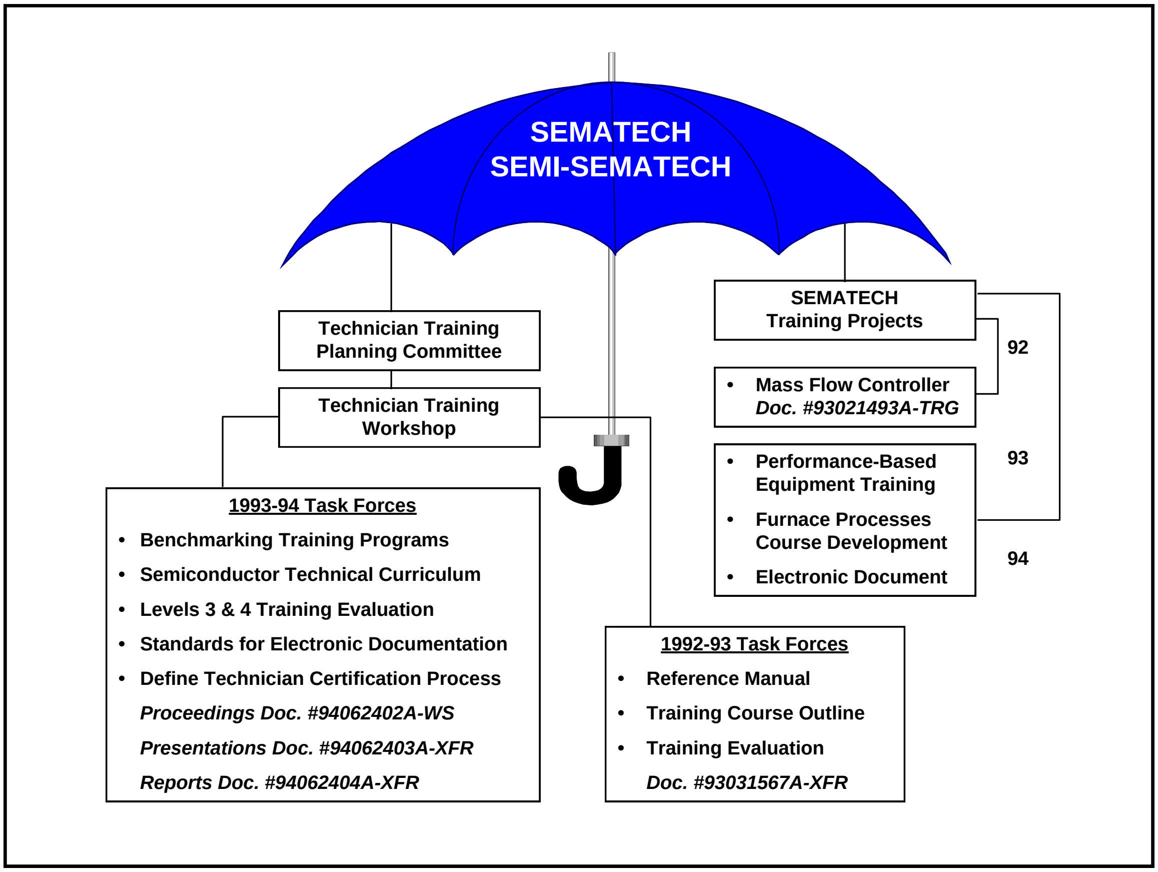


**Performance-Based Equipment Training Definition**

- PBET is the result of the work of two task forces
  - Following the 1992 Technician Training Workshop, the best methods for technical and equipment training were explored
  - Reference foil -- SEMATECH umbrella

- The results were published and are available
  - Doc. # 93031567A-XFR

    Reference Appendix F for SEMATECH Technology Transfer document request forms (page F-7)
  - Additional SEMATECH transferable courses (pages F1-F7)
- Some of the task forces' recommendations included:
  - Training providers should adopt a performance-based training approach
  - Training users/suppliers should adopt and use the first three levels of evaluation
    - We will cover levels of evaluation later
  - Educate managers on how PBET is efficient
  - Educate trainers on why PBET is necessary and how to implement it
  - Educate participants on why PBET is necessary and how they will benefit



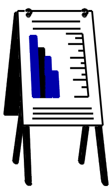

The PBET concept evolved following the 1992 Technician Training Workshop. Two task forces explored the best methods known for technical and equipment training. The results of this research were published and can be obtained through the SEMATECH Technology Transfer Department (Doc. # 93031567A-XFR).

The task forces made some key recommendations that resulted in the creation of this training project. Some of the task forces' recommendations included:

- Training providers should adopt a performance-based training approach
- Training users and suppliers should adopt and use the first three levels of evaluation. (We will cover levels of evaluation later in this course)
- Educate managers on how PBET is efficient, including the business performance improvement process
- Educate trainers on why PBET is necessary and on how to implement the process
- Educate participants on why PBET is necessary and how they will benefit from it

**Intended Audience**

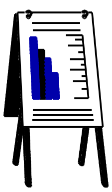
- Originally intended for SEMI/SEMATECH members, but methodology is also recommended for SEMATECH members
- Anyone who trains others in the concepts of operation, maintenance, and/or repair of process equipment



- PBET applies for all of the following:
  - Rules, laws, regulations
  - Concept
  - Procedure
  - Process or principle
- This course is instructor-led and foil-driven
  - Feel free to ask questions
- Each module has a practice session and skill test
  - Ample opportunity will be provided to master concepts presented in this course

**Introductions:**

***Instructor Note:*** *Take a few minutes to have all participants give their name, where they're from, their background, project description, and why they're taking the PBET course (expectations)*



- *Document (record) expectations and post flipchart*
- *Throughout this course, use the flipchart to record concerns, questions, ideas, etc.*
- *Post on wall.*

# Intended Audience

- **SEMI/SEMATECH Member Companies**
  - **Equipment Suppliers**
  - **OEM Manufacturers**
- **SEMATECH Member Companies**

- **Who should attend this workshop?**
  - **Equipment Trainers**
  - **Technical Training Developers**
  - **Technical Trainers**

    ***. . . no experience necessary***

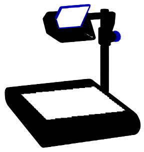
This training session is intended for any participant who is responsible for training others in the operation, maintenance, and/or repair of process equipment.

This is an entry level course in instructional design. Neither a degree in education nor a degree in engineering is required. Training experience is also not necessary.

While the principles presented in this course can benefit anyone who is responsible for training others, equipment trainers, technical trainers, and technical training developers can best profit from this class.

Although this class is instructor-led and foil-driven, interaction with the instructor is always encouraged. Feel free to ask questions. "No question is dumb, except for the thoughts that remain silent and hidden in someone's conscience."

You will have an opportunity to exercise your mastery of the concepts presented in this class. Each module will have a practice section as well as a skill test section.



**Class Schedule, Facilities, and Logistics:**

1. Class will be held ____________ through _____________ from ____________ to _____________

**Lunch**

2. Lunch break from ____________ to ___________

**Breaks**

3. A 15-minute break will be provided during the morning and afternoon sessions. The class will resume exactly 15 minutes after each break.

**Amenities**

4. Coffee, soft drinks, and water have been provided at the rear of the conference room. Feel free to refill at any time.

**Telephones**

5. Telephones are located _____________________________ ______________________________________. Restrooms are in the area ___________________________________.

**Emergency Exits**

6. In the event of an emergency, we would exit this room through the ______________ doors, exit out of the building through _______________, and gather at the ____________________________.

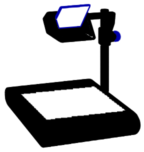
**Instructional Assistants**

7. There are several instructional consultants monitoring the class to lend assistance during the training session. Feel free to call on them if you have a question or a concern.

**Evaluation Forms**

8. Please don't forget to fill out both sides of the course evaluation sheet before you leave the class today. Your input is appreciated. Without your feedback we have no idea if we are serving your training needs.

# Workshop Logistics



**Course Outline**

- Course title is Performance-Based Equipment Training
- These are the modules this course covers
- This foil is an example of a serial or linear listing of lessons, referred to as a course outline

***Instructor Note:***

*Estimated time for each module --*

| | | *Day 1* | *Day 2* | *Day3 (suggested order)* |
|---|---|---|---|---|
| *IN-1* | *0:45* | *1* | | |
| *IN-2* | *0:45* | *2* | | |
| *IN-3* | *1:00* | *3* | | |
| *ID-1* | *0:30* | *4* | | |
| *AN-1* | *2:00* | *5* | | |
| *AN-2* | *2:00* | *6* | | |
| *AN-3* | *1:30* | | *1* | |
| *DS-1* | *0:30* | | *2* | |
| *DS-2* | *1:00* | | *3* | |
| *DS-3* | *1:00* | | *4* | |
| *DS-4* | *0:30* | | *5* | |
| *DS-5* | *0:45* | | *6* | |
| *DS-6* | *2:00* | | | *3* |
| *DV-1* | *1:30* | | *7* | |
| *PL-1* | *1:00* | | | *1* |
| *PL-2* | *1:30* | | | *2* |
| *DL-1* | *0:30* | | | *4* |
| *DL-2* | *0:30* | | | *5* |
| *DL-3* | *0:30* | | | *6* |
| *EV-1* | *0:30* | | | *7* |

*Total estimated time = 20:15 hrs.*

*NOTE: Estimated time for completion of 20 modules does not include time for breaks. Use the course map on next page to optimize time and instructional efficiency. The average day should include approximately 6:45 hours of class time.*

# PBET Course Outline

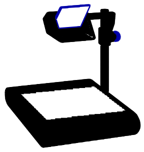
| SECTIONS | MOD.# | CONTENT |
|---|---|---|
| 1 Introduction | IN-1 | Course Orientation |
| | IN-2 | Identify PBET Characteristics |
| | IN-3 | List PBET Design Phases |
| 2 Identify | ID-1 | Perform Needs Analysis |
| 3 Analyze | AN-1 | Perform Task Analysis |
| | AN-2 | Write Performance Objectives |
| | AN-3 | Develop a Skills Hierarchy |
| 4 Design | DS-1 | Develop Skills Tests |
| | DS-2 | Describe Relevant Practice |
| | DS-3 | Analyze Resource Materials |
| | DS-4 | Select Delivery Method |
| | DS-5 | Summarize a PBET Lesson |
| | DS-6 | Complete a Second PBET Lesson Plan |
| 5 Develop | DV-1 | Develop Instructional Materials |
| 6 Pilot | PL-1 | Describe Trainer Characteristics |
| | PL-2 | Pilot a PBET Lesson Plan |
| 7 Deliver | DL-1 | Describe Trainer Responsibilities |
| | DL-2 | Prepare a Training Curriculum Checklist |
| | DL-3 | Create Action Plan for PBET Implementation |
| 8 Evaluate | EV-1 | Describe Evaluation Levels |

This course is titled Performance-Based Equipment Training. The class schedule for this course is available through the SEMATECH and SEMI/SEMATECH communication systems. The topics/modules this PBET course covers are listed above.

Initially, the PBET course will be offered to trainers and developers from SEMI/SEMATECH member companies. The first round of participants will be selected based on criteria set by SEMATECH member companies.

Most classes are offered in Austin, while some will be presented on the East and West Coasts. The course will become a transferable course in 1995.

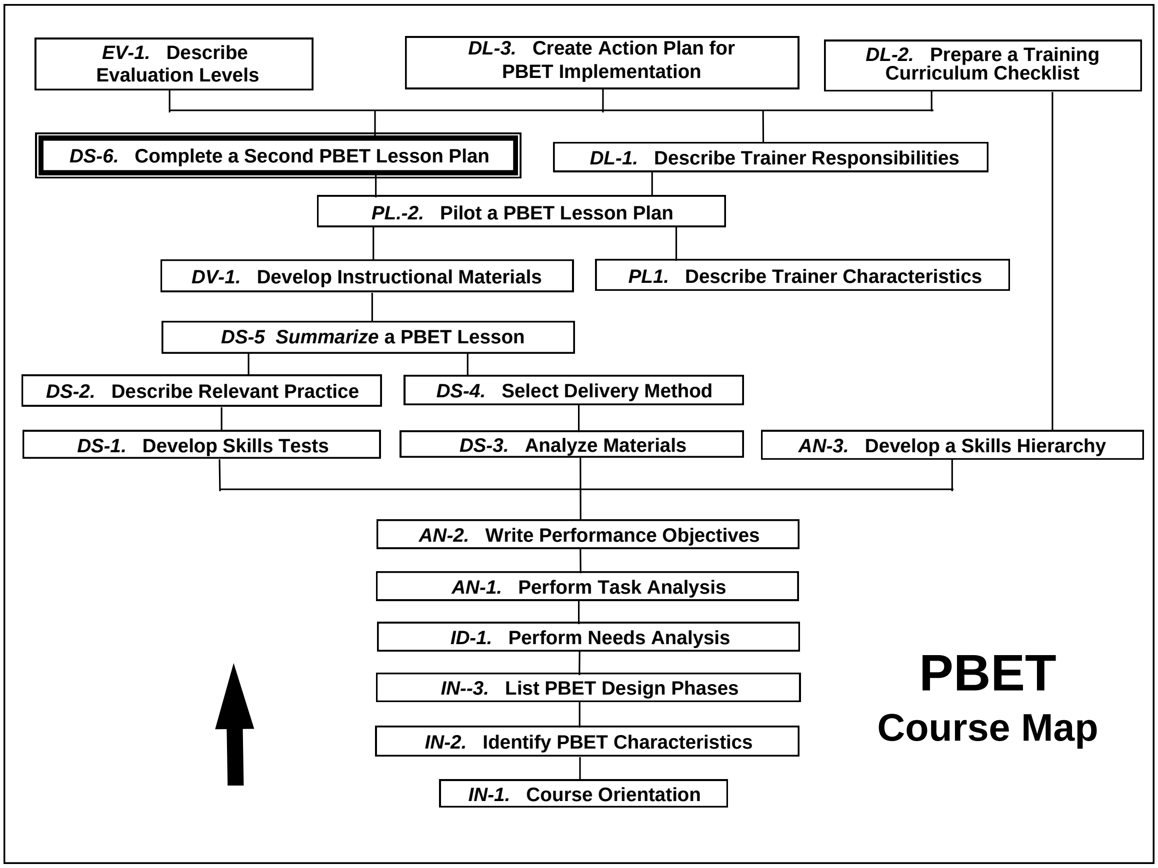
The vision SEMATECH has of PBET is to improve training practices while at the same time raising the skill level of the American semiconductor workforce.



**PBET Course Map**

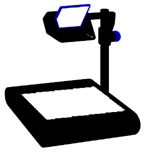
- The course map (page IN-1-6) shows the branching capabilities
  - Logical sequencing of modules
  - Equipment availability
  - Materials availability
  - Time constraints
  - Audience needs
- Class schedule is available in SEMATECH and SEMI/SEMATECH communication systems
- Most classes are offered in Austin; some are offered on the East and West coasts
- The PBET course will become a transferable course in 1995
- SEMATECH's vision of PBET is:
  - To improve training practices and raise the skill level of the American semiconductor workforce
- This course is an extension of the short February 1994 SEMATECH Technician Training Workshop
  - Ten modules were covered in that workshop
- Some modules were developed subsequent to the February workshop

***Instructor Note**: Leave the PBET course map foil out for use throughout the course*




This course is an extension of the short session presented at the SEMATECH Technician Training Workshop held in February 1994. Ten modules were covered in that workshop and more were developed subsequent to the February workshop.

The PBET workshop agenda for the week will be as follows: Monday, Tuesday, and Wednesday morning we will cover the first 15 modules of instruction. You will develop a lesson plan for a task assigned by the course instructor. On Wednesday afternoon you will work on developing a second PBET lesson plan for a specific course. The remainder of the modules will be covered on the afternoon of the third day.



**PBET Workshop Agenda**

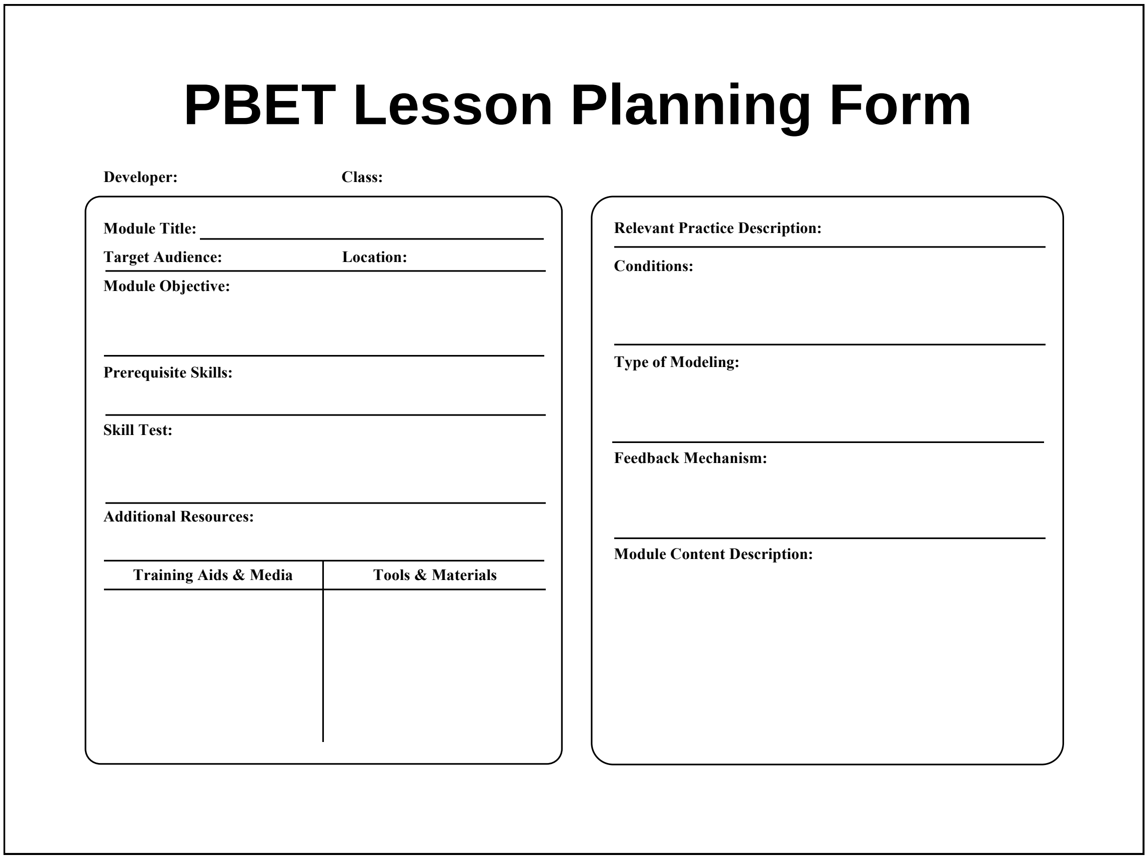
- Agenda for the week:
  - Monday through Wednesday morning, cover 15 modules up through and including the Pilot section in your manual
  - Develop a lesson plan on a task assigned by the course instructor and one on your own
  - Wednesday afternoon, develop a second PBET lesson in an area of specific interest (DS-6)
  - The remaining five modules will be covered in the remaining time on Wednesday afternoon

***Instructor Note:*** *Show participants the examples in the Appendix A. Also show the location of extra blank Lesson Planning Forms following tab #9.*

- Take out the PBET Individual Performance Checklist from your binder (Appendix, A-17). Fill out your name and today's date, and initial the first blank under *Participant*
- Fill out name and date, initial completed modules
- Leave the checklist on your table at all times
- One of the course instructors will sign the checklist for each completed module

**Introduction of Performance-Based Equipment Training**

- We've talked about how PBET came about at SEMATECH and how this week will proceed
- Now we're going to cover Performance-Based Equipment Training



# PBET Lesson Planning Form

**Developer:** **Class:**

**Module Title:**

**Target Audience:** **Location:**

**Module Objective:**

**Prerequisite Skills:**

**Skill Test:**

**Additional Resources:**

| Training Aids & Media | Tools & Materials |
|---|---|
| | |

**Relevant Practice Description:**

**Conditions:**

**Type of Modeling:**

**Feedback Mechanism:**

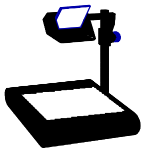
**Module Content Description:**

In Appendix A you will find examples of Lesson Planning Forms.

***NOTES:***

***NOTES:***

## IN-2 IDENTIFY CHARACTERISTICS OF PBET



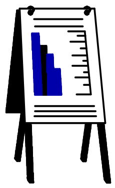
- Every module has a performance objective
- The performance objective is a clearly stated, measurable description of how participants will perform the intended activity or task
- *Ask a volunteer to read the objective from the foil*
- In this module, participants will list six characteristics of PBET -- not five or seven-- just six
- *Point out the test on page IN-2-9. Explain that each PBET module objective has a test that is used to measure participant performance of the objective*

***Brainstorm Activity:***

***Directions:***

*Ask participants to count 1-4 or 5. Form groups of same numbers. Ask participants: "What are your pet peeves or things that bother you about training?"*

*Have them think about these things in their small groups (table groups) and make a group list. Give them five minutes to compile their list and one minute to choose the top four items on their list.*



*Record the top 4-5 items from each group's answers on your flipchart as one list. Tell them that all or most of these things do not apply to PBET. Ask participants to return to seats.*

***Time:*** *5 – 10 minutes*

**IN-2**

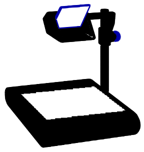
# IDENTIFY CHARACTERISTICS OF PERFORMANCE-BASED EQUIPMENT TRAINING

**OBJECTIVE:**

**Upon completion of this module, you will identify the six characteristics of Performance-Based Equipment Training (PBET).**

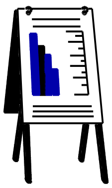
Every one of our modules has a performance objective. The performance objective is a clearly stated and measurable description of how participants will perform the intended activity or task. In other words, it describes what the participant is expected to do at the end of the module to demonstrate a desired level of understanding or competency in the specific skill covered.

In this module you will be expected to list, in writing, the six characteristics of Performance-Based Equipment Training.



**Performance-Based Equipment Training**

- This is our definition for PBET



- Actually, PBET is SEMATECH's formula for Building Excellence in Training
- Here's how this course will do it:

Principles

Practice

Preparation

Performance

$$P = B \cdot E \cdot T$$

**Training**

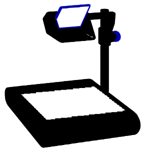
**Excellence**

**Building**

## Performance-Based Equipment Training

**DEFINITION:**

**PBET is equipment training based on front-end analysis that ensures participants are able to reach mastery of job skills as described in clearly stated and measurable learning objectives.**



**Six Characteristics of PBET**

- The task forces concluded that there are six characteristics of PBET
- They modeled their PBET principles after Performance-Based Training. The characteristics of PBET are:
  - Performance objectives derived from analysis
  - Identifies the prerequisite skills
  - Course content is derived from performance objectives
  - Subject matter experts (SMEs) are key to the success of a training program, but are not the only source for course content
  - Maximized hands-on practice
  - Skill tests to measure level of competency
  - Repeated practice and skill tests until mastery is achieved
  - Meaning acceptable level of performance, not necessarily 100 percent
- Explain that "mastery" may be difficult for participants to achieve in a training situation where time is a limiting factor
  - Equipment training at the supplier's facility
  - Versus training at the chip manufacturer's facility

## Six Characteristics of PBET

- **Derive performance objectives from analysis**
- **Identify prerequisite skills**
- **Derive course content from performance objectives**
- **Maximize hands-on practice**
- **Develop skill tests to measure competency**
- **Repeat practice and skill tests until mastery is achieved**

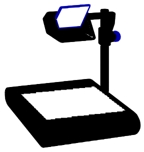
The task forces modeled their PBET principles after Performance-Based Training but placed the emphasis on equipment training. They concluded that there are six characteristics of PBET.

Based on their conclusions, Performance-Based Equipment Training:

1. Is based on performance objectives which describe intended results and are derived from analysis of actual needs (i.e., from task and goal analysis).
2. Identifies the prerequisite skills participants need to make progress toward the new objectives.
3. Derives the content of instruction from the performance objectives.
4. Designs a course to maximize hands-on practice for skill improvement.

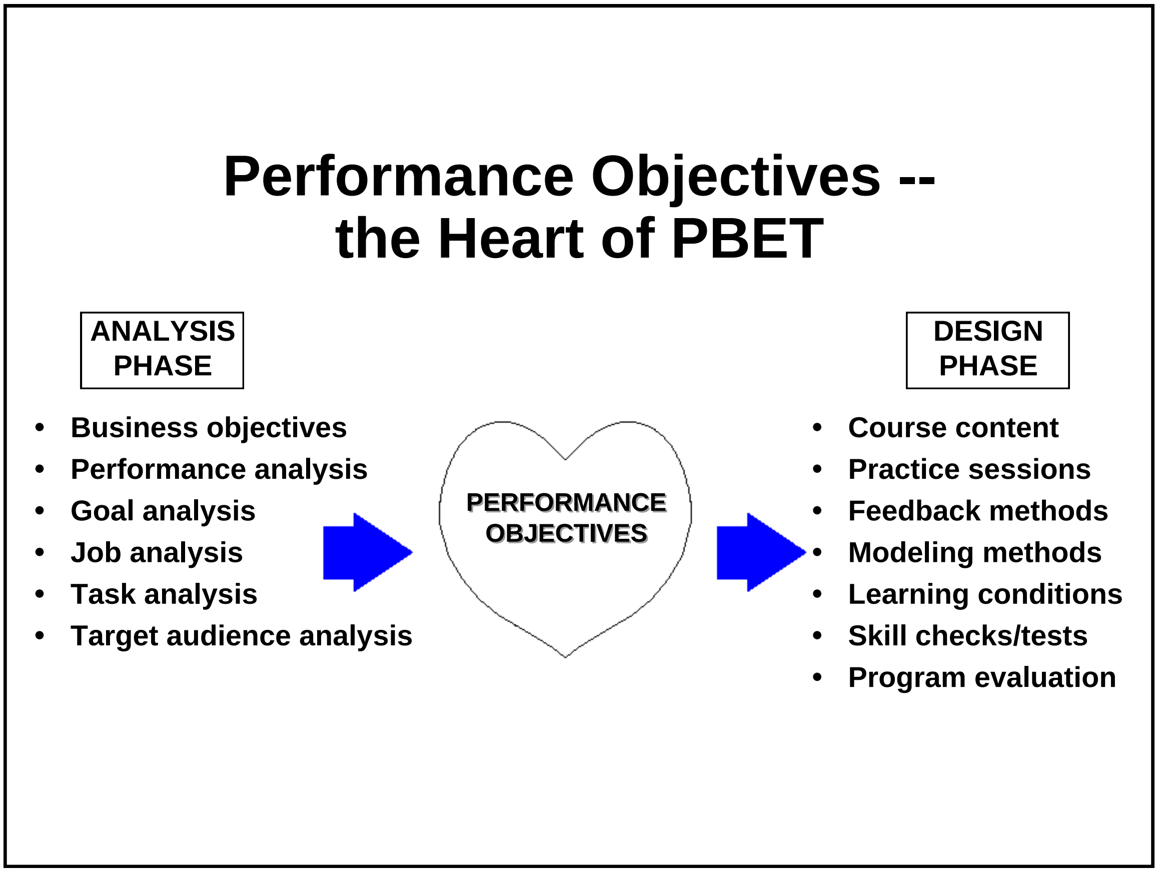
***NOTES:***

5. Provides skill test (skill checks) for diagnosing difficulties and confirming mastery of the skills.
6. Allows for continued practice on each objective, followed by skill checks, until mastery is demonstrated. (Mastery means an acceptable/adequate level of performance. It does *not* reflect a specific percentage such as 100 percent or 90 percent.)



**Performance Objectives -- the Heart of PBET**

- Performance objectives are the heart of PBET
- Creating a list of performance objectives is *the* most important thing in planning for training
- Objectives answer the question, “How will I know if they can do it?”
  - The answer is, “When they can perform as stated in the objective”
- Performance objectives emerge from the analysis phase
- Performance objectives help guide the instructional plan, and later they function in a more detailed capacity within the instructional design
  - We will cover these elements in detail later




The single most important step in instructional planning is creating a list of performance objectives. They are the *heart* of the performance-based training program. Performance objectives emerge from needs that are discovered during the analysis phase.

Objectives are participant-oriented. They help answer the question, "How will I know if they can do it?" The answer is, "When they can perform as stated in the objective."

In a way, performance objectives contribute in two capacities. Initially, they help guide the overall instructional plan, and later in a more detailed capacity, they function within the instructional design. This will be explained later in more detail.

***NOTES:***

***NOTES:***

**Practice Exercise**

- Practice exercises allow the participants to review information that's been presented
- Practice exercises should be relevant to intended performance
- Feedback should be immediate
- Select the six statements that represent true characteristics of PBET

## PRACTICE EXERCISE

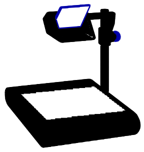
**Place a ✓ next to the statements that represent true characteristics of PBET.**

- ☐ **A. Performance objectives are derived from analysis.**
- ☐ **B. Any student, regardless of education, may participate.**
- ☐ **C. Trainees must possess certain prerequisite skills.**
- ☐ **D. Performance objectives determine course content.**
- ☐ **E. Tests determine the ranking of students in a class.**
- ☐ **F. PBET maximizes the use of hands-on practice.**
- ☐ **G. Skill tests determine mastery of skills.**
- ☐ **H. PBET allows for practice on each objective, followed by skill checks, until mastery is demonstrated.**

✎✎✎✎✎

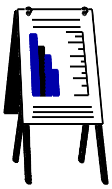
In typical performance-based training classes, practice exercises are used so the participants have opportunities to review information that's just been presented. The practice exercise should always be relevant to intended performance.

In the above practice exercise you are asked to select the true characteristics of PBET. Please make your selections and then turn the page to check your answers.



**Self-Check**

- When participants select six correct statements and feel confident in mastery, they take the skill test
- However, if more practice is needed because mastery wasn’t attained, participants may practice further
  - For example, writing the six PBET characteristics
- Once mastery level is attained, participants proceed to actual skill test



- If participants had difficulty identifying the six characteristics of PBET, walk them through the following on the flipchart:
  - Performance objectives from analysis
  - Prerequisite skills needed
  - Performance objectives determine course content
  - Hands-on practice
  - Skill tests
  - Repeat practice, skill checks, mastery

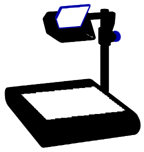
# Self-Check

- ☑ **A. <u>Performance objectives</u> are derived from analysis.**
- ☐ **B. Any student, regardless of education, can participate.**
- ☑ **C. Trainees must possess certain <u>prerequisite skills</u>.**
- ☑ **D. Performance objectives determine <u>course content</u>.**
- ☐ **E. Tests determine the ranking of students in a class.**
- ☑ **F. PBET maximizes the use of <u>hands-on practice</u>.**
- ☑ **G. <u>Skill tests</u> determine mastery of skills.**
- ☑ **H. PBET allows for <u>practice</u> on each objective, followed by <u>skill checks</u>, until <u>mastery</u> is demonstrated.**

***NOTE:*** ***If you feel you need more practice, review the module, and then practice writing the six characteristics of PBET on a blank sheet of paper. Otherwise, proceed to the skill test.***

If the participants selected the correct six statements and feel confident that they have achieved mastery of this objective, they may take the skill test. However, if more practice is needed because the desired level of mastery wasn't attained, then the participants may choose to practice the skill further.

For instance, they may choose another method of practice such as *writing* the six PBET characteristics. Once participants are comfortable with their mastery level, they may take the actual skill test.



**Skill Test**

- Skill test should always match requirements of the performance objective
- If participants don’t achieve mastery, then they may ask:
  - For more practice
  - For assistance
  - To retake the test (until mastery is achieved)
- Let me know when you have completed the skill test and we will review the correct answers

**SKILL TEST**

**Place a T in front of the statements that are true regarding PBET training.**

**1. ___Participants receive an attendance certificate for completing the course.**

**2. ___Participants practice a skill until they are ready to take the test.**

**3. ___Performance objectives precede the needs analysis phase.**

**4. ___ Course content is determined solely by subject matter experts.**

**5. ___Course content is determined by performance objectives.**

**6. ___Skill tests determine mastery of skills.**

**7. ___Skill tests are used to grade and compare ranking of course students.**

**8. ___Performance objectives are derived once course content is in place.**

**9. ___Performance objectives are derived from analysis.**

**10. ___Participants, regardless of entry skills, can participate in the class.**

**11. ___Participants must have certain prerequisite skills.**

**12. ___There is practice for each objective, followed by skill checks, until mastery is demonstrated.**

The skill test should match the requirements of the objective as stated earlier in the module.

Again, if the participant does not achieve mastery of the intended skill, then the participant may ask for more practice or assistance, or retake the test until mastery is achieved.

**Self-Check**

- Have participants check their own work
- Discuss differences
- Explain similarities

**SELF-CHECK**

1. ___Participants receive an attendance certificate for completing the course.
2. _T_Participants practice a skill until they are ready to take the test.
3. ___Performance objectives precede the needs analysis phase.
4. ___Course content is determined solely by subject matter experts.
5. _T_ Course content is determined by performance objectives.
6. _T_ Skill tests determine mastery of skills.
7. ___Skill tests are used to grade and compare ranking of course students.
8. ___Performance objectives are derived once course content is in place.
9. _T_ Performance objectives are derived from analysis.
10. ___Participants, regardless of entry skills, can participate in the class.
11. _T_ Participants must have certain prerequisite skills.
12. _T_ There is practice for each objective, followed by skill checks, until mastery is demonstrated.

**IN-3** **LIST PBET DESIGN PHASES**

- We've covered performance objectives and how they are the heart of PBET
- We've looked at PBET's six characteristics and how PBET came about at SEMATECH
- Now we're going to cover the seven basic phases in *developing* PBET

**List Seven Basic Phases in the Development of PBET Systems**

- *Ask a volunteer to read the objective from the foil*
- The seven basic phases of PBET development may also be referred to as steps
- *Point out the test on page IN-3-17*

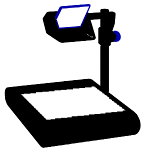
**IN-3**

## LIST SEVEN BASIC PHASES IN THE DEVELOPMENT OF PBET SYSTEMS

**OBJECTIVE:**

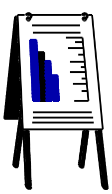
**List the seven basic phases in the development of Performance-Based Equipment Training (PBET) systems.**

The basic phases of development in performance-based equipment training programs or systems may also be referred to as steps.



**Seven Basic Phases in the Development of Performance-Based Equipment Training**

- This foil identifies the seven basic steps of developing PBET
- These seven steps are the structure of our instructional design
- Traditionally, these steps/phases are referred to as ISD, Instructional System Design
  - Most ISD models follow a similar sequence but may use different terminology
- Notice that the seven basic steps of developing PBET are the tab pages in your notebook
- Behind each tab page is a list of modules that are covered in the step of development
- Remember, the objective for this module is to list the seven steps of developing PBET
  - You might want to use a mnemonic device such as an acronym or rhyme to remember these steps
  - The acronym is:  IADDPDE



***Instructor Note:*** *Write the acronym IADDPDE on the flipchart.  Point out that the last three letters rhyme:*

I ADD PDE

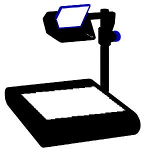
## Seven Basic Phases in the Development of Performance-Based Equipment Training

1. **Identify**
2. **Analyze**
3. **Design**
4. **Develop**
5. **Pilot**
6. **Deliver**
7. **Evaluate**

These are the seven basic steps of developing performance-based equipment training. They're the steps we used as our structure in the instructional design of PBET. Traditionally, development steps or phases are referred to as ISD, Instructional System Design. Most ISD models follow a similar sequence but may use different terminology. For instance, the step we refer to as "Deliver" may be "Implement" in another ISD model.

Notice that the seven basic steps of developing PBET are used as the tab pages in your participant guide. Behind each tab page there's a list of modules that are covered in that step of development.

As you may recall, the objective for this model is to list the seven steps of developing PBET.



**1. Identify a Need**

- When a discrepancy or problem in performance is noticed, a performance analysis should be conducted
- A performance analysis can help determine the cause and possible solutions
- Sometimes training isn't the solution
  - Attitude problems, poor instructions, no supervision, etc.
- New performance standards may mean employees' skills should be upgraded
  - Solution could be writing new specifications/ procedures, followed by a checklist
- New equipment and existing training programs are excellent candidates for applying PBET
- When training is the solution, performance analysis information can be used in designing training
- Suggested reading: *Analyzing Performance Problems*, Robert Mager and Peter Pipe

## 1. Identify a Need

- **Identify a performance discrepancy**
- **Identify a new performance standard**
- **Identify a need for new product training (PBET)**

1. Identify
2. Analyze
3. Design
4. Develop
5. Pilot
6. Deliver
7. Evaluate

There are many reasons for developing training programs, but training isn't always the best or only solution to a performance problem. When a discrepancy or problem in performance is noticed, a performance analysis should be conducted to help determine the cause and possible solutions.

Sometimes training *isn't* the solution. Perhaps the problems stem from inadequate environment, an attitude problem, lack of incentive, no specifications, poor instructions, or no supervision; or perhaps employees aren't in a position to practice their skills. (*Use it or lose it.*)

For instance, if new performance standards have been established, employees' skills may need upgrading. Maybe all that's required to pass along the information to employees is writing new specifications and procedures, followed by a checklist.

***NOTES:***

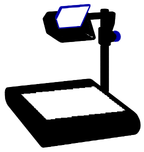
New equipment and existing training programs are excellent candidates for applying PBET methodology. When new products are released, this usually means new training programs should be developed; that is unless training already exists for an older model with similar features and processes. When training *is* the solution, performance analysis information can be used in designing the training program.

For more information on performance analysis, consult the bibliography. Mager and Pipe's *Analyzing Performance Problems* is widely used in the industry.

Once it's evident that new or revised equipment training is needed, there are many issues the instructional developer and equipment user need to address, including:

- What are the customer's expectations beyond training objectives? For example, delivery date, deliverables, budget, etc.
- What are the supplier requirements for meeting expectations? For example, time, access to experts, access to equipment, access to baseline data, cost, etc.
- Who has training needs, problems, or skill deficiencies? What is known about this person or group? (Apply target audience analysis and job description analysis.)
- What are the performance problems or needs? (Apply performance analysis and task analysis.)
- Who are the customers/performers in the training evaluation cycle?
- What are the performance (training) objectives? What are the criteria and conditions under which the performer will be evaluated for each training objective?

Note: A suggested checklist of questions for training user/training supplier planning meeting (an expansion of the above list is provided in Appendix A of the 1992-93 Task Force Guidelines on Training Evaluation, SEMATECH DOC. # 93031567A-XFR).



**2. Analyze the Need**

- During the second phase of PBET, designers and developers look at:
  - The business goals,
  - Nature of the job and tasks associated with the equipment
  - Target audience--who will be trained.
- After front-end analysis, developers are ready to determine performance objectives for the course they will design
- Performance objectives state in clear language what the performer must do to demonstrate competency
- There are three levels of performance objectives:
  - Terminal objectives
  - Enabling objectives
  - Prerequisite objectives
- A skills hierarchy shows the relationships of the course objectives

- Once it’s evident that new or revised equipment training is needed, there are many issues to consider
  - Customer’s expectations beyond training objectives
  - Supplier requirements for meeting expectations
  - Who has training needs, problems, or skill deficiencies
  - Performance problems or needs
  - Customers/participants in training evaluation cycle
  - Performance objectives

***Instructor Note:*** *The bibliography appears in Appendix A on page A-19*

## 2. Analyze the Needs

- **Perform job/task analysis**
- **Determine target audience**
- **Derive performance objectives from analysis**
  - **Terminal objectives**
  - **Enabling objectives**
  - **Prerequisite objectives**
- **Develop a skills hierarchy**

**1. Identify**
**2. Analyze**
**3. Design**
**4. Develop**
**5. Pilot**
**6. Deliver**
**7. Evaluate**

The terminology used for analyzing needs is often used synonymously. To quote from the *Trainer's Professional Development Handbook*, "Harless' *front-end analysis* and Mager and Pipe's *performance analysis*, which once signified their specified methods of performance problem solving, have now become synonymous in some circles for the process of needs assessment. So have the terms *task analysis, competency assessment, competency modeling*, and *job analysis*, although each originally referred to a particular approach to analyzing performance problems and determining learning needs."

***NOTES:***

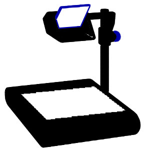
The second step in the PBET development process is to analyze the needs. During this phase of PBET development, designers and developers look at the business goals as well as the nature of the job and tasks associated with the equipment and the target audience. PBET design is always preceded by a thorough front-end analysis.

Once front-end analysis has been completed, instructional developers are better prepared to determine the performance objectives for the course they will design.

Performance objectives are the statements that appear at the beginning of a training session that explain in clear, simple language what the performer must do to demonstrate competency in a particular skill.

Performance objectives can be categorized into three groups: terminal objectives, enabling objectives, and prerequisite objectives.

The performance objectives are systematically arranged into a skills hierarchy that shows the logical sequence for designing the training (see example on page IN-1-6). The hierarchy of skills helps illustrate how the skills relate to each other while progressing from the simplest to the most complex.



**3. Design the Course**

- Skill tests are written
- Relevant practice descriptions are written, including:
  - What skills will be practiced
  - How the skills will be modeled
  - The practice conditions
  - The feedback mechanisms
- Additional resource materials are considered and analyzed
- Delivery method and media are selected
- A summary and sequence for the instructional events of each module (or lesson) is written.

## 3. Design the Course

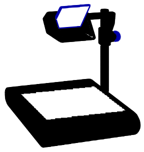
- **Develop skill tests (skill check)**
- **Describe relevant practice methods**
- **Analyze supporting instructional and resource materials**
- **Select delivery method and media**
- **Summarize the lesson plans**

1. **Identify**
2. **Analyze**
3. **Design**
4. **Develop**
5. **Pilot**
6. **Deliver**
7. **Evaluate**

Skill tests are written to match the requirements that are stated in corresponding performance objectives. Tests or skill checks are the evaluation instruments used to measure a participant's performance as compared to the stated objective.

In the design phase, the developer determines the type of practice sessions to include in each instructional module. A provision is made for the training materials and/or the instructor to model or demonstrate the type of performance given in the related objective. Feedback mechanisms are designed so the participant knows how well he or she is doing during the actual training session.

Also, during the design phase, additional resource materials are evaluated to determine their relevance and use in the course, and given budget restraints and delivery date, the appropriate delivery method is selected. Finally, the instructional events sequencing should be summarized for each module or lesson so that the intentions of the designer remain clear throughout the development and delivery phases.



**4. Develop Course Material**

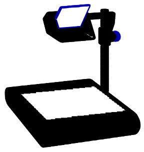
- The instructional development phase is like the construction phase in the building industry
- Building contractor/developer reviews:
  - Objectives, skills hierarchy
  - Available resources
  - Delivery method and media
  - Modeling/practice method
  - Suggested feedback mechanism
- The outcomes of this phase are:
  - Participant guide
  - Instructor guide
  - Instructional aids, etc.

## 4. Develop Course Materials

- **Determine course content**
- **Develop course materials**
- **Develop instructional aids**

**1. Identify**
**2. Analyze**
**3. Design**
**4. Develop**
**5. Pilot**
**6. Deliver**
**7. Evaluate**

The development course materials phase is the instructional development phase. This instructional development phase is like the construction phase in the building industry. The building contractor reviews the objectives, examines the skills hierarchy, and knows what and when certain resources are going to be used. Given budget constraints and a delivery date, the builder decides what type of delivery method (equipment, tools) to use to produce the best results. In the training world, this equates decisions about instructor-led courses, self-paced individualized courses, audiovisual aids, and written materials.



**5. Pilot the Course**

- Piloting the course is a tryout of the course and materials
- It allows for fine-tuning of the course before it's delivered
- PBET helps ensure successful results
- The developer may or may not teach the course
- The course can be taught by trainers or SMEs under developer guidance
- Provide a participant evaluation sheet for their initial reactions
- Revise the course based on assessment
- PBET course was piloted four times
  - Revised accordingly
  - Continuous improvement

## 5. Pilot the Course

- **Try out the course**
- **Assess course performance**
- **Revise the course**

**1. Identify**
**2. Analyze**
**3. Design**
**4. Develop**
**5. Pilot**
**6. Deliver**
**7. Evaluate**

Piloting the course is like having the dress rehearsal before the actual performance. The pilot phase is the tryout or test of the course and materials. It also allows for fine-tuning before a course is delivered. The PBET methodology helps ensure that the results will be successful and gratifying to participants, developers, and customers.

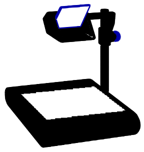
Assuming that all phases of the analysis, design, and development were conducted according to the details summarized in preceding discussions, then it is easy to predict success during the first test of the course materials.

The course developer may or may not be the person to teach the course. Perhaps the course can be taught initially by trainers or other subject matter experts under the guidance of the developer. In either case, subject matter experts should be on hand to assess the course performance and to edit course materials as they are presented.

***NOTES:***

An evaluation sheet should be available for course participants to provide feedback regarding the course, instructor, and course materials.

Based on the outcomes of the pilot class, subject matter experts, trainers, and developers can determine which areas of the course worked well and which components need improvement.  The next step is to revise the course as necessary before it is delivered a second time.



**6. Deliver the Course**

- In this phase of PBET, the course is implemented
- Developers provide an instructor and participant guide
- Developers may also:
  - Arrange a “train-the-trainer” session (e.g. fourth day of PBET course)
  - Arrange practice and feedback
  - Provide an evaluation instrument

## 6. Deliver the Course

- **Implement the training course**
  - **– Participant Guide**
- **Orient and direct the trainers**
  - **– Instructor Guide**
- **Arrange practice and feedback**

**1. Identify**
**2. Analyze**
**3. Design**
**4. Develop**
**5. Pilot**
**6. Deliver**
**7. Evaluate**

This is the phase everyone has been waiting for -- it's the indication that all of the hard work of the design and development staff is completed, and now the trainers can begin to implement the course.

In PBET systems, the developers provide an instructor guide and a participant guide, as well as any additional instructional aids that are needed during the course.

The developers may also provide a "train-the-trainer" program to teach trainers how to administer the new course. Training the trainer would include explanation and procedure for modeling the desired performance, adequate time for relevant practice, and how to incorporate feedback into the course.

An evaluation instrument should be available for feedback from class participants regarding the course, instructor, course materials, and their general satisfaction with the training.

**7. Evaluate the Course**

- The evaluation phase determines effectiveness and relevance of the equipment training program
- PBET programs are the communication between equipment supplier and equipment user
- Training must be accurate, relevant, and appropriate for the audience
- How well the workforce understands equipment affects manufacturing

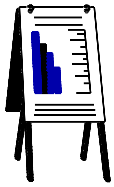
## 7. Evaluate the Course

- **Develop evaluation system**
- **Implement evaluation system**
- **Interpret results and provide feedback**
- **Continue to improve course**

1. Identify
2. Analyze
3. Design
4. Develop
5. Pilot
6. Deliver
7. Evaluate

We will use the traditional four levels of evaluation, which we'll cover later in the course.

The evaluation phase attempts to obtain feedback from the customers about the appropriateness and effectiveness of a specific training program.



**Review**

***Instructor Note:*** *Have the audience participate in the review by using the flipchart. Record their responses*

- There are seven phases or steps in the PBET development process
- *Ask participants to list the seven phases*
- Identify
  - Performance discrepancy
  - Performance standard
  - Need for new product training
- Analyze
  - Goals
  - Jobs/tasks
  - Target audience
  - Performance objectives
  - Skills hierarchy
- Design
  - Skill tests
  - Analyze supporting resources
  - Practice methods

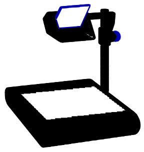
## Review

### Seven Phases in the Development of Performance-Based Equipment Training

1. Identify
2. Analyze
3. Design
4. Develop
5. Pilot
6. Deliver
7. Evaluate

These are the seven phases or steps of the PBET development process. Let's review the activities of each step.

1. *Identify*. In the first phase there is a request or need for a training course as the result of identifying a performance discrepancy. Identifying a performance standard, the desired outcome, or the need to develop training for a new product is also part of this phase.
2. *Analyze.* At the start of the project, time is spent analyzing various important issues before any design or development work is begun. Issues analyzed include: performance objectives, goals, jobs, tasks, the target audience, and a skills hierarchy.
3. *Design.* In the design phase, information from the analysis phase is used to derive: skill tests to analyze appropriate supporting resources for the course and to design appropriate practice methods. The design phase is the foundation for the content and the structure of the course.



- Develop
  - Modules with:
    - Performance objectives
    - Skill tests (Level 2 evaluation)
    - Resources
    - Content
    - Practice
    - Feedback
- Pilot
  - Try out the course
  - Level 1 evaluation
  - Make revisions as necessary
- Deliver
  - Course is implemented
  - Instructor orientation
- Evaluate
  - Evaluation instruments (Level 3) are implemented
  - Feedback data is used to improve the course over its lifetime

***Instructor Note:*** *If you use the example of building a new home as an example of the seven phases of PBET:*

- *Identify – is the need for a new home*
- *Analyze – is how many bedrooms or how large a kitchen*
- *Design – is the floor plan and type of roof/windows*
- *Develop – is when the contractor takes over*
- *Pilot – is when you move in and try it out*
- *Deliver – is when the contractor returns to make changes*
- *Evaluate – is when you decide on what improvements should be made throughout the life of the home*

4. *Develop.* This is the construction phase of the process. Decisions are made about the most appropriate delivery and media to use. During this time, individual units of instruction, or modules, are developed. Each module will have its own corresponding performance objective, skill test, set of resources and aids, content, practice, and feedback mechanisms.

5. *Pilot*. When the course materials are completed, the developer must pilot (test) the course. A course evaluation is also used to assess *participant* reaction to the course. Revisions are made as necessary to ensure the course is accurate, relevant, and free of mistakes in content or typing.

6. *Deliver.* At this point the course is ready to be delivered or implemented. The developer gives the trainers an orientation or explanation of how the class is to be conducted.

7. *Evaluate.* Once the course is in place and operational, the developer will want to evaluate or assess the performance of the course. Evaluation instruments are implemented, and the results provide feedback to the developers, trainers, managers, investors, and customers about the adequacy of the course. Feedback data is used primarily to improve the course over its useful lifetime.

**Practice Exercise**

***Instructor Note:*** *Have participants complete the practice exercise in their notebooks*

- Recall, if you will, the acronym “I ADD PDE” I mentioned earlier

**PRACTICE EXERCISE**

**List the seven basic phases in the design of Performance-Based Equipment Training in the correct order:**

**1.** ______________________________

**2.** ______________________________

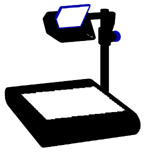
**3.** ______________________________

**4.** ______________________________

**5.** ______________________________

**6.** ______________________________

**7.** ______________________________



**Self-Check**

- Your answers should match the answers on the foil
- If you're confident you've mastered this objective, you may take the skill test
- If you need more practice, practice listing the seven phases on a separate sheet of paper
  - Then when ready, take the skill test

# Self-Check

## Seven Basic Phases in the Design of Performance-Based Equipment Training

1. Identify
2. Analyze
3. Design
4. Develop
5. Pilot
6. Deliver
7. Evaluate

If your list matches the one shown on this foil, and you feel confident that mastery of this objective has been achieved, then you may take the skill test.

If more practice is needed because the desired mastery level has not been attained, then you may practice the skill a little more by actually writing the list of seven phases of PBET on a separate sheet of paper.

When you’re ready, you may proceed to take the actual skill test.

**Skill Test**

- The skill test should match the requirements of the stated objective
- If you do not achieve mastery, you may:
  - Ask for more practice or assistance, or retake the test until mastery is achieved

## SKILL TEST

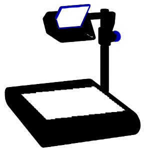
**On a blank sheet of paper, list the seven basic phases in the design of Performance-Based Equipment Training.**

**When finished, compare your answers with the list provided in this module. Repeat the test if necessary, and ask for additional practice or assistance.**

The skill test should match the requirements of the objective as stated earlier in the module.

Again, if you do not achieve mastery of the intended skill, then you may ask for more practice or assistance, or retake the test until mastery is achieved.

# Identify



## ID-1 PERFORM NEEDS ANALYSIS

**PBET Phases**

- We've talked about the seven phases of Performance-Based Equipment Training
- Now we're going to move to the first phase in PBET -- Identify a Need, and talk about needs analysis

**Perform Needs Analysis**

- There are different approaches to conducting a needs analysis
- Experts have spent years researching and writing about determining needs
  - In this workshop, we only have time to touch on the basics and steer you toward some excellent references
- *Ask a volunteer to read the objective from the foil*
- This course looks at two phases of needs analysis
  - The first is to identify the performance need
  - The second is to identify the performance solution
- *Refer them to the PBET Simplified Needs Analysis Worksheet and the test on page ID-1- 7.*
- You will learn to use this worksheet to conduct a simplified needs analysis

**ID-1**

# PERFORM NEEDS ANALYSIS

**OBJECTIVE:**

**Working in teams use the needs analysis worksheet provided for this lesson to analyze a performance problem. Each team will work through the needs analysis process described in this module.**

Over the years, much research has been conducted and many books have been written on the subject of needs analysis. This course simplifies the process by utilizing a two-phased approach to this skill: *(1) Identify the performance need*. This phase is triggered by events that lead to concerns about a performance problem. To help you understand why there is concern, you may use four different techniques to gather information to help you analyze the performance problem. *(2) Identify the performance solution*. In this phase you may examine four categories of causes to performance problems. These categories may help you select the correct solution for a specific performance problem.

From this lesson, you will learn to use a worksheet to conduct a simplified needs analysis. You will be provided scenarios of performance problems and the opportunity to use the worksheet with a group of peers to -- (1) select the most appropriate techniques for gathering data, (2) list possible causes of the discrepancy, and (3) list solutions for each possible cause.

**PBET SIMPLIFIED NEEDS ANALYSIS**

**Informal Triggers**

- Triggers can instigate a need for performance improvement.  For example:
  - New standards, goals, or desired outcomes
  - New equipment, products, or processes
  - Examination of performance data
- The trigger is followed by a formal needs analysis
  - A good analyst will not jump to quick solutions

| PBET SIMPLIFED NEEDS ANALYSIS | | | |
|---|---|---|---|
| **Identify the Performance Need** | | Identify the Performance Solution | |
| ***Informal Triggers*** | | | |
| • **New standards, goals, or outcomes**<br>• **New epuipment, products, or processes**<br>• **A readily apparent performance discrepancy** | | | |

The process of PBET begins with the discovery that there is a performance problem. There are a variety of "triggers" that can instigate a concern about improving performance. Among them are:

- New standards, goals, or desired outcomes
- New equipment, products, or processes
- Examination of performance data

A good analyst will not jump to an immediate solution, such as the "training solution"! Rather, these situations should prompt more careful scrutiny.

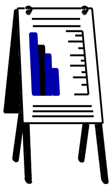
**PBET SIMPLIFIED NEEDS ANALYSIS**

**Formal Techniques**

- Care must be taken to avoid wasting money on the wrong solutions to performance problems.
- In *Figuring Things Out: A Trainer*'s *Guide to Needs and Task Analysis*, authors Ron Zemke and Tom Kramlinger identify four major techniques to use in identifying performance needs:
  - Observations
  - Interviews
  - Surveys/questionnaires
  - Performance data:
- *Ask students to suggest types of data that can be analyzed. They will likely suggest: production rates, scrap rates, down time, mean-time between failure, yield, time to repair, setup time, etc.*

**Activity**

***Directions:*** *Have a few participants tell the group how the training need for his/her project was determined. Participants may need to begin by reviewing with the class what their specific project is.*



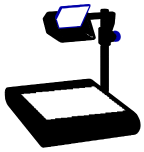
*As each person tells how his/her project's need was determined, write on the flipchart whichever of the four approaches was used -- observations, interviews, questions, or performance data.*

| PBET SIMPLIFED NEEDS ANALYSIS | | | |
|---|---|---|---|
| **Identify the Performance Need** | | Identify the Performance Solution | |
| *Informal Triggers* | ***Formal Techniques*** | | |
| • New standards, goals, or outcomes<br>• New epuipment, products, or processes<br>• A readily apparent performance discrepancy | • **Conduct observations**<br>• **Conduct Interviews**<br>• **Conduct surveys and/or questionnaires**<br>• **Examine performance data** | | |

Performance problems are often difficult to detect. Therer may seem to be obvious symptoms and training is often the most prescribed solution. However, without careful analysis, it is all too easy to spend a lot of money and still have a performance discrepancy. In *Figuring Things Out: A Trainer's Guide to Needs and Task Analysis*, authors, Ron Zemke and Tom Kramlinger, identify four major techniques to use in identifying performance needs:

1. Observations
2. Interviews
3. Surveys/questionnaires
4. Performance data

Their book presents information for trainers who are trying to select the right needs analysis procedure. Their book, and others in the bibliography, can be helpful in creating worksheets and tools for implementing analysis techniques. In addition, guidelines are provided for interpreting the data that is collected.



**PBET SIMPLIFIED NEEDS ANALYSIS**

**Possible Causes of Performance Problems**

- Once the performance need or discrepancy is clearly identified, it is time to consider the possible causes of the problem
  - Consider four categories of possible causes:
  - *Equipment problem*. Consider some of these equipment related problems that can contribute to poor performance: design flaws, unrealistic specs (wrong tool for the desired task), inaccurate, out of calibration, too complex, poor ergonomics, not reliable, requires too much maintenance, etc.
  - *Improper or inadequate incentives.* Organizations and environments can provide incentives or disincentives. Consider such possibilities as: rewarding negative behavior (sacrificing quality for quantity), failing to reward positive behavior, positive behavior is difficult and unrewarding, etc.

| PBET SIMPLIFED NEEDS ANALYSIS | | | |
|---|---|---|---|
| Identify the Performance Need | | **Identify the Performance Solution** | |
| *Informal Triggers* | *Formal Techniques* | ***Possible Causes of Performance Problems*** | |
| • New standards, goals, or outcomes<br>• New epuipment, products, or processes<br>• A readily apparent performance discrepancy | • Conduct observations<br>• Conduct Interviews<br>• Conduct surveys and/or questionnaires<br>• Examine performance data | • **Equipment problem**<br>• **Improper or inadequate incentives**<br>• **Lack of information**<br>• **Lack of skills** | |

Once the performance need or discrepancy is clearly identified, it is time to consider the possible causes of the problem. One or more of the formal identification techniques may have given you some good clues about the causes. But, it is best to give systematic consideration to four categories of causes:

1. *Equipment problem.* Poor performance can be attributed to equipment related problems, for example: design flaws, unrealistic specifications (wrong tool for the desired task), inaccuracy, out of calibration, too complex, poor ergonomic design, unreliable, and requires too much maintenance.

2. *Improper or inadequate incentives.* Organizations and the environment provide incentives and disincentives. Consider these possibilities: rewarding negative behavior (rewarding high throughput while sacrificing quality), failing to reward positive behavior, and making positive behavior unnecessarily difficult or unpleasant.

  - *Lack of information.* People may not be able to perform as desired because of these possible reasons: no feedback, inadequate feedback, no instrumentation available, cannot read instruments, no specs, poorly written specs, poor labeling, lack of communications, etc.
  - *Lack of skills.* When the equipment performs properly, the individual wants to perform according to standard, and the individual has been provided the needed information about the task and the individual still cannot perform according to standard, there is a skill deficiency that needs to be addressed.
- Two performance "gurus" have developed expanded models for determining performance problems
  - Thomas F. Gilbert, *Human Competence: Engineering Worthy Performance*
  - Robert F. Mager, *Analyzing Performance Problems* -- *or, You Really Oughta Wanna.*

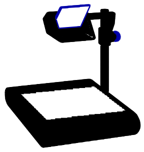
3. *Lack of information.* When a person is not provided the information they need to make the correct task decision, they are unable to perform according to standard. But, if the person is told what to do, that may be all that is needed to enable them to do it. So consider systems that provide little or no information: no feedback mechanisms, inadequate feedback mehanisms, no instrumentation available, cannot read instruments, no printed specifications, and poor labeling of parts, tools, manuals, pipes, connections and gauges.

4. *Lack of skills.* When the equipment performs properly, the individual wants to perform according to standard, and the individual has been provided the needed information about the task and the individual still cannot perform according to standard, there is a skill deficiency that needs to be addressed.

Two performance “gurus” have developed expanded models for determining the cause of performance problems:

- Thomas F. Gilbert has developed a six-cell matrix for examining six areas that affect an individual’s ability to perform according to standard. You can find out more by consulting his book, Human Competence -- Engineering Worthy Performance.

- Robert F. Mager has developed a flow chart and a job aid that ensure that no stone is left unturned when seeking the cause of performance problems. His ideas are clearly developed in his book, *Analyzing Performance Problems or You Really Oughta Wanna.*

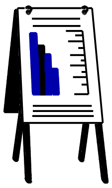


**PBET SIMPLIFIED NEEDS ANALYSIS**

**Possible Solutions to Performance Problems**

Each of the four categories of causes suggest their own solutions:

1. *Equipment problem* -- may require re-engineering
2. *Improper or inadequate incentives* -- may require a change in the performance management system
3. *Lack of information* -- provide feedback via: job aids, specs, manuals, signs, readbacks, expert systems, EPSS, and labeling
4. *Lack of skills* -- provide practice, give instructions, provide training



**Brainstorm Solutions to Performance Problems**

- *Ask the audience to think of some possible causes for this performance discrepancy: Product is failing electrical test.*
  - Lack of data or information
  - Equipment or instrument problem
  - Improper or inadequate incentives
  - Lack of knowledge or skills

| PBET SIMPLIFED NEEDS ANALYSIS | | | |
|---|---|---|---|
| Identify the Performance Need | | **Identify the Performance Solution** | |
| *Informal Triggers* | *Formal Techniques* | *Possible Causes of Performance Problems* | ***Possible Solutions to Performance Problems*** |
| • New standards, goals, or outcomes<br>• New epuipment, products, or processes<br>• A readily apparent performance discrepancy | • Conduct observations<br>• Conduct Interviews<br>• Conduct surveys and/or questionnaires<br>• Examine performance data | • Equipment problem<br>• Improper or inadequate incentives<br>• Lack of information<br>• Lack of skills | • **Re-engineering**<br>• **Create or improve incentives**<br>• **Provide feedback or job aids**<br>• **Provide practice or training** |

Each of the four categories of causes suggest their own solutions:

1. *Equipment problem.* An equipment problem requires re-engineering.

2. *Improper or inadequate incentives.* An incentive problem requires the creation, the improvement, or the elimination of certain incentives.

3. *Lack of information.* A lack of information requires that information be provided. This may be provided through on-the-job feedbace. Or, it may be provided in the form of job aids which include: specifications sheets, manuals, signs, readbacks, expert systems, electronic performance support systems, or labeling.

4. *Lack of skills.* A lack of skills requires that an individual have a chance to receive renewed practice with feedback or a training program may be required.

**Practice Exercise**

**Time:** 10 minutes

**Directions:**

- Refer to page 7.
- Read the scenario.
- Refer to the needs analysis worksheet in your manual.
- As a group brainstorm the following items:
- (1) Suggest types of data gathering technique(s) that could be used to determine possible causes, e.g., observations, interviews, surveys, and/or performance data
- (2) Suggest possible causes for the performance problem, e.g., data, instrument, incentive, and/or knowledge
- (3) Suggest possible solutions for each possible cause

***Instructor Note:*** *Have participants fill in the matrix in their notebooks. Lead this activity and fill-in data on foil or flipchart. "Lack of Skills" is the only item that requires a training solution.*

## PRACTICE EXERCISE

**HUMAN PERFORMANCE PROBLEM IDENTIFIED: The business has committed to lowering the percentage of scrap. Data shows that the breakage that occurs while removing wafers from furnaces is higher in Fab 1 than in Fab 2.**

**ANALYZE: Brainstorm for possible causes and solutions to the problem. Fill in the needs analysis worksheet with specific examples for each item.**

**(1) How will you gather data?**
Observations: ______________________________
Interviews: ______________________________
Surveys: ______________________________
Performance Data: ______________________________

| **(2) What are some possible causes?** | **(3) What are some possible solutions?** |
|---|---|
| Lack of data or information: | Suggested solution(s): |
| Problem(s) with equipment or instrument: | Suggested solution(s): |
| Improper or inadequate incentives: | Suggested solution(s): |
| Lack of skills: | Suggested solution(s): |

**Skill Test**

- Refer to the scenario in the Skill Test
- Repeat the same procedure as in the preceding practice exercise
- Work with the team at your table and together decide on the best solution(s) to the possible causes of the performance problem

SKILL TEST

HUMAN PERFORMANCE PROBLEM IDENTIFIED: Downtime problems on an ion implanter have been traced to problems with ion sources. They are frequently rebuilt incorrectly (parts re-installed backwards or upsidedown) and/or found to be contaminated (bits of bead blasting present).

ANALYZE: Brainstorm for possible causes and solutions to the problem. Fill in the needs analysis worksheet with specific examples for each item.

| | |
|---|---|
| (1) How will you gather data?<br>Observations: ______________________<br>Interviews:______________________<br>Surveys: ______________________<br>Performance Data: ______________________ | |
| (2) What are some possible causes? | (3) What are some possible solutions? |
| Lack of data or information: | Suggested solution(s): |
| Problem(s) with equipment or instrument: | Suggested solution(s): |
| Improper or inadequate incentives: | Suggested solution(s): |
| Lack of skills: | Suggested solution(s): |

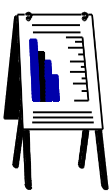
# Analyze

## AN-1 PERFORM TASK ANALYSIS

- We've completed the Identify phase of PBET
- Now we will move on to the Analyze phase
  - Please turn to the Analyze section of your notebooks (Tab #3)

**Describe the Basic Steps of Task Analysis**

- Due to time constraints, we can't thoroughly cover task analysis in this module
- However, you will have the opportunity to perform a simple task analysis
- *Ask a volunteer to read the objective from the foil*
- *Refer participants to the test on page AN-1-10*



**Brainstorming Activity**

- What are the benefits of task analysis?

**AN-1**

# PERFORM A TASK ANALYSIS

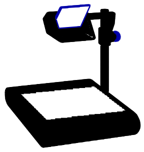
**OBJECTIVE:**

**Upon completion of this lesson, you will perform a task analysis.**

It's beyond the scope of this training session to thoroughly cover the task analysis process. It would probably take four to eight hours to really master the skills of performing a task analysis.

In this lesson, you're expected to remember the eight basic steps in the task analysis process.

Later, you'll have the opportunity to perform a simple task analysis.



**Basic Steps of a Task Analysis**

- Task analysis is one of the key features of the PBET development process
- Begin by gathering and reading all documentation on the equipment and tasks
  - During reading research, compile a list of questions you still need answered
- Observe and interview the people considered expert performers, or subject matter experts (SMEs)
  - This is your opportunity to get answers to your questions
- Record all of the steps and decisions involved in the performance of task
  - Record by writing, audiotape, or videotape
- Always look for hidden knowledge
  - Hidden knowledge often takes the form of:
    - Prerequisite skills
    - Rules and procedures
    - Small bits of information
    - Theory or technique
    - Any information the SME relies on from memory
- When hidden information is detected, record all steps, events, tools, materials, etc.

## Basic Steps of a Task Analysis

1. **Gather and read all relevant documentation**
2. **Interview and observe the expert performers**
3. **Record the steps and decisions involved**
4. **Look for hidden knowledge**
5. **Flowchart the steps in the task**
6. **Detail each step in the task**
7. **List tools, materials, documents, etc.**
8. **Perform the task**

Task analysis is one of the key features of the PBET development process. Analysts use the information obtained from task analysis to determine the skills and background information needed to identify performance objectives and eventually determine the contents of the new course.

Analysts begin by gathering and reading all available documentation on the equipment and tasks. They compile a list of questions regarding information that's not available or isn't clearly defined in the documentation.

After analysts identify people who are regarded as *expert performers*, or *SMEs*, they interview the experts and ask questions about the equipment, tasks, and documentation.

- Detail tasks in a step-by-step fashion so anyone can read and follow them
- Test the completeness of the details by performing the task from the new written procedure

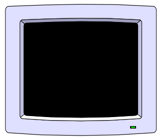
The expert is observed performing the actual tasks the course participants would be expected to perform under the same conditions. Even while the expert explains what is being done at each step of the task, analysts continue to ask questions. Analysts record in writing, audiotape, and/or videotape the steps involved in the performance of the task.

Videotaping is recommended because analysts can give their full attention to the environment, equipment, expert, tools, materials, and interaction as the tasks are being performed. The results of taping are beneficial since an audio/visual capture of the events can be replayed later. Furthermore, parts of the task analysis can be played back during a training session or specific frames captured by computer software to create 35mm slides or overhead transparencies or to include in the actual participant guide.

In the process of conducting a task analysis, analysts are constantly looking for *hidden knowledge* that's not available in the documentation for the equipment, or that experts have failed to mention. Hidden knowledge may include small bits of information, prerequisite skills, concepts, rules, procedures, theory, techniques, or data which the expert may recall from memory and that is required or helpful in the execution of the specific task. Analysts' investigative tactics must be very keen to sense a situation when the expert performer is in the process of recalling hidden knowledge during the performance of a task.

Analysts should be alert, so pertinent knowledge isn't overlooked. These bits of information should be recorded along with the steps, events, tools, and materials that are used in performing the task.

Finally, the detailing of the task in a step-by-step fashion should be refined so it's readable by anyone else. Another recommendation is for analysts to perform the task with the newly written procedure.



**Video Task Analysis Exercise**

1. *State the purpose of the videotape exercise and describe some details about the machine in the example; include some background information about why the task analysis was required. There is about a one-minute segment of tape that shows the machine with protective panels in place and then with the panels removed. The machine is shown with the wafer autofeeder in operation*
2. *Identify things to look for during the playback of the 15 minute task analysis example videotape. Have the participants count from 1-6 and split the class into groups for this activity. Have the participants write information on the task analysis worksheet. Have each person in their small groups watch for something different in the video and record the information on the worksheet; identify:*

Note: The 7th activity is done as one group

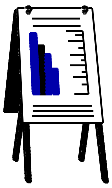
(1) *Prerequisite skills needed for performing the task*
(2) *Types of tools, materials, and equipment needed*
(3) *Hidden knowledge used by the subject matter expert*
(4) *Concepts that may need to be explained but are not introduced by the SME*
(5) *Possible hazards and safety procedures*
(6) *Other related procedures*
(7) *Ways in which the design of the instructional lesson could make it easier to train others to perform the procedure in the example*

## VIDEO TASK ANALYSIS EXERCISE

**Now you'll have the opportunity to perform an important part of a task analysis. As you observe the expert performer, remember to look for prerequisite skills, types of tools, materials and equipment, hidden knowledge, important concepts, possible hazards and safety procedures, and other related procedures. When the video exercise is completed, think of ways in which you could design an instructional lesson to make it easier to teach someone to perform the task demonstrated in the video.**
**You will be using the worksheet located on the following page.**

Note: An additional task analysis worksheet is located in Appendix A.

3. *Play the tape and start taking notes related to the preceding items. At the place where the SME's glasses are shown dangling over the autofeeder (12:30 min.), press the Pause button. Ask participants for their comments regarding the items on the list. Compare your notes to theirs and discuss them.*



*Using the flipchart, write all comments based on the six categories. Here are some examples:*

***Prerequisites:***

- *Overview of machine*
- *Basic mechanical skills*
- *Location and names of parts*
- *Basic machine knowledge*
- *Knowledge of wafer characteristics*

***Safety:***

- *When and where to turn power on/off*
- *Preparation of system prior to maintenance*
- *Proper use of safety glasses*
- *List of hazards*

***Tools and materials:***

- *Allen wrenches (hex tools)*
- *Brush*
- *Lubricants*
- *Screwdriver*
- *Flashlight*
- *Cleaning materials*
- *Arkansas stone (polishing)*

**PERFORMANCE-BASED EQUIPMENT TRAINING**

**TASK ANALYSIS WORKSHEET FOR VIDEO EXERCISE**

**Analyst:**________________________________ **Date:**________________________________

**Subject Matter Expert:**________________________________________________________

**Location:**__________________________________________________________________

**Job or Course Title:**__________________________________________________________

**Task:**______________________________________________________________________

**Task Description:**____________________________________________________________

______________________________________________________________________________

______________________________________________________________________________

______________________________________________________________________________

**Importance Statement:**_______________________________________________________

______________________________________________________________________________

______________________________________________________________________________

______________________________________________________________________________

**Prerequisites:**_______________________________________________________________

______________________________________________________________________________

______________________________________________________________________________

______________________________________________________________________________

**Tools and Materials:**_________________________________________________________

______________________________________________________________________________

***Hidden Knowledge:***

- *Handwritten instructions*
- *Type of brush to use*
- *Manual operation of components*
- *Why you shouldn't remove the realigner*
- *Why not use Acetone?*

***Critical Concepts:***

- *Names and functions of autofeeder parts*
- *Backlash gear*
- *Leadscrew*
- *Vacuum switch*
- *Theta rotation motor*
- *Vacuum chuck*

***Other Related Procedures:***

- *Removal of covers*
- *Lock-out Tag-out*
- *Special tests*
- *Power-down procedure*
- *How to move components*

4. *Continue to play the tape until the end of the task analysis to give participants more practice identifying more of the items mentioned in the flipcharts*
5. *Stop the tape when it gets to the end of the task analysis demonstration, and then ask for more comments regarding the example. They should come up with many more additions to the original lists including several major safety issues*
6. *Rewind the video tape and remove it from the VCR.*

**Hazards and Safety:**________________________________________________

**Hidden Knowledge:**________________________________________________

**Critical Concepts:**________________________________________________

**Other Related Procedures:**________________________________________

**Course Design Considerations:**____________________________________

***Design of instruction:***

- *Classroom preparation of participants prior to performance of the procedure, including: tool list, materials, overview of subassemblies, overview of procedure, and safety issues*
- *Have available a documented procedure*
- *Show what panels to remove*
- *Provide related nomenclature*
- *Provide exploded view pictorial diagrams*
- *Provide a free-standing unit*
- *Demonstrate subassembly removal/replacement*

**Example No. 1 of a Task Listing**

- There are different ways to detail a task
- This foil is an example of a simple task listing

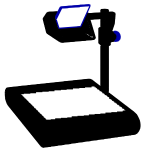
***Instructor Note:*** *Have the participants read the foil silently*

# Example No. 1: Task Listing

**Starting a Car and Pulling Out from a Parking Space**

1. Insert key into ignition switch.
2. Rotate the key and ignition switch to ON position.
3. Hold key at START position until the engine starts.
4. If necessary, using your right foot, press accelerator pedal slightly to keep the engine running.
5. Release the accelerator pedal and step on the brake pedal.
6. Check rearview mirror and sideview mirrors.
7. Place gear shift lever in Reverse (R) position.

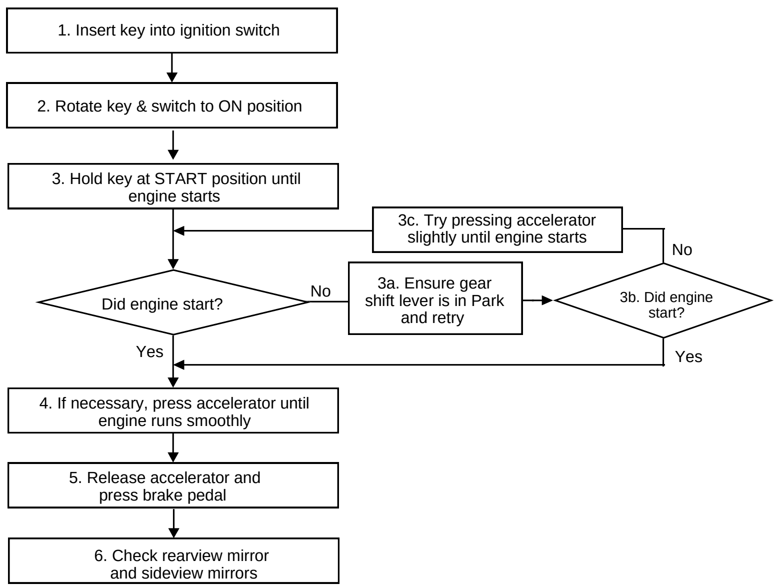
There are different ways to detail a task. The foil on this page illustrates an example of a simple task listing.



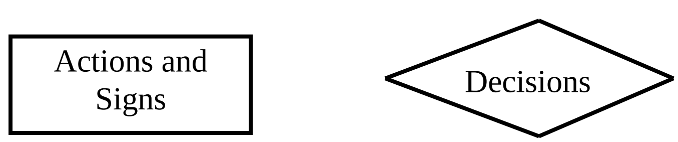
**Example No. 2:  Task Detailing -- Flowcharting**

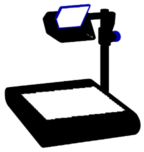
- This is another example of task detailing/listing
  - Flowcharts work well when thinking through the process and when making decisions becomes more difficult than *doing* the task
- Flowcharts make it easy to see, at a glance, the relationships between the steps in the sequence
- Actions are always written in rectangles
- Decisions are always written in diamonds

# Example No. 2: Task Detailing -- Flowcharting




Another way of detailing or listing a task is to put it into flowchart form. Flowcharts work well when thinking through the process, and when making decisions becomes more difficult than *doing* the task. The use of flowcharts makes it easy to see, at a glance, the relationships between steps in the sequence. Actions are always written in rectangles, and decisions are always written in diamonds.





**Example No. 3:  Task Detailing -- Cause-Effect Relationship Chart**

- This example of task detailing is a cause-effect relationship chart
- This foil shows the sequence of steps, actions taken, and results
  - The results are feedback
- This type of chart can be used in providing feedback to *participant*s to indicate the effect of their performance

# Example No. 3: Task Detailing -- Cause-Effect Relationship Chart

| STEP | ACTIONS | RESULTS |
|---|---|---|
| 1. | Insert key into ignition switch. | Proper key will slip in easily. |
| 2. | Rotate key and ignition switch toward the ON position. | Oil lamp and temp. lamp will light. Listen for sound of seat belt buzzer or door left open. |
| 3. | Hold key at START position until the engine starts. | Engine should start immediately if gear shift lever is in Neutral or Park. |
| 4. | If necessary, press accelerator pedal with right foot to keep engine running. | Engine will sputter and perhaps stop if it is not receiving the right amount of fuel. Listen for the sound of the engine running. It should run smoothly. |
| 5. | Release the accelerator pedal and press on the brake pedal. | You may engage the transmission when the engine is stabilized. |
| 6. | Check rearview mirror and sideview mirrors. | Look for reflection of possible obstructions. |
| 7. | Place gear shift lever in Reverse (R) position. | If placed in the proper position, the letter R will be easily visible and possibly illuminated on the gear shift indicator. |

Another way to detail a task is to create a cause-effect relationship chart. There are a variety of charts that can be designed to show how actions performed during the task can result in certain effects. This chart shows the sequence of steps, the actions taken, and the results. It can be used to provide feedback to the *participant* to indicate the effect of the performance.

**Skill Test**

**Legos Task Detailing/Listing**

**Materials:** Legos -- enough for each pair of *participant*s, pad of paper

**Time:** 1 hour

**PBET Course Map**

***Relevance:*** *The Legos and the task analysis will be used in the development for the first PBET lesson plan and in later modules.*

***Directions:*** *Tell participants that during the PBET analysis phase a Lego assembly training need was discovered. Tell them they will do a Lego task detailing/listing. At their tables, have participants team up into pairs. Explain that while each pair will do the task detailing/listing, one person will act as the SME and assemble the Legos, and the other will act as analyst and record the step-by-step task. Remind them to look for hidden knowledge.*

***Rules:*** *They may only record the task in words.*

***Break:*** *When participants have completed the task detailing/listing exercise, ask them to disassemble their Legos and take a ten-minute break.*

***Ask:*** *What they discovered about doing a task detailing/listing*

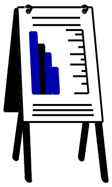
- It's very time-consuming
- The expert performer may not mention many of the steps and decisions
- It requires a great deal of mental energy to look for hidden knowledge and to capture all of the steps

**SKILL TEST**

**In this module, you will complete a task listing and detailing on a specific task that the course instructor will assign to designated teams. This is the initial step in the development of your first PBET lesson plan.**

## AN-2 WRITE PERFORMANCE OBJECTIVES

- We've talked about the importance of task analysis in the development of PBET training
- Now, we're going to discuss how to prepare effective performance objectives



**Brainstorm: When Do We Know that Learning Has Occurred?**

- Learning requires an observable change in performance
- Learning is a series of steps *(draw seven steps on flipchart or use poster):*
  - Baseline knowledge (bottom)
  - Instruction
  - Knowledge
  - Attitude
  - Experience
  - Habit
  - Desired skill (top)

**Prepare Performance Objectives**

- As part of PBET, the instructional designer describes what participants need to demonstrate while in the course
- Performance objectives are clear statements understood by all the participants
- Objectives are:
  - Performance-based
  - Specific
  - Measurable or observable
  - Relevant to requirements of task to be performed
- *Ask a volunteer to read the objective from the foil*
- *Reference the test on page* AN-2-15

**AN-2**

## WRITE PERFORMANCE OBJECTIVES

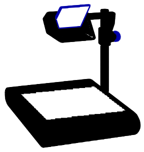
**OBJECTIVE:**

**Prepare at least one performance objective in an area of your expertise. The objective must contain three minimum requirements: *performance*, *condition*, and *standard*.**

***Note:*** *Write the objective in the Lesson Planning Form provided for you in this workshop.*

As part of the analysis phase in developing PBET, the instructional designer sets out to describe the performance the participant needs to demonstrate while enrolled in a course. The performance objective serves as this vehicle for description.

The *performance objective* or *instructional objective* is a clear statement that's understood by all participants. The objective is performance-based, specific, measurable or observable, and relevant to the requirements of the course or task to be performed.



**An Objective Statement Answers Questions**

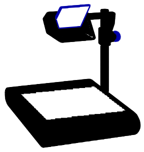
- Objective statements answer questions like these
- Objective statements provide information to questions of who, what, where, when, and how (4Ws and 1H)
- Simple, clearly stated objectives tell participants exactly what's expected of them

## An Objective Statement Answers Questions Like These

- **Who is the performer?**
- **What task is the performer expected to do?**
- **How will the performance be evaluated?**
- **How accurate must the performance be?**
- **What are the conditions for performing the task?**
- **What materials and resources will be needed?**
- **When is the performance supposed to occur?**
- **Where is the performance to occur?**

An objective statement provides information that answers typical questions such as those in the foil above.

If a single, clear statement can provide all of the needed information, then there is very little left for the participant to interpret. Objectives take the guesswork out of the training program and ensure that everyone, including instructors and participants, have a clear understanding of what is expected. Course participants should never need to try to out-guess or "psyche-out" the instructor.



**Three Characteristics of a Well-Stated Objective**

- *Performance* tells what action will be performed
- *Condition* tells how or with what the action will be performed
- *Standard* tells the performance standard, criterion, or measurement method

## Three Characteristics of a Well-Stated Objective

- **Performance**
- **Condition**
- **Standard**

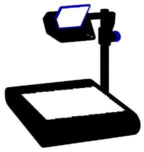
A well-stated objective has at least three components:

- Performance
- Condition
- Standard

*Performance* tells what action will be performed.

*Condition* tells how or with what the action will be performed.

And, *Standard* tells the performance standard, criterion, and measurement method.



**Three Characteristics of a Well-Stated Objective No. 1**

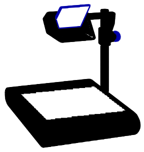
- The *performance* part of the objective tells what participants will do as a result of training

## Three Characteristics of a Well-Stated Objective

**No. 1**

| | |
|---|---|
| ***Performance*** | **The performance is the action that results from executing the task that is described in the objective.** |
| **<Example>** | ***Calibrate a QM-500 mass flow controller.*** |

The performance part of the objective tells what the participants will do as a result of training.



**Three Characteristics of a Well-Stated Objective No. 2**

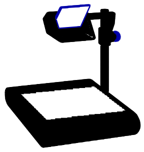
- The *condition* tells the circumstances/conditions that must be present during the course participant's performance
- The condition part of the objective should clearly state the conditions under which the performance will occur

# Three Characteristics of a Well-Stated Objective

**No. 2**

| | |
|---|---|
| ***Condition*** | **The condition describes the environment, location, and/or the situation where the performance is to occur, and it tells what materials, supplies, tools, equipment, and resources may be used while performing the objective.** |
| **<Example>** | ***In a classroom the trainee will be provided with a mis-calibrated QM-500 MFC, hand tools, and appropriate test instruments.*** |

The condition part of the objective tells the circumstances or "conditions" that must be present when the performance occurs. The condition should be clearly stated.



**Three Characteristics of a Well-Stated Objective No. 3**

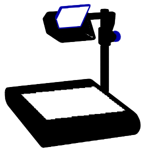
- The standard tells the acceptable level of performance
- Often, standards refer to:
  - A specific manual or procedure, “in accordance with procedure 5-2-1”
  - A time limitation, “in 15 minutes”
  - Numbers, as in, “10 per cycle, to the nearest hundredth, with zero errors”

# Three Characteristics of a Well-Stated Objective

## No. 3

| | |
|---|---|
| ***Standard*** | **The standard gives the acceptable level of performance (*standard of performance*). It may be stated in terms of how accurate the performance must be, how many times it must be done, or how much time is allowed.** |
| **<Example>** | ***The 10 steps of the calibration procedure must be performed in correct sequence according to Spec. No. 4.3.6 and completed within 30 minutes.*** |

The standard part of the objective tells the acceptable measure or "standard" of performance which the course participant must demonstrate.



**Example of a Well-Stated Performance Objective**

- In this example, what is required of participants under specific circumstances and how they will be measured has created a particularly lengthy objective
  - Whenever possible, strive to keep objectives brief and simple

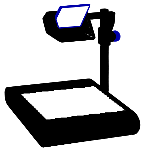
***Instructor Note:*** *Underline the three components on the foil with the participants watching -- performance, condition, standard -- in three different color markers. (Much the way a sentence is diagrammed)*

- *You may point out that this is a terminal objective*
- *This example is an objective for a full course*

# Example of a Well-Stated Performance Objective

***Given a mis-calibrated QM-500 MFC, hand tools, and appropriate test instruments, the trainee will calibrate a QM-500 mass flow controller according to the 10-step procedure given in Spec. No. 4.3.6. The calibration must follow the correct sequence of steps, and be completed within 30 minutes.***

When combined, the three components of the performance objective would appear as in this example.  Not all performance objectives, however, need to be as lengthy and wordy as this one.



**Questions and Answers to "Get at" the Three Parts of a Performance Objective**

***Instructor Note:*** *Introduce Questions/Answers table*

**Participant Activity:**

- You have four examples of performance-based objectives in your notebooks
- Take a few minutes to read them to yourselves, and underline (diagram) the three components in each objective

***Instructor Note:*** *Allow five minutes or so to complete this activity, and then as a group review their answers*

## Questions and Answers to "get at" the Three Parts of a Performance Objective

| QUESTIONS | ANSWERS |
|---|---|
| ***To get at the <u>performance</u>, ask --***<br><br>**What exactly do I want technicians to do as a result of this training program which they cannot do now?** | • **Locate**<br>• **Operate**<br>• **Maintain**<br>• **Replace**<br>• **Adjust**<br>• **Disassemble**<br>• **Install**<br>• **Troubleshoot**<br>• **Calibrate** |
| ***To get at the <u>conditions</u>, ask --***<br><br>**Under what conditions should they be able to perform these tasks?** | • **From memory**<br>• **With a standard tool kit**<br>• **While wearing gas mask**<br>• **With schematics** |
| ***To get at the <u>standard</u>, ask --***<br><br>**How well do I want them to perform each of these tasks?** | • **According to Spec XYZ**<br>• **To the component level**<br>• **Within four hours**<br>• **10 out of 12**<br>• **Accurate to 0.01 micron** |

Below are four examples of performance-based objectives, each of which contain the performance, the condition, and the standard.

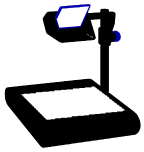
- Given a 14-point daily checklist and an *Astaire Model 1950* stepper, conduct a routine daily inspection and determine without errors the operational readiness of the machine. Note any discrepancies. The results of your inspection must be within range of the specifications given in the checklist.

- Having available a list of 50 major assemblies and components of the *BRN-1200* diffusion furnace, locate each component on the actual furnace in the fab and in the presence of your trainer. Give a short explanation of the purpose of each item on the list. Acceptable performance is 45 out of 50 components located and explained correctly to your trainer.

***NOTES:***

- Given a list of 10 parts, a list of functional descriptions, and a pictorial of the *Robby* wafer handler, match each part exactly to its corresponding location in the picture and the appropriate description.

- At the location of the *ZAP-5500* plasma etch system, (1) point out each of six potential equipment hazards, (2) explain the type and significance of each hazard, and (3) briefly state the proper working safety procedures. Each of the six items must agree with the list of hazards and safety descriptions given in the National Laboratory Safety training manual.



**Performance Words**

- When you write objectives, choose specific action words:
  - Mark
  - Recall
  - Circle
  - Label
  - Install
- Avoid vague or abstract words:
  - Learn
  - Know
  - Conclude
  - Understand
  - Awareness
- Be sure the words you use state measurable or observable performance standards

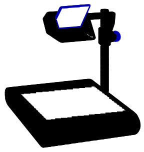
## Performance Words

**Action Words:** ☺ ***state, operate, identify, construct, draw, write, describe, calibrate, etc.***

**Abstract Words:** ☹ ***appreciate, know, understand, apply knowledge, interest, awareness, etc.***

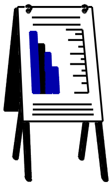
It's helpful to use a list of action verbs when you write objectives. When writing objectives, choose words that describe *actions*. Select words that represent performances that can be observed or measured.

Stay away from words that are *fuzzy abstractions* that can neither be observed nor proven that someone has performed them.



**Commonly Used Performance Words**

- Performance words may be regarded as skills
- Some skills may:
  - Overlap
  - Never be used in certain job classifications
  - Always be used by all job classifications
- There's a list of performance words in your notebooks that may help to create performance objectives for your participants
- Some performance words (*) may require some kind of indicator to fully demonstrate capability or competence



**Participant Activity**

- *Have the group name a real tool that's used in their business*
- *Write the name of the tool at the top of the flipchart*
- *Tool example: Have participants select performance words from the foil and brainstorm how they'd use them in creating objectives for learning the specific tool*
- *Write their responses under the tool name*
  - *State the function of* ______________
  - *Calibrate the* ____________________
- *More examples*: *If more practice seems necessary, repeat this activity by creating objectives for a real work-related process, for example*:
  - -- *Product inspection*
  - -- *Data collection*
  - -- *Interpreting alarms, etc.*

# Commonly Used Performance Words

| | | |
|---|---|---|
| **show** | **test** | **design** |
| **select** | **tune** | **infer*** |
| **use** | **prove** | **deduce*** |
| **find** | **justify** | **predict*** |
| **state** | **apply** | **invent** |
| **draw** | **relate** | **discover** |
| **write** | **verify** | **propose*** |
| **identify*** | **specify** | **integrate** |
| **locate*** | **contrast** | **synthesize*** |
| **gather** | **construct** | **generalize*** |
| **illustrate** | **analyze*** | **examine** |
| **describe*** | **organize*** | **manipulate** |
| **measure** | **formulate** | **diagnose** |
| **prepare** | **estimate** | **troubleshoot** |
| **classify** | **interpret** | **formulate** |
| **compute*** | **distinguish** | **facilitate*** |
| **discriminate** | **compare** | **reorganize** |
| **operate** | **determine** | **calibrate** |
| **assemble** | **differentiate** | **repair** |
| **adjust** | **program** | |

** Performance words which may require an indicator*

Performance words may be regarded as skills. Some skills may tend to overlap and dovetail with each other; some may never be used in certain job classifications; and still others may always be used by all job classifications.

Here are some performance words, or skills, that may help to create appropriate performance objectives for your specific audience.

Some performances (*) are invisible or neutral as in compute, organize, or identify. In such cases it is useful to add a visible indicator to the desired performance. For example, to clarify identify, *write*: identify by matching items, pointing, or writing a paragraph.

**Practice Exercise**

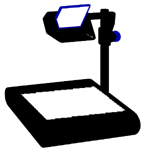
- Practice writing performance objectives using the list of commonly used performance words and selecting a topic in an area of your own choice.
- Write the objectives in the chart in your notebook and review your objectives with your colleagues from your table group
- Create a third performance objective for an area of your expertise and review it with your colleagues

**PRACTICE EXERCISE**

| | Performance | Condition | Standard |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |

Using the list of commonly used performance words, write two performance objectives in the chart above. When you have completed your objectives, review them with your colleagues from your group table.

In the third space in the chart, create a performance objective from your own area of expertise and review it with your colleagues.



**Practice Exercise**

- Please complete the practice exercise by circling or marking the objectives that are well-stated

## Practice Exercise

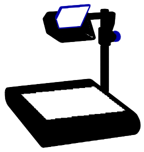
1. **Having attended at least one class in semiconductor processing, be able to have a sense of appreciation for submicron technology.**
2. **Having attended the Thermite Furnace Class, be able to calibrate a thermocouple.**
3. **Having available 10 wafers and the MiG-19 inspection system, be able to locate 100% of the defects and correctly categorize them according to the station job aid. You will have 30 minutes in which to perform this task.**
4. **Assuming that all tools, parts, and documentation are available, the lamp uniformity must be within 0.5% of the specification.**
5. **Without referring to any resources, locate and describe the function of each component on the BRN-1 gas control panel with 100% accuracy.**

Here is an opportunity to practice differentiating between well-stated objectives and objectives that are not. Read each statement and determine if the statement has all of the elements of a good objective.

Check each objective for the following criteria:

- Does the objective have a performance, that is, an action to be done?
- Does the objective state the condition(s) for performing the action?
- Does the objective indicate the standard of performance for the action?

Circle or mark the objectives that are well-stated.



**Self-Check**

- Compare your answers to the correct answers, and then proceed to the skill test

## Self-Check

☹ 1. **Having attended at least one class in semiconductor processing, be able to have a sense of <u>appreciation</u> for submicron technology.** ***NO PERFORMANCE WORDS USED***

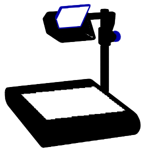
☹ 2. **Having attended the Thermite Furnace Class, be able to calibrate a thermocouple.** ***NO CONDITION OR STANDARD***

☺ 3. **Having available 10 wafers and the MiG-19 inspection system, be able to locate 100% of the defects and correctly categorize them according to the station job aid. You will have 30 minutes in which to perform this task.** ***GOOD P.O.***

☹ 4. **Assuming that all tools, parts, and documentation are available, the lamp uniformity must be within 0.5% of the specification.** ***NO PERFORMANCE IS INDICATED***

☺ 5. **Without referring to any resources, locate and describe the function of each component on the BRN-1 gas control panel with 100% accuracy.** ***GOOD PERFORMANCE OBJECTIVE***

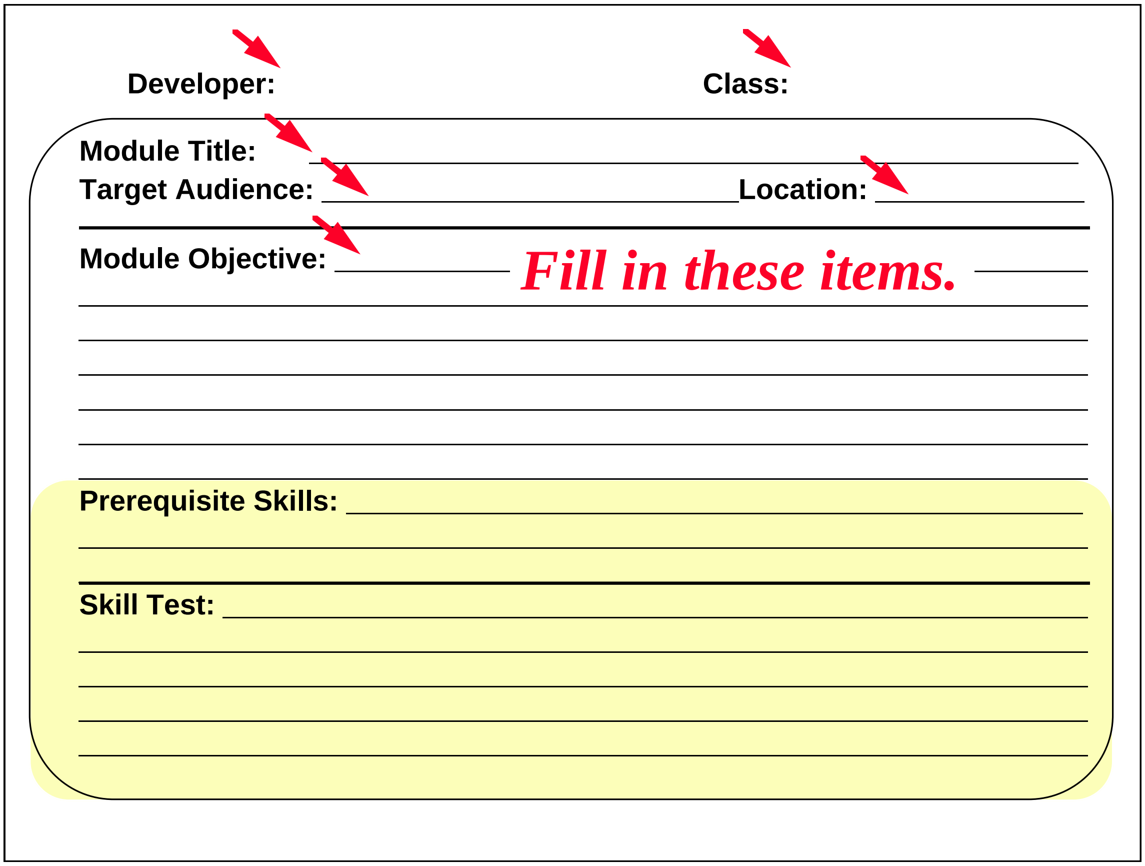
When ready, participants may proceed to take the actual skill test.



**Introduction to the Lesson Planning Form**

Please remove the Lesson Planning Form from the front pocket of your Participant's Guide:

- Fill out the forms as follows:
- The first form will be used for the Lego Assembly project, which will be used as the common project for all class participants
  - Developer: *your name*
  - Class Title: Performance-Based Equipment Training
  - Module Title: Assemble Legos Model
  - Target Audience: PBET course participant
  - Location: PBET classroom
- The second form will be used for a specific individual project in your own area of expertise
  - Developer: *your name*
  - Class Title: *Name of the course for which you have brought materials and expertise*
  - Module Title: *The specific lesson within the course that you will be developing in this class*
  - Target Audience: *A few words that describe the typical learners to attend this lesson*
  - Location: The place or places where you would expect to train students in this module. This may be a classroom, a fab, a lab, or other location.


Developer: Class:

Module Title: ______

Target Audience: ______ Location: ______

Module Objective: ______ *Fill in these items.* ______

Prerequisite Skills: ______

Skill Test: ______

This is the top of the front side of the SEMATECH Lesson Planning Form provided for participants of this training session*. You will use this form to prepare a complete lesson plan in an area assigned to you by the course instructor. You'll continue to use this sheet for the remainder of this workshop. Please make the following entries at this time:

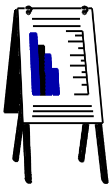
1. Developer: *Your name*
2. Class Title: *Title of the course*
3. Module Title: *Title of the lesson*
4. Target Audience: *Intended audience*
5. Location: *Where this module will be performed*
6. Module Objective: *The clearly stated performance objective*

* **Note:** Additional copies of the SEMATECH Lesson Planning Form, including a definitions page and one example from an actual training program, can be found in Appendix A of this manual.

**Skill Test** (Test has two parts)

**(1)  Lego Assembly**

Using the space on page AN-2-16, write a clearly stated performance objective that includes all of the following elements:



***Instructor Note:*** *Write bullets on flipchart*

- Trainees must assemble a _________ Lego model
- Must use available Lego parts
- May use an approved job aid
- May use verbal instructions
- When completed, the model must match the model shown in the Lego model container or some other accepted regulation prototype.

- Check your work against the requirements on page AN-2-16
- When satisfied, have instructor review your objective
- If acceptable, transfer objective to Legos Assembly Lesson Planning Form

***Instructor Note:*** *The module objective should be close to the following: Given a set of Lego parts, verbal instructions, and an appropriate job aid, assemble the Lego model so it matches the exact specifications of the model shown on the Lego container or some other acceptable regulation prototype*

**(2)  Individual Project**

- Using the space on page AN-2-16, write a clearly stated performance objective in an area of your own expertise
- Check your work against the requirements on page AN-2-16
- When satisfied, have instructor review your objective
- If acceptable, transfer objective to the second Lesson Planning Form

## SKILL TEST

This test requires that you write two clearly stated objectives. Both objectives must satisfy these minimum requirements:

- The objective should contain three minimum requirements: *performance, condition,* and *standard.* If necessary, underline the three parts of the objective as you did on page AN-2-8.
- The performance part of the objective must not be abstract nor fuzzy. (Review page AN-2-10, if necessary.)
- The objective should be written clearly so that a peer will understand what is required.

1. The first objective must include the elements which your instructor has written on the flip chart. Use this space to write your first draft. When you are ready, your instructor will review your draft.

2. The second objective is to be in an area of your own expertise. On the third day of this class, you will write an entire lesson plan based on the objective you write here today. Use this space to write your first draft. When you are ready, your instructor will review your draft.

## AN-3 DEVELOP A SKILLS HIERARCHY

**Phases of PBET**

- We've completed a task analysis and derived some performance objectives
- Now we're ready to develop a skills hierarchy

**Develop a Skills Hierarchy for Equipment Training**

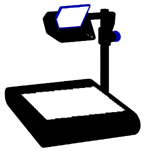
- In the Prepare Performance Objective module we identified what is necessary in a well-stated performance objective
- Now we will use some of that information as we develop a skills hierarchy of enabling objectives
- *Ask a volunteer to read the objective from the foil*
- The test for AN-3 matches the objective. See page AN-3-10.

# AN-3

## DEVELOP A SKILLS HIERARCHY

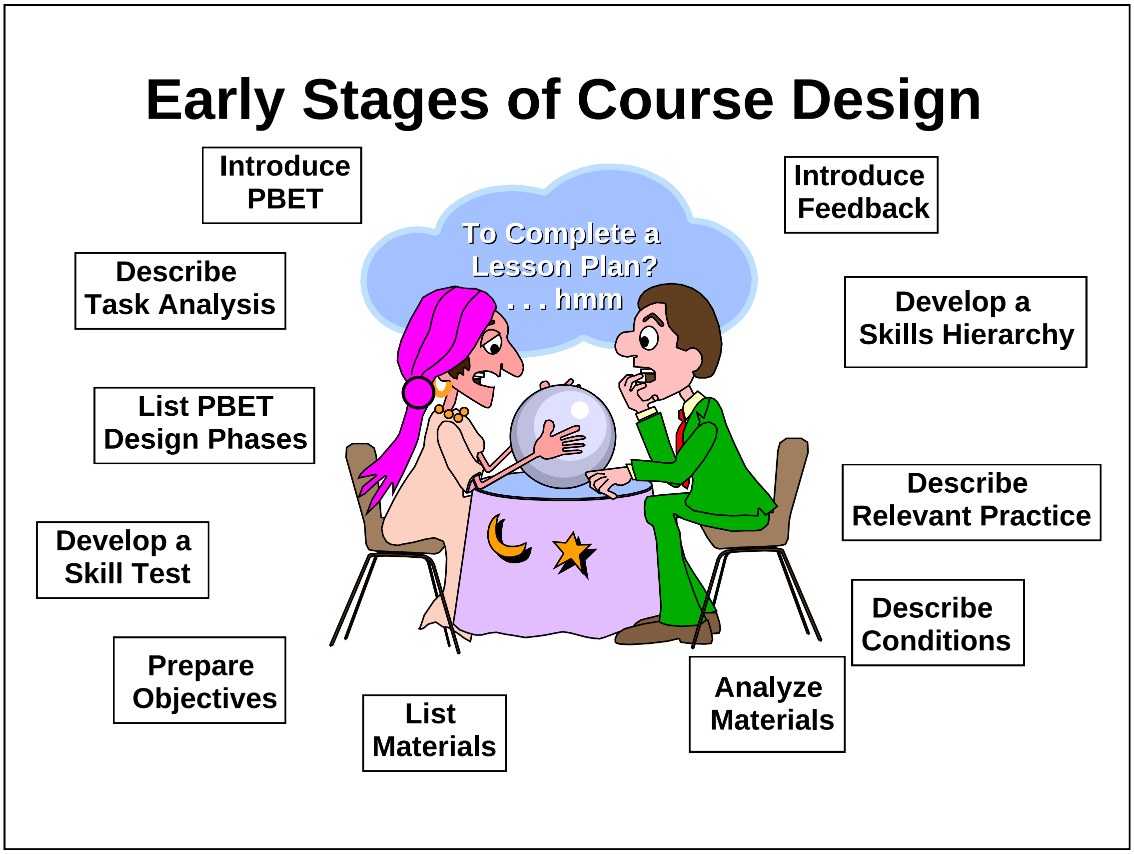
**OBJECTIVE:**

**Given a terminal objective for equipment training, develop a skills hierarchy of enabling objectives. Label objectives according to classification -- *terminal*, *enabling*, or *prerequisite*. Show the relationships to each one by drawing a skills hierarchy.**

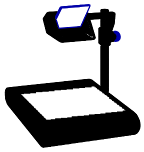


**Early Stages of Course Design**

- Have you ever seen yourself in this predicament -- all these topics to cover and confused by how they should be sequenced?
- Initially, you may find that it's difficult to decide how the training course will fit together
- You may wonder what the logical sequence of the topics should be

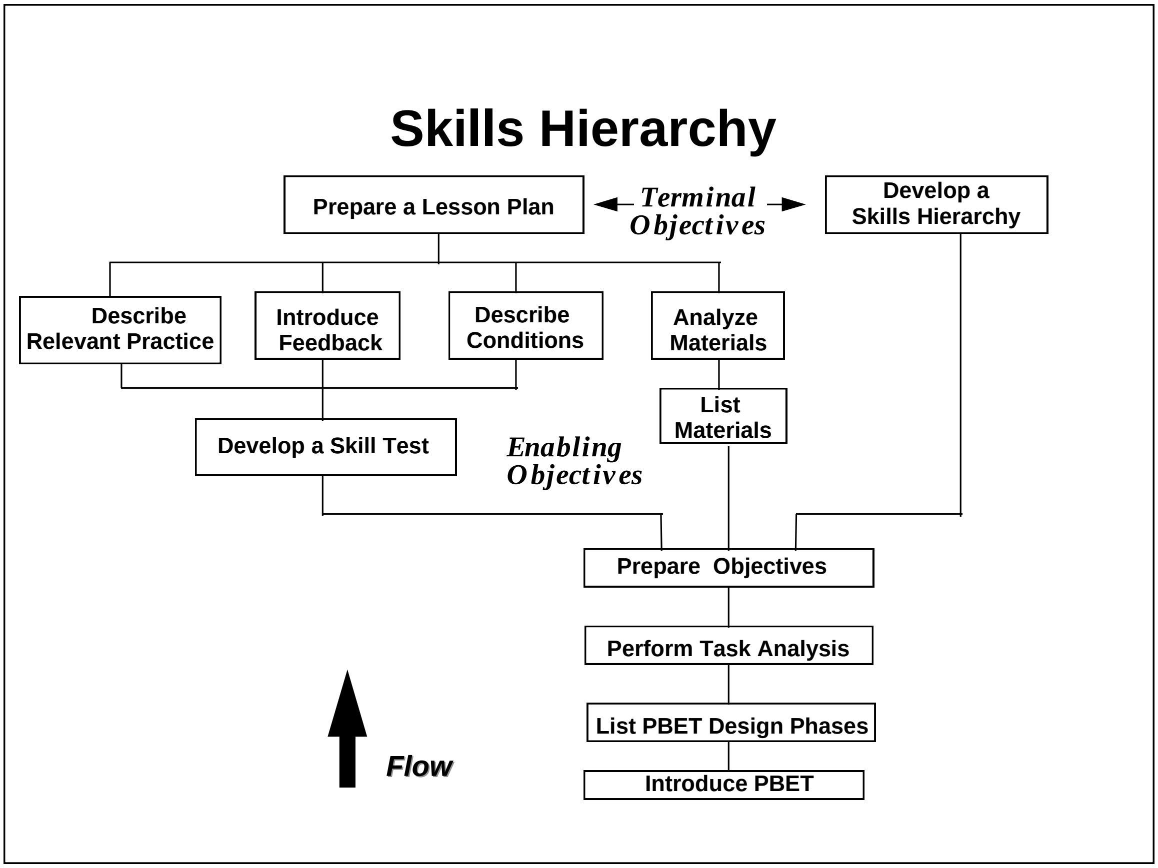



Initially, it may be difficult to see how the organization and structure of the training course will fit together.  You may wonder what the logical sequence should be.



**Skills Hierarchy**

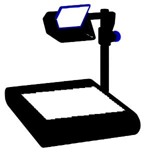
- A skills hierarchy is like a roadmap
- It graphically shows how subordinate skills serve as enabling objectives to the terminal objective
- Subordinate skills are arranged in the most logical sequence and in levels of increasing sophistication
- Some skills may have no relevance to others
  - They can be performed at any time prior to terminal objectives
  - This diagram is sometimes referred to as a shorthand pyramid
- Designing a PBET training course requires a logical and sound structure
  - Also helpful for designing self-paced instructional programs, CBT and multimedia




A skills hierarchy is like a road map. It's a graphic representation of paths in a course. It shows how the different levels of subordinate skills serve as enabling objectives that lead to the terminal objectives.

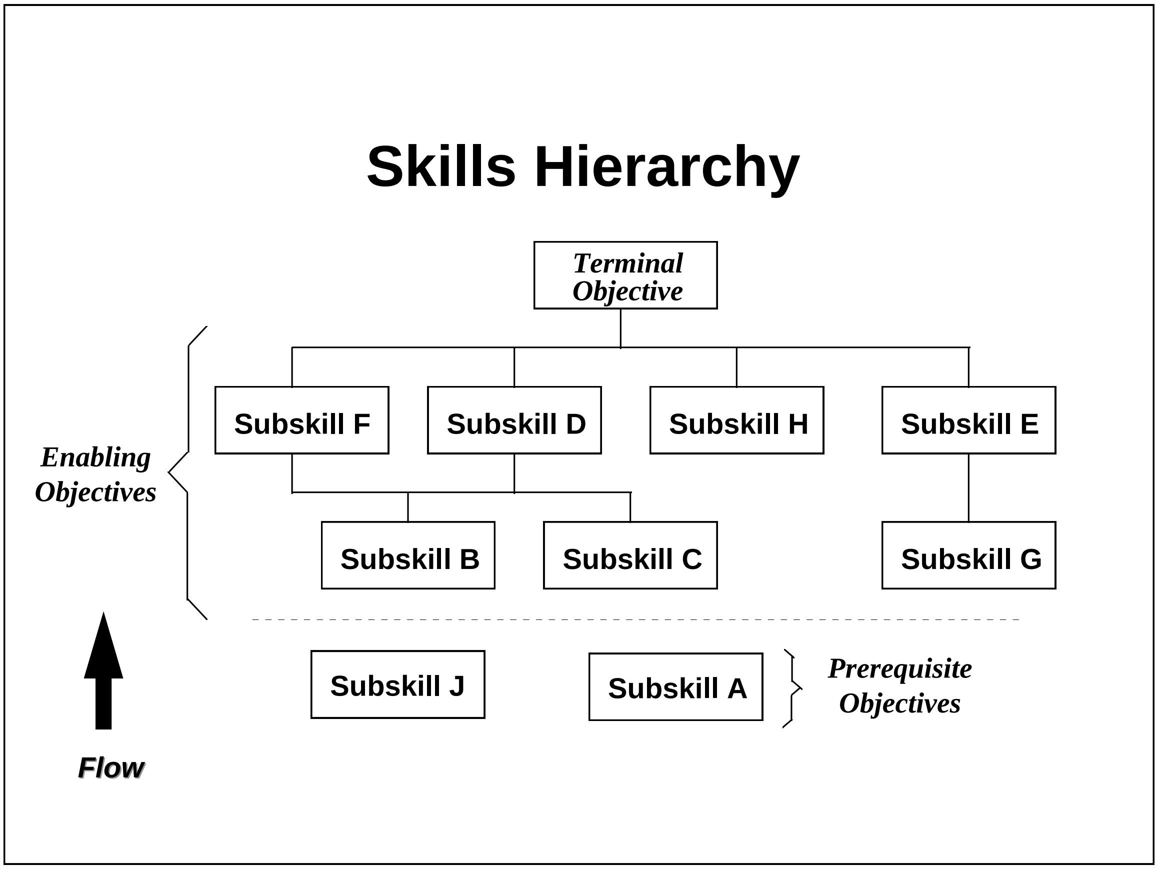
The structure of the hierarchy in this foil shows how instructional elements of a course are logically arranged. It's easy to see which subskills are prerequisites to others. There may be some skills that have no relevance to other skills; these can be performed at any time prior to attempting the terminal objectives.

Normally, instructional designers use shorthand objectives to label individual boxes in the skills hierarchy. This may be why this type of diagram is also referred to as a *shorthand pyramid*. There are different types of performance objectives. The objectives in this slide have been categorized as enabling objectives and terminal objectives.



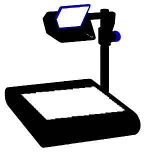
**Objectives in a Skills Hierarchy**

- To determine the best structure for the course, you need to look at the final, *terminal* objectives
- A skills hierarchy provides a structure for relating the different supporting skills and competencies to the terminal objectives
- This skills hierarchy shows three categories of objectives
  - Prerequisite objectives
  - Enabling objectives
  - Terminal objectives




To design a PBET training course, you need a logical, sound structure you can follow as you organize your course. To determine the best structure for the course, you need to look at your final or *terminal* objectives and their subordinate objectives.

A skills hierarchy indicates where and how the support skills relate to the terminal objective. A *skills hierarchy* provides a structure for relating the different supporting skills and competencies to the terminal objective. The subordinate objectives consist of *enabling* objectives and *prerequisite* objectives.



**Three Categories of Objectives**

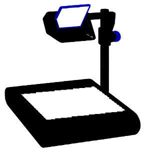
- There are three categories of objectives:
  - **Prerequisite** -- these objectives state what performers must have mastered before taking the course
  - **Enabling** -- these objectives are what the performers must master to “enable” or assist them to master the terminal objective
  - **Terminal** -- these objectives are the significant final or “terminal” outcomes of the training program
- Training programs generally have a set of course objectives that organize the sequence of topics covered

## Three Categories of Objectives

| TYPE | DESCRIPTION | EXAMPLES |
|---|---|---|
| • Terminal Objectives | These are the significant, final outcomes of a training program. | • Design a process<br>• Troubleshoot problems<br>• Repair equipment<br>• Perform maintenance<br>• Program a process recipe<br>• Operate a machine |
| • Enabling Objectives | These are the objectives which must be mastered if an individual is to master the terminal objective. | • Write a process recipe<br>• Interpret computer screens<br>• Follow safety procedures<br>• Identify hazards<br>• Locate and describe parts<br>• Describe process steps<br>• List process steps |
| • Prerequisite Objectives | These are the objectives that state what an individual must have mastered before entering the training course. | • List four areas of a fab<br>• Describe a cleanroom<br>• Use Ohm's law to calculate . . .<br>• Operate a multimeter<br>• Interpret the metric system<br>• Read and write English |

Training programs generally have a set of course objectives that organize the sequence of the topics covered. There are three categories of performance objectives as illustrated in this foil. They are:

- Terminal objectives
- Enabling objectives (subordinate to the terminal objective)
- Prerequisite objectives (subordinate to the terminal and enabling objectives).



**Guidelines for Interpreting a Skills Hierarchy**

- The skills hierarchy shows which subskills must be learned before going on to a higher skill.
- It does not tell which skill out of the entire group should be learned first. There could be a variety of starting points.
- It does not indicate the proper sequence in which steps of a task should be performed.
- It does not relate anything about the importance of each skill.
- The relative importance of a skill in a skills hierarchy does not indicate the degree of difficulty that a person will have learning that skill.

## Guidelines for Interpreting a Skills Hierarchy

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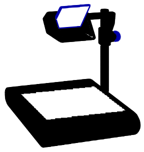
- **The relative importance of a skill in a skills hierarchy does not indicate the degree of difficulty that a person will have learning that skill.**

A skills hierarchy has one main purpose -- it tells you the sequence in which lessons, or modules, can be learned.

A skills hierarchy should not be misunderstood with the steps in a procedure.  It is not necessarily the sequence in which a task should be performed.  This is because a course designer may have determined that several steps of a task could be learned in any order.

In addition, the lessons listed in a skills hierarchy are not necessarily in the order of importance nor in the order of difficulty.

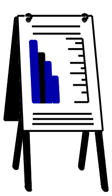


**Guidelines for Developing a Skills Hierarchy**

Prior to creating a skills hierarchy, you will need a well-stated terminal objective containing all 3 elements, then

- Place the paper at the top of the workspace
- Write subordinate objectives in shorthand form on sticky-back paper (Post-it Notes ™)
- When designing, you generally start from the top and work your way down
- Begin with the terminal objective by asking "what skills must I be able to do first before I can do this one?"
- Repeat the process for each of these subordinate objectives and so on
- Be ready and willing to create new objectives
- All subskills must be derived from terminal skills. If not relevant to the terminal skill, it should be set aside
- Skills hierarchies should be created and approved by committee

**Class Brainstorming Activity**



***Instructor Note:*** *You will lead this activity. Write this terminal objective and enabling skills on large Post-it Notes and attach to flip chart at front of room. Have participants practice creating a skills hierarchy. Start with "what skills must I be able to do first before I can do the next one?"*

"Meet and greet an old acquaintance"

| | |
|---|---|
| greet | look |
| speak | recall |
| identify | compare |
| shake hands | see |
| walk | observe |

## Guidelines for Developing a Skills Hierarchy

- **Write out the complete terminal objective and place it at the top of the workspace.**
- **Write out all subordinate objectives in short form on individual index cards, sticky note paper, etc.**
- **To organize the hierarchy, look at each objective and ask, "what must I be able to do before I can do this?" Then, position objectives accordingly.**
- **Be ready and willing to create new objectives if required.**
- **All subskills must be derived from terminal skills. If a subskill has no relevance to the terminal skill, it should not be included in the hierarchy.**
- **Skill hierarchies should be validated.**

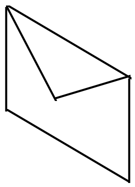
There is no easy way to develop skills hierarchies; however, the process can be facilitated with the use of index cards or sticky-back paper such as 3-M Post-it Notes™. Write the complete terminal objective and place it at the top of the workspace, then ask yourself, "what (skills) must I be able to do before I can do this?" Place these skills under the terminal objective, then repeat the process for these skills and so on.

To reduce time and errors, the skills hierarchy should be developed and approved by a committee made up of interested parties, such as; trainers, developers, subject matter experts, and customers.

Now is a good time to practice developing a simple skills hierarchy. Your instructor will lead the class through an exercise on designing a skills hierarchy required to "meet and greet an old acquaintance."

**Skills Hierarchy Practice Exercise**

- Now you will have an opportunity to practice building a skills hierarchy for this set of objectives



**Two-Person Team Activity**

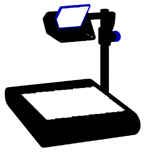
- *Hand out the envelopes containing the shorthand objectives designated for the AN-3 Skills Hierarchy Practice Exercise.*
- *Have participants work in pairs to develop a skills hierarchy from the objectives contained in the envelope.*
- *Review each skills hierarchy and assist each group as necessary.*
- *Review results with class to clarify any major issues. The answers are apparent when the class is shown the overhead for page AN-3-9*
- *Audience may have difficulty understanding logic of why safety procedures don't always come first in a training situation.*
  - *Use analogy of unfamiliar equipment such as a disposable diaper production system, automatic white blood cell counter, electrocardiogram, sterilization system, engine diagnostic system, etc.*

# Skills Hierarchy Practice Exercise

- **Terminal Objective:**
  - **Perform daily functional checks on manufacturing equipment**
- **Subordinate Shortform Objectives:**
  - **Explain safety procedures**
  - **interpret computer screens**
  - **Interpret alarms**
  - **Describe controls and indicators**
  - **Identify hazards**
  - **Locate major equipment components**
  - **Identify equipment contamination sources**
  - **Describe process characteristics**

Work with a colleague at your table to build a skills hierarchy from the set of objectives shown on this slide. Remember, for each objective you should ask the question, “what do I need to know first before I can do this and then what do I learn next?”

Use index cards, paper strips, or sticky-back note paper to build the skills hierarchy unless your instructor provides some pre-printed paper strips.



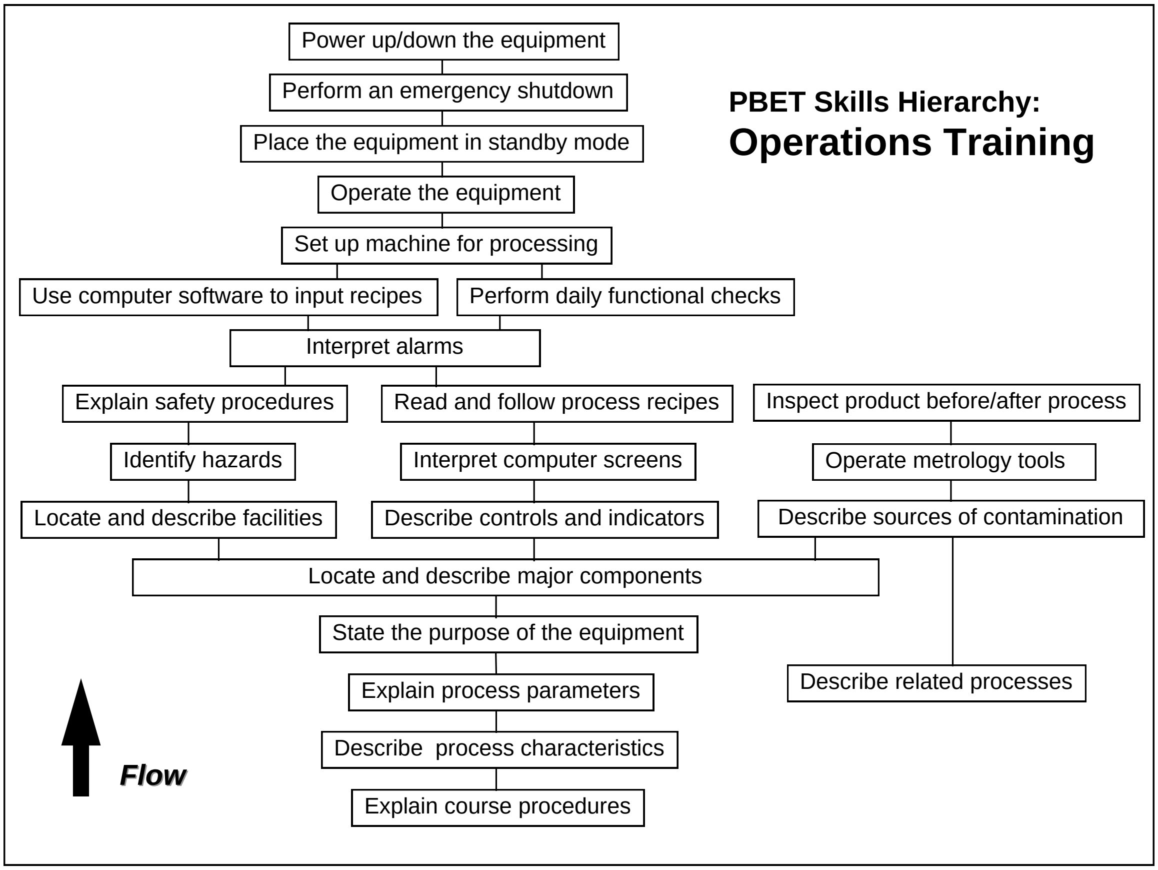
**Operations Training Skills Hierarchy**

- Most PBET courses for training in operations and product inspection contain skills similar to the ones in this foil
- Depending on the tool and manufacturer, the sequencing number and type of modules may vary

***Instructor Note:*** *Ask participants which of the skill boxes they would need to train an operator in everything, except how to "power-up and power-down the equipment"*

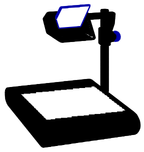
*Which boxes/modules would be needed to teach wafer inspection for a specified tool?*

- *Ask if they can think of any prerequisites for this hierarchy foil*




This slide represents a typical skills hierarchy or course map for an equipment operations training course. Most PBET courses designed to train operators, technicians and engineers in the operations and product inspection for a specific processing tool will contain a set of skills similar to these.

Depending on the type of tool -- its complexity and sophistication, and its manufacturer -- the number and types of modules, as well as their sequence may vary.



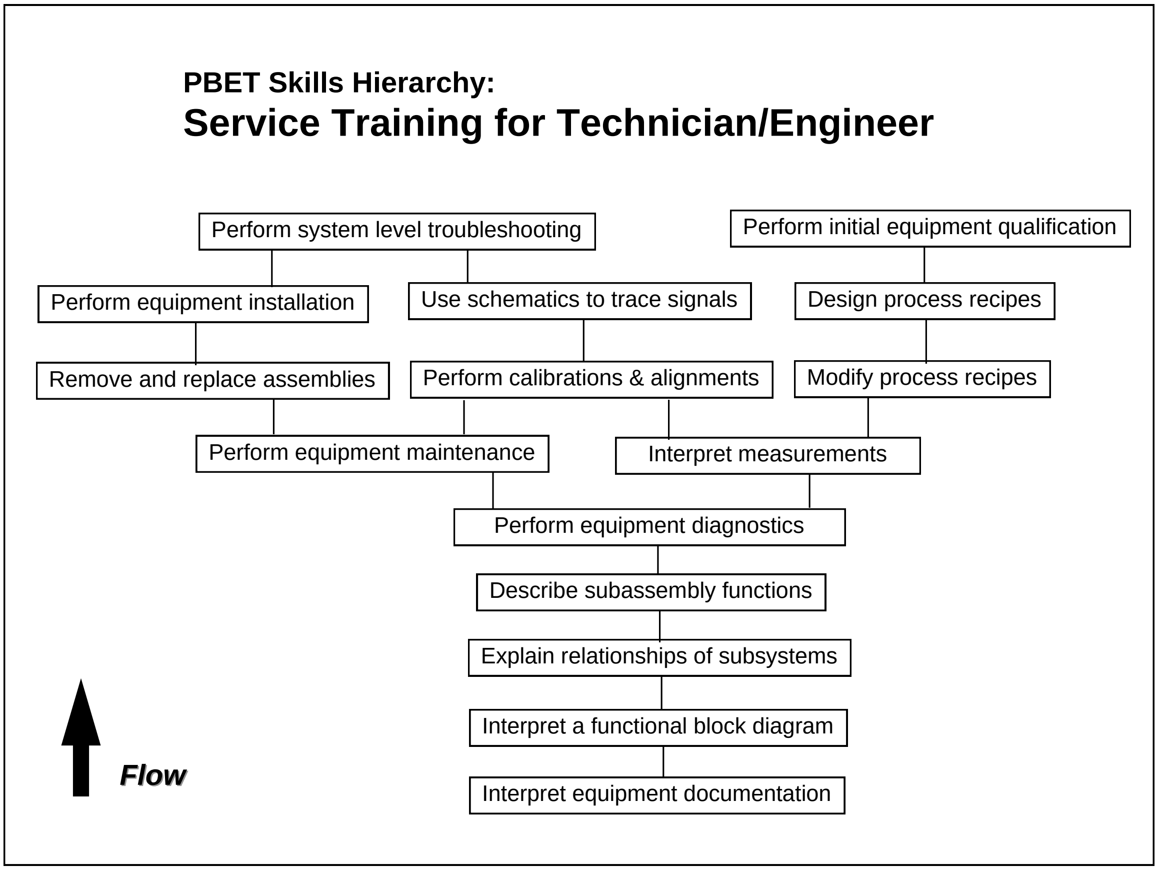
**Service Training Skills Hierarchy**

- This is a PBET skills hierarchy for a course for technicians/service engineers
- This course trains technicians/engineers in the skills and knowledge necessary for a semiconductor processing tool including:
  - Maintenance
  - Troubleshooting
  - Installation
  - Qualification
- The operations training course as seen in the foil we just viewed is a prerequisite to this course
- With each of these hierarchies, you can see how easy it can be to customize training for specific needs

***Instructor Note:*** *Ask participants which of the skill boxes they would need to qualify a tool for processing*

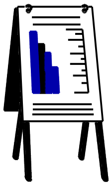
*Which boxes/modules would be needed to perform calibrations? To perform routine maintenance?*

- *Ask if they can determine the prerequisites for this hierarchy foil*




This is a simplified example of a PBET skills hierarchy for a training course designed for technicians and/or service engineers. It's a training course for the skills and knowledge needed to maintain, troubleshoot, install, and qualify a semiconductor processing tool.

The operation course shown in the preceding foil is to be considered a prerequisite to this service training course. It's easy to see in both examples of PBET course maps how the courses can be easily customized to meet a customer's specific training needs. A skills hierarchy/course map can help you determine with a glance which courses should be taught.



**Skill Test**

- Brainstorm with your Legos teammate(s) a list of enabling objectives for the Legos Assembly activity
  - *Identify the materials they will need to assemble the Legos model*
- Use the 3-M Post-it Notes ™ and flipchart paper to create a skills hierarchy with "Assembling a Legos Model" as the terminal objective.
- Have the instructor review the results of your team's work.

***Instructor Note:*** *When everyone has completed this exercise, review the Legos skills hierarchy with each group. Compare differences and discuss them. Have participants transfer prerequisites to Lego Assembly Lesson Planning Form.*

- Examples of objectives:
  - Prerequisite
    - -- Differentiate colors
    - -- Count from 1 to 100
    - -- Identify geometric shapes and concepts
    - -- Manual dexterity
    - -- Follow verbal instructions
    - -- Distinguish left from right
  - Enabling
    - -- State the purpose of the model
    - -- Visualize the model
    - -- Name the parts
    - -- Identify the parts
    - -- State purpose of the parts
    - -- Categorize the parts
    - -- Use the job aid
    - -- Follow assembly procedures
    - -- Fasten/unfasten Lego parts

## SKILL TEST

- **Gather your team members and brainstorm enabling objectives for a task assigned by your instructor.**
- **Use the 3-M Post-it Notes™ to create a skills hierarchy from these enabling objectives.**
- **Designate the prerequisite objectives by drawing a line between the prerequisite objectives and the enabling objectives**
- **When the skills hierarchy is approved by the instructor, write the prerequisite skills in the Lesson Planning Form.**

**Supplementary Activity**

- You have already created a skills hierarchy for the Legos assembly task
- On the last day of class you will complete the following skills test for an area in your own expertise:
  - Select a terminal objective from your area of expertise
  - Create a skills hierarchy consisting of:
    - Prerequisite objectives
    - Enabling objectives
    - Terminal objectives
  - Reduce subordinate objectives to shorthand objectives
  - Write shorthand objectives on sticky notes or in pencil on paper
  - Build the skills hierarchy on the flipchart, poster board, or paper
  - Compare your skills hierarchy with the examples given on the previous pages
  - Have the instructor review each participant's skills hierarchy
- A skills hierarchy must show the subskills to learn before moving on to higher skills
- When the hierarchy has been completed, have the workshop instructor or aide review the diagram

## SUPPLEMENTARY ACTIVITY

**You have created a skills hierarchy for the assigned task. On the last day of class you will complete the following skills test for an area in your own expertise.**

1. **Select a terminal objective from your own area of expertise or one that the instructor has assigned to you. Create a skills hierarchy consisting of performance objectives, including terminal, enabling, and prerequisite objectives.**

   A. **Start by reducing the subordinate objectives to shorthand objectives.**

   B. **If available, write each shorthand objective on sticky-back paper or index cards. If not available, then use pencil and paper so you can easily erase and make changes.**

   C. **Use a sheet of paper, posterboard, or flipchart paper on which to build the skills hierarchy.**

2. **The skills hierarchy must show which subskill must be learned before going on to higher skills.**

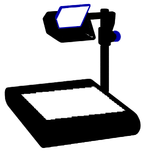
3. **When you have finished, have the workshop instructor or one of the workshop aides review your diagram.**

# Design

Module No. | Page No.

**DS-1 DEVELOP SKILL TESTS**

- We've seen how important objectives are in developing a skills hierarchy



**PBET Course Map**

- Here's where we are on the PBET course map
- We have three possible routes to follow
- Now we'll talk about developing PBET skill tests

**Develop Skill Tests**

- The instructional goal should be successful instructional programs
- Excellent instructional design and delivery still require measuring results of the learning activity
- Skill tests are the measurement instruments
- Level 2 evaluation tools

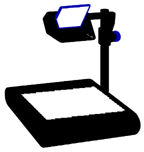
**DS-1**

## DEVELOP SKILL TESTS

**OBJECTIVE:**

**Given a performance objective for equipment training, develop a skill test to match the requirements of the objective. The test must be conducted under the same conditions as indicated in the corresponding objective. The performance standard must also match that of the stated objective.**

The purpose of instruction is to produce improvements in human performance. It should be the instructional goal, therefore, to design the instructional program for success. But, even the finest instructional design techniques and dynamic delivery methods cannot be proven successful unless there is some way to measure the results of the learning activity. This is the reason for having measurement instruments we often refer to as "tests."

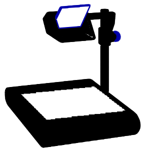


**Traditional Applications of Tests**

- Tests come in many forms
- Some determine how well course participants perform in comparison to others
  - In the same course
  - In the same area
  - In the same country
- Some tests determine how well *participant*s perform against requirements of the course

# Traditional Applications of Tests

Tests come in many different forms. Sometimes tests are used to determine how well course participants perform in comparison to others in the same class, school, area, or country. At other times, tests are used to measure how well course participants perform against the requirements of the course.



**Norm-Referenced Testing Vs. Performance-Based Testing**

- There are two ways to look at the results of testing:
  - Norm-referenced approach
  - Performance-based approach
- In a norm-referenced test, a technician scored 90 out of 100:
  - Despite failing the safety section, the overall grade looks good
- In performance-based scoring, NC indicates not complete:
  - Final score remains blank until requirement is satisfied
  - Technician is not allowed to operate equipment until all skills are complete

***Instructor Note:*** *There's a performance checklist in Appendix A, page A-17*

## Norm-Referenced Testing vs. Performance-Based Testing

| | | Norm-Referenced Scoring | Performance-Based Scoring |
|---|---|---|---|
| 1. | Describe Process Steps | 10 | ✓ |
| 2. | Name 25 Major Parts of the System | 10 | ✓ |
| 3. | Locate 35 Major Parts of the System | 10 | ✓ |
| 4. | Describe Function of 35 Parts | 10 | ✓ |
| 5. | Identify 10 Hazards & Explain Safety | 0 | - |
| 6. | Describe Functions of Controls | 10 | ✓ |
| 7. | Perform Daily Equipment Checks | 10 | ✓ |
| 8. | Interpret Computer Screens | 10 | ✓ |
| 9. | Interpret Process Recipes | 10 | ✓ |
| 10. | Operate the System | 10 | - |
| | Final Score | 90 | NC* |

**This person is not yet competent or has not yet mastered all of the PBET course requirements.*

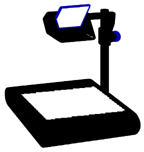
In general, there are two ways to look at the results from testing. One is the *norm-referenced* approach, and the other is the *performance-based (competency-based)* approach.

Examine for a moment the results of testing obtained from a technician who attended an equipment operator training course.

In the norm-referenced scoring system, the technician scored a very respectable 90 points out of 100. Despite the fact that the technician either failed the safety section or was not present when it was covered, the overall impression is that the technician passed with a good grade.

***NOTES:***

On the other hand, the performance-based method of scoring simply indicates an *NC* to inform the technician and others that the course is *not complete* or that the technician is *not yet competent*. The final score remains blank until the requirement is satisfied. Also, if the training system is truly performance-based, the technician would not be allowed to operate the equipment until all the prerequisite skills have been completed, including the safety skills. This explains the blank space next to the Operate the System under the Performance-Based scoring column.



**Requirements for Writing Effective PBET Skill Tests**

- A skill test needs to match the objective to measure the outcome of performance
- Performance objectives must include performance, condition, and standard

## Requirements for Writing Effective PBET Skill Tests

**A well-written skill test must be a good match to a well-written performance objective, which is accompanied by three important components:**

- **Performance requirement**
- **Conditions under which the performance is to occur**
- **Standard of performance must match the stated objective**

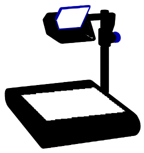
When instructional systems have solid, well-stated objectives that inform course participants what is expected of them at the end of a course or unit of instruction, a well-matched skill test is needed to measure the outcomes of the performance.

The skill test must match the performance objective in terms of the stated performance, the conditions under which it occurs, and the standard for observing or measuring the performance.

**Practice Exercise**

- Verify that practice examples have skill tests that match their performance examples
- After reading the examples and determining an answer, compare your answer with a colleague
- If you need assistance, consult with the workshop instructor or assistant

***Instructor Note:*** *If you prefer, you may have the participants complete the practice exercises as a group*



**Skill Test Example No. 1**

***Instructor Note:*** *After participants have completed the practice, review the correct answer*

- The correct answer is, "Yes, they match"

# Skill Test Example No. 1

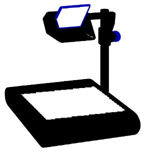
**WAFER INSPECTION SKILL TEST**

**OBJECTIVE: Given 10 production wafers of different masking levels, and having available all the necessary resources and metrology tools in the fab, identify which wafers have defects, and locate the area and nature of the defect. The inspections must be 100% accurate and completed within 40 minutes.**

**SKILL TEST: Perform the following wafer inspection skill test in the presence of your trainer.**

- **You will be provided all necessary items you will need for the wafer inspection test including the metrology tool in the fab.**
- **The instructor will provide 10 wafers of known origin and types of process defects.**
- **For each wafer tell the instructor where the defect is located and explain the nature of the defect.**
- **Performance standard is 100% accuracy and will require no more than 40 minutes to complete.**

The foil shown above is a practice exercise. Read the objective and skill test for Example No. 1, and decide if the skill test is appropriate for this example. Discuss your answer with a colleague. If you need assistance, consult with the workshop instructor or assistant.



**Skill Test Example No. 2**

***Instructor Note:*** *After participants have completed the practice, review the correct answer*

- The correct answer is, “No, they don’t match”
  - Objective says “execute”
  - Skill test says “show”

# Skill Test Example No. 2

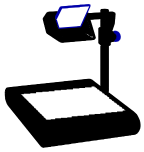
**RUN A FIRST MASK EXPOSURE JOB**

**OBJECTIVE: Given the proper reticle, resist-coated wafers, and a job number, load the reticle and the wafers into the *Astaire-1950 Stepper*, call up the proper job parameters, and execute a first mask exposure job. Your performance will be evaluated by the course instructor against the Operations Specifications.**

**SKILL TEST: At the designated stepper, explain to your trainer the procedure for executing a first mask exposure job.**

- **Show him where you would load the wafers and where to place the reticle.**
- **Show him on the stepper which job parameters to use.**

Read the objective and skill test for Example No. 2, and decide if the skill test is appropriate for the objective. Discuss your answer with a colleague. If you need assistance, consult with the workshop instructor or assistant.



**Skill Test Example No. 3**

***Instructor Note:*** *After participants have completed the practice, review the correct answer*

- The correct answer is, “No, they don’t match”
  - Objective says “perform”
  - Skill test says “number”

# Skill Test Example No. 3

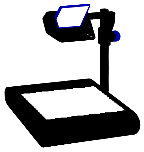
**PERFORM AN RF GENERATOR ALIGNMENT**

**OBJECTIVE: Assuming all tools, parts, schematics, and alignment specifications are available, perform a complete alignment on an *FRQ-5000* RF generator. The alignment must be completed in less than 20 minutes and the harmonic distortion <5%.**

**SKILL TEST: Given the following steps required in the *FRQ-5000* RF generator alignment, number them in the proper order from 1 to 6.**

- **Set up the frequency counter for a frequency of 13.5 MHz.**
- **Adjust crystal amplifier for maximum output.**
- **Connect the oscilloscope to the AGC test point.**
- **Adjust the output of the first IFPA to maximum.**
- **Monitor the SWR meter on the front panel.**
- **Adjust the PA LC network for maximum power.**

Read the objective and skill test for Example No. 3, and decide if the skill test is appropriate for the objective. Discuss your answer with a colleague. If you need assistance, consult with the workshop instructor or assistant.



**Skill Test Example No. 4**

***Instructor Note:*** *After participants have completed the practice, review the correct answer*

- The correct answer is "Yes, they match"

***Instructor Note:*** *Talk to the participants about the different types of skill tests as you walk them through the Guidelines for Writing Certification Tests in the Appendix of their notebook -- page C-8 and C-9.*

# Skill Test Example No. 4

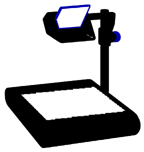
**LOCATE AND DESCRIBE SIX PARTS OF A WAFER**

**OBJECTIVE: Given a diagram of a wafer and the correct wafer terminology, locate the six parts of a wafer by matching the correct descriptions.**

**SKILL TEST: Using the wafer diagram and the list of matching words and statements from the Appendix, correctly locate and identify the six parts of a wafer.**

Read the objective and skill test for Example No. 4, review the Appendix pages and decide if the skill test is appropriate for the objective. Discuss the answer with a colleague. Refer to pages C-8 and C-9 in Appendix C for an example of this test.

***Instructor Note:*** *Walk the participants through the Guidelines for Writing Certification Tests in Appendix C (page C-5) of their notebooks following Tab 9*



**Skill Test**

***Instructor Note:*** *Two parts to this test: (1) Legos, (2) Participants individual project*

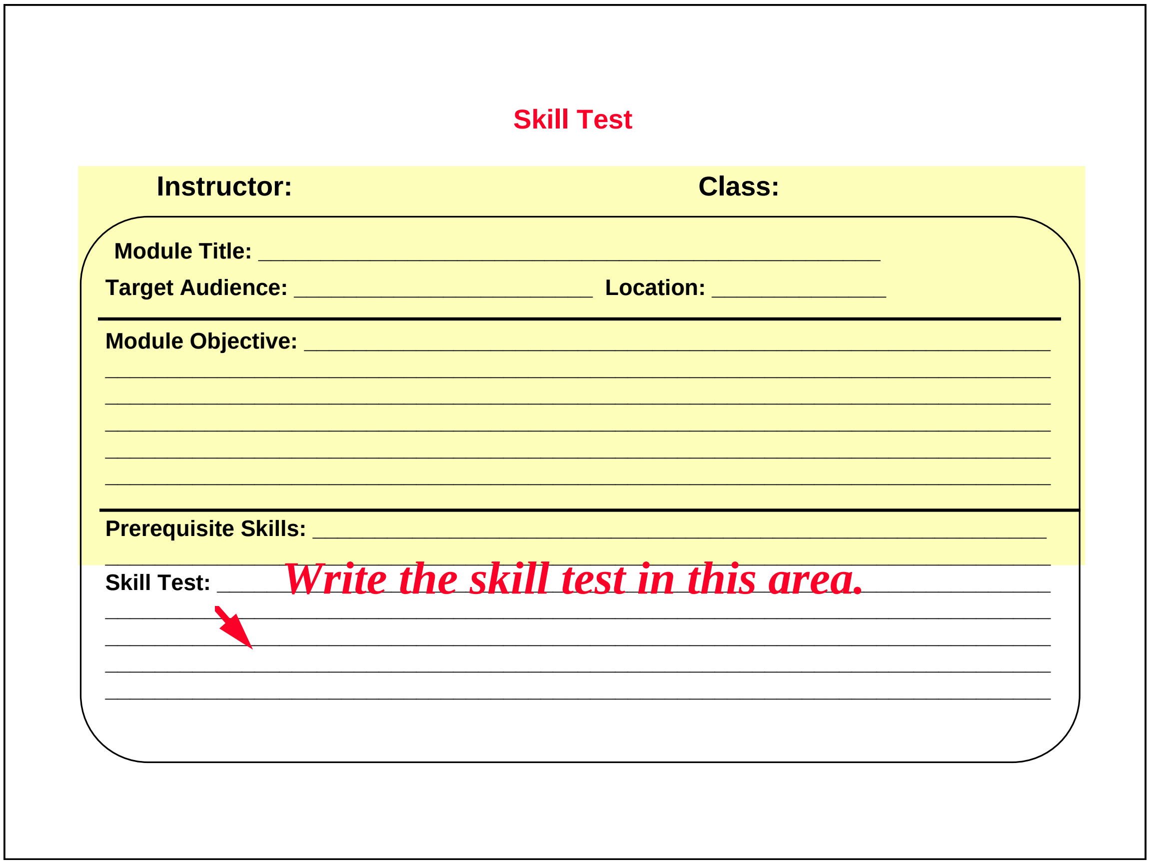
**Lesson Planning Form**

(1) The skill test for the Lego assembly lesson will be written in the Lesson Planning Form

- *Have participants describe what will be included in the test*

(2) Using a performance objective from your area of expertise, or one created in Module AN-3, develop a skill test to match the objective

- Test must be conducted under the same conditions as stated in the objective
- Write the objective and skill test on a separate sheet of paper
- Please note that this skill test matches the objectives for this module
- *Review each participant's test*
- You may ask for assistance



Skill Test

Instructor: Class:

Module Title: ______________________________________________

Target Audience: ______________________ Location: _____________

Module Objective: ____________________________________________________

Prerequisite Skills: ____________________________________________________

Skill Test: ___ *Write the skill test in this area.* ___

SKILL TEST

- **Review the module objective with your project colleague.**
- **Review the important elements of designing skill tests as described in this module.**
- **Draft a skill test on separate paper, then review and edit your work so that it conforms to the criteria described in this module. Does the skill test match the objective in terms of: __ performance, __ condition and __ standard?**
- **If it is a “hands-on” test, have you provided instructions for both trainer and trainee in clear, user-friendly language?**
- **If it is a written test, have you provided some sample test items or a clear description of the type of written test that will be given?**
- **Ask the course instructor to review the test description. The instructor will use the same criteria as above to evaluate your work.**
- **When the drafted test is approved by the course instructor, you and your colleague should transfer the extended narrative form to your Lesson Planning Forms.**
- **Now, take your second Lesson Planning Form on which you have already written an objective for a lesson of your own choosing. Design a test for that objective and fill in the Skill Test section. When finished, have the course instructor review this test.**

## DS-2 DESCRIBE RELEVANT PRACTICE

- We've covered how to develop skill tests for PBET
- Now we're going to talk about relevant practice in training materials

**Describe Relevant Practice to Support Objectives**

- *Ask a volunteer to read the objective from the foil*

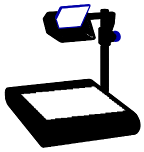
**DS-2**

# DESCRIBE RELEVANT PRACTICE TO SUPPORT OBJECTIVES

**OBJECTIVE:**

**Given an objective in your area of expertise, write a description of relevant practice that includes a description of the following elements:**

- **The activity trainees will be doing when practicing the <u>performance</u>**
- **The <u>conditions</u> under which the practice activity is to occur**
- **A <u>feedback</u> mechanism to inform your trainees how well they are doing**
- **The type of <u>modeling</u> that will be used to demonstrate desired performance**



**Four Components of Relevant Practice**

- Relevant practice includes:
  - Performance
  - Conditions
  - Modeling
  - Feedback
- Performance -- the activity performed based on the performance objective (This has been defined in a previous module.)
- Conditions -- how, where, and with what the practice occurs
- Modeling -- a way of demonstrating the performance to the course participants
- Feedback -- given during the practice, a way of letting course participants know how they are progressing

## Four Components of Relevant Practice

| | |
|---|---|
| • Performance | The activity which the trainees will be doing when they are practicing the intended performance stated in the objective. |
| • Conditions | Where, how, and with what the relevant practice is to be performed. |
| • Modeling | The method in which the performance can be demonstrated to the trainees. |
| • Feedback | The indicators, signs, or cues that trainees can use to measure their own performance. |

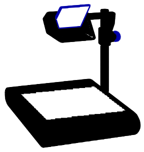
In order to provide the most effective way of practicing a desired performance, there are four specific components that must be included in describing relevant training practice. ***Performance*** defines what the course participants will be doing when they are practicing the intended skill that's stated in the performance objective. For example, if the objective requires that technicians leak-check the process chamber of an ion implanter, then that's what they should practice.

***Conditions*** describe how and with what the relevant practice will be performed. In some cases a similar activity can be substituted for the actual relevant practice. For example, if the objective requires someone to identify components inside an ion implanter, then a color photograph or videotape of the implanter could be substituted.

***NOTES:***

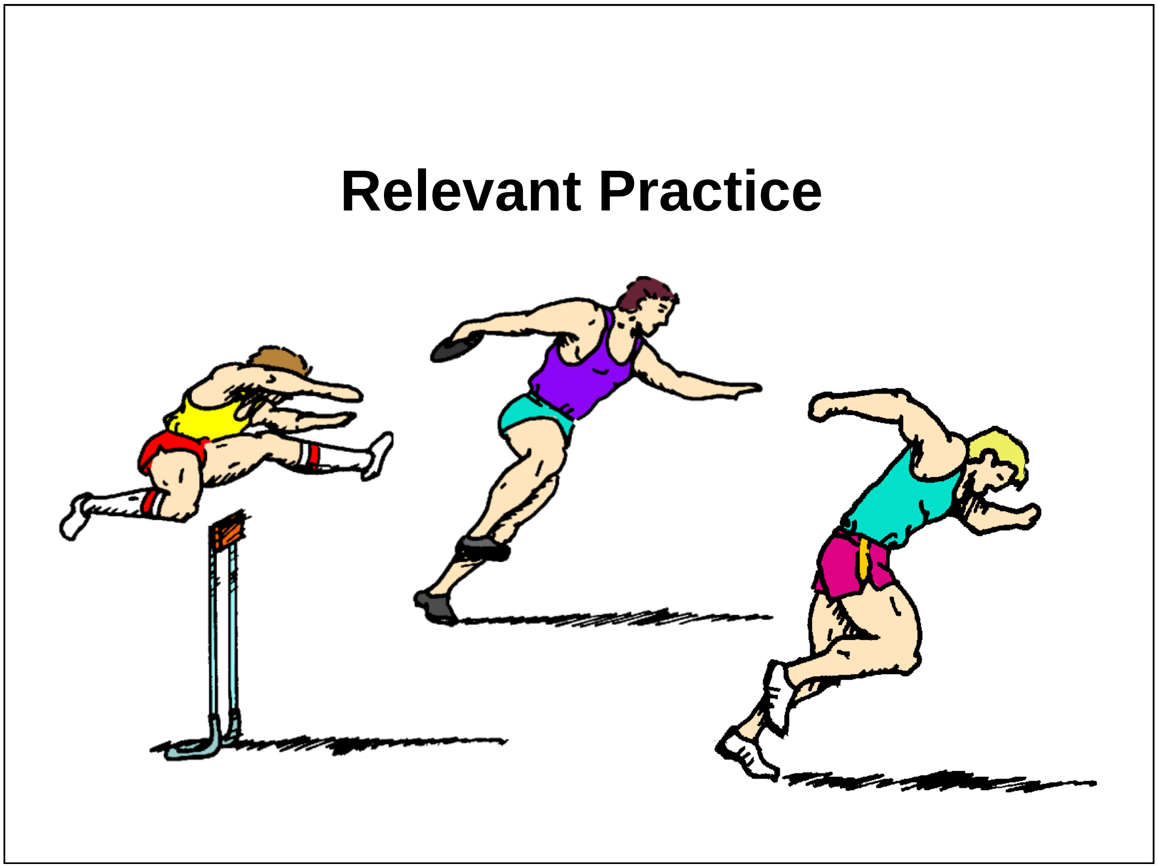
***Modeling*** provides a way in which the performance can be demonstrated to a course participant. Again, the trainer or another competent performer can model the desired performance. As with the feedback mechanism, and depending on the type of performance, there may be other ways in which the performance can be modeled.

***Feedback*** wherever possible, provides indicators, signs, or cues that the course participants can use to measure their own performance. And, if that's not possible, feedback provides a means for informing the participants about how well they are progressing.



**Relevant Practice**

- The more an activity is repeated, the more successful the performance
- Unless practice is relevant to the performance objective, it will have little benefit
- In track and field, a discus thrower gains little by practicing sprinting and hurdling -- they're unrelated skills
- Relevant practice would be gained by practicing with the hammer -- the motions are similar to discus-throwing
- In training, as in athletics, practice must be relevant to the performance required
- Conditions during practice need to be relevant to conditions that will exist during the actual performance

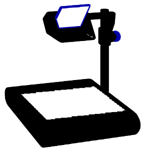



The more we repeat an activity, the more chances we have of improving the outcomes of subsequent performances. Practice must be relevant to the performance objective, otherwise there is little benefit from it.

For instance, in this track and field example, how much improvement can a discus thrower gain by sprinting and hurdling? Probably none. The three skills are unrelated. Throwing the discus requires a different set of skills and physical stature.

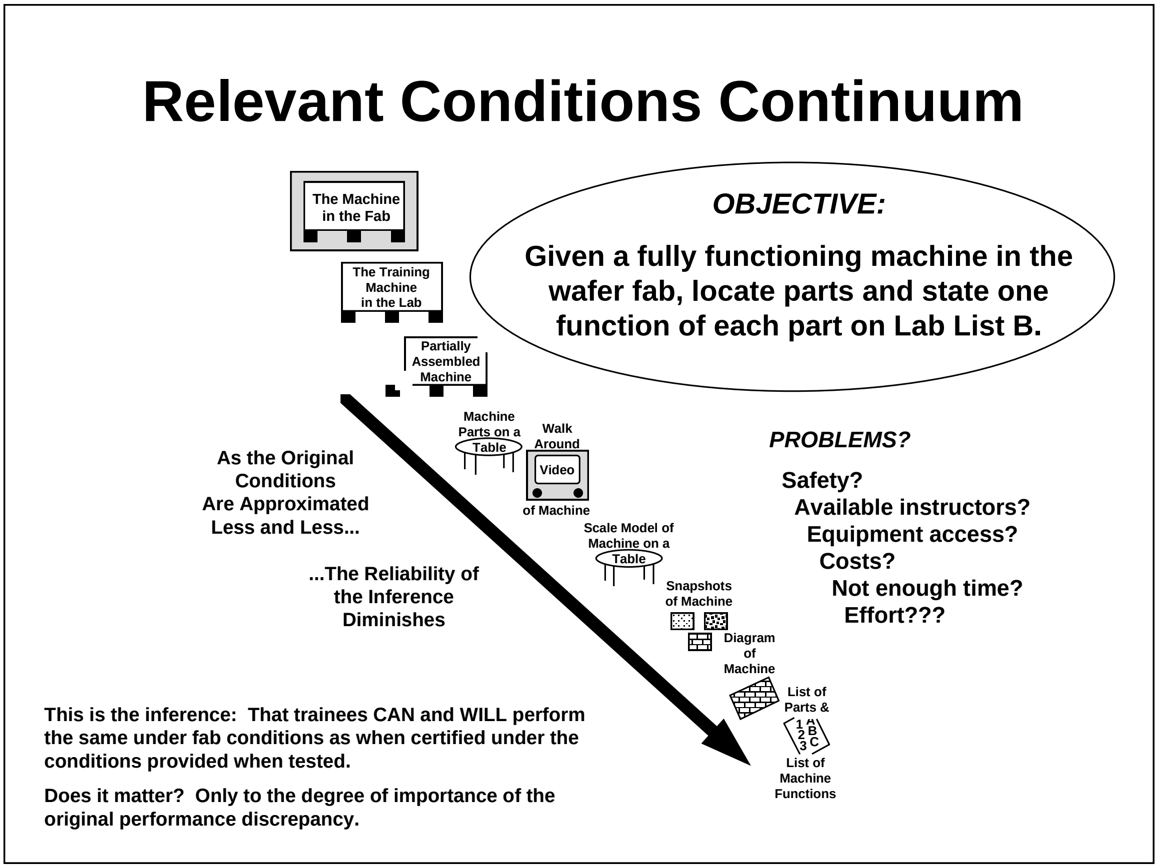
Whether in training or athletics, the performance that's practiced should mirror the performance that will be required later.

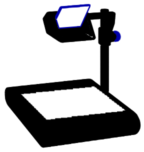
Relevancy also applies to the conditions of the practice. Conditions during practice should closely resemble the actual conditions that will exist later.



**The Dick Goutal Relevant Practice Conditions Scale**

- This scale describes the resulting effect of using other objects or conditions to practice the requirement of the actual objective
- Read the objective in the circle
- Look at the change in conditions starting from the top, a machine in Fab, to the bottom, a list of machine functions
- The result is - as the original conditions are approximated less and less, the reliability of the inference diminishes
- The inference we (trainers) often make is that trainees <u>can</u> and <u>will</u> perform the same under Fab conditions as when certified under the conditions provided when tested
- Does it matter? Only to the degree of importance of the original performance discrepancy


Relevant Conditions Continuum
The Machine in the Fab
The Training Machine in the Lab
Partially Assembled Machine
Machine Parts on a Table
Walk Around Video of Machine
Scale Model of Machine on a Table
Snapshots of Machine
Diagram of Machine
List of Parts &
1 A
2 B
3 C
List of Machine Functions
OBJECTIVE:
Given a fully functioning machine in the wafer fab, locate parts and state one function of each part on Lab List B.
As the Original Conditions Are Approximated Less and Less...
...The Reliability of the Inference Diminishes
PROBLEMS?
Safety?
Available instructors?
Equipment access?
Costs?
Not enough time?
Effort???
This is the inference: That trainees CAN and WILL perform the same under fab conditions as when certified under the conditions provided when tested.
Does it matter? Only to the degree of importance of the original performance discrepancy.



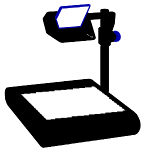
**Relevant Practice -- Model Behavior**

- Another way of learning proper techniques is to watch someone demonstrate or model an activity
- If live demonstrations aren't possible, videos, slides, or films can be used

## Relevant Practice

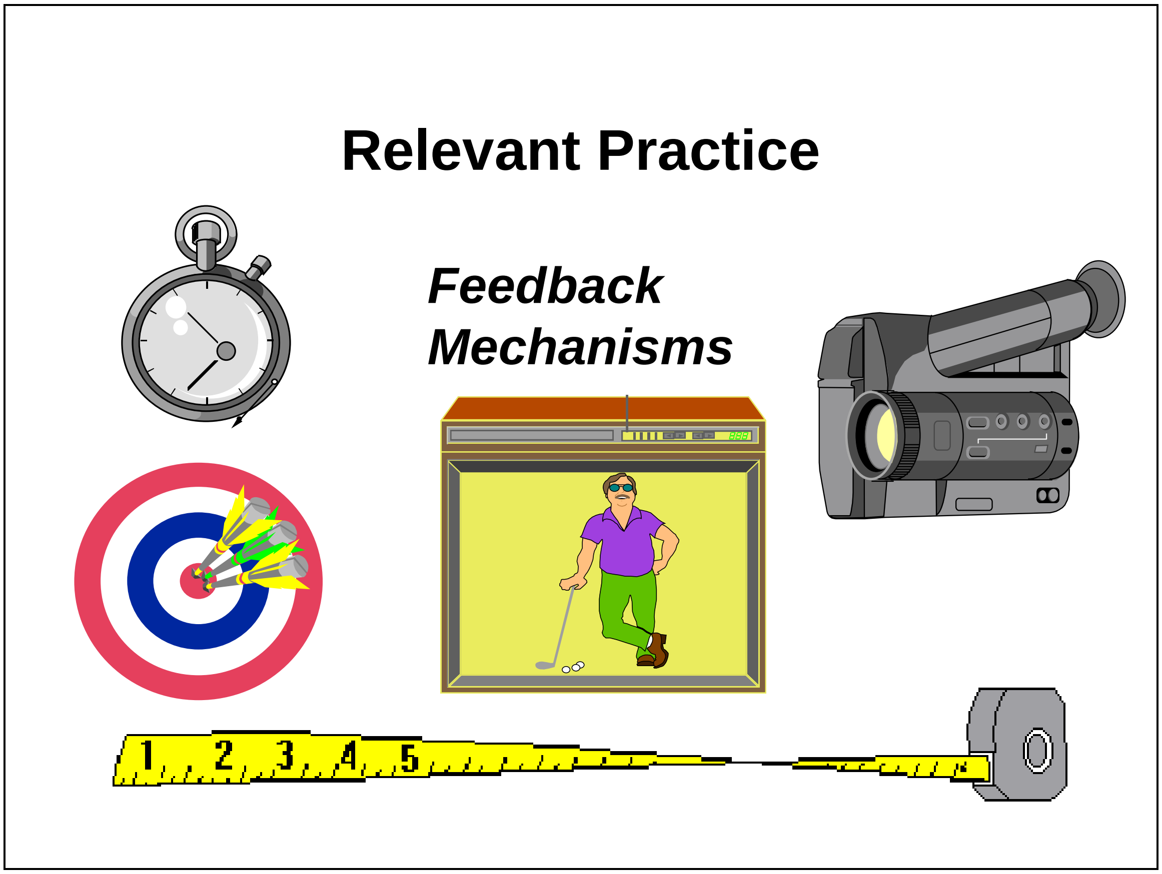
***Model Behavior***
***- Demonstrate***
***- Coach***
***- Train***

Another way of learning the proper techniques for performing a task during practice is having someone or something demonstrate or model the activity. In athletics, this task is usually handled by coaches and trainers, however, other methods can be used. For example, videotapes, slides, films, etc., can demonstrate or model the necessary activity or procedure.



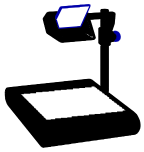
**Relevant Practice -- Feedback Mechanisms**

- Athletes and others want their progress measured
- They want to see how much they're improving




Athletes and other performers need to know how well they are progressing toward their desired objectives. In the case of the discus thrower, a measuring tape can measure the distance he or she is able to hurl the discus.

The measuring tape becomes the *feedback mechanism* to measure improvement. Unfortunately, if there's no improvement, the measuring tape won't tell him or her how to improve. Once again, a coach or a trainer can provide this feedback. Today, technologists are also using video and computer analysis to improve athletic performance.



**Pitfalls to Avoid When Planning Relevant Practice**

- The following are some common pitfalls to which some training developers fall victim
- Partial practice -- objective says “calibrate a vacuum system throttle valve”
  - Partial practice would be to “describe how to calibrate a vacuum system throttle valve”
- Disproportionate practice -- too little or too much practice; for example, objective says troubleshoot vacuum system
  - Plenty of practice on schematic tracing, but little time spent on actual vacuum leak detection methods
- Misdirected practice -- when performers can rely on signals for the correct answers
  - A wear pattern or an instructor’s reaction that signals the correct answer
- Limited practice -- when practice is limited due to lack of operational equipment, lack of individualized practice, or only practice on diagnosis versus equipment

# Pitfalls to Avoid When Planning Relevant Practice

- **Partial practice**
- **Disproportionate practice**
- **Misdirected practice**
- **Limited practice**

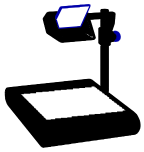
In planning and developing practice that's relevant, avoid the common pitfalls to which some training developers fall victim.

*Partial practice* – If the objective is to "*calibrate* a vacuum system throttle valve," partial practice would be to "*describe* how to calibrate a vacuum system throttle valve."

*Disproportionate practice* – Too much practice or too little practice.

*Misdirected practice* – When performers can rely on other signals for the correct answers, such as wear patterns or the instructor's reaction to clue them to the correct answers.

*Limited practice* – When practice is limited due to lack of operational equipment, lack of individualized practice and too much group practice; only practicing on paper and diagrams instead of equipment, etc.



**1. Examples of Relevant Conditions**

***Instructor Note:*** *Read the foil to the participants and ask if there are any questions about the performance of the practice activity*

What if your training scenario is one or more of these:

1A. Best Case Scenario

You have available:

– Unlimited access to production equipment
– A training lab with appropriate equipment
– Plenty of classroom space
– A dedicated trainer for each area
– On-line computer documentation, etc.

**-OR-**

1B. Alternative Scenario

You have:

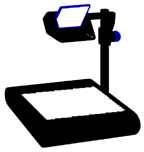
– Limited access to production equipment
– Few trainers available
– Adequate classroom space

# 1. Examples of Relevant Conditions

**Objective:** **Given a list of 10 parts belonging to an ion source, locate them and state the purpose of each one.**

**1A.** **<u>Best Case Condition</u>: Have the exact ion source available so students can practice.**

**1B.** **<u>Alternative Condition</u>: Have available one or more color photographs of the exact ion source with alphanumeric labels.**



**2. Other Examples of Relevant Conditions**

***Instructor Note:*** *Read the foil to the participants and ask if there are any questions about the conditions of the practice activity*

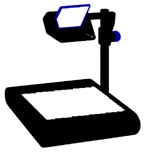
# 2. Other Examples of Relevant Conditions

**Objective:** **Given a list of 10 parts belonging to an ion source, locate them and state the purpose of each one.**

**2A.** <u>**Best Case Condition**</u>**: Classroom.**

**2B.** <u>**1st Alternative Condition**</u>**: Shop area, storage area.**

**2C.** <u>**2nd Alternative Condition**</u>**: Ion implanter inside fab.**



**3. Examples of Modeling Methods**

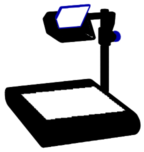
***Instructor Note:*** *Read the foil to the participants and ask if there are any questions about the modeling of the practice activity*

# 3. Examples of Modeling Methods

**Objective:** **Given a list of 10 parts belonging to an ion source, locate them and state the purpose of each one.**

**3A.** **Best Case Modeling Method: A trainer or other technician can point at one part of the ion source, say the name of the part, and describe the purpose of it.**

**3B.** **Alternative Modeling Method: Provide one or more color pictures; one part of the ion source has a label on it naming the part and a short description of the purpose of the part.**



**4. Examples of Feedback Mechanisms**

***Instructor Note:*** *Read the foil to the participants and ask if there are any questions about the feedback mechanisms of the practice activity*

# 4. Examples of Feedback Mechanisms

**Objective:** **Given a list of 10 parts belonging to an ion source, locate them and state the purpose of each one.**

**4A.** **<u>Best Case Feedback Mechanism</u>: A trainer or other technician can inform the trainee of the number of correct responses the trainee made and which specific ones were correct.**

**4B.** **<u>Alternative Feedback Mechanism</u>: The trainee will have available a checksheet with the correct responses.**

**Practice Exercise No. 1**

***Instructor Note:*** *Assign each of the following practice exercises to small groups. (The same exercises can be assigned to different small groups if you have a large class.)*

*Have participants read their practice exercise, and as a group decide on the answers. One person from each group will present their answers to the class*

*Show the foil for each practice exercise when the small groups are explaining their answers*

1. Description of Performance - tell which wafers have defects and locate the area and nature of the defect
2. Description of Conditions
   - Best case - classroom with 10 real wafers or 10 pictures of wafers with defects
   - Alternative or none - 10 real wafers in the Fab
3. Description of Modeling Method
   - Best case - a person
   - Alternative or none - video/slides/color pictures
4. Description of Feedback Mechanism
   - Best case - checklist of correct responses *
   - Alternative or none – peer trainer

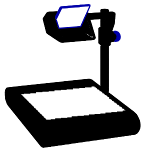
**The best case for feedback mechanism is a system whereby the learner can immediately check his/her own work and tell what's wrong and how to correct it*

## Practice Exercise No. 1

**Objective:** **Given 10 production wafers of different mask levels, tell which wafers have defects and locate the area and nature of the defect.**

1. **Description of Performance**
   - **Same as objective**
2. **Description of Conditions**
   - **2A. Best case**
   - **2B. Alternative or none**
3. **Description of Modeling Method**
   - **3A. Best case**
   - **3B. Alternative or none**
4. **Description of Feedback Mechanism**
   - **4A. Best case**
   - **4B. Alternative or none**

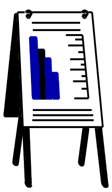
Decide as a small group what would be the best case and the alternative for the example above. Be prepared to share your answers with the class.



**Practice Exercise No. 2**

***Instructor Note:*** *Ask the small group that was assigned this practice exercise to share their answers with the class*

1. Description of Performance
2. Best case – real stepper in classroom
   - Alternative or none – a stepper in fab or photos with labels
3. Best case – trainer or an expert
   - Alternative or none – video or drawings
4. Best case – checksheet
   - Alternative or none – real person



***Instructor Note:*** *List basic 4-step approach to on-the-job training and describe how the PBET model is similar.*

| Traditional OJT Approach | PBET Approach |
|---|---|
| 1. *Tell them* what they are expected to do | State performance *objective* in the beginning |
| 2. *Show them* how to do it | *Model* the performance |
| 3. *Let them do it* while you coach them | *Relevant practice* with *feedback* |
| 4. *Let them show you* | *Skill test* |

## Practice Exercise No. 2

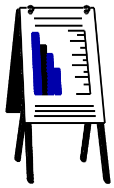
**Objective:** **Given an *Astaire Stepper* and a 14-step checksheet designated for "daily checks," the trainee will perform each daily check accurately, and relate any errors or nonstandard conditions to the trainer. The trainee must also interpret the nonconforming conditions correctly to the trainer.**

1. **Description of Performance**
   - **Same as objective**
2. **Description of Conditions**
   - **2A. Best case**
   - **2B. Alternative or none**
3. **Description of Modeling Method**
   - **3A. Best case**
   - **3B. Alternative or none**
4. **Description of Feedback Mechanism**
   - **4A. Best case**
   - **4B. Alternative or none**

Decide as a small group what would be the best case and the alternative for the example above. Be prepared to share your answers with the class.

Here's an easy way to help you remember the steps in the PBET training model. Let's compare it to a more traditional approach to doing on -the-job training.

| <u>Traditional OJT Approach</u> | <u>PBET Methodology</u> |
|---|---|
| 1. *Tell them* what they are expected to do | State the *performance objective* up front |
| 2. *Show them* how to do it | *Model* the performance |
| 3. *Let them do it* while you coach them | Give them *relevant practice* with *feedback* |
| 4. *Let them show you* | They perform the *skill test* |



**Skill Test**

- Using the performance objective, skill test, additional resources, and list of aids, tools, and materials for the Legos lesson you are developing, write a relevant practice description to explain (*list on flip chart*):
  - How to orient Legos when assembling
  - Special verbal or hand cues
  - How to hold Legos when assembling
  - How to fasten and unfasten Legos
  - How the job aid will be used, etc.
- Be sure the description includes the four components of an effective practice
- Write the description in your Lesson Planning Form
- Please note that the skill test matches the objective
- If you don't achieve mastery, ask for assistance, or rework the test until mastery is achieved

**SKILL TEST**

- **Review the Lesson Planning Form you are developing for the lesson assigned to you by the course instructor.**
- **Review the important elements of relevant practice covered in this module.**
- **Discuss with your project partner various ideas for modeling, arranging conditions, and providing feedback for the trainee's practice session(s).**
- **Fill in the Relevant Practice sections (there are four of them) on the back of your Lesson Planning Form.**
- **Review your work against this criteria:**

  **__ Performance -- Does the performance statement match the objective?**

  **__ Condition -- Does the condition match the objective?**

  **__ Modeling -- Have you stated who or what will be used to show the trainee how to perform the activity? Have you stated what part of the practice will be modeled (all of it or just a part of it)?**

  **__ Feedback -- Have you stated what indicators, signs, or cues will help trainees measure their own performance, or have you stated who will evaluate/coach the trainee?**
- **Ask the instructor to review your "Relevant Practice Description." The instructor will use the same criteria as above to determine "sign off" on this module.**

✏✏✏✏✏

The skill test should match the requirements of the objective as stated earlier in the module.

Again, if the course participant does not achieve mastery of the intended skill, then the participant may ask for assistance, or rework the test until mastery is achieved.

***Instructor Note*:** Reference Semitherm Lesson Planning Form in Appendix D (pages D-5 & 6) for examples

**Relevant Practice Description:**

**Conditions:**

**Type of Modeling:**

**Feedback Mechanism:**

**Module Content Description:**

## DS-3 ANALYZE RESOURCE MATERIALS

**PBET Course Map**

- We are now at this location on the PBET course map
- Now we're going to cover how to analyze available resource materials

**Analyze Resource Materials**

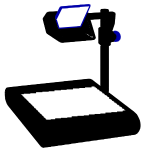
- *Ask a volunteer to read the objective from the foil*
- *Ask audience "how many brought resource materials?"*

**DS-3**

# ANALYZE RESOURCE MATERIALS

**OBJECTIVE:**

**Having available resource materials that you will use or that you have previously used to teach a course, diagnose assumptions about entry level skills that are suggested but not explained in the materials.**

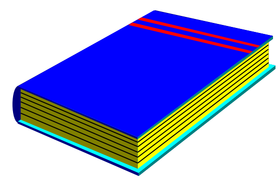


**Select Supporting Resources and Instructional Materials**

- Regardless of how the course is presented, developers need to evaluate supporting resources for relevancy
- Supporting resource materials may include:
  - Technical manuals
  - Textbooks
  - Videotapes
  - Charts
  - Foils
  - Slides
  - Written procedures
  - Checklists
  - Brochures

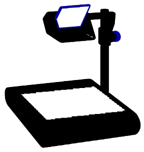
## Select Supporting Resources and Instructional Materials

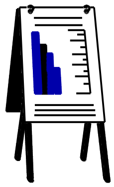
- **Technical Manuals**
- **Textbooks**
- **Videotapes**
- **Slides**
- **Brochures**
- **Checklists**
- **Written Procedures**



Regardless of the style of instructional techniques an instructor uses in the course--whether it's traditional instructions, performance-based, self-paced, or group instruction--the developer must evaluate the supporting resources used in the course for relevancy.

Supporting resource materials can take the form of technical manuals, textbooks, videotapes, charts, foils, slides, written procedures, checklists, and even sales brochures. The instructor needs to compare the subject matter resources with the objectives, skill tests, and target audience description of the course.





**Evaluate Supporting Resource and Instructional Materials**

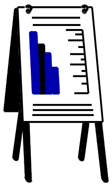
- *Ask participants what they consider when they evaluate supporting instructional materials*
- *Write their responses on the flipchart*
- *Possible answers from past groups have included:*
  - *Performer audience*
  - *Reading level*
  - *Vocabulary of materials*
  - *Coverage of content*
  - *Ease of use/reader friendliness*
  - *Appropriate technical level*
  - *Information assumptions*
- When developers evaluate instructional materials for relevancy, they need to consider:
  - Target audience
  - Performance objectives
  - Skill tests
- To supplement materials, developers may decide to:
  - Order different materials
  - Use visiting subject expert lecturers
  - Create material
  - Summarize important items
- *Explain to the audience the problem with using a list of technical terms to start a lesson or a course. Show them what can happen by asking them for a list of technical terms that are commonly used in our industry.*

## Evaluate Supporting Resources and Instructional Materials

- **Are there adequate examples for the target audience?**
- **Are the skills and concepts adequately covered?**
- **Is the language or reading level appropriate?**
- **Is it too technical -- not technical enough?**
- **If a student tried the material, what would he or she think?**
- **Are the assumptions made that a learner might not understand?**
- **Is the glossary in the front or the back of the book?**

With the requirements of the performance objective and skill test established, the developers need to evaluate and diagnose the relevance and appropriateness of the material for the audience.

Developers need to determine if the material provides adequate coverage of the subject matter, or what's necessary to supplement the instruction. They may decide to order different material, supplement the course with a visiting lecturer, create the material themselves, or summarize important items for the course participants, etc.



*Ask them for words that begin with the letter "A", e.g., angstrom, arsenic, antimony, align, antisotropic, anti-reflective coating, acid, ampere. Ask them if they can relate these words to each other.*

**Practice Exercise**

- In Appendix B of your notebook, there are samples of text materials
  - Select a subject in which you lack competency
- Read the sample and highlight or list knowledge assumptions the author made
- Check your findings with a colleague

***Instructor Note:*** *You may wish to review their findings as a group*

*Take each sample one at a time. Have the students read the first one, and then critique together*

**PRACTICE EXERCISE**

- **Select an example of text material with which you are not familiar.**
- **Read through it and underline or highlight assumptions.**
- **Compare your list with a colleague's and discuss any differences.**

Select at least one example of text material that deals with a subject in which you cannot claim competence. There are several examples in Appendix B of your notebook.

Read through the text and list any assumptions the writer seems to have made about the beginning skills of his or her readers. Feel free to underline or highlight the assumptions in the examples.

Check your list with a colleague to see if he or she agrees with you.

**Skill Test**

- Select a written resource from a subject you teach
- Show it to me so I can select a passage for a colleague to diagnose
- If available, and time permits, use the copier to make copies of the pages I select
- Give the copies to a colleague to diagnose assumptions in the materials

***Instructor Note:*** *Instructor assigns colleagues*

- Explain to the colleague the intention of the book's target audience and any prerequisites
- As you review your colleague's materials, write feedback on the pages in pencil or on sticky notes
- Your colleague will do the same for your resource

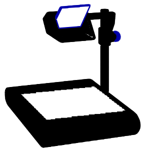
***Instructor Note:*** *Select about 10 pages from the introductory section for colleagues to review*

*Reference Appendix D (page D-2) for those who did not bring documents*

**SKILL TEST**

- **Select a written resource for a subject you are responsible for teaching.**
  **Show the material to your instructor so he/she can select a passage for a colleague to diagnose. Typically, the instructor will select the first section in the material.**
- **The instructor will do the same for all course participants.**
- **Exchange materials with another course participant.**
  **- Describe the target audience who would be required to read the material.**
  **- Explain any prerequisite skills/knowledge that the target audience must have before attempting to read the material.**
- **You will review a colleague's resource material for inappropriate assumptions, unclear explanations, confusing information, and inappropriate structure. Make comments and suggestions on a separate sheet of paper or use sticky paper notes to localize problem areas on specific pages of the document.**
- **When you have finished diagnosing a colleague's material, return it to the owner and review each other's materials.**

**Write the titles or names of the resources you plan to use in the Lesson Planning form.**



**Lesson Planning Form**

- There’s no need for additional resources for the Legos training

**Module Objective:** ______________________________

______________________________

______________________________

______________________________

______________________________

______________________________

**Prerequisite Skills:** ______________________________

______________________________

**Skill Test:** ______________________________

*Fill in the Additional Resources needed to support the module.*

______________________________

______________________________

**Additional Resources:** ______________________________

______________________________

## DS-4 SELECT A DELIVERY METHOD

**PBET Course Map**

- We've covered how to analyze materials
- Now we're going to talk about how to select a delivery method

**Select a Delivery Method**

- *Ask a volunteer to read the objective from the foil*

DS-4

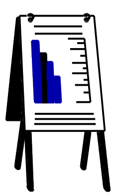
# SELECT DELIVERY METHOD

**OBJECTIVE:**

**Given the course objectives and performer information, determine the delivery method for the training module you are developing.**

**Decide on Delivery Method and Type of Media**

- At this stage in the design phase of PBET, developers have a good sense of needed content
- Now, developers can decide on delivery method and type of media to use
- Developers should consider a variety of solutions for delivery methods and media selection
- Developers should consider the following as they make their selections:
  - Training effectiveness
  - Learning retention
  - Scheduling
  - Budget constraints
  - Audience characteristics



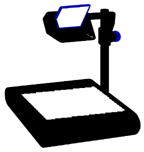
**Brainstorm Delivery Methods**

- Instructor-led lecture
- Self-paced individualized instruction
- Computer-based instruction
- Computer-assisted instruction
- Programmed instruction
- One to one, peer training, on-the-job training
- Group activity
- Videotape
- Interactive video
- Multimedia

By this stage, instructional developers should have a very good idea of the amount and type of content that's needed in the training module. The majority of the design work has been completed along with the task analysis, performance objectives, skill tests, and any review of available resources.

Based on the results of the preliminary analysis and design work, developers can now decide on the delivery method and the type of media to use.

There are a variety of options and solutions for developers to consider as they plan for training effectiveness and learning retention. Developers should consider scheduling and budget constraints when deciding on the best delivery and media methods.



**List Additional Instructional Aids and Supporting Materials**

- Successful developers know how to organize information and activities into effective presentations
  - They are proactive
- Developers must decide which training aids, tools, materials, and delivery methods enhance the learning process
- If sound and motion are important elements of the performance, video and slide film should be considered as aids
- If enlarged or close-up views are important, consider handouts with illustrations or photos, or posters and charts

***Instructor Note:*** *Ask participants if there are any particular types of aids or materials that haven't been mentioned, but which they have found effective. Refer participants to the Training Media Decision Chart on page A-11 of Appendix A*

## List Additional Instructional Aids and Supporting Materials

| TRAINING AIDS & MEDIA | TOOLS & MATERIALS |
|---|---|
| • Transparency Foils | • Test Wafers |
| • Equipment Manual | • Hand Tools |
| • Video | • Test Instruments |
| • Checklists | • Astaire Stepper |
| • Flipchart & Markers | • Strip Chart Recorder |
| • Drawing Board | • Microscope |
| • Paper & Pencils | • Coater-Developer |
| • Job Aid | • Calculator |
| • Camcorder | • SPC Control Charts |

Successful instructional developers have learned how to organize a variety of information and activities into a well-planned presentation. They are proactive project managers.

Developers must look ahead into the application they are creating and decide on the best delivery method, media, training aids, tools, and materials to enhance the learning process during the training session. You will find a helpful Training Media Decision Chart in Appendix A (page A-11).

Developers need to determine the importance of sound and motion to the subject. If they're relevant, then video and slide films should be considered. If participants would benefit from a close view of things, then handouts with illustrations or photographs should be considered. If having an enlarged view would be helpful, then posters or charts might be a wise choice. These are just some of the considerations that need to be made by instructional developers.

**Practice Exercise**

- Have participants turn to the sample Lesson Planning Form in Appendix A, page A-1
  - This sample shows what type of information goes where
- Have participants turn to the real Lesson Planning Form in Appendix A, page A-3
  - This example is from a real lesson
- There are blank forms for you to copy and use at work
- Develop ideas about the delivery of your lesson and the type of media you'll use
- Reference Appendix D (Semitherm examples)

Turn to the Appendix A to review the sample Lesson Planning Form. This sample explains the type of information that is necessary. Next, review the example of a real Lesson Planning Form, and look at the information that it contains.

**Skill Test**

- Review the list of prerequisite skills and enabling objectives for the Lego assembly lesson
- Discuss with a colleague the different delivery methods you can use based on:
  - Topic
  - Objective
  - Test
  - Target audience
- Using the other information you've included on your Lesson Planning Form, decide on the best solutions and a job aid based on:
  - Time
  - Cost
  - Effectiveness
  - Space
- Decide on the type of job aid you will use
- Have the instructor approve your idea for a job aid to use in the lesson

***Instructor Note:*** *When you have approved the job aid idea for the Lego exercise, sign off on the objective for this module on the performance checklist*

## SKILL TEST

**Review the list of prerequisite skills and enabling objectives for the assigned lesson. Discuss with a colleague the different delivery methods you can use based on: topic, objective, test, and target audience. Consider the information on your Lesson Planning Form and decide the best solutions and a job aid based on: time, cost, effectiveness, and space.**

**Discuss your job aid idea with the instructor.**

***NOTES:***

**Additional Resources:** ______________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

| Training Aids & Media | Tools & Materials |
|---|---|
| | |
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## DS-5 SUMMARIZE A PBET LESSON

- By now you have selected the practice activities to include in your lesson and the type of delivery method and resource materials you will need for delivering the lesson
- In the next lesson you will learn the importance of writing instructions to help you structure the elements of a lesson into a logical and easy-to-follow sequence

### Explain the Importance of Writing Instructions in a Lesson Plan

- The strategy for delivering the lesson: The lesson
  - Is an outline showing logical sequence of steps to follow in delivering the lesson
  - Explains what concepts need to be introduced
  - Explains what skills the performers will need to learn, practice, and demonstrate competency
- In general, a written summary of the lesson helps structure the lesson and serves as a guide for the development and delivery phase of the lesson

- *Ask a volunteer to read the objective from the foil*
- *Refer to the backside of the Lesson Planning Form*

# DS-5

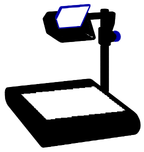
# Summarize a PBET Lesson

**OBJECTIVE:**

**Having completed all of the prerequisite steps in the PBET Lesson Planning Form, summarize the lesson you are preparing. The summary will be reviewed and approved by the PBET course instructor.**

The final step in designing a PBET lesson is to write a description of the strategy for organizing and delivering the lesson. This description can be an outline showing logical sequence of steps to follow in delivering the lesson. It can have enough narrative to explain what concepts need to be introduced, and to describe the type of skills the performers will need to learn and practice. It also explains the types of instructional aids, materials, supplies, equipment, etc., that will be required and how they will be used during the lesson.

In general, a written summary of the lesson helps structure the lesson, and serves as a guide for the development and delivery phase of the lesson.



**Items to Include in the Lesson Summary**

**1. Statement of Relevance:**

- Tells how the lesson fits into the larger scheme of things: e.g.,
  - The preceding lessons
  - The next lesson(s)
  - The overall course
- Legitimizes the reason for the existence of the lesson
  - It may also be viewed as a "purpose" statement for the lesson
- Builds confidence on the part of the audience
- Motivates the audience to listen and participate
- The lesson should provide benefits to the audience in the way of:
  - Increased knowledge and understanding of concepts and skills
  - Improved ability to perform their respective jobs
- What might happen if the lesson were left out?

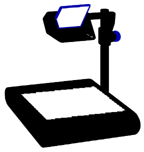
## Items to Include in the Lesson Summary

1. A description of relevance
   - What benefit will the lesson provide?
     - » What's in it for the student?
   - How does this lesson support
     - » The overall training course?
     - » A specific training program?
     - » A trainee's understanding or skills?
     - » A specific task, job, career, etc.?

The summary of a lesson's content should answer the basic question: "What's in it for me?" In other words, what benefit is the lesson to those who are in attendance?

The lesson summary should have at least one short paragraph describing the relevance of the lesson. In general, the lesson should support any or all of the following: the equipment being studied, the overall training program, a trainee's understanding or skills, and a specific job in the related industry. The lesson must have a "legitimate" reason for being included in a training program, or it could be a waste of valuable time and resources.

Here is an example of a statement of relevancy: "The operating procedures of the Astaire 1950 Stepper were introduced in the preceding lesson of this training program. This lesson covers maintenance requirements. Maintenance, specifically cleaning and lubrication, is very important to ensure the reliable operation of the mechanical parts of the stepper."



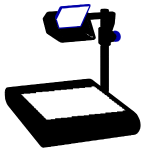
**2. Logistics**

- Specify any instructional aids, media, or supplies that will be used and how they will be applied
- Give a recommended location and an alternative location or conditions for delivering the lesson
- Describe any special lighting, heating, cooling, or seating arrangements
- If other human resources are needed, such as SMEs, indicate how to contact them and how much lead time is needed
- Indicate whether arrangements need to be made to purchase, rent, borrow, or reserve any of the items mentioned

## Items to Include in the Lesson Summary

2. **Logistics**
   - **Special instructions and/or requirements:**
     - » **Instructional aids, media, supplies, etc.**
   - **Location, environment, conditions, etc.:**
     - » **Room, temperature setting, lighting, special seating**
   - **Purchases, reservations, rentals, etc.:**
     - » **Equipment, supplies, materials, personnel**

The lesson summary should include any special instructions or requirements, to remind you and others who might need to use the lesson plan, about the logistics involved in the delivery of the lesson. If supplies, materials, equipment, and/or supporting personnel are needed, how will they be procured? Indicate whether arrangements need to be made to purchase, rent, borrow, or reserve any of the items mentioned.



**3. Sequence of Events:**

- Can be in outline form with short, but concise narrative, to describe each step of the lesson
- Shows the logical sequence to be followed in the delivery of the lesson
- Tells what materials and equipment will be needed at each step of the lesson
- Sequence of events should include the basic 4-step training process:
  - Read the objective, in other words, *tell them*
  - Model the performance, or *show them*
  - Give them practice & feedback, *let them try it*
  - When ready, give them the skill test, *let them show you*
- The approximate time needed to conduct each step

## Items to Include in the Lesson Summary

**3. Sequence of events**

- **Transition into new lesson**
- **Explain lesson objective *(tell them)***
  - **» Introduce concepts and skills**
- **Model the desired performance *(show them)***
- **Provide time for practicing *(let them try it)***
- **Provide time for skill test *(let them show you)***

The key to success in lesson planning is organization. This part of the PBET lesson designing phase requires the instructional developer to think carefully about each of the important events that will occur in the lesson being designed. This is where a word processor may be helpful to accommodate any changes you might want to make along the way.

You should outline in short narrative form how you will proceed to deliver the lesson. The outline will show the logical sequence of the major parts in your lesson and the approximate time needed to accomplish each part. It will also tell what materials you will need at each step of the lesson and how they will be used.

In this part of the lesson summary, explain how you will follow through the four basic steps of the PBET training process, including; (1) explaining the objective, (2) modeling the performance, (3) relevant practice, and (4) the skill test.

**Practice Exercise -- Module Content Descriptions**

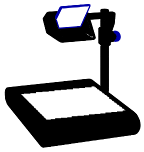
- *Have participants turn to the sample Lesson Planning Forms in Appendix A*
- *Review lesson plan on page A-1 together with audience -- ask them to refer to this in the future*
- *Review page A-3 together with audience*
  - *Explain what's good about the Module Content Description and what was left out*
  - *Ask audience for their comments*
- *Ask them to review individually several examples of Module Content Descriptions contained in Appendix D*

**Skill Test**

- Review the Lesson Planning Form you are developing for the Legos assembly lesson
- Discuss with a colleague the items you will include in your Module Content Description:
  1. Statement of relevance
  2. Logistics
     - Special instructions and/or requirements
     - Location, environment, conditions
     - Purchases, rentals, personnel, reservations
  3. Sequence of events

**SKILL TEST**

- **Review the Lesson Planning Form you are developing for the lesson assigned to you by the course instructor.**
- **Review the key elements of a content description as covered by the instructor in the preceding slides.**
- **Discuss with a colleague the items you will need to include in your Lesson Summary**
- **Draft the Lesson Summary in outline form first before transferring it to the Lesson Planning Form, for example:**
    1. **Description of relevance -- explain why this lesson is important to the trainee**
    2. **Logistics -- list items to be used and how they will be used in the lesson**
    3. **Sequencing of events -- list step-by-step plan for sequencing the introduction, objective, explanation of subject matter, modeling, job aid orientation, practice, and testing.**
- **Ask the course instructor to review the outline. The instructor will use the same criteria as above.**
- **When the summary outline is approved by the course instructor, transfer the extended narrative form to the Lesson Planning Form.**
- **Have the instructor perform a final review of your Lesson Summary and sign-off your checklist.**



- On a blank sheet of paper, draft a Lesson Summary in outline form first, before transferring it to the Lesson Planning Form
- Ask the course instructor to review the outline
- When the summary outline is approved by the course instructor, transfer the extended narrative form to the Lesson Planning Form

***Write a summary of your lesson plan in this section.***

**Module Content Description:** ______________________________________________

## DS-6 COMPLETE A SECOND PBET LESSON PLAN

**PBET Course Map**

- Here is where we are on the PBET course map
- We have completed all of the enabling objectives to this module
- Now in the Design phase of PBET, we're going to discuss why the lesson plan is important
- Please turn to the Design phase in your notebooks

**Complete a Second PBET Lesson Plan**

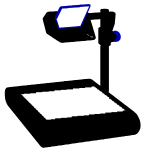
- *Ask a volunteer to read the objective from the foil*

**DS-6**

# COMPLETE A SECOND PBET LESSON PLAN

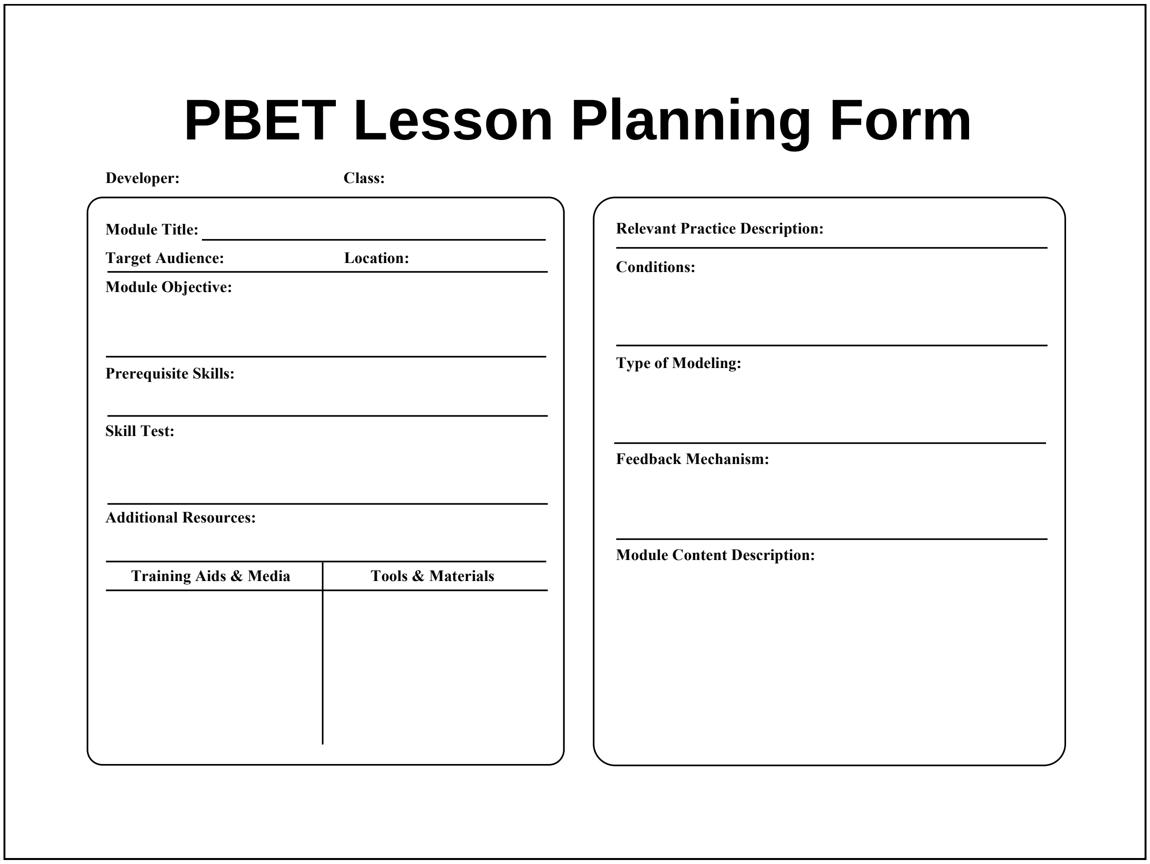
**OBJECTIVE:**

**Given a PBET Lesson Planning Form, prepare at least one lesson plan in an area of your training responsibility. All sections of the form must be completed according to the standards delineated in the PBET Participant Guide.**



**Lesson Planning Form**

- As we have progressed through our PBET modules, you have been completing a Lesson Planning Form
- The Lesson Planning Form acts as a source document for the PBET training you develop
- It summarizes in writing the decisions you've made including:
  - Class
  - Module title
  - Target audience
  - Location
  - Module objective
  - Prerequisite skills
  - Skill test
  - Additional resources
  - Training aids and media
  - Tools and materials for practice
  - Relevant practice description including:
    - Conditions
    - Type of modeling
    - Feedback mechanism
  - Summary of module content



# PBET Lesson Planning Form

Developer: Class:

Module Title:

Target Audience: Location:

Module Objective:

Prerequisite Skills:

Skill Test:

Additional Resources:

| Training Aids & Media | Tools & Materials |
|---|---|
| | |

Relevant Practice Description:

Conditions:

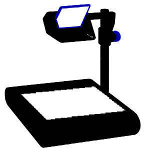
Type of Modeling:

Feedback Mechanism:

Module Content Description:

Through some of the PBET modules, you have been completing a Lesson Planning Form. The Lesson Planning Form will act as your source document as you develop your PBET training. It summarizes in writing the decisions you've made, including:

- Class
- Module title
- Target audience
- Location
- Module objective
- Prerequisite skills
- Skill test
- Additional resources
- Training aids and media
- Tools and materials for practice
- Relevant practice description including:
  - Conditions
  - Type of modeling
  - Feedback mechanism
- Summary of module content



**The Lesson Planning Form Is Not an Instructor Guide**

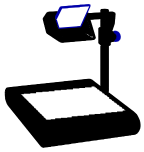
- The Lesson Planning Form is not intended to contain your entire training course
- It's more of an outline for each of your lessons or modules--it's a design tool
- The *instructor guide* is the document that contains comprehensive details and all of the modules of your training course
- In the Deliver phase of PBET, we will take a closer look at the instructor guide

## Lesson Planning Form Is Not an Instructor Guide

- **Don't confuse the Lesson Planning Form with the instructor guide.**
- **The Lesson Planning Form acts as an outline for the lessons/modules in PBET training courses.**

The Lesson Planning Form isn't intended to contain the detailed information of your entire training course. It's more of an outline for each of the lessons or modules that are part of your training course. Since the Lesson Planning Forms contain information for each module, they are the perfect documents to review *prior* to instructing the course.

The *instructor guide* is the document that contains all of the modules of your training course as well as the comprehensive details. We will take a closer look at the instructor guide in the Deliver phase of PBET.



**The Lesson Planning Form Is Your Outline**

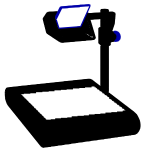
- The Lesson Planning Form guides you as you develop your instructor guide
- It helps you develop each of the modules/lessons that are part of your entire training course
- Lessons/modules are designed and developed so they are self-contained units of instruction
  - While they can stand alone, they are intended to be part of the whole training course
  - They need to relate to the other lessons/modules in the course

## The Lesson Planning Form Is Your Outline

- **It contains the instructional decisions you made about your PBET training.**
- **It will guide you as you create the training course.**

The Lesson Planning Form functions as an outline as you develop your instructor guide. It helps you develop each of the modules or lessons that are part of your entire training course.

Every lesson or module is designed and developed so it is a self-contained unit of instruction. While these lessons/modules can stand alone, they are intended to be part of the whole training course. They need to relate to the other lessons/modules in the course you develop.



**The Structure of the Lesson**

- Lessons/modules vary in length
- They may also vary in location. Some may be taught in classrooms, some in fabs, labs, etc.
- Every lesson/module needs a common structure or form:
  - Each lesson/module needs:
    - An introduction
    - A statement of relevance
    - Main content
    - A conclusion

## The Structure of the Lesson

- **Each lesson or module will vary in length.**
- **Lessons or modules may stand alone as self-contained lessons, but they all need a framework or structure.**

Lessons/modules are expected to vary in length. They may also vary in training location, as some may need to be taught in classrooms, some in fabs, labs, etc.

Regardless of their length or content, every lesson/module needs a common structure or form. They need an introduction, a statement of relevance (to the job, a career, etc.), a main content, and a conclusion.

***Instructor Note:*** *Have participants refer to the example and sample Lesson Planning Forms in Appendices A and D. Briefly walk participants through the information in each document. Ask if there are any questions*

*Refer them also to the "Prepare Performance Objectives Module, AN-2"*

**Skill Test**

- The skill test for this particular module is to complete a Lesson Planning Form for a simple lesson in an area of your training responsibility
- When you have completed the form, have the workshop assistant or instructor review it
- For an example of a lesson to work on, refer to the sample course map for a PBET Operations course

**Performance Chart**

- When each item is reviewed and completed, the assistant/instructor will check the item completed and sign the chart
- The Performance Chart needs to be signed by you and the instructor upon completion of the Lesson Planning Form and Performance Chart

## Skill Test

**Prepare a second Lesson Plan for a simple lesson in an area of your own training expertise.**

**You may consult any part of this course manual for assistance, or you may ask any of the course instructors or participants for help.**

Refer to the completed sample Lesson Planning Form in Appendix A and Module AN-2, which explains how to write objectives, as you complete your Lesson Planning Form. Make final adjustments to your Lesson Planning Form, and when you feel you are ready, have your instructor or one of the workshop aides review it. They will review each form and check off each completed item.

When the entire Lesson Planning Form has been completed, both you and the instructor should sign the sheet to indicate mastery of this particular module's objectives.

# Develop

| Module No. | | Page No. |
|---|---|---|
| DV-1: | Prepare Training Aids and Materials<br>Design of overhead transparency<br>Use of foils, flipchart and marker board<br>Develop a job aid for a PBET lesson | DV-1 |

## DV-1 DEVELOP INSTRUCTIONAL MATERIALS

- Up to now our discussions have focused on the analysis and design of a PBET lesson plan
- In this module we will focus our attention on the actual production of the instructional materials you will need to pilot your first PBET lesson

- *Have a volunteer read the objective from the foil*
- We will introduce very basic concepts of instructional materials development
- There are many resources available to teach these concepts
- The focus will be on developing the job aid and any other instructional aids you may need to help you pilot your first PBET lesson

**DV-1**

# Develop Instructional Materials

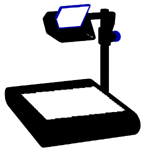
**OBJECTIVE:**

**Having completed a Lesson Planning Form, produce the training aids and media that you will need to support the PBET lesson you are preparing. The materials you create will be reviewed and approved by the PBET course instructor.**

Up to now we have concentrated our discussions on the analysis and design of the elements that will become a part of the PBET lesson plan. You have completed the requirements of the lesson planning phase, but you have not yet developed the actual materials and aids that will be used in the execution of the pilot or delivery phase.

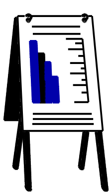
This module introduces very basic concepts of instructional materials development. This topic is beyond the scope of this course. There are many resources available from universities, community colleges, and consulting firms that can provide these training services.

The focus of this module will be on developing the job aid and any other instructional aids you might need to help you pilot your first PBET lesson.



**Preparing Training Aids and Materials**

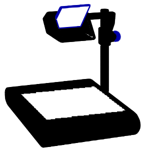
- The following are some typical training aids and materials:
  - Checklists, flowcharts, state tables, decision trees, instructions, and other aids, which can be produced at this time
  - Instructions, explanations, data sheets, schematics, drawings, and job aids, which can be created, also
- In this module we will focus our attention on the job aid you are to create for use in the pilot phase of the PBET lesson you are designing
- These first few items can be delivered using any convenient but effective media such as listed on this foil
- The participant guide is the student's manual and is a requirement of the PBET methodology
- The manual provided for you in this class is an example of a participant guide
- All forms of media are important to learn, however, only the flipchart and foils will be discussed
- Consult page A-11 in your manual, the Training Media Decision Chart



- Notice that a glossary list was not included.  Although a glossary can be helpful as a quick reference, it should not be used as a teaching tool

# Prepare Training Aids & Materials

- **Checklists and instructions**
- **Flipchart**
- **Drawings**
- **Job aids**
- **Participant's guide**
- **Transparency foils**
- **Photographs**
- **35 mm Slides**
- **Videotape**
- **Other resources**

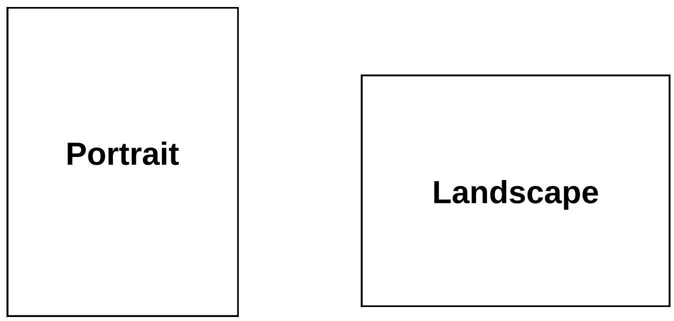


**Design of Overhead Transparency Foils**

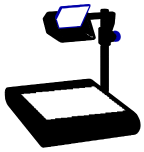
- Formats:
  - Two basic formats -- portrait versus landscape
  - Most books and manuals are printed in portrait
  - SEMATECH uses almost exclusively the landscape style
  - Stick to one format and try not to mix them in a presentation

# Design of Overhead Transparency Foils

## Formats




**Stick to one format or the other. Try not to mix them.**



**Font Types, Styles, Sizes**

- Note the sizes and styles of fonts chosen for this foil
- Recommend use of Helvetica bold whenever possible
- Recommend font sizes between 18 and 36 point for classroom presentation
- 14 point works sometimes for small classrooms.
- For large auditorium-size presentations -- step up to a larger font size
- Try not to mix different font types or styles in the same message
- Refrain from using all upper case letters except for titles and headings

## Design of Overhead Transparency Foils (28 pt.)

# FONT TYPES, STYLES, SIZES (36 pt.)

24 pt. Helvetica, Normal, **Bold**, *italics*, <u>underline</u>

24 pt. Times Roman, Normal, **Bold**, *italics*, <u>underline</u>

20 pt. Helvetica, Normal, **Bold**, *italics*, <u>underline</u>

20 pt. Times Roman, Normal, **Bold**, *italics*, <u>underline</u>

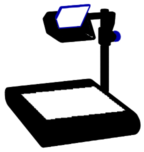
18 pt. Helvetica, Normal, **Bold**, *italics*, <u>underline</u>

18 pt. Times Roman, Normal, **Bold**, *italics*, <u>underline</u>

14 pt. Helvetica, Normal, **Bold**, *italics*, <u>underline</u>

14 pt. Times Roman, Normal, **Bold**, *italics*, <u>underline</u>

*NOTE: Text size on the foil on this page appears 60 percent of actual size.*



**Use of Color for Text Only**

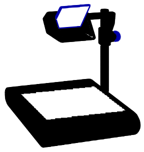
- The foil "speaks for itself"
- Color-blind people have difficulty distinguishing shades of green and red
- Stick to the four B's:  black, blue, brown and burple
- Try not to mix too many colors within the same foil

# Design of Overhead Transparency Foils

## Use of Color for Text Only

- **Black on white background is easy to read.**
- **Blue on white is fairly easy to read.**
- **Burple on white is also easy to read.**
- **Brown on white is OK too.**
- **Green is not too difficult to read.**
- **But, red is getting difficult to read.**
- **Orange is not so good.**
- **Yellow is one of the worst.**
- **White or yellow on a black background is OK.**

**Remember. The four B's are the best.**



**General Guidelines for Using Foils**

- Transparencies are extremely helpful in delivering effective technical training
- One must ensure that if the message is important enough to put on a foil, then the audience should be allowed to read it or the instructor explain what's on it
- Foils can help reduce your preparation time because the information you may want to convey to your audience is already on the foil
  - However, don't make the foils your crutch
- Follow these general guidelines wherever possible
  - Always have a replacement lamp available for the overhead projector
  - Learn the proper time to turn on and shut off the overhead projector, or learn to use a flap over the lens
  - Learn the proper presentation techniques for using the overhead and transparencies
- Projection screens versus white marker boards
  - The marker board allows the instructor to write directly on the board
  - The white shiny board creates unfavorable reflections
- Projecting onto a flipchart allows the instructor to mark on the flip chart and tear off the information
- Whenever possible, use pictures to express an idea. “Pictures say a thousand words.”
- Introduce examples of graphical foils.

# Design of Overhead Transparency Foils

## General Guidelines for Using Foils

- **Try not to exceed more than 8 lines per foil.**
- **Stick to one theme in a foil.**
- **Use bullets rather than paragraph narrative.**
- **Try not to read from the foils.**
- **Use pointers or markers to emphasize a point.**
- **Know when to switch the overhead on and off.**
- **If it's important enough to put on a foil, then give people a chance to read it.**
- **Whenever possible, say it with pictures.**

**General Guidelines for Using Flipchart and Marker Boards**

- The flipchart is great for brainstorming ideas in class
- It is an excellent notepad for keeping track of class comments, concerns, and questions to be referred to at a later time
- Some of the rules for foils apply here, too
- Refer to the flipchart paper taped around the classroom
- Note the different styles
- Some are good examples and others are not

# Guidelines for Using the Flipchart and Marker Boards

- Great for notepad and brainstorming.
- Print large and legibly.
- It's OK to mix two or three colors.
- Stick to the four B's.
- Beware of different marker types.
- Use bullets and short sentences.
- Use graphical designs wherever possible.
- Be creative.
- Use soft stick masking tape.

**Skill Test**

- Review the Lesson Planning Form you are developing for the Legos assembly lesson
- Discuss with a colleague the design of the job aid and other materials you will need for the pilot phase of this class project
- Draft the job aid and other materials
- Call on one of the course instructors to review your draft
- One of us will do a final review and approve the job aid for use in the pilot phase of the project™

***Instructor Notes:*** *Participants will be looking for ideas for a job aid; tell them of past examples from previous classes*:

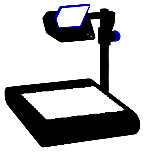
- *Some have used masking tape to label parts*
- *Some have used a numbering system to identify parts, for example, "the 3x6 Lego block"*
- *Some have used flipchart paper to draw designated subassembly locations*
- *Some used the skills hierarchy for introducing the lesson to the student*
- *Some used 3-M Post-its™ to designate specific locations for parts on the assembly table*
- *Some drew the outline of the parts on flipchart paper in the proper assembly sequence*
- *Some used an assembly checklist so the instructor could check off each item as it was assembled*

## Skill Test

- **Review the Lesson Planning Form you have prepared for the lesson assigned to you by the course instructor.**
- **Review the information covered by the instructor in this module.**
- **Discuss with a colleague the items you will need to include in your job aid and whatever training materials you will need.**
- **Draft the job aid and other materials.**
- **Ask the course instructor to review your draft.**
- **Have the instructor perform a final review and approval of your job aid, and if needed, other materials.**

# Pilot

## PL-1 DESCRIBE TRAINER CHARACTERISTICS

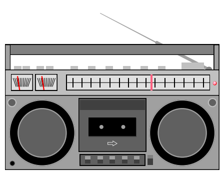


**PBET Course Map**

- Here's where we are now on the PBET course map
- Before we pilot our lesson, we need to talk about how trainees react to various trainer characteristics and training situations. Our goal as trainers is to motivate students to learn

**Describe Trainer Characteristics**

- In this module, you will be asked to recall five specific skills you can use to foster a positive learning environment
- *Ask a volunteer to read the objective from the foil*
- Refer to page A-13 in Appendix A to see how the Observation Sheet will be used to tie PL-1 to PL-2.



**Group Activity - Introduction:** Read excerpt from Mager's "Developing Attitude Toward Learning"

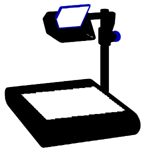
- *Play violin music on cassette player*
- *Read the "Young Violinist" then stop the music*
- *Now there are several ways that this story could have ended. Explain*
- *Ask participants if any have ever taken music lessons*
- *Ask for a show of hands of how many still play that same instrument*
- *Well, in the case of our young violinist, he took music lessons for a few months, then lost interest*
- *What could have been some reasons for why a young musician would lose interest in learning a musical instrument?*

**PL-1**

# DESCRIBE TRAINER CHARACTERISTICS

**OBJECTIVE:**

**Given a scenario in a training activity, be able to select at least five favorable trainer characteristics that could be used in dealing with the situation.**



**Recall Trainer Characteristics**

- Think of someone in your past who was exceptional in the role of:
  - Teacher
  - Coach
  - Boss
  - Instructor
- Try to recall some of that individual’s personal and professional attributes that helped you to successfully complete a course or perform a task
- List some of those attributes in your notebook

**Share Trainer Characteristics with Someone**

- *Pass basket of candy around the class*
- Please take one piece of candy, but do not open it at this time
- Find a person in the room who has the same type of candy, that is, same color of wrapper
- Now, each of you take about five minutes to share the positive experience you had with the trainer or teacher in your past
- When the 10 minutes are concluded, I will ask you to return to your seats

## Describe Trainer Characteristics

Think of someone in your past who was exceptional in his/her role as your teacher, coach, boss, or instructor.

Try to recall some of their personal and professional attributes that helped you to successfully complete a course or perform a task.  List a few of those attributes here:

____________________________________________

____________________________________________

____________________________________________

____________________________________________

____________________________________________

Share these thoughts with a colleague in the audience.

**Group Activity: Trainer Characteristics**

- Share your list of effective trainer attributes with the colleagues at your table and discuss each person's list of characteristics
- Compile all of the characteristics suggested by your group into a master list and write the list on the flipchart. As you compile:
  - Combine similar or duplicate items
  - Star (✰) at least three items on your list that your group considers to be the "most important characteristics"
- *Allow 5-10 minutes for groups to create their lists*
- Select a spokesperson to present your list to the class
- *Have spokespersons present each group's work*

## GROUP ACTIVITY: COMPILE TRAINER CHARACTERISTICS

**Share your list of effective trainer attributes with the colleagues at your table and discuss each person's list of characteristics.**

**Compile all of the characteristics you have discussed into a master list and write the group's list on the flipchart. As you compile:**

- **Combine similar or duplicate items.**
- **Star (☆) at least three items on your list that your group considers to be the "most important characteristics."**
- **Select a spokesperson to present your list to the class. Compare your ideas with those of the other groups.**

✎✎✎✎✎

- *Point out that many of the items on their lists are desirable PBET trainer characteristics*
- The effective PBET trainer sets the tone of the training by:
  - Using positive reinforcement/feedback with trainees
    - This includes throughout the relevant practice, not just waiting for the finish of the practice
    - Positive reinforcement and words of encouragement can lead the trainee to the desired outcome
    - Do not, however, reinforce undesirable behavior
    - Apply constructive criticism in a non-threatening manner to help trainees learn what they need to do to improve their performance
  - Using words, facial expressions, and body language that signal acceptance rather than disdain or rejection

**Role-Play (optional)**

***Instructor Note:*** *Demonstrate an example of how you would respond when a trainee calls you about an alarm situation that occurred on a machine after a boat or cassette of wafers had just been loaded*

- *Demonstrate a bad example or two*
- *Demonstrate the proper response*

The effective PBET trainer sets a positive tone of training by:

- Using positive reinforcement/feedback with trainees. This includes throughout relevant practice, not just waiting for the conclusion of the practice. By using encouragement and positive reinforcement, trainers can lead the trainees to the desired outcome.
- Applying constructive criticism to help participants understand what they need to do to improve their performance.
- Encouraging participation.
- Using words, facial expressions, and body language that signal acceptance rather than disdain or rejection.

**Using Plenty of Rewards at Appropriate Times**

Why? People tend to repeat things they find rewarding!

| | |
|---|---|
| <u>A Safe Environment;</u><br><u>Not an Anxious</u><br>☞ Private, not public, practice.<br>☞ Relevant, not unpredictable, tests. | <u>A Stimulating Course;</u><br><u>Not a Boring One</u><br>☞ Variety in voice, pacing, activities.<br>☞ Student control over length of sessions. |
| <u>An Ego-Boosting Experience;</u><br><u>Not a Humiliating One</u><br>☞ "Good accomplishment!"<br>☞ "Let me write down your suggestion for others." | <u>A Satisfying Time;</u><br><u>Not a Frustrating One</u><br>☞ Objectives clear at all times.<br>☞ Time for individual practice is provided for all to succeed. |

**Role-Play Scenario A**

Norton: Ralph, can you come down to the diffusion bay for a minute? I think I've got a problem.

Ralph: Okay! Norton, what is it this time? This better be quick cause I'm overdue for a coffee break.

Norton: I don't know Ralph, I loaded the cassette of wafers like you showed me, checked the recipe parameters, pressed the *start* button and then the alarm started screaming. I didn't know what to do.

Ralph: Sheesh! I just showed you how to fix this problem yesterday. (Man, I don't believe this.)

*Ralph proceeds to the computer screen, reads the alarm message, figures out what the problem is and corrects it.*

Ralph: Okay. Did you see what I did?

Norton: Yeah! Sure, Ralph.

Ralph: See, there's nothing to it. Next time you should be able to figure it out yourself. (Boy! One of these days, Norton. Pow!)

**Role-Play Scenario B**

Norton: Ralph, can you come down to the diffusion bay for a minute. I think I've got a problem.

Ralph: Hey, Norton, what's happening, ol' buddy?

Norton: I don't know Ralph. I loaded the cassette of wafers like you showed me yesterday, checked the recipe parameters on the computer screen, pressed the *start* button and then the alarm started screaming. I didn't know what to do.

Ralph: Hey, Norton, relax. No problem. It's just a little hiccup in the system. As you might remember from yesterday's training session, what's the first thing we should do when you get an alarm on the system?

Also, the effective PBET trainer sets a positive tone of training by:

**Avoiding Adverse Reactions**

Why? People learn to avoid things they're hit with!

| Fear and Anxiety | Frustration |
|---|---|
| ☞ "You won't understand this, but..."<br>☞ "Half of you won't be here a month from now."<br>☞ "I know you're new, but come on up here and show the rest of the class how to rebuild this assembly."<br>☞ "The test will be a surprise."<br>*Other causes of fear . . .?* | ☞ Too much information too fast.<br>☞ Instructor can't be heard.<br>☞ Print materials unreadable.<br>☞ Tests not based on objectives.<br>☞ All students forced to work at the same pace.<br>☞ Refusing to answer questions.<br>*Other causes of frustration . . .?* |
| Humiliation | Boredom |
| ☞ "You've got a long way to go if you're going to run this machine like Jane!"<br>☞ "Look at this!! I've never seen *that* mistake before!!"<br>*Other causes of humiliation . . .?* | ☞ Monotonous, repetitious instructor voice.<br>☞ Student must sit through material he or she already knows.<br>☞ Room too warm.<br>*Other causes of boredom . . .?* |

**Role-Play Scenario B (continued)**

Norton: Well, I did check the computer screen, but I couldn't remember what to do beyond that.

Ralph: What were you looking for on the computer screen? I mean, what did you expect to see?

Norton: I know what you're getting at Ralph -- I should have seen the error message at the bottom of the screen.

Ralph: Good! Now you're backtracking, Norton, which is exactly what I taught you to do when you have to troubleshoot some of these basic problems.
Okay, where do you check to find out what the error message is about?

Norton: The Error Message Cross-Reference Book?

Ralph: Right on! But, remember, we can't bring it inside the cleanroom until the equipment supplier puts the Error Message Cross-Reference on-line for us. So, what can we do in the meantime?

Norton: Backtrack?

Ralph: You got it right again, Norton. Nice going. Alright go back through the steps you went through before the alarm went off. Show me what you did.
*Eventually, Ralph figures out that the cassette was not set properly on the cassette baseplate, which was the reason for the alarm.*

Ralph: Now, Norton, if another alarm should occur -- try backtracking. If that doesn't help you get at the problem, just give me or Alice a call in the training center and one of us will look up the corrective action for you.

***NOTES:***

**Practice Exercise**

**Materials:** Flipchart

**Time:** 20 – 40 minutes

***Directions:*** *Assign each table group one of the following exercises. Allow participants time to complete their exercises and then have each group present to the class their training scenario and their solution. Encourage open discussion and class input.*

Here are some typical training scenarios you might encounter in real life. Select one or more of the effective trainer characteristics listed on the flipcharts that could be used to address each particular situation. If none of the characteristics can effectively address the situation, brainstorm some additional skills that would be helpful for a trainer to use.

When responding to these exercises, remember that as trainers it is our inherent responsibility to help motivate our learners and to not embarrass them or reduce their self-esteem.

**PRACTICE EXERCISE**

**Your small group will be assigned one of the following training scenarios. Select one or more of the effective trainer characteristics listed on the flipcharts that could be used to address each particular situation. If none of the characteristics can effectively address the situation, brainstorm some additional skills that would be helpful for a trainer to use. When responding to these exercises, remember that as trainers it is our inherent responsibility to help motivate our learners and to not embarrass them or reduce their self-esteem.**

**Record your solutions on the flipchart, and be prepared to share these with the class.**

1. **There are six participants in a three-day equipment operations class, and all of them have satisfied the necessary prerequisites for the course. One of the participants had to leave class three hours early on the first day, and as a result has fallen behind on the second day of class.**

   **Which characteristics of a trainer can be applied to this case? Describe how each skill would best be used. What should the trainer do to improve the participant's opportunities for success?**

2. **In a vacuum pump rebuilding class, the instructor always leads the class through an explanation and demonstration of the steps required in the proper assembly and disassembly of a vacuum pump. Each participant is given a copy of the step-by-step procedure to follow along with the instructor. When the demonstration is completed, participants are allowed time to practice the same procedure on their own assigned vacuum pump. During the practice sessions, one of the maintenance technicians wants to know how much vacuum grease to apply onto an O-ring.**

   **Which characteristics of a trainer can be applied to this case? Describe how each skill would best be used. What could the instructor do or say that would help the performer remember this part of the task next time?**

✐✐✐✐✐

(continued on next page)

***NOTES:***

**PRACTICE EXERCISE ( Continued)**

3. **In a particular equipment maintenance training course, participants are required to perform specific functional checks on the machine to determine the tool's readiness for production use. The participants by this time will have already completed a component identification lesson, which would have covered the location of all controls and indicators as well as all major subsystems. One of the maintenance technicians forgot where the water cooling flow indicator is located on the machine.**

   **Which characteristics of a trainer can be applied to this case? Describe how each skill would best be used. What could the instructor do or say that would help the performer recall the location of this part?**

4. **The instructor of a specific process-related course stated at the beginning of class that the course is intended to be an introductory course for manufacturing technicians having less than 12 months of industry experience. After all participants have introduced themselves, you find out that six of the participants have an average of ten years experience in the subject, and the remaining seven students in the class match the target audience description for the course.**

   **How should the trainer handle this situation? Which characteristics of a trainer can be applied to this case? Describe how each skill would best be used.**

5. **In a software training class for a specific inspection system, students are required to work together in groups of three. One student in one of the groups appears to be dominating the others in his team and doesn't allow the others time to use the workstation assigned to their group.**

   **How should the trainer handle this situation? Which characteristics of a trainer can be applied to this case? Describe how each skill would best be used.**

(continued on next page)

## *NOTES:*

**PRACTICE EXERCISE (Continued)**

6. **During a process equipment operations class, performers are asked to stop the tool in the middle of the process to simulate an emergency intervention procedure. At some point in the procedure, the performers are required to remove a wafer from the tool with the aid of a vacuum wand. Near the end of the practice exercise, one person in the class accidentally drops the wafer. The wafer breaks and there are pieces of silicon scattered inside the wafer feeding assembly.**

   **How should the trainer handle this situation? Which characteristics of a trainer can be applied to this case? Describe how each skill would best be used.**

7. **There are six participants in a three-day equipment operations class, and all of them have satisfied the necessary prerequisites for the course. One of the participants had to leave class three hours early on the first day, and as a result will probably fall behind on the second day of class. One of the participant's colleagues volunteered to assist him through lunch and breaks to bring the person up to the level of the others.**

   **Which characteristics of a trainer can be applied to this case? Describe how each skill would best be used. What should the trainer do?**

✏✏✏✏✏

**Skill Test**

- Repeat the process with one of the unused scenarios
- Compare your work with others at the table

## SKILL TEST

**Each participant will repeat the procedure from the practice exercise using one of the scenarios that was not previously used.**

**When finished, compare your work with others at your table.**

✐✐✐✐✐

## PL-2 PILOT A SHORT PBET LESSON

**PBET Course Map**

- We have reached our first terminal objective in the PBET course

**PBET Lesson**

- We've talked about why trainer characteristics are important in PBET
- Now we're going to look at why testing a lesson is important during the Pilot phase of PBET

**Pilot a Short PBET Lesson**

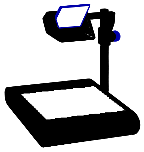
- *Ask a volunteer to read the objective from the foil*

# PL-2

## PILOT A SHORT PBET LESSON

**OBJECTIVE:**

**Try out/pilot a short PBET lesson as either a performer or trainer and identify the pilot results.**



**Performance-Based Equipment Training Requires a Pilot Test**

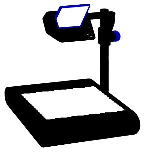
- As part of the PBET Pilot phase, you *try out* the training materials that have been developed
- This allows developers/trainers to see how well the materials work in a training situation
- The pilot is an effective way to determine which areas:
  - Need some improvement
  - Work particularly well
  - Can be eliminated

## Performance-Based Equipment Training Requires a Pilot

- **All PBET training courses need a tryout or pilot before the courses are delivered.**
- **The pilot is the first opportunity to try out the efforts from the earlier PBET phases.**

As part of the Pilot phase of PBET, you *try out* the training materials that have been developed. This is the developer's/trainer's opportunity to see how well the materials work in a training situation.

Piloting the materials is an effective way to determine which areas need some improvement, work particularly well, or can even be eliminated.



**Piloting PBET Courses**

- During the pilot, developers and trainers need to determine how effective their course design is.  They need to pay attention to:
  - Content
  - Sequence
  - Clarity
  - Comprehension
  - Accuracy
  - Relevance
  - Training medium
  - Practice exercises
  - Participation and activity levels
  - Time and length
- This information is best collected through observations by SMEs and from the course evaluations

## Piloting PBET Courses

**Allows developers to detect areas that:**

- **Need some improvement or reorganization**
- **Are successful and work well**
- **Can be eliminated**

During the pilot, developers and trainers need to determine how effective their course design is. They need to pay attention to:

- Content
- Sequence
- Clarity
- Comprehension
- Accuracy
- Relevance
- Training medium
- Practice exercises
- Participation and activity levels
- Time and length

This type of information is best collected during the pilot through observations by subject matter experts and from the course evaluations.

**Practice Exercise**

During the PBET Pilot phase, developers have the opportunity to fine-tune the course before it's delivered

**Pilot a Short PBET Lesson -- Legos Exercise**

***Instructor Note:*** *Tell participants that now they will have the opportunity to pilot their Legos training. Everyone in their group is to present a portion of the training and fill out the pilot observation sheet that's in Appendix A*

*Remind them that the Legos example has included most of the phases of PBET, while their actual course will include all aspects and phases of PBET that come before the Pilot phase*

**Time:** Approximately 15 minutes

**Materials:** Legos, a job aid, a pilot observation sheet (Appendix A, page A-13), and Legos assembly training directions that were developed by participants earlier in the training -- i.e., module AN-1

***Directions:*** *Have one person from each pair of the Legos training developers switch tables. Participants are to follow the verbal directions exactly as they are provided. During the pilot of their Legos training, developers are to look for areas that indicate* improvement efforts will be needed

**Rules:** Use the basic 4-step approach to training:
1. Tell them -- explain the objective
2. Show them -- model the performanace
3. Let them try it -- relevant practice with feedback
4. Let them show you -- administer the skill test

**PRACTICE EXERCISE**

**Pilot the PBET assembly training lesson.  As training developers you have:**

- **Completed the task analysis**
- **Prepared the objectives**
- **Developed the skills hierarchy**

**NOTE: Don't forget to apply the simple 4-step training process:**

1. **Tell them what they are going to do -- explain the performance objective**
2. **Show them what/how to do it -- model the intended performance**
3. **Let them do it -- give them practice with feedback**
4. **Let them show you how to do it -- administer the skill test**

It's also during the Pilot phase of PBET that developers have the opportunity to fine-tune the course before the course is delivered.

This practice exercise will provide the opportunity for you to pilot your PBET assembly training lesson.

**Skill Test**

***Instructor Note:*** *This skill test is done as a group activity. Ask participants what they discovered about their training lesson during their Legos pilot training. Have them focus on what they would improve as a result of the pilot*

*Ask the audience questions such as:*

- Did the instructor follow the lesson plan?
- Did you have adequate time to complete it?
  - Enough tme to practice?
- Was there something done that enhanced your ability to learn and assemble it?
- Was the instructor's communications okay?
  - Adequate feedback and coaching?
- What about the job aid -- helpful?
- Suggestions?
- How would you use this lesson in the future?

## SKILL TEST

**Based on the PBET lesson, identify the areas of the training that work well and the areas that need to be improved.**

✎✎✎✎✎

# Deliver

## DL-1 DESCRIBE TRAINER RESPONSIBILITIES

**PBET Course Map**

- Here’s where we are now on the PBET course map

**PBET Phases**

- We have completed the Pilot phase of PBET
- Now, as part of the Deliver phase of PBET, we’re going to discuss the trainer’s responsibilities

**Describe Trainer Responsibilities**

- *Ask a volunteer to read the objective from the foil*
- We will be brainstorming the responsibilities of effective trainers
  - We will compile a list of everyone’s impressions

**DL-1**

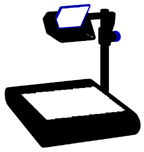
## DESCRIBE PBET TRAINER RESPONSIBILITIES

**OBJECTIVE:**

**List at least five responsibilities of an effective trainer.**

In this module, you will brainstorm a list of five responsibilities of an effective trainer. You'll be asked to share this list with other participants in this class.

Everyone's opinions will be combined to create a comprehensive listing of an effective trainer's responsibilities.



**Group Activity Trainer Responsibilities**

**Time:** 5-15 minutes

- List in your notebooks five responsibilities of an effective PBET trainer
- Discuss these responsibilities with the people at your table
- Compile a group list of these responsibilities on your flipchart
- Choose a spokesperson for your group
  - This person will read the list to the class when your group is asked

# GROUP ACTIVITY

## Describe Trainer Responsibilities

1. **Each participant will list <u>five</u> responsibilities of an effective trainer; for example:**
   - **Provides quality instruction at all times**
   - **Stays up to date in the latest technology**
   - **Updates the employee's training records**
2. **Share your list with others in your group.**
3. **Compile the group's list on an easel pad.**
4. **Select a spokesperson from each group.**

**Procedure:**

1. Make a list of at least <u>five</u> responsibilities that you would expect of an effective trainer in your company.

   ________________________________________

   ________________________________________

   ________________________________________

   ________________________________________

   ________________________________________

2. Share your list with other course participants at your table. Feel free to discuss these responsibilities with each other.
3. If an easel pad is available at your table, compile a group list from the participants at your table and write your group's list on the pad.
4. Select a spokesperson for your group, and when the class facilitator calls on your table, your spokesperson will read aloud the list compiled by your group.

**Skill Test**

- In your notebooks, list at least five responsibilities of an effective trainer

**SKILL TEST**

**List five responsibilities of an effective trainer:**

***NOTES:***

***NOTES:***

## DL-2 PREPARE A TRAINING CURRICULUM CHECKLIST

**PBET Course Map**

- This is an optional module, depending on the makeup of the audience or their needs
- We discussed trainer responsibilities
- Now we're going to cover developing an individualized curriculum

**Complete a Training Checklist**

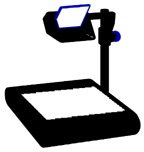
- *Ask a volunteer to read the objective from the foil*

**DL-2**

# PREPARE A TRAINING CURRICULUM CHECKLIST

**OBJECTIVE:**

**Having available a skills hierarchy of performance objectives, skill tests, supporting instructional materials, and a detailed task analysis, assemble a training checklist for training others in an area of your own expertise.**



- SEMATECH Manufacturing Technician Training and Certification Process is a good example of a certification system (Appendix C)
- It is the system that is currently used in the training and certifying of manufacturing technicians at SEMATECH
- These techniques can be applied to similar situations, for example:
  - Equipment assembly personnel
  - Final test personnel
  - Field service engineers (FSE)
  - Process engineers
  - Certification of customers by supplier

**SEMATECH Manufacturing Technician Training and Certification Process**

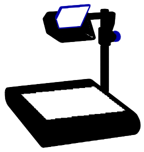
**PURPOSE:**

**The purpose of the Manufacturing Technician (MT) Training and Certification program is to document the demonstration of the skills required for safe operating, process monitoring and/or maintaining process equipment according to SEMATECH specification.**

SEMATECH Manufacturing Technician (MT) Training and Certification Process is a good example of a certification system. It is the system that is currently used in the training and certifying of manufacturing technicians at SEMATECH.

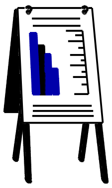
These techniques can be applied to similar situations, for example:

- Equipment assembly personnel
- Final test personnel
- Field service engineers (FSE)
- Process engineers
- Certification of customers by supplier



**What Are Some Other Side Benefits of the MT Certification Program?**

- Read the purpose statement from the SEMATECH MT Training and Certification Process



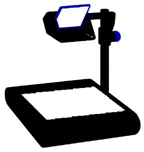
- Brainstorm some other benefits of certifying the technicians and engineers who work on equipment

## What Are Some Other Side Benefits of the MT Certification Program?

- **Provides a "learning by design" attitude rather than by "trial and error."**
- **Forces us to organize and manage the training of all MTs.**
- **Develops a cooperative team environment.**
- **Establishes a baseline for MT skills across all shifts.**
- **Could be tied to advancement requirements within Manufacturing Methods.**

The process for training and certifying manufacturing technicians can be found in the Technician Certification handouts in Appendix C of this notebook. There are four essential documents:

1. SEMATECH MT Certification Process
2. Guidelines for Writing Certification Tests
3. Guidelines for Developing Training and Certification Checklists
4. Manufacturing Technician Training Checklist (example)



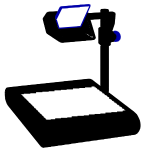
**How It Works**

- In Appendix C of your notebook you'll find essential documents such as:
  - SEMATECH Manufacturing Technician and Certification Process
  - Guidelines for Developing Training and Certification Checklists
  - Manufacturing Technician Training Checklist
  - Guidelines for Writing Certification Tests
- Please refer to the first one, SEMATECH Manufacturing Technician and Certification Process

## How It Works

1. **Communications and Ownership**
   - **Training Request Form Is Issued**
     - » **Shift Manager**
     - » **Document Control**
     - » **Peer Trainer**
       - **Training specialist**
       - **An experienced MT**
       - **Process engineer or technician**
       - **Equipment engineer or technician**
       - **Field service engineer**
     - » **Process Engineer or Technician**
     - » **Equipment Engineer or Technician**
     - » **MT Trainee**
2. **Prepare an Individualized Roadmap**

Read the purpose statement from the SEMATECH MT Training and Certification Process. Brainstorm some other benefits of certifying the technicians and engineers that work on equipment.



**Major Steps**

***Instructor Note:*** *Walk performers through the highlights of the SEMATECH Manufacturing Technician and Certification Process document. Point out that Step 3, the 4-Step Training Process, is an example of a PBET technique*

# Major Steps

**Step 1 Kickoff Meeting**

- Manager, MT trainee, and peer trainer
- Importance of training, schedule, expectations

**Step 2 Roadmap Explanation**

- What will be done, how long, how evaluation will be conducted

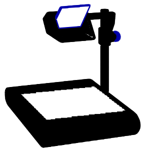
**Step 3 4-Step Training Process**

- Trainer tells trainee what the trainee will do
- Trainer explains, shows and answers questions
- Trainee practices and trainer provides coaching
- Trainee explains, shows and answers questions

**Step 4 Record Keeping**

- Both agree mastery of a skill has occurred
- Both sign and date the training checklist

The foil above shows some of the major steps that are included in the SEMATECH Manufacturing Technician and Certification Process document.



**Major Steps (Cont'd)**

***Instructor Note:*** *Continue explanation of major steps in Certification Process*

**Step 5 Certification Test**

- Must achieve competency on performance test (hands-on)
- Written test must be completed
- Both must be done error-free
- Successful completion is determined by assigned engineer or technician
- Remedial action -- engineer or technician will notify the manager and the trainer with further recommendations

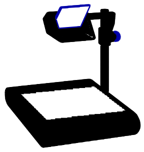
**Step 6 Recognition**

- Sign the certificate and present to MT

**Step 7 Recertification**

- Significant spec violation
- Significant spec change
- Periodic abbreviated recertification

Steps 5, 6, and 7 in the foil above are also part of the major steps in the SEMATECH Manufacturing Technician and Certification Process document.



**Guidelines for Developing Training and Certification Checklists**

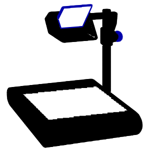
- Please turn to the Guidelines for Developing Training Checklists in Appendix C, page C-12
- These guidelines describe the minimum requirements

***Instructor Note:*** *Walk participants through the highlights of the Guidelines for Developing Training Checklists*

## Guidelines for Developing Training and Certification Checklists

- **Required Materials**
  - Training Request Form
  - Course Prerequisites
  - Task Analysis
  - List of Training Objectives
  - Relevant Documentation
  - Training Checklist
  - Estimated Time for Completion
  - Certification Test
    - Performance Test
    - Written Test
  - Certification Form

The Guidelines for Developing Training Checklists describe what trainers must do to develop certification training materials. The SEMATECH Guidelines for Developing Training Checklists document, in Appendix C of your notebook, shows the minimum requirements.



**Three Parts of a Manufacturing Technician Training Checklist**

- Please turn to the Manufacturing Technician Training Checklist in Appendix C, page C-17

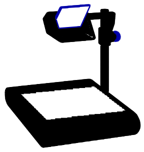
## Three Parts of a Manufacturing Technician Training Checklist

I. Core Courses

II. Non-Tool Training

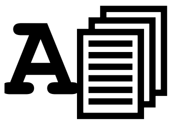
III. Tool-Related Skills

The foil above shows the three main categories of the SEMATECH Manufacturing Technician Training Checklist. This checklist is also in Appendix C.



**Core Courses**

If you look at the checklist in Appendix C, page C-17, you will see the columns for participant, trainer, and date

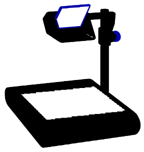


***Instructor Note:*** *Walk participants through the highlights of the core courses*

# I. CORE COURSES

| | DESCRIPTION | TIME |
|---|---|---|
| 1. | Week One Orientation<br>– PC Windows<br>– E-Mail<br>– HAZCOM<br>– Site Safety<br>– Chemical Safety<br>– Cleanroom Entry Cert. | 28 |
| 2. | WorkStream Training | 14 |
| 3. | Semiconductor Process Overview | 8 |
| 4. | Electrical Safety | 6 |
| 5. | Lockout/Tagout | 1 |
| 6. | RS1/Quickstart | 7 |
| 7. | Intro to Statistical Methods | 7.5 |
| 8. | Passive Data Collection | 7.5 |

The foil above presents information for some of the core courses from the checklist. Refer to the example of the SEMATECH Manufacturing Technician Training Checklist to see how the information for the checklist is recorded.



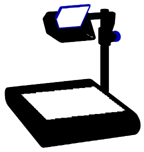
## II. Non-Tool ATDF Training

***Instructor Note:*** *Walk participants through the highlights of the Non-Tool ATDF Training segment*

## II. NON-TOOL TRAINING

1. **Tour of Bay**
2. **Safety Items**
3. **Key Contacts**
4. **Housekeeping**
5. **Wafer Handling**
6. **Equipment Owners**
7. **Timesheets**
8. **Special Codes**
9. **Hazardous Waste**

The foil above is a brief overview of items in the second category of the checklist. Please refer to the example of the SEMATECH Manufacturing Technician Training Checklist to see the complete list of Non-Tool Training.



**Tool-Related Skills**

***Instructor Note:*** *Walk participants through the highlights of the Tool-Related Skills segment*

- Note that this list of competencies could be the same or modifications of the skills described in the course map for operator training mentioned in Module AN-3, page AN-3-11

## III. TOOL-RELATED SKILLS

1. Process Overview
2. Equipment Overview
3. Locate and Describe Related Hazards
4. Describe Safety Procedures
5. Locate and Describe Controls and Indicators
6. Define Operating Codes or Software Commands
7. Read and Interpret Specifications
8. Process Wafers According to Specifications
9. Apply Principles of SPC to the Tool
10. Preventive Maintenance
11. Qualifications
12. Troubleshooting (optional)
13. Engineering Audit

The foil above shows an overview of the Tool-Related Skills from the third category. Please refer to the SEMATECH Manufacturing Technician Training Checklist for the complete list of tool-related skills.

**Skill Test (Optional)**

***Instructor Note:*** *Have participants complete the skill test. Remind them to ask for assistance if they have questions*

- For those participants who are interested in developing a training checklist of their own, SEMATECH has provided blank forms in the Appendix
- Additional time will be allotted on the last day of class to allow participants to work on their certification checklists

## SKILL TEST

**Using a sample job training checklist and a job/task analysis for a specific job in your work area, develop a training checklist.**

Refer to the example of the SEMATECH Manufacturing Technician Training Checklist as you complete the skill test above.  Please ask for assistance if you have any questions.

## DL-3 CREATE AN ACTION PLAN FOR PBET IMPLEMENTATION

**PBET Course Map**

- We've covered completing a training curriculum checklist
- Now we're going to discuss creating an action plan to implement PBET

**Create an Action Plan for PBET Implementation**

- Once you return to your workplace you'll need to have a plan or course of action to follow to get PBET accepted and implemented

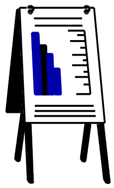
- *Ask a volunteer to read the objective from the foil*
- In this module we will rely on some group discussion and brainstorming, too

**DL-3**

# CREATE AN ACTION PLAN FOR PBET IMPLEMENTATION

**OBJECTIVE:**

**At the end of this module, complete an action plan for implementing PBET at your company.**



**Getting Buy-in at Your Company**

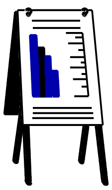
- *Ask participants to show by raising their hands which of them already have "buy-in"*
- *Ask each of the participants who raised their hands why they have "buy-in" at their companies, and record their responses on the flipchart*
  - *Have participants record their responses in their notebooks*
- *Ask the participants who don't yet have the "buy-in" they need, why they think it isn't there* -- *what are the obstacles?*
  - *Flipchart their responses*
  - *Post both lists where the participants can see them*

**The reasons why companies are willing to implement PBET:**

Many companies are eager to implement Performance-Based Equipment Training. In the space above, list the reasons companies are willing to implement PBET. Use the reasons from the flipchart.

**Reasons Companies Are Implementing PBET**

- *Tell participants that now you're going to open the class to a group discussion and brainstorming session to assist those who still need "buy-in." Have participants refer to the flipcharts if the discussions/brainstorming need a starting point*



- Create a flipchart page with the title "Possible Solutions," and list participants' ideas that could be solutions. The following suggestions may be added to their lists, if appropriate:
  - SEMATECH recommendations/endorsement
  - Customer expectations
  - Benchmarking
  - Having management read *What Every Manager Should Know About Training* by Robert Mager

**Possible solutions or actions for implementing PBET:**

Record solutions or actions that may help you overcome PBET objections or obstacles at your company.

**PBET Implementation Action Plan**

**Time:** Approximately 20 minutes

**Materials:** Participant guide, pen/pencil

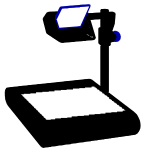
***Directions:*** *Tell participants to create their own PBET Implementation Action Plan by filling in the action plan in their notebooks. They may ask their colleagues or the course instructor for input or assistance*

## PBET IMPLEMENTATION ACTION PLAN

| The Action | Who Is Responsible | When It Will Be Completed |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

# Evaluate

## EV-1 DESCRIBE LEVELS OF EVALUATION



**PBET Course Map**

- Here's where we are now on the PBET course map

**PBET Phases**

- We've covered implementing SEMATECH PBET
- Now we're going to talk about the last phase of PBET, the Evaluation phase

**Evaluate Training**

- *Ask a volunteer to read the objective from the foil*

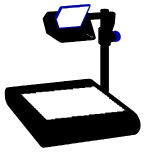
**EV-1**

# EVALUATION OF TRAINING

**OBJECTIVE:**

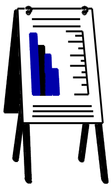
**Given evaluation characteristics, identify all four levels of evaluation correctly.**

The Evaluation phase is the seventh and last phase in performance-based training.



**The Evaluation Phase of PBET**

***Instructor Note:*** *Ask participants how they currently evaluate training*



**Brainstorm and Capture Ideas**

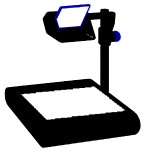
- Who or what part of the training program gets evaluated?
- Why is it important to evaluate training?

## The Evaluation Phase of PBET

- **Determines the effectiveness and relevance of the equipment training program**
- **Obtains feedback from customers relating to the appropriateness and effectiveness of the training program**

Evaluation systems are used to determine the relevance and effectiveness of performance-based equipment training programs.

In general, trainers, training managers, instructional developers, students, managers, and administrators need to know the outcomes of a training program to determine the value that it provides and to continuously improve the program.



**Donald Kirkpatrick's Four Levels of Evaluation**

- ***Level 1 -- measures participant's reactions***
  - Captures participant's first reactions to training
  - Evaluation sheets check course material, information, instructor, setting, etc.
  - Sometimes referred to as "smile sheets" or course satisfaction sheets because they gauge participant reaction
- ***Level 2 -- measures participant's learning***
  - Can be a written test, demonstration, or simulation that tests participants' skills/ knowledge against course objectives
- ***Level 3 -- measures application of learning***
  - Conducted at the participants' work site a few months after training
  - Determines if participants are using their new skills
  - Is accomplished by observation and/or interviews/assessments from participant, supervisors, and perhaps customers
- ***Level 4 - -measures return on investment***
  - Searches for training impact and value
  - Looks for cost benefits in terms of business results (ROI)

## Donald Kirkpatrick's Four Levels of Evaluation

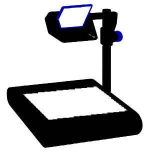
**Level 1 -- Measures participant's first reactions**

**Level 2 -- Measures participant's learning**

**Level 3 -- Measures application of learning at the workplace**

**Level 4 -- Measures return on investments**

We base our PBET evaluation system on Donald Kirkpatrick's four levels of evaluation. (Kirkpatrick is a well-respected former professor and training consultant.)



**Level 1**

- Refer to the SEMATECH example (in Appendix E of your manual). This is a Level 1 evaluation tool. It is a scannable form that can be easily scored; responses can be tabulated by spreadsheet software for ease of reporting course results

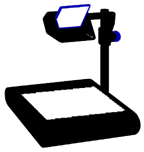
# Level 1 --
# Measures Participant's First Reactions

**Information is captured in questionnaires:**

- **Sometimes referred to as course satisfaction sheets**
- **They gage participant's first reactions to training**

*Level 1* is when the participant's first reactions to training are captured. It is usually administered immediately after the completion of a training program. Items such as questionnaires/evaluation sheets ask for feedback on course material and information, the instructor, the setting, etc. This form of Level 1 evaluation is often referred to as "smile sheets" or course satisfaction sheets because they gauge participant reaction.

Refer to the SEMATECH example in Appendix E, page E-1, of your manual. This is a Level 1 evaluation tool. It is a scannable form that can be easily scored; responses can be tabulated by spreadsheet software for ease of reporting course results.



**Level 2**

- Level 2 evaluations can be administered for each lesson of a course as well as include a pretest and posttest
- How was Level 2 conducted in this course?

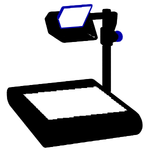
## Level 2 -- Measures Participant's Learning

**Tests participant's skills and knowledge against the course:**

- **Can take the form of simulation, demonstration, or written or hands-on test**
- **Skill tests used in PBET**
- **Sometimes called a test, skill check, evaluation, pretest, posttest, etc.**

*Level 2* is an evaluation technique that measures learning. It can be a written test, a demonstration, or a simulation that tests a participant's skills or knowledge against the course objectives.

Level 2 evaluations can be administered for each lesson of a course as well as include a pretest and posttest. How was Level 2 conducted in this course?



**Level 3**

***Instructor Note:*** *Have participants look at the Semitherm Level 3 Evaluation example in Appendix E, page E-5, in their notebooks*

*Explain how the Semitherm model is designed to work:*

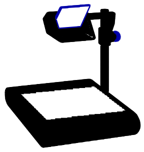
- Based on:
  - Job and task analysis
  - Performance objectives
  - Performance in class
  - Performance after class on-the-job

**Level 3 --**
**Measures Application of Learning at the Workplace**

**Conducted a few months after training at workplace:**

- **By interviews, observations, or assessments from participants and supervisors**
- **Determine if participants are using their new skills**

A *Level 3* evaluation is conducted at the participants' work location to determine if the participants are actually using their new skills. Three to four months after the training, a Level 3 evaluation is accomplished either by observation or through interviews/ assessments from the participant, the supervisors, and perhaps the customers.



**Level 4**

- Explain how the Semitherm model works Appendix E, (page E-9)
  - Codes (A-T) are used to represent performance objectives (skills) from the course
  - The codes are matched with work done on equipment that requires a specific skill
  - The Field Service Engineering (FSE) report has a place where the code can be written in
  - The FSE report indicates time to repair (TTR)
  - TTR is tracked over time to see if training helped reduce it
- SEMATECH currently uses Levels 1, 2, and 3. Evaluation information is used to improve training courses
- The SEMATECH Technician Training Council has a task force investigating ways for Level 3 and 4 evaluations to be conducted

# Level 4 --
# Measures Return on Investments

**Measures the value of the training activity within the company**

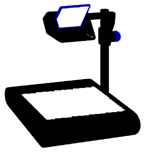
**What is the impact to the company in terms of:**

- **Time saved?**
- **Improved productivity?**
- **Improved efficiency?**
- **$$ saved?**

A *Level 4* evaluation is the most difficult to obtain because it searches for training impact and value. It looks for the cost benefits in terms of business results -- the return on the training investment. In PBET, it requires tracking the cost benefits of having a trained workforce and relating these benefits to improved equipment utilization and improved manufacturing efficiency.

Please refer to the Semitherm Level 4 evaluation in your Participant guide:

- Codes (A-T) are used to represent performance objectives (skills) from the course
- The codes are matched with work done on equipment that requires a specific skill
- The FSE report has a place where the code can be written in
- The FSE report indicates time to repair (TTR)
- TTR is tracked over time to see if training helped reduce it



**Skill Test**

- Write the correct evaluation level number in the skill test blank
- Please note that the skill test matches the objective
- If you don't achieve mastery, you may ask for more practice or assistance, or retake the test

## Skill Test

**Level ___**

- **Conducted at workplace a few months after training**
- **Determines if participants are using new skills**

**Level ___**

- **Gages participant's reactions to training**
- **Questionnaires sometimes referred to as course satisfaction sheets**

**Level ___**

- **Written test, demonstration, or simulation that measures participant's skills against course objectives**

**Level ___**

- **Looks for return in investment of training within the company**

Read the evaluation characteristics in the skill test above and identify the correct evaluation level by writing the appropriate number in the blank.

The skill test should match the requirements of the objective as stated earlier in the module.

Again, if you do not achieve mastery of the intended skill, then you may ask for more practice or assistance, or retake the test until mastery is achieved.

# APPENDIX A

# PBET Lesson Planning Form Definitions

**Instructor's Guide** **Class:** Guidelines for Effective Equipment Training

**Module Title:** Effective Lesson Planning Using Principles of Performance-Based Equipment Training

**Target Audience:** Who is the targeted audience? **Location:** SEMATECH Tech. Trng. Workshop

## Module Objective:

The *performance objective* or *instructional objective* is a clearly written statement that is understood by all performers. The objective is performance based, specific and measurable, and relevant to the requirements of the course or task to be performed. A well-written objective statement contains three important requirements.

1. *Performance* is the action that results from executing the task that's described in the objective.
2. *Condition* describes the environment, location, and/or situation where the performance is to take place, and it tells what materials, supplies, tools, equipment and resources may be used while performing the task.
3. The *standard* gives the acceptable level of performance. It may be stated in terms of how accurate the performance must be, how many times it must be performed, and how much time is allowed.

**Prerequisite Skills:** The skills that are necessary before the performers may participate in the training.

## Skill Test:

Any instructional system that utilizes *well-stated objectives* as a means of informing performers how they are expected to perform at the end of a course or a unit of instruction should have an accompanying *well-matched skill test*. The skill test measures the outcomes of the performance. The test must match the objective in terms of performance, condition, and standard.

## Additional Resources:

Given the requirements of the performance objective and the skill test, the instructional designer sets out to evaluate and diagnose the relevance and appropriateness of the material for the targeted audience. The designer determines if the material provides an adequate coverage of the subject matter. For example: Are there adequate examples? Are the skills and concepts adequately covered? Are there assumptions made that a learner might not understand? Is the language or reading level appropriate? Is it too technical--not technical enough? If a performer tried the material what would he or she think? Having examined the material, the designer determines what supplementary material is needed.

| Training Aids & Media | Tools & Materials for Practice |
|---|---|
| Determine additional aids that will be required; for example, written procedures, flipchart, foils, photographs, models, etc. If possible, describe title of each aid and place them in numerical order as they are to be presented.<br><br>Note: SMEs and other qualified performers may be used as models or subject information. | List equipment, tools, and supplies that are required as part of the practice and final performance. |

## Relevant Practice Description:

In this space, describe what the performers will be doing when they are practicing the intended *performance* that is stated in an objective.

The more we repeat an activity, the more chances we have of improving the outcomes of subsequent performances. However, the practice must be relevant to the stated objective.

A good relevant practice description contains four important ingredients.

1. *Performance*
2. *Conditions*
3. *Modeling*
4. *Feedback*

## Conditions:

Describe how and with what the relevant practice is to be performed. In some cases, a similar activity may be substituted for the real relevant practice.

## Type of Modeling:

Provide a way in which the performance can be demonstrated to a performer. The instructor or some other competent performer can model the performance. Various forms of media may also be used to model the performance; for example, pictorials, diagrams, sample practice sheets, videotape, and photographs.

## Feedback Mechanism:

Wherever possible, provide indicators, signs, or cues that performers may use to measure their own performance. And if that isn't possible, provide a means for informing the performers how well they are progressing. The instructor can provide feedback, but other methods can also work as effectively; for example, video recording and still photography. Use also checklists, job aids, a list of correct responses, etc.

## Summary of Module Content:

Describe the contents of the module so that other instructors can understand it enough to be able to teach it and manage it. In the summary include the following suggestions:

1. A description of relevance -- what benefit will the module provide the participant?
2. Which teaching aids will be used at what time with which concepts?
3. Which skills are to be introduced, modeled, practiced, and tested?
4. The order in which specific concepts and skills are to be introduced.
5. The conditions in which the module is to be performed.

# PBET Lesson Planning Form Sample

## Astaire Model 1950 Stepper

**Instructor's Guide** **Class:** Stepper Operator Training

**Module Title:** Module 4: Perform Daily Checks

**Target Audiences:** Litho operators with >6 mos. Exp **Location:** Classroom/lab/fab

**Objective:**
Given an Astaire Stepper and a 14-step checksheet for "daily checks," the performer will perform each daily check accurately and relate any errors or nonstandard conditions to the instructor. The performer must also interpret the nonconforming conditions correctly for the instructor.

**Prerequisite Skills:** Completion of Modules 1-3

**Skill Test:**
Given an Astaire Stepper and a checksheet listing all elements to be inspected on a daily basis, the performer will go directly to the designated inspection site, evaluate the conditions that are to be checked, note the conditions on the checksheet, interpret the situation for the instructor, and suggest a correct course of action if necessary. Place a ✓ in the Comment section if an item meets the standard, or a **?** if an item does not meet the requirement. You have 15 minutes to perform this task.

**Additional Resources:**
Optional: Operator Manual, Chapter 4, pages 1-12.

| Teaching Aids & Media | Tools & Materials for Practice |
|---|---|
| FOILS<br><br>1. Daily Checks Locator Map<br>2. Electronics Cabinet – 1, 2<br>3. Electronics Cabinet – 3, 4<br>4. Control Console – 5, 6, 7<br>5. Stepper Unit– 8, 9<br>6. Wafer Feed Sys. – 10, 11<br>7. Merc. Lamp and Laser – 12, 13<br>8. Pneumatic Gauges – 14<br>9. Daily Checklist | 14-step daily checklist<br>Classroom<br>Overhead projector<br>Astaire Stepper |

## Relevant Practice Description:

The first assignment requires the performer and a peer to go into the lab/fab, and using the provided checklist, locate and determine the status of all elements listed on the Daily Checklist.  The peer will evaluate the responses by using a sheet that has listed, not only the elements, but also the conditions that should be present prior to starting the workday.

## Conditions:

The initial orientation will be presented in a classroom setting with an overhead projector, screen, and tables or desks on which to take notes.  The relevant practice exercise and the skill test must be conducted at the Astaire Stepper.

## Type of Modeling:

The instructor will use the overhead projector to locate the required daily check sites on the locator maps. Since several of the elements have already been located in Modules 3 and 5, the emphasis should be on conditions rather than locations.

## Feedback Mechanism:

The instructor will relate the readings, conditions, and indicators to exactly what the performer will see when conducting the inspection.  The instructor should also relate the conditions to the process so the performer will understand the importance of conformance to the required specifications.

## Summary of Module Content:

The module will require the performer to determine that the Astaire Stepper is in proper operating condition for the day's production.  The locations of the check sites will be noted during the lecture portion of the module and the performer will be given reproductions of the overhead projection graphics.  During the practice portion of the module, the performer will identify acceptable conditions from several examples. The performer will also use the Astaire Stepper and a peer-evaluated checksheet to locate and describe the elements relevant to "daily checks."  The skill test will consist of the performer identifying, recording, interpreting, and suggesting corrective action if necessary.

# PBET Lesson Planning Form

| | |
|---|---|
| **Developer:**<br>**Module Title:** | **Class:** |
| **Target Audience:** | **Location:** |

**Module Objective:** ____________________

**Prerequisite Skills:** ____________________

**Skill Test:** ____________________

**Additional Resources:** ____________________

| Training Aids & Media | Tools & Materials for Practice |
|---|---|
| | |

**Relevant Practice Description**

- **Conditions:** ____________________

____________________
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- **Type of Modeling:** ____________________

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- **Feedback Mechanism:** ____________________

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**Module Content Description:**____________________

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# PBET Lesson Planning Form

| **Developer:**<br>**Module Title:** | **Class:** |
|---|---|
| **Target Audience:** | **Location:** |
| **Module Objective:** | |
| | |
| **Prerequisite Skills:** | |
| | |
| **Skill Test:** | |
| | |
| **Additional Resources:** | |
| | |
| **Training Aids & Media** | **Tools & Materials for Practice** |
| | |

**Relevant Practice Description**

- **Conditions:** ____________________

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- **Type of Modeling:** ____________________

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- **Feedback Mechanism:** ____________________

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**Module Content Description:** ____________________

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# PERFORMANCE-BASED EQUIPMENT TRAINING

## TASK ANALYSIS WORKSHEET

ANALYST: ______________________________ DATE: ____________________

SUBJECT MATTER EXPERT: __________________________________________

LOCATION: ________________________________________________________

JOB OR COURSE TITLE: _____________________________________________

TASK: ____________________________________________________________

TASK DESCRIPTION: ________________________________________________

__________________________________________________________________

__________________________________________________________________

__________________________________________________________________

IMPORTANCE STATEMENT: ____________________________________________

__________________________________________________________________

__________________________________________________________________

__________________________________________________________________

PREREQUISITES: ___________________________________________________

__________________________________________________________________

__________________________________________________________________

__________________________________________________________________

TOOLS & MATERIALS: _______________________________________________

__________________________________________________________________

__________________________________________________________________

__________________________________________________________________

HAZARDS & SAFETY: ______________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

HIDDEN KNOWLEDGE: _____________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

CRITICAL CONCEPTS: _____________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

OTHER RELATED PROCEDURES: _____________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

COURSE DESIGN CONSIDERATIONS: __________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

**TRAINING MEDIA DECISION CHART (DS4)**

| Media | Advantages | Disadvantages | When To Use |
|---|---|---|---|
| Print | • Self-paced<br>• Easy review/reference<br>• Easy revision<br>• Economical | • Can't demonstrate motion<br>• Requires audience that likes to read | • Provides factual information<br>• Describes workflow, functions<br>• As an adjunct |
| Audiographic | • Good for poor reading audience<br>• Easy access of equipment<br>• Self-paced<br>• Economical | • Can't demonstrate motion<br>• Not suitable for revision | • Recognition/discrimination of audio stimuli<br>• Self-study training |
| Instructor-Led Workshops | • Dynamic presentation - interaction<br>• Can incorporate all media<br>• Provides coaching and feedback<br>• Flexible | • May involve travel costs<br>• Inconsistent presentation<br>• Scheduling | • When audience is at one site<br>• When teaching interpersonal skills |
| Videotape | • Addresses visual, audio, color, motion needs<br>• Evokes emotion<br>• Consistent presentation<br>• Good for poor reading audience | • Considerable development time and budget<br>• Needs hardware<br>• Not suitable for revision | • Demonstrating proper performance of complex tasks/role modeling<br>• Promotion<br>• Subjects that have long shelf life<br>• Self-study or instructor-led |
| Interactive Videodisk | • Addresses visual audio, motion<br>• Highly interactive<br>• Self-paced<br>• Consistent presentation<br>• Eliminates/reduces need for instructor<br>• Easily administered/managed | • Considerable development time and cost<br>• Needs hardware<br>• Not suitable for revision | • Demonstrating proper performance tasks/role modeling<br>• Subjects that have a long shelf life - core curriculum |
| Multimedia | • Self-paced<br>• Consistent presentation<br>• Interactive<br>• Easily administered/managed<br>• Full audio<br>• Full high quality video | • Considerable development time and cost<br>• Needs hardware<br>• Revisions are costly | • Teaching computer-related knowledge/skills<br>• Audience that uses computers regularly<br>• Subjects that have a long shelf life |

**OBSERVATION SHEET FOR PBET**
**Assembly Training Pilot**
**(PL2)**

Observe the performer and your group's pilot assembly training. As you observe, think about what improvements might be necessary, based on the pilot experience, and record them on this sheet.

1. Was the training activity important to you and/or your job? _____ If it could have been improved, tell us how. ____________________________________________
______________________________________________________________________
______________________________________________________________________

2. Was the practice relevant? _____ If it could have been improved, tell us how. _____
______________________________________________________________________
______________________________________________________________________
______________________________________________________________________

3. Was the modeling adequate? _____ If it was not, tell us how it could have been improved.__________________________________________________________
______________________________________________________________________
______________________________________________________________________
______________________________________________________________________

4. Was the feedback mechanism appropriate? _____ If it could have been improved, tell how.____________________________________________________________
______________________________________________________________________
______________________________________________________________________
______________________________________________________________________

5. Were the training materials effective and appropriate? _____ How could the training materials be improved? ______________________________________
______________________________________________________________________
______________________________________________________________________
______________________________________________________________________

**Class Performance Record**
**PBET Modules**

| Names | IN-1 | IN-2 | IN-3 | ID-1 | AN-1 | AN-2 | AN-3 | DS-1 | DS-2 | DS-3 | DS-4 | DS-5 | DS-6 | DV-1 | PL-1 | PL-2 | DL-1 | DL-2 | DL-3 | EV-1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | | | | | | | | | | | | | | | | | | | | |
| 2. | | | | | | | | | | | | | | | | | | | | |
| 3. | | | | | | | | | | | | | | | | | | | | |
| 4. | | | | | | | | | | | | | | | | | | | | |
| 5. | | | | | | | | | | | | | | | | | | | | |
| 6. | | | | | | | | | | | | | | | | | | | | |
| 7. | | | | | | | | | | | | | | | | | | | | |
| 8. | | | | | | | | | | | | | | | | | | | | |
| 9. | | | | | | | | | | | | | | | | | | | | |
| 10. | | | | | | | | | | | | | | | | | | | | |
| 11. | | | | | | | | | | | | | | | | | | | | |
| 12. | | | | | | | | | | | | | | | | | | | | |

# Performance-Based Equipment Training

## Individual Performance Checklist

**Name:** ____________________________________ **Company:** ____________________

| **Objectives** | | **Date** | **Participant** | **Instructor** |
|---|---|---|---|---|
| IN-1. | Course Orientation | ________ | ________ | ________ |
| IN-2. | Identify PBET Characteristics | ________ | ________ | ________ |
| IN-3. | List PBET Design Phases | ________ | ________ | ________ |
| ID-1. | Perform Needs Analysis | ________ | ________ | ________ |
| AN-1. | Perform Task Analysis | ________ | ________ | ________ |
| AN-2. | Write Performance Objectives | ________ | ________ | ________ |
| AN-3. | Develop a Skills Hierarchy | ________ | ________ | ________ |
| DS-1. | Develop Skills Tests | ________ | ________ | ________ |
| DS-2. | Describe Relevant Practice | ________ | ________ | ________ |
| DS-3. | Analyze Resource Materials | ________ | ________ | ________ |
| DS-4. | Select Delivery Method | ________ | ________ | ________ |
| DS-5. | Summarize a PBET Lesson | ________ | ________ | ________ |
| DS-6. | Complete a Second PBET Lesson Plan | ________ | ________ | ________ |
| DV-1. | Develop Instructional Materials | ________ | ________ | ________ |
| PL-1. | Describe Trainer Characteristics | ________ | ________ | ________ |
| PL-2. | Pilot a PBET Lesson Plan | ________ | ________ | ________ |
| DL-1. | Describe Trainer Responsibilities | ________ | ________ | ________ |
| DL-2. | Prepare a Training Curriculum Checklist | ________ | ________ | ________ |
| DL-3. | Create Action Plan for PBET Implementation | ________ | ________ | ________ |
| EV-1. | Describe Evaluation Levels | ________ | ________ | ________ |

***Participant:*** __________________________ ***Instructor:*** __________________________

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# APPENDIX B

**Examples of Supporting Instructional and Resource Materials**

***Target Audience:*** *Anyone who needs to learn how to use DOS.*

## Starting DOS (page 4)

### The Enter Key

The Enter key is labeled with a bent left arrow (¿) like the return key on a typewriter, it is used to mark the end of a line. In general, DOS doesn't know what you have typed until you press Enter, so remember: You end a command by pressing Enter.

### The Backspace Key

The Backspace key is labeled with a long left arrow (←). It erases the last character you typed; use it to correct typing errors.

### STARTING THE SYSTEM

If you’re not using a fixed disk, open the latch of drive A (the left-hand drive) and put in the DOS system diskette. The diskette goes in with the label up and away from the machine, as shown in Figure 2-2. When the diskette is all the way in, close the latch.

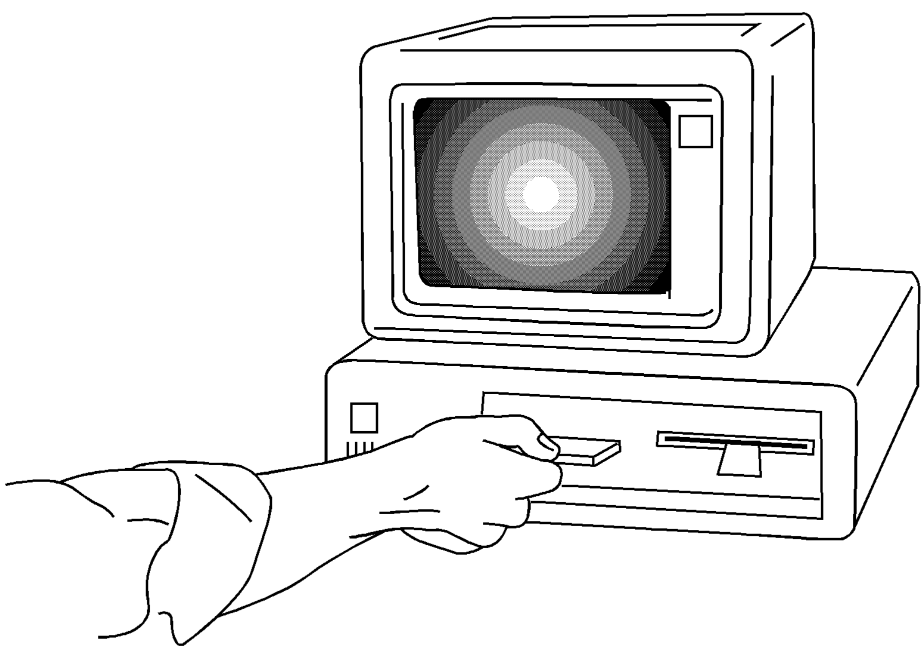

***Figure 2-2. Inserting the DOS System Diskette***

***Target Audience:*** *Anyone who needs to learn how to use a wordprocessor*.

## Word Processing (page 3)

If you're unlucky, the cursor on your word processor may drive you nuts by rapidly flashing on and off.)

As you type, the cursor moves along. Each new letter appears on the space where the cursor was, and the cursor then moves to the next space to the right. (The cursor also indicates the place where text is going to be deleted or changed.)

### *Memory and Storage*

When text appears on a word processor's screen, it's simultaneously stored in the computer's *memory* (actually, it's stored in the memory first, and then displayed on the screen, but both happen virtually simultaneously). The portion of memory you write your text in is called **RAM** (for "random access memory"), **read/write memory** or **R/W memory**.

Since a computer's memory goes blank when you turn the computer off, you must store what you want to keep on **floppy disks** (also called **diskettes** or **floppies**).

Floppies are one of several kinds of **storage media**. *Storage*–implying a certain amount of permanence–is distinguished from *memory*–which, in computers (unlike elephants), is ephemeral.

Floppies are the word processor's equivalent of filing cabinet drawers. Each will hold several dozen **files**. A file is any piece of text that you give a name. It can be thousands of words long, or just one word long. You can split long files in two, and combine short files into one. You decide what makes up a file, by giving a chunk of text a distinct name.

A floppy looks sort of like a 45-rpm record in its jacket and is made of essentially the same stuff as recording tape. Floppies are enclosed in square jackets, which are about 1/16" thick and usually measure 8", 5 1/4" or 3 1/2" on each side (these are the common sizes).

Information is **written** onto floppies, and **read** off of them, by devices called **disk drives**. This is done by a **read/write head**, which is mounted at the end of a short arm that moves back and forth over the disks while they spin around at high speed.

Files can also be stored on a cassette tape, or on something called a **hard disk**.

***Target Audience:*** *Semiconductor manufacturing technicians who have worked in the industry at least one year. Most of these technicians are high school graduates. Many will have an AS degree or equivalent education. They should have already met the prerequisite, which is having completed a 2-day class on semiconductor processing overview.*

## Introduction to Photolithography (page 4)

### Wafer Condition Prior to Lithography

The condition of the wafer upon arrival in the lithography area is very important to know. The surface topography of the wafer has a direct effect on the process specifications required at the resist coating step as well as at the exposure step. The surface condition may affect the ability of the resist to adhere to the wafer and to spread uniformly. Whether the wafer surface is shiny or appears dull has a direct bearing on the subsequent settings of the alignment and exposure systems in the printing equipment.

### Wafer Condition After Lithography

Wafers usually flow from lithography into the etch area and occasionally flow into the ion implant area. The pattern printed on a wafer has certain features that will help facilitate the etch and implant processes. The lithography process not only ensures that certain line width requirements (resolution) be met, but also ensures that each masking layer properly overlaps the preceding layer (registration). Another consideration of the resist coating on the wafer is that the resist be able to withstand the environmental conditions of the etch and ion implant processing equipment.

### Process Types

There are two types of photolithography processes. These are referred to as the negative and positive lithography processes. The type of process used in any specific application is dependent on various factors, such as: product type, line width requirements, mask design, photoresist type, exposure method (machine type), and other engineering preferences.

## Diffraction of Light

Light generally travels in straight lines until obstructed in some way. The results of the interference upon the wave front of light is to cause *interference* patterns or *diffraction* bands. This phenomenon can be easily demonstrated if you hold two fingers in front of your eye in such a way that you look at a light source through the very fine slit between them when they are not pressed together. See Figure 3-19. The experiment works best if the light comes from a long thin lamp, such as a fluorescent tube. You will see alternating dark and light bands as you bring your fingers closer together (Figure 3-20). If you try the same experiment with a white incandescent light, you will see color bands.

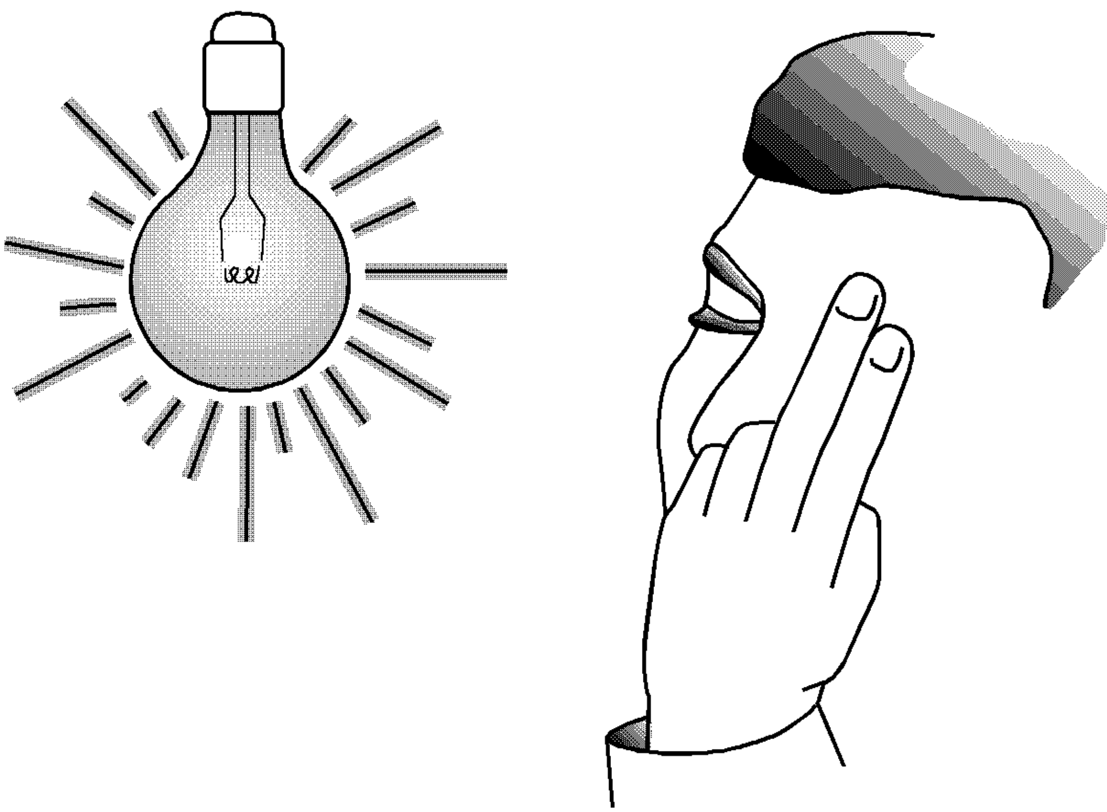

***Figure 3-19. A Simple Way to Observe Diffraction***

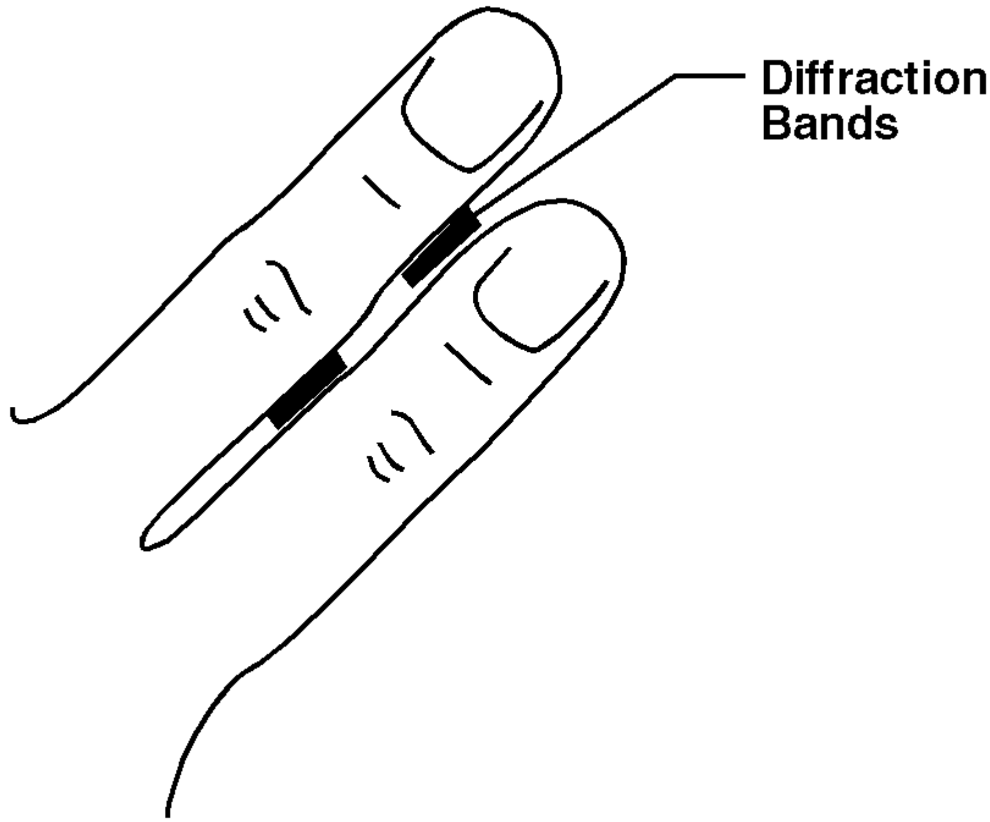


*Figure 3-20.  Diffraction Bands Between Fingers*

When the sources of light are large and the openings through which light passes are large, the effect of diffraction is hardly noticeable.  However, when the light sources are either very small or far away and the openings are very small, then the effect of diffraction is of some concern.  The latter of the two is of significant importance in the semiconductor industry.

When light comes in contact with the edges of microstructures on masks and reticles, light is scattered from the edges in the form of waves or bands.  Diffraction patterns essentially rob exposure energy and scatters it away from the desired field of exposure. The problem is compounded in small holes such as the contacts on the integrated circuit where diffraction patterns are easily generated by the four walls of the small windows in a dark field mask (Figure 3-21).  Because of diffraction it is much more difficult to effectively print contact holes than it is to print straight lines through a bright field mask.

## Furnace Processes and Related Issues in Semiconductor Manufacturing

# Introduction to Furnace Processes

**This manual was developed by the Electronics Training Division of the Texas Engineering Extension Service (TEEX), the Texas A&M University System, under contact from SEMATECH (Requisition No. A 33887)**

**S-72 PTAB Performance Based Equipment Training Project**

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**Acknowledgments**

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## Module Introduction

This module defines a furnace process and shows where the furnace processes fit into the sequence of wafer fabrication. The difference between a grown film and a deposited film is explained. The student is then introduced to the other furnace processes of diffusion, annealing, alloying, ashing, and reflow. A glossary follows the text to help those students who may not be familiar with the terms used in semiconductor processing. A set of evaluation questions is provided at the end of the module to be used by the student to check his or her understanding of the material presented.

**Module Outline**



**List of Figures**



**List of Tables**

## MODULE OBJECTIVES

After completing this module, the student will be able to

1. Explain in one sentence the purpose of a furnace process.

2. Identify at least one characteristic of each of the following processes: anneal, alloy, ashing, diffusion, deposition, gettering, oxidation, and reflow.

3. Describe where the furnace processes occur in the overall semiconductor manufacturing process.

4. List at least six semiconductor processes that use a furnace. For each process give a characteristic of the physical effects of the process on the product being manufactured.

## COURSE FOCUS AND DIRECTION

This course provides an introductory overview of hardware and processes related to furnaces in semiconductor manufacturing. Anyone assigned to work in the diffusion furnace area or who has an interest in the subject may enroll in this course; however, these individuals must have the prerequisite skills and knowledge as stated in the previously published course description.

A pre-test will be given at the beginning of the course to assess the audience's level of understanding of furnace processes and related topics. A post-test will be administered at the end of the course to determine the amount of improvement students will have gained from the course.

A variety of theoretical and practical topics covering both equipment and process will be presented. This course will help manufacturing personnel solve simple furnace related problems by providing useful and relevant background information. It will also help distinguishing between basic equipment and process related problems.

The course is structured as a series of modules, each covering a topic related to furnace process or equipment. Table 1 is a list of the modules that make up this course. The first three modules (1, 2, and 3) present an overview of furnace processes and equipment. The fourth module covers the properties of gases and gas flow. The fifth module identifies potential hazards and respective safety procedures pertaining to furnaces. The next five modules (6, 7, 8, 9, and 10) each discuss five important sub-systems related to the furnace, namely, temperature measurement/control, mass flow controllers, gas delivery systems, vacuum systems, and wafer handling/transfer systems. The following six modules (11, 12, 13, 14, 15, and 16) each deal with the different types of furnace processes, namely, anneal, alloy, oxidation, deposition, diffusion, ashing, reflow, and gettering processes. This is followed by a module (17) on film thickness and particle measurements. The next two modules (18 and 19) discuss preventive maintenance issues and troubleshooting process/equipment problems. The last module (20) presents a brief discussion of future industry trends in furnace processing.

1. Introduction to Furnace Processes
2. Equipment and Process Parameters
3. Furnace Equipment Overview
4. Properties of Gases and Gas Flow
5. Hazards and Safety
6. Temperature Measurement and Control
7. Mass Flow Controllers
8. Gas Delivery Systems
9. Vacuum Systems
10. Wafer Handling and Transfer Systems
11. Anneal Processes
12. Alloy Processes
13. Oxidation Processes
14. Deposition Processes
15. Diffusion Processes
16. Ashing, Reflow, and Gettering Processes
17. Film Thickness and Particle Measurements
18. Preventive Maintenance Issues
19. Troubleshooting Process and Equipment Problems
20. Future Trends in Furnace Processes

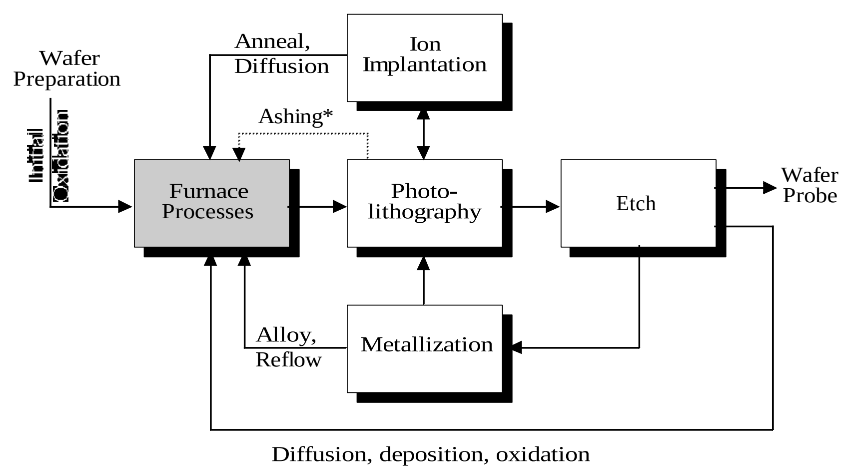
*Table 1. List of course modules*

## WHAT IS A FURNACE PROCESS?

A furnace process is a wafer fabrication process that makes use of temperatures, significantly above room temperature, to aid or enable the desired chemical reaction relative to the fabrication of semiconductor devices. The furnace chamber may contain gases at high, low or atmospheric pressure depending on the specific process.

## FURNACE PROCESSES IN SEMICONDUCTOR MANUFACTURING

Figure 1 shows where furnace processes fit into the overall sequence of wafer fabrication. Furnace processes occupy a noble position in wafer fabrication since they are typically performed first. Typically, wafers enter the furnace area from four other fab areas. Newly sliced and polished wafers come from the wafer preparation area. Wafers that have had some processing come from other areas, such as ion implant, metallization, or the etch areas. Wafers almost never come into the furnace area from photolithography (the exception being ashing). This is because photoresist, which is applied in the photolithography process, is an organic material that decomposes when subjected to high temperatures. This could result in the contamination of the process chamber and the production wafers. Some older semiconductor processes utilize furnaces for burning-off or "ashing" photoresist off of the wafers, but this method is not recommended for submicron processing. Wafers leave the furnace area and go to photolithography for further processing. Etch or ion implant processes typically follow photolithography.




FP01_001 *Ashing is not recommended for submicron processing

*Figure 1. Where common furnace processes fit into wafer fabrication*

Furnaces can be used to grow/deposit films, to diffuse dopants into the wafer, to anneal crystal defects after ion implantation, to alloy metal films, and to reflow/planarize doped glass layers. More details on these processes will be provided later in this course.

## Growing and Depositing Films

Films are grown or deposited on the wafer surface to form a layer that has different electrical characteristics than the substrate. In general, the growth of a film, such as silicon dioxide, uses and incorporates some of the substrate atoms into the film, resulting in the consumption of part of the substrate, as illustrated in Figure 2.

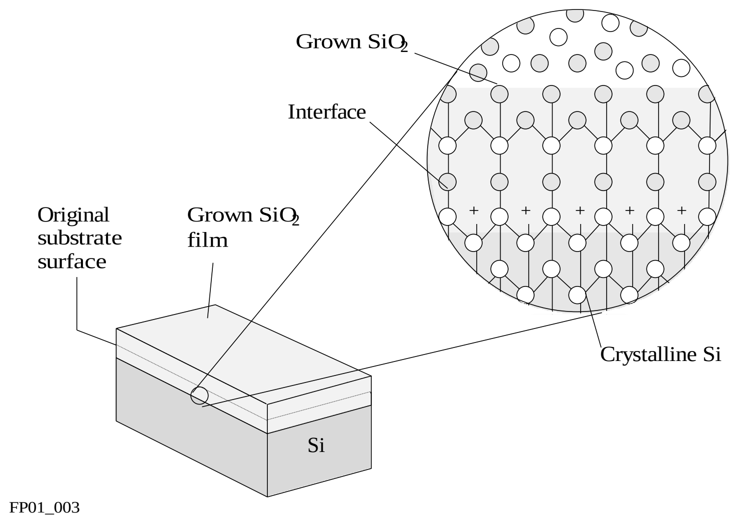



*Figure 2. A grown silicon dioxide ($SiO_2$) film*

A deposited film, on the other hand, lies on the surface of the substrate and does not incorporate any of the substrate atoms into the film, as illustrated in Figure 3. All of the materials needed for the film are provided by the process gas mixture.

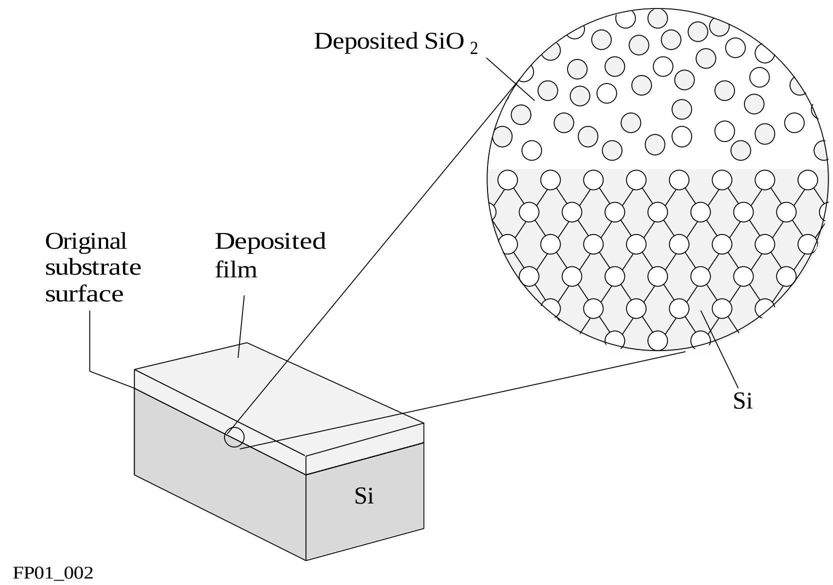



*Figure 3.* *A deposited silicon dioxide ($SiO_2$) film*

## Diffusion

Diffusion is the process of introducing the dopant atoms into the crystal lattice structure of the layer. First, a saturated layer of dopants is deposited on or near the surface in a furnace process called predeposition, as in Figure 4(a), or implanted into the surface in an ion implant process. Then, the dopant atoms are driven into the crystal structure where they diffuse (spread out) as shown in Figure 4(b).

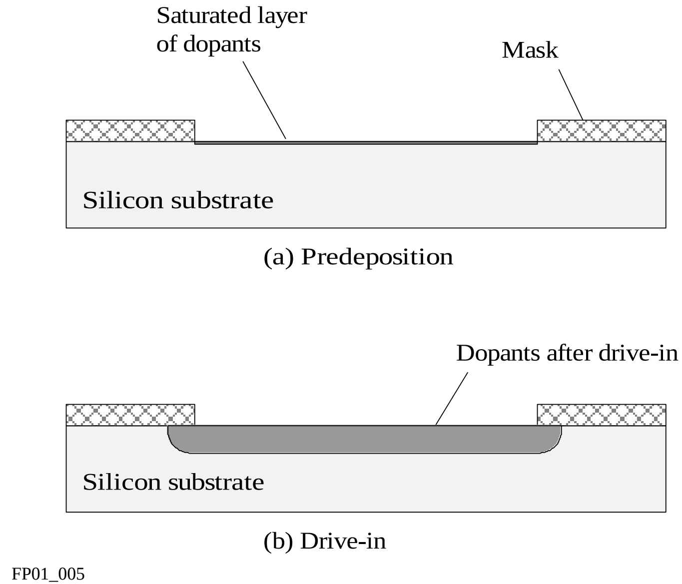



*Figure 4. Diffusion of dopants into a silicon substrate*

## Annealing

Thermal annealing of wafers in a furnace is used to heal the small crystal fractures, especially after an ion implant process as illustrated in Figure 5. During annealing, the silicon atoms move back into their lattice positions and the covalent bonds between the atoms that were broken during the implant process are re-established. Further, the dopant ions are aligned into the lattice structure. The dopant atoms become activated when the bonds are established.

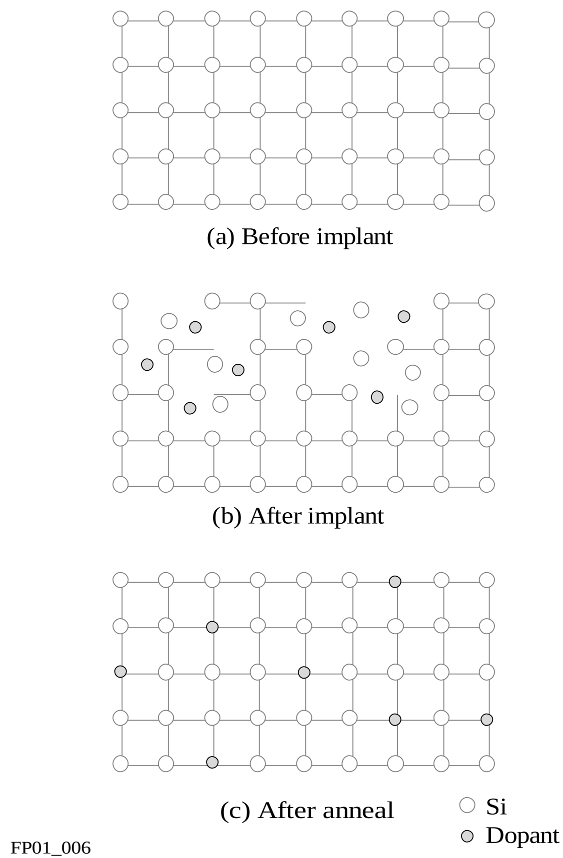



*Figure 5. Thermal annealing of ion implant damage*

## Alloying

Wafers are heated in a furnace after the metallization process, which causes the metal to combine with the silicon in the contact areas, forming an alloy. Alloying (sometimes called sintering) improves the adherence of the metal to the silicon surface and improves the electrical characteristics of the contact.

## Ashing

Ashing is a process used to strip photoresist from a wafer, by the application of heat. When this is done in a furnace, the wafers are raised to a high temperature (about 700°C) in the presence of oxygen ($O_2$). Currently, however, photoresist is ashed with oxygen ($O_2$) in a plasma reactor usually without adding external heat. High temperature ashing in a furnace is not recommended for submicron processes.

## Reflow

Reflow is the process of raising the wafer to a high temperature (about 900°C) to round the sharp corners of the doped oxide insulating layer and slope the sidewalls in the contact areas. This process allows good step coverage of the metallization that follows. Figure 6(a) shows a boron/phosphorus doped oxide layer before reflow. Note the sharp corners and vertical sidewall. After reflow, the corners are rounded and the sidewalls sag a little as in Figure 6(b). Figure 6(c) has the metallization layer added.

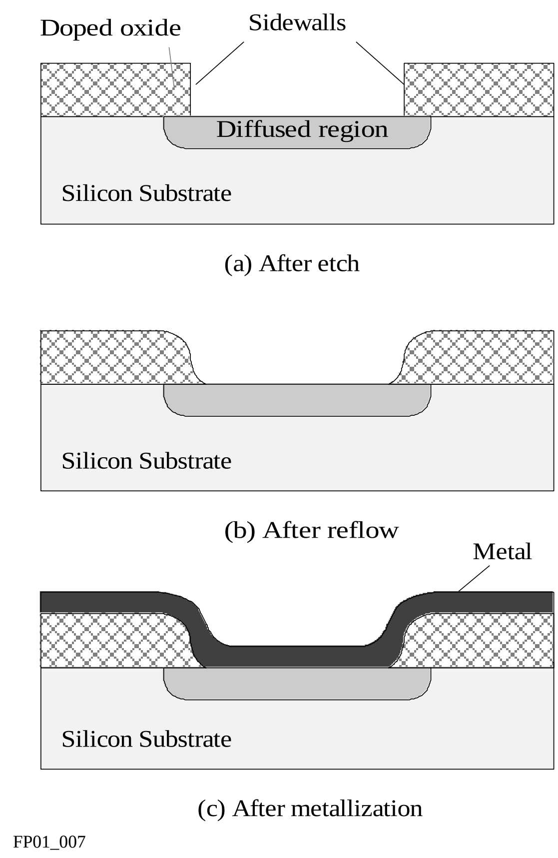



*Figure 6. Using the reflow process to round edges and taper sidewalls*

## Typical Furnace Processes

Table 2 lists many of the common furnace processes that will be covered in this course.

| OXIDATION | DEPOSITION | DIFFUSION | ANNEAL | ALLOY | OTHER |
|---|---|---|---|---|---|
| Dry | APCVD | Predeposition | Furnace Anneal | Al-Si Alloy | Ashing |
| Wet | LPCVD | Drive-in | RTA | Pt-Si Alloy | Reflow |
| HiPOx | PECVD | | | | Gettering |

*Table 2. Common furnace processes*

## SUMMARY

This module initially introduces the reader to a list of other modules that comprises the course on "Furnace Processes and Related Issues". The purpose of the furnace process is to aid and enable suitable chemical reactions that are used in semiconductor fabrication. The position occupied by furnace processes in the overall scheme of wafer fabrication is shown with respect to wafer fabrication, ion implantation, photolithography, metallization, and etch processes. Finally, the characteristics of six typical furnace processes, namely, film growth/deposition, diffusion, annealing, alloying, ashing, and reflow, are briefly explored.

## GLOSSARY OF TERMS

**Al-Si alloying**
An alloying process in which the deposited Al metal or Al-Si alloy layer is alloyed to the underlying silicon substrate. Al-Si alloying is used to fabricate ohmic contacts.

**alloy**
A thermal process in which a metal layer is heat treated with silicon in order to improve contact and electrical characteristics between the two. The two most important alloying processes are Al-Si and Pt-Si

**anneal**
A thermal process used to heal the small crystal fractures caused primarily by the ion implant process. During annealing, the silicon and dopant atoms move into the crystal lattice positions.

**APCVD**
Abbreviation for atmospheric pressure chemical vapor deposition. The APCVD process is a chemical vapor deposition (CVD) technique which is performed at or near atmospheric pressure (760 Torr).

**ashing**
A process in which photoresist is stripped off the wafer surface by the application of heat and in the presence of oxygen ($O_2$). Modern techniques of ashing use an oxygen plasma reactor to remove the resist layer.

**covalent bond**
A chemical bond between atoms in which electrons are shared.

**diffusion**
A thermal process in which dopant atoms at or near the wafer surface are redistributed deeper into the bulk of the wafer. For diffusion to occur, both heat and a concentration gradient are required.

**dopant**
A chemical element, from the third or fifth group of the periodic table, which is incorporated in trace amounts in a semiconductor crystal, to favorably alter its electrical characteristics. Examples of common dopants used in

silicon are boron (B), phosphorus (P), arsenic (As), and antimony (Sb).

**doped oxide**

Silicon dioxide ($SiO_2$) containing a few percent of silicon dopants (B, P). Doped oxide has a lower softening (reflow) temperature as compared to undoped oxide.

**drive-in**

Drive-in is the second stage of the dopant diffusion process in which the saturated dopant on the wafer surface is driven into the wafer to obtain the required junction depth. (The first stage is predeposition.

**gettering**

Gettering is the process of removal of crystalline defects and metal contaminants from the active region of the substrate.

**HiPOx**

Abbreviation for high pressure oxidation. HiPOx is the process of oxidation of the wafer by the application of a high pressure (10-20 atms).

**LPCVD**

Abbreviation for low pressure chemical vapor deposition. The LPCVD process is a chemical vapor deposition (CVD) technique which is performed at a pressure below atmospheric pressure (0.1-1.0 Torr).

**metallization**

A process usually performed by evaporating or sputtering a thin film of metal or alloy on the surface of a wafer.

**organic compound**

A chemical compound of carbon (C), hydrogen (H), and one or more other elements, such as oxygen (O) or nitrogen (N).

**PECVD**

Abbreviation for plasma enhances chemical vapor deposition. The PECVD process is a chemical vapor deposition (CVD) technique which used a plasma to aid in the deposition process.

**photolithography** A micropatterning process in which a pattern is transferred from a photomask onto the wafer using a technique similar to photography.

**planarization** A process that smooths the contours of the wafer surface by improving surface topography.

**plasma** A fourth state of matter composed of charged and uncharged particles which is used in semiconductor processing as a means to energize and drive chemical reactions, such as ashing.

**predeposition** Predeposition is the first stage of the dopant diffusion process in which the surface of the wafer is saturated with the dopant. (The second stage is drive-in).

**Pt-Si alloying** An alloying process in which the deposited Pt metal layer is alloyed to the underlying silicon substrate. Pt-Si alloying is used to fabricate Schottky-barrier contacts.

**reflow** A high temperature process that rounds the corners of the doped oxide insulating layer and slopes the sidewalls. This process allows good step coverage of the metallization that follows.

**RTA** Abbreviation for rapid thermal anneal. RTA process is an annealing technique which has a short process time (order of seconds).

**substrate** A wafer that is the basis for subsequent processing operations in the fabrication of semiconductor devices or circuits.

## EVALUATION QUESTIONS

1. A furnace process in wafer fabrication uses high temperature to

   a. reduce particulate contamination.
   b. increase the gas pressure.
   c. aid/enable the desired chemical reaction.
   d. disable any chemical reaction from occurring.

2. In submicron processing, wafers that enter the furnace area never come from the following fab area:

   a. ion implant
   b. etch
   c. photolithography
   d. metallization

3. The growth of a film, such as silicon dioxide ($SiO_2$), on a silicon substrate

   a. is a purely physical process.
   b. incorporates some of the substrate atoms into the film.
   c. does not incorporate any substrate atoms into the film.
   d. is called diffusion.

4. The process of depositing a film on a substrate surface

   a. is a purely physical process.
   b. incorporates some of the substrate atoms into the film.
   c. does not incorporate any substrate atoms into the film.
   d. is called diffusion.

5. Diffusion is the process of

   a. raising the wafer temperature to smooth the deposited doped oxide topography.
   b. causing metal to react with silicon in the contact areas.
   c. healing the small surface defects caused by the ion implant process.
   d. introducing dopant atoms into the crystal lattice of the substrate.

6. Thermal annealing is the process of

   a. raising the wafer temperature to smooth the deposited doped oxide topography.
   b. causing metal to react with silicon in the contact areas.
   c. healing the small crystal defects caused by the ion implant process.
   d. introducing dopant atoms into the crystal lattice of the substrate.

7. Alloying is the process of

   a. raising the wafer temperature to smooth the deposited doped oxide topography.
   b. causing metal to react with silicon in the contact areas.
   c. healing the small surface defects caused by the ion implant process.
   d. introducing dopant atoms into the crystal lattice of the substrate.

8. The reflow process consists of

   a. raising the wafer temperature to round the corners of the deposited doped oxide.
   b. causing the metal to react with silicon in the contact areas.
   c. healing the small surface defects caused by the ion implant process.
   d. introducing dopant atoms into the crystal lattice of the substrate.

9. Ashing refers to the process of

   a. removing metal from the wafer surface.
   b. removing photoresist from the wafer surface.
   c. developing photoresist patterns on the wafer surface.
   d. etching oxide after photolithography.

10. Typical furnace processes include:

    a. oxidation, photolithography, diffusion, anneal/alloy
    b. oxidation, deposition, diffusion, anneal/alloy, reflow
    c. wet/dry etch, deposition, metallization, anneal/alloy
    d. oxidation, metallization, diffusion, anneal/alloy

# APPENDIX C

## SEMATECH MANUFACTURING TECHNICIAN TRAINING AND CERTIFICATION PROCESS

**Purpose**

The purpose of Manufacturing Technician Training and Certification is to document the demonstration of the skills required for safe operating, process monitoring and/or maintaining of process equipment according to SEMATECH specification.

**How it Works**

1. Communications and Ownership

The manufacturing technician's manager issues a Training Request form including a description of the MT's background and experience, training needs, and job expectations.

The form is routed to the following for signatures:

a. ATDF Shift Manager - The manager has responsibility over the employee's career development and to support production in the ATDF.

b. Document Control - The document control center inputs training related data:
   * trainee's name,
   * course(s)
   * date training was requested
   * training completion date
   * certification date
   * recertification date.

c. Peer Trainer (lead technician) - The peer trainer is anyone who is already certified in the specific job that the MT is to be trained to do. Or, the trainer can be someone who is recognized to have outstanding expertise, such as:
   * experienced MTs
   * process engineers
   * equipment engineers
   * field service engineers
   * training specialists.

d. Process Engineer - The process engineer, or tool owner, plays a major role in contributing to the content of the training and certification program. The engineer is responsible for defining the operating specs as well as the process specs for the assigned tool; thus, the engineer may be directly involved in the actual certification process as well as the training.

e. Equipment Engineer - The equipment maintenance technician or engineer may also be involved in the MT training and certification process.

f. MT Trainee - The MT trainee signs the training request to show his/her commitment to the training program. The trainee will receive a training and certification checklist. This serves as the individual's preliminary career development roadmap.

2. Prepare an Individualized Roadmap

After the training request has been received and signed by all affected parties, the peer trainer prepares the standard SEMATECH MT Training and Certification Checklist for the assigned work area. The peer trainer reviews the training goals and objectives with all affected parties. An individualized roadmap is determined and the peer trainer is given permission to start the training process.

**Major Events** There are several steps to the certification process.

**Step 1** Kickoff Meeting. The manager meets with the trainee and peer trainer and explains why the training is important and what will be expected from the MT on the job after the training is completed. Any additional expectations will also be covered at this time, such as length of time to complete training, number of hours dedicated to training, etc.

**Step 2** Roadmap Explanation. The trainer will begin by explaining the trainee's training and certification roadmap. The trainer will explain what will be done, how long it will take, and how performance will be evaluated.

**Step 3** Four-Step Training Process. While following the individualized roadmap to guide the training process, the trainer will apply four basic steps in the training process.

a. Trainer tells the trainee what the trainee is expected to do.
b. Trainer demonstrates the required skill and answers the trainee's questions.
c. Trainee practices the skill while the trainer coaches the trainee. Trainee practices until the desired level of competency is achieved.
d. Trainee explains, demonstrates, and answers the trainer's questions.

**Step 4** Record Keeping. When both the trainer and the trainee agree a skill has been mastered, the trainer initials and dates the training checklist. The process in steps 3 and 4 is repeated until the MT performs all skills related to a task or job with acceptable competence.

**Step 5** Certification Test. During the certification test the MT must complete the task according to specification with no assistance or errors. In addition to the performance portion of the certification test, a written test will also be administered for each level of certification. Only after achieving a perfect score on both the performance tests and the written tests will a MT be certified.

Successful Completion. If the engineer or person responsible for the certifying is satisfied with the performance, the engineer will sign the certificate and inform the trainer and the MT's manager that the MT is certified and ready to be assigned to the job the MT has been trained to perform.

Remedial Action. If the MT did not perform according to the specification or made errors, the engineer will notify the manager and trainer that the MT will need additional supervised practice or training.

**Step 6** Recognition. After receiving the certification documentation from the trainer and the person accountable for the certification, the Level 3 manager will sign the certificate and present it to the MT.

**Step 7** Recertification. The same procedure applies for MTs requiring recertification.

# GUIDELINES FOR WRITING CERTIFICATION TESTS

**Introduction**

These guidelines describe what a trainer will need to do to develop written tests for a manufacturing technician certification program.

**Basic Rules**

Follow these basic rules when preparing written tests for certifying manufacturing technicians:

1. Early Warning. Prior to the start of the training program, the trainer should explain to the MT the objectives of the course and the test that will be used to evaluate his performance. A MT should know in advance the topics to be covered on the test. This information will help steer the MT's learning.

2. Test Styles. Select a test style that fits the target audiences' learning preferences. The method of testing should be easy to administer, manage, and maintain as well as easy for the MT to understand how to perform the test.

3. Open Book. In most cases, MTs should be allowed to use the same resources they would have available when performing the tasks and job they have been trained to do. This includes specifications, manuals, checklists, etc.

4. Objective-Driven. Tests should match the objectives of the training and certification program. A test should not be subjective and open to scrutiny. If the training program has a strong foundation of sound performance objectives, and if the test is based on the objectives, then there is a stronger probability that the MT's performance will be measured in an objective manner.

5. Specifications. Ultimately, it is the SEMATECH operating specifications that determine the specific content of the certification tests. Objectives are derived from the specifications. The performance objectives provide the means for measuring a MT's ability to perform according to the specification.

6. Test the Test. Tests are only as good as the people who design them. Written tests have to be carefully designed to prevent ambiguity, inferences, and misinterpretations. The author of the test must remain open-minded and flexible. The test should be administered several times. After each test session, MTs should be allowed to critique the test to determine if unfair, irrelevant, or confusing questions need to be revised.

7. Update the Test. Ensure that the test is kept up to date as specifications are updated. The continuous improvement concept also applies to designing effective tests.

8. Pretest or Sample Test. A prerequisite test, or "pretest," may be helpful in assessing entry level skills for new or prospective MTs. This test usually includes a sampling of questions from the actual certification test.

**Required Resources**

Training and Certification Checklists containing Performance Objectives

Specifications for the Designated Work Area and for Related Process Tool(s)

Relevant Resource Materials considered Necessary for the Performance of a Task

**Test Styles**

Tests can be written in various styles. The test style should fit the specific application for which a test is designed to serve. In general, the test developer should use the simplest method that will provide a fair means of evaluating a MT's skills.

Matching Tests

- Match words
  - Match words to statements
  - Match names and/or statements to objects
  - Combination of all of the above

- Multiple-Choice
  - A statement followed by two or more choices
  - Two or more choices within a statement

- Fill in the blank
  - Word statements with missing words
  - Tables with missing information

- Complete the statement

- True or False tests

- Tests requiring a written response

**Locate & Describe Items**

Verbal Style. Have the list of parts, components, systems, or objects available on paper or computer and verbally test the MT at the actual workstation.

Written Style. Matching test - match names, objects, and descriptions. The same skill can be accurately tested by using photographs, drawings, or video of the equipment when the actual machine is not available.

**Explain Steps in a Process**

Verbal Style. Given an actual SEMATECH specification, the MT can be asked direct questions regarding the process at the actual work location.

Written Style. Practically any test style can be used to test for an understanding of a process flow. Even flash cards containing word descriptions of the process or actual photographs can be used as a means of testing for the correct order of all steps in the process.

**Recall Parameters in a Process**

Verbal Style. Having available an actual SEMATECH specification, the MT can be asked direct questions regarding the process at the actual work location.

Written Style. Any test style can be used to test for recall of specific information contained within a specification.

## EXAMPLES OF TEST STYLES

**Matching Test**

Matching Words to Statements

| | | | |
|---|---|---|---|
| A. | Wafer | D. | Notch |
| B. | Die | E. | Flat |
| C. | Scribe lines | F. | Test die |

1.__ A single isolated product device on a wafer.

2.__ These run vertically and horizontally on a wafer to isolate individual dice.

3.__ Special devices on the wafer that help engineers tell the results of the process.

4.__ A small alignment hole on the edge of a wafer.

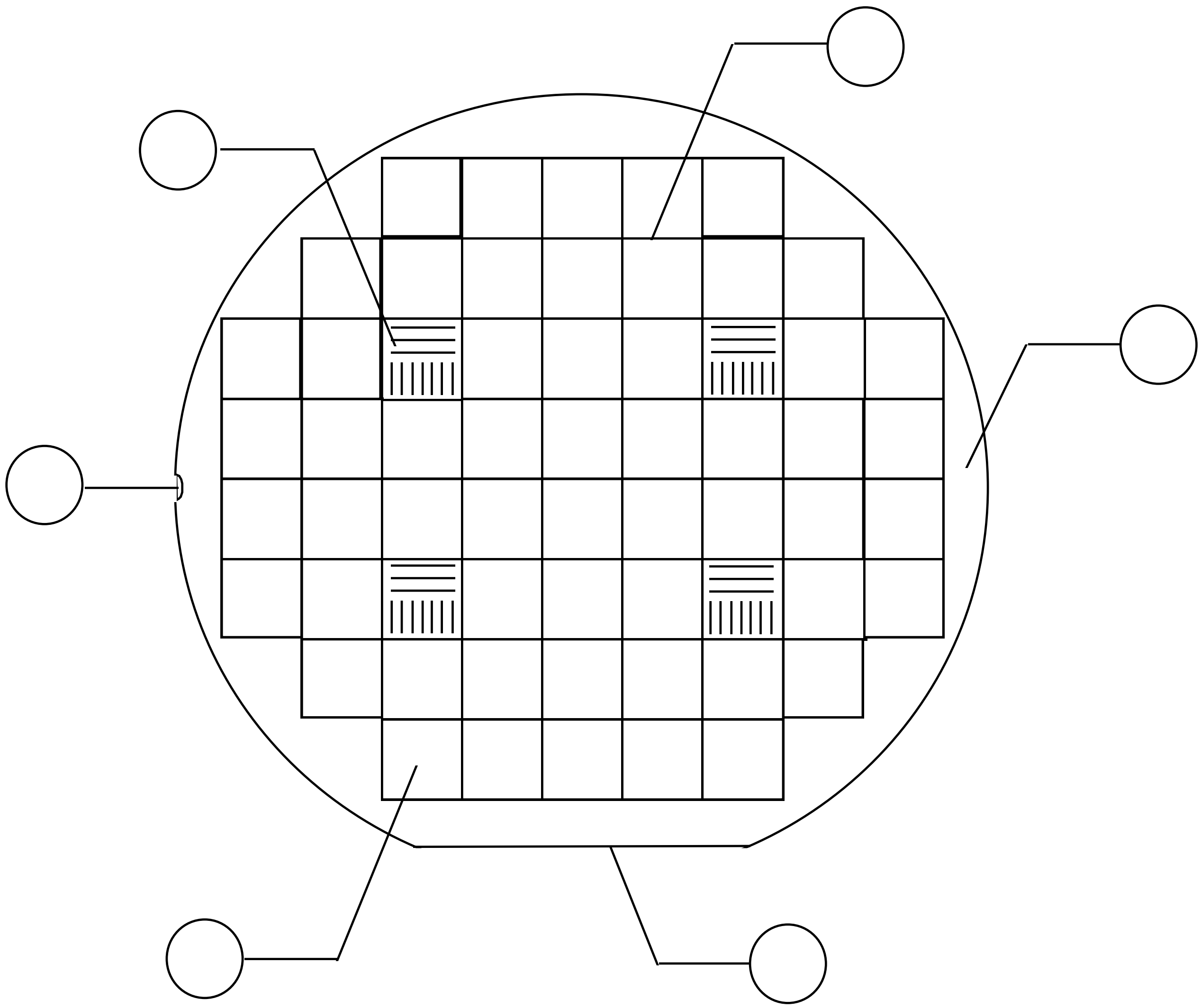
5.__ A straight alignment indentation on a wafer's edge.

6.__ A flat circular slice of silicon on which many semiconductor ICs are built.

**Matching Test**

Matching Words and Statements to Objects

Match the items on the facing page with the objects in the figure on this page.



**Multiple Choice**

1. Proper airflow in critical areas serves two functions -
   A. cooling and heating.
   B. cooling and contamination control.
   C. barometric pressure and contamination control.
   D. humidity and contamination control.

2. Humidity interferes with the ability of:
   A. the vacuum in wafer handling systems.
   B. resist to adhere to the wafer surface.
   C. MTs to perform their jobs.
   D. lens focus system.
   E. all of the above.
   F. none of the above.

3. Select the statement that best describes the term "through-the-lens."
   A. A point of view outside the plane of the projection lens.
   B. Light rays that pass through the same plane as the projection lens.
   C. Same as enhanced global alignment.
   D. TTL refers to the type of alignment used when dark field lighting is used.

4. Given a list of tools, which are used to measure critical dimensions? (Circle all that apply.)
   A. Optical microscope
   B. Confocal microscope
   C. Scanning slit microscope
   D. Scanning electron microscope
   E. Interference microscope
   F. Ellipsometer

5. In microlithography, the (NA, resolution, depth of focus) is defined as the smallest isolated feature which is repeatedly printed by a photolithography process.

**Fill in the Blank**

Word Statements with Missing Words

1. In microlithography, the _ _ _ _ _ _ _ _ _ _ is defined as the smallest isolated feature that is repeatedly printed by a _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ process.

Tables with Missing Information

Use this table to test your troubleshooting skills. Place an "X" in the appropriate place to a specific "Defect ID" to some "Possible Causes due to Process Variations." The first one has been done for you as an example.

**True or False Tests**

Indicate whether a statement is correct or incorrect by writing the word "true" or "false" next to each statement.

1. _____ Mercury can be found in the stepper within the high intensity lamp.

2. ____ Commonly used cleaning slovents, IPA and acetone are highly flammable.

3. ____ Most develop solutions are acidic.

Indicate which statement is true by placing a checkmark next to the statement.

1.__ As a precautionary, one should avoid breathing in the yellow room.

2.__ HMDS is considered highly explosive at room temperature.

3.__ Wafers brought to the stepper will have been coated with photoresist.

## GUIDELINES FOR DEVELOPING TRAINING AND CERTIFICATION CHECKLISTS

**Introduction**

These guidelines describe what a trainer will need to do to develop certification training materials. What is described here is the minimum requirement.

**Required Materials**

Training Request Form
Course Prerequisites
Task Analysis
List of Training Objectives
Relevant Documentation
Training Checklist
Estimated Time for Completion
Certification Test
Certification Form

**Training Request Form**

The first step in the training and certification process requires that the manufacturing technician's (MT) manager submit a training request to the respective peer trainer in the MT's work area. The form contains important information that will help you strategize the learning roadmap for the MT trainee.

**Course Prerequisites**

The course prerequisites describe the knowledge and/or skills that the MT needs to have before beginning a training program. Here are some examples of prerequisites:

Courses:

- E-Mail Training
- Site Safety Orientation
- Chemical Safety
- Workstream
- Cleanroom Entry
- IC Process Overview
- Digital Circuits
- DC and AC Electronics
- Physics 101

Skills:

- Typing Speed (30 wpm)
- Soldering using pencil tip soldering iron
- Wafer handling
- Microscope usage
- Practical oscilloscope applications
- Use of basic hand tools
- Operate leak detector

**Task Analysis**

In general, SEMATECH engineers have written operating, process, and maintenance specifications to ensure that processes and tasks are done on schedule or when required and with some desired result in mind. There may be some instances where segments of a MT's job has not been documented. If this should occur, a task analysis (TA) should be performed. The TA identifies when a task must be done and describes how the task is done step-by-step. The TA can then be used as part of the MT's training checklist.

**Training Objectives**

Training objectives state what the MT will be able to do as a result of the training. Objectives describe a performance that is clearly visible and measurable.

<Example> Given a cassette containing 25 200mm wafers, the MT will use the vacuum wand to transfer all 25 wafers to a quartz boat without dropping, scraping or contaminating the wafers.

<Example> Given a 20-question test, the MT will correctly answer at least 85% of the questions.

<Example> Given a list of 35 major components, the MT will locate and describe each component on the ion implanter within a time period of 60 minutes.

<Example> Walk thru the etch area with your trainer, identify all possible hazards and describe the proper safety procedure for dealing with each hazard.

Training objectives should follow an order of hierarchy depending on their level of complexity. The order of performance should be from the simplest to the most complex. Additional knowledge and skills, sometimes hidden and not observable, may also be required before an objective can be achieved. These objectives must also be included in the list of training objectives.

<Example> Recall from memory the action to take when a XXX-XX error is noted on the tool.

<Example> State the difference between Kev and ma.

<Example> Explain the difference between Charles's Law and Boyle's Law.

<Example> List at least 3 items that are needed for ionizing a gas in a plasma etch reactor.

**Relevant Documentation**

Ensure that all necessary reference documentation including videos and other applicable resources will be available when you need them for the training process. Here are some items to consider:

Safety Module
Standard Operating Procedures (SOPs)
Specifications
Supplier Manuals and Schematics
Theory of Operation
Text Books
Other Suggested Resources

On the training checklist indicate the pages or sections of the document that the MT should read to support the performance of a specific objective on the training checklist.

**Training Checklist**

The training checklist is a form that the trainer and MT use to track their progress. It lists all the objectives that the MT will achieve or be able to do so as a result of the training course. Next to each task are two underlined spaces. When the trainer and the MT agree that the activity has been mastered, they initial and date the appropriate objective. When all the objectives have been initialed, a certification test can be scheduled.

**Estimated Time for Completion**

The time estimate includes the number of hours of on-the-job training as well as the number of additional hours needed for reading assignments or for doing homework. The time estimate should also state the approximate duration of the course. For example, a training course may include several four-hour sessions that will be completed over a two-month period.

**Certification Test**

To become certified, the MT must demonstrate the ability to perform the tasks learned in training to the person accountable for the respective work area. The person doing the certification could be a process engineer, equipment engineer, field service engineer, Level 3 manager, or another qualified MT. In order to ensure the integrity of the certification program, the individual doing certification must have demonstrated competence in the specific area and/or tool where the trainee is to be tested.

| | |
|---|---|
| Performance Test | The MT will demonstrate the tasks to the person doing the certifying without any errors. |
| Written Test | The MT will complete the written test without errors. |

Recertification may be required if an individual's performance drops below standard or if the MT has not performed the task for a specified period of time.

**Certification Form**

Once all the criteria for certification have been met, the trainer, Level 3 manager, and the person doing the certifying will sign the certification form. The Level 3 manager will present the certification to the MT. The trainer will report the completion of the training program to the training department.

## MANUFACTURING TECHNICIAN TRAINING CHECKLIST

As trainee completes each class or procedure, trainee and trainer (or instructor) should initial and date each section.

| I. | CORE COURSES | TIME | TRAINEE | TRAINER | DATE |
|---|---|---|---|---|---|
| | **WEEK ONE – ORIENTATION**<br>To include: PC/Windows<br>E-Mail<br>HAZCOM<br>Site Safety Orientation<br>Chemical Safety<br>Cleanroom Entry Certification | 28 | | | |
| 2. | WorkStream Training | | | | |
| 3. | Semiconductor Processing Overview | 8 | | | |
| 4. | Electrical Safety | 6 | | | |
| 5. | Lockout/Tagout | 1 | | | |
| 6. | RS1/Quickstart | 7 | | | |
| 7. | Intro to Statistical Methods | 7.5 | | | |
| 8. | Passive Data Collection | 7.5 | | | |

| II. | NON-TOOL ATDF TRAINING | TIME | TRAINEE | TRAINER | DATE |
|---|---|---|---|---|---|
| 1. | Tour of bay including familiarization of all equipment in the bay. | | | | |
| 2. | Safety Items<br>a. Demonstrate proper evacuation routes<br>b. Demonstrate the correct use of personal protective equipment<br>c. Identify the different types of alarms<br>d. Identify the emergency phone numbers<br>e. Identify the hazards in the bay<br>f. Demonstrate how to contact security and the reasons for contacting them | | | | |
| 3. | Key Contacts<br>a. Demonstrate how to use the paging system<br>b. Demonstrate how to contact management<br>c. Demonstrate how and why to contact fab stores | | | | |
| 4. | Housekeeping<br>a. Demonstrate the proper housekeeping policies in the ATDF | | | | |
| 5. | Wafer Handling<br>a. Demonstrate the correct way to handle wafers and the use of the transfer tool<br>b. Demonstrate the correct way to use the notch finder<br>c. Demonstrate the correct way to use the wafer sleuth tool | | | | |
| 6. | Equipment Owners<br>a. Identify the equipment owners for your area | | | | |
| 7. | Timesheets<br>a. Demonstrate how to correctly fill out a timesheet and where to send it | | | | |
| 8. | Special Codes<br>a. Identify the special codes and nonmenclatures used in the ATDF | | | | |
| 9. | Hazardous Wastes<br>a. Identify and/or demonstrate the proper procedure for the removal/exit of hazardous wastes | | | | |

| III. | TOOL RELATED SKILLS | TIME | TRAINEE | TRAINER | DATE |
|---|---|---|---|---|---|
| 1. | Process Overview<br>a. Describe product before and after the process<br>b. List major process parameters<br>c. List major process steps<br>d. Briefly describe process equipment | | | | |
| 2. | Equipment Overview<br>a. Locate and descibe major systems, subsystems, and components | | | | |
| 3. | Locate and Describe Related Hazards<br>a. Chemical<br>b. Electrical<br>c. Thermal<br>d. Optical<br>e. Mechanical<br>f. Radiation | | | | |
| 4. | Describe Safety Procedures for Items in #3 | | | | |
| 5. | Locate and Describe Controls and Indicators<br>a. Control panels, keyboards, etc...<br>b. Information displays, CRT, etc...<br>c. Switches, gauges, joysticks, etc...<br>d. Describe relationships between items in 2 and 5 | | | | |
| 6. | Define Operating Codes or Software Commands | | | | |
| 7. | Read and Interpret Specifications<br>a. Process specifications<br>b. Operating specifications<br>c. Station maintenance specifications | | | | |
| 8. | Process Wafers According to Spec<br>a. ID lot number and select appropriate recipe<br>b. Load and unload wafers<br>c. Setup stations<br>d. Operate station<br>e. Monitor process<br>f. Interpret alarms and take appropriate corrective action | | | | |
| 9. | Apply Principles of SPC to the Tool<br>a. Interpret process data<br>b. Plot data on control charts<br>c. Make appropriate decisions regarding corrective action<br>d. Troubleshoot the tool and the process to the subsystem level | | | | |
| 10. | Preventative Maintenance<br>a. Shiftly<br>b. Daily<br>c. Weekly | | | | |
| 11. | Qualifications | | | | |
| 12. | Troubleshooting (optional) | | | | |
| 13. | Engineering Audit | | | | |

# APPENDIX D

**Examples of Completed Lesson Plans Courtesy of Semitherm**

| | |
|---|---|
| **Instructor Guide:** #01 | **Class:** Semitherm VTP-1500 Operations |
| **Module Title:** VTP-1500 Vertical Furnace Course Introduction | |
| **Target Audience:** Operators, Technicians, Engineers -- anyone responsible for operating the VTP-1500 | **Location:** Classroom |
| **Prerequisite Skills:** Basic computer skills, basic electronics, mechanical skills | |

**Module Objective:** Upon completion of this module, the participant will be able to

- List expectations regarding the course
- Follow the course format and schedule
- Understand the purpose of the performance objectives
- Understand the course completion criteria
- Complete the course pretest
- Tour the facilities and learn evacuation procedures for the site of the class

**Skill Pretest:** The pretest will be administered during this module. Two functions are served by this test: (1) The pretest is designed to measure each participant's competency level regarding the contents of the course. (2) The instructor can tailor the pace and contents of the course based on the results of the pretest. There is no passing grade requirement for this test.

**Additional Resources:** The instructor will require an assistant. This person can take the participants on a tour of the facilities while the instructor grades the pretest.

| Training Aids & Media | Tools & Materials for Practice |
|---|---|
| 1. Overhead projector and screen<br>2. Transparency of the facility layout<br>3. Pointer and transparency markers<br>4. Flipchart and markers to take notes<br>5. Name tents and markers<br>6. Class roster<br>7. Registration forms<br>8 Transparency of course outline or map<br>9. Transparency of Individual Progress Chart<br>10. Transparency of Class Progress Chart | None required |

**Relevant Practice Description:** Not applicable

**Conditions:** Not applicable

**Type of Modeling:** Not applicable

**Feedback Mechanism:** Not applicable

**Module Content Description:** The purpose of this module is to welcome the participants to the class and to allow them and the instructor time to get acquainted before starting the class. Participants should fill out the registration form if they have not already done so. Participants are asked to write their names on the name tents using the markers provided. Then everyone is allowed to introduce themselves. During the introductions, the instructor can check the attendance for the day.

The instructor will explain the location and procedures for: accessing the break areas, cafeteria, restrooms, telephones, health services, etc. Safety is of a major concern, so hazards are pointed out and safety procedures are explained including emergency procedures and the evacuation routes.

Class schedules are announced, including meeting times, breaks, lunch, and specific times when equipment will be available for demonstrations, practice, and testing sessions.

The instructor will explain the course format including the purpose of the course and the individual module objectives. Participants will learn that the course is based on performance objectives that are derived from careful front-end analysis. Skill tests are administered in each module to determine each participant's understanding of concepts and level of skill competency. The tests are graded individually and appropriate feedback is provided by the instructor or the course materials to ensure participants know how well they are doing at all times.

Participants are informed that the course is a performance-based equipment training (PBET) course, and as such, it allows for plenty of relevant practice to support the concepts and performance of skills demonstrated by the instructor. Wherever possible, participants will receive as much "hands-on" practice on the VTP-1500 Vertical Furnace System as is possible.

The course outline or course map is explained. If a course map is available, the instructor can point out the logical sequencing of individual units of instruction (modules). The instructor can explain the specific order of modules for the specific class based on current needs.

Satisfactory completion of the VTP-1500 Operations course by each participant requires satisfactory performance of each skill test attempted. The pretest and posttest must be taken by each participant; however, the results are not used to rank the participants against each other. Instead, the results of the posttest are compared to the pretest to determine the extent of individual improvement in learning the VTP-1500. Each participant will have an "Individual Performance Chart" where the participant can record performance on the pretest, posttest, and individual learning modules. Both the instructor and the participant are required to sign the IPC as an indication of agreement between the two that all or specific instructional modules have been completed. The instructor will have a "Class Performance Chart" to track the completion of modules as they are completed by each participant.

The instructor asks the audience if they have any specific needs or expectations from this class that have not already been mentioned. The instructor writes the list on flipchart paper and will continue to use the paper to record issues and questions that might arise during the course. The instructor will check off the items as the expectations are met or as issues and questions are resolved.

When the class has completed taking the pretest, a training assistant arrives to escort the class on a tour of the facility. During this time, the instructor can grade the pretest and tally the scores. The instructor may or may not be able to establish a baseline from the results unless there is a noticeable pattern of scores in certain areas of the test which the instructor can identify as being either strong or weak competencies.

The instructor passes out the participant guides along with the results of the pretest. The instructor will review the results of the pretest with the class when the participants return from the tour. The instructor explains any modifications in the course from the original course map. The participant guide is explained and the first module begins.

<table>
<tr><td>Instructor Guide: #02</td><td>Class: Semitherm VTP-1500 Operations</td></tr>
<tr><td colspan="2">Module Title: VTP-1500 Vertical Furnace Overview</td></tr>
<tr><td>Target Audience: Operators, Technicians, Engineers -- anyone responsible for operating the VTP-1500</td><td>Location: Classroom and/or at the VTP-1500</td></tr>
<tr><td colspan="2">Prerequisite Skills: Basic computer skills, basic electronics, mechanical skills</td></tr>
<tr><td colspan="2">Module Objectives:<br>1. Given a functional block diagram and pictorial drawings, the student will be able to locate and describe the function of the nine specific major subsystems in the VTP-1500 Vertical Furnace with at least 90% accuracy.<br><br>2. Using an operational VTP-1500 Vertical Furnace and a checklist, the student will be able to locate and describe the components of each of the following major subsystems to items on the checklist with 90% accuracy: (a) process chamber/heater element system, (b) temperature control system, (c) gas delivery system, (d) exhaust/pressure control system, (e) computer control system, (f) water flow control system, (g) interlock system, (h) wafer transfer system, and (i) power distribution system.<br><br>3. Using available documentation the student will be able to identify wafer transfer movement designations and wafer station designations of the VTP-1500 Vertical Furnace with 90% accuracy.</td></tr>
<tr><td colspan="2">Skill Test: (1) The instructor will provide a checklist of nine major subsystems of the VTP-1500 Vertical Furnace. At the VTP-1500 the student will locate each item on the checklist and describe to the instructor the purpose of each subsystem. Acceptable performance on this test is 90% or better. (2) On the reverse side of the checklist will be a pictorial diagram of the wafer transfer station. The student will be asked to name the major components of the wafer transfer system and to identify the wafer transfer movement designations -- direct load, load, unload, preload, and post load</td></tr>
<tr><td colspan="2">Additional Resources: None</td></tr>
</table>

| Training Aids & Media | Tools & Materials for Practice |
|---|---|
| 1. Overhead projector and screen<br>2. Pointer and transparency markers<br>3. Flipchart and markers to take notes<br>4. Transparencies:<br>(1) course outline or map<br>(2) Fig. 1<br>(3) Fig. 2.2<br>(4) Fig. 2.3<br>(5) Fig. 2.4<br>(6) Fig. 2.5<br>(7) Fig. 2.6<br>(8) Fig. 2.7<br>(9) Fig. 2.8<br>(10) Fig. 2.9<br>(11) Fig. 2.3 without callouts<br>(12) Fig. 2.4 without callouts<br>(13) Fig. 2.5 without callouts<br>(14) Fig. 2.6 without callouts<br>(15) Fig. 2.8 without callouts | 1. VTP-1500 Vertical Furnace (if available)<br>2. Videotape of VTP-1500 (if tool is not available) |

**Relevant Practice Checklist**

| **Relevant Practice Description:** |
|---|
| **Type of Modeling:** The instructor will use the overhead projector and transparencies 7 - 9 to point out the major subsystems of the VTP-1500. He will show the location of the nine major subsystems and describe the function of each item with respect to the overall function of the VTP-1500. The instructor will create an interactive environment and will answer all questions provided by the audience. |
| **Conditions:** The practice session can be done in the classroom using the overhead and transparencies 14 - 18. After the preliminary practice session in the classroom, the instructor will take the participants to the location of an actual VTP-1500 where he will point out the actual location of the subsystems on the tool. |

| |
|---|
| **Feedback Mechanism:** When he feels that the participants are ready for relevant practice, the instructor will use transparencies 14-18 to quiz the class on the location of the nine major subsystems. The instructor will allow each student to respond to his questions as he points at the location of each subsystem.<br><br>Another way to practice locating the subsystems would be to provide the class with a set of illustrations and then ask students to locate the components on the graphics. On another sheet of paper, students could be asked to write a statement describing the function of each subsystem. Students can check their own work by comparing it with the information in the participant guide. |
| **Module Content Description:** This module introduces participants to the location and function of nine major subsystems of the VTP-1500 Vertical Furnace. Participants will be expected to know the location of these items directly on the tool; however, plenty of classroom practice will be provided before participants are tested directly on the tool. It is also a requirement for participants to be able to describe the basic function of each of the nine major subsystems.<br><br>In addition, participants will learn the names of the major components of the wafer transfer system and be able to identify the wafer transfer movement designations -- direct load, load, unload, preload, and post load |

<table>
<tr><td>Instructor Guide: #03</td><td>Class: Semitherm VTP-1500 Operations</td></tr>
<tr><td colspan="2">Module Title: Process Characteristics</td></tr>
<tr><td>Target Audience: Operators, Technicians, Engineers -- anyone responsible for operating the VTP-1500</td><td>Location: Classroom</td></tr>
<tr><td colspan="2">Prerequisite Skills: Completion of the following courses: Module 2 of the VTP-1500 Operations course, completion of the SEMATECH Furnace Processes course or equivalent, and basic college chemistry.</td></tr>
<tr><td colspan="2">Module Objective: Given a list of processes available on the VTP-1500 Vertical Furnace and a list of specific process characteristics, the student will be able to match the characteristics to the process with at least 90% accuracy.</td></tr>
<tr><td colspan="2">Skill Test: Participants will be given a list of processes which are available on the VTP-1500 and a list of hardware and process characteristics. Participants are required to match each process to its relevant hardware and process characteristics.</td></tr>
<tr><td colspan="2">Additional Resources: None</td></tr>
<tr><th>Training Aids & Media</th><th>Tools & Materials for Practice</th></tr>
<tr><td>1. Overhead projector and screen<br>2. Pointer and transparency markers<br>3. Flipchart and markers to take notes<br>4. Transparencies:<br>(1) course outline or map<br>(2) block diagram 3.1<br>(3) atmospheric system vs. LPCVD<br>(4) polysilicon deposition bullets<br>(5) silicon nitride deposition bullets<br>(6) dry ox process bullets<br>(7) pyrogenic process bullets<br>(8) H2 anneal process bullets<br>(9) POCl3 dep. proc. bullets<br>(10) HTO process bullets<br>(11) TEOS process bullets<br>(12) block diagram 3.2<br>(13) Fig. 3.3 Process Characteristics table</td><td>None required</td></tr>
</table>

**Relevant Practice Checklist**

| |
|---|
| **Relevant Practice Description:** |
| **Conditions:** The relevant practice for this module will take place entirely in the classroom. |
| **Type of Modeling:** The instructor will use the transparencies provided for this module to describe the versatility of the VTP-1500 in handling a variety of furnace processes. When the instructor has completed presenting the process and hardware characteristics of each configuration, the instructor will verbally quiz the audience to give them practice in associating process characteristics to hardware requirements. The flipchart can be used for this activity. |
| **Feedback Mechanism:** The instructor will provide appropriate feedback during the practice session. The instructor can also refer students to their participant guides or reference the transparencies as needed. These materials can also serve as feedback mechanisms. |
| **Module Content Description:** This module introduces participants to the various process configurations that can be performed in the Semitherm VTP-1500 Vertical Furnace. At this point it is very important that participants have previously completed the prerequisite courses listed on the front cover of this instructor guide. Or, participants should have equivalent work experience.<br><br>In summary, it is assumed that participants will already have the necessary chemistry and general furnace process background to be able to understand the applications of the VTP-1500. For a refresher of the process concepts mentioned in this module, consult the SEMATECH Furnace Processes participant guide.<br><br>Block diagram 3.1 is used to list and categorize the different process configurations of the VTP-1500. Each process is summarized briefly by using the bullet transparencies listed on the front page of this instructor guide. The instructor will describe the equipment requirements for each process and explain the function of the process configuration.<br><br>The purpose of the module is to ensure that the participants in the course are able to discriminate between one process and another in terms of hardware requirements and process characteristics. |

| | |
|---|---|
| **Instructor Guide:** #04 | **Class:** Semitherm VTP-1500 Operations |
| **Module Title:** Safety | |
| **Target Audience:** Operators, Technicians, Engineers -- anyone responsible for operating the VTP-1500 | **Location:** Classroom and/or at the VTP-1500 |
| **Prerequisite Skills:** Completion of the following courses: Modules 2 & 3 of the VTP-1500 Operations course, completion of the SEMATECH Furnace Processes course or equivalent, and basic college chemistry. | |
| **Module Objective:**<br>(1) From memory, the student will be able to identify the four classifications of safety hazards associated with working on or around the VTP-1500 Vertical Furnace with 100% accuracy.<br><br>(2) Given a list of the nine major functional subsystems described in Module 2, the student will be able to identify which of the four classifications of hazards are associated with each of the subsystems and cite at least one example of each with 100% accuracy.<br><br>(3) Given a safety violation scenario by the instructor, the student will be able to describe what consequences may/will occur due to the safety violation.<br><br>(4) Using a functional VTP-1500 Vertical Furnace, the student will be able to locate and operate all EPO and EMO switches and give an example of a scenario in which the switches might be used.<br><br>(5) From memory, the student will be able to list the possible consequences of activating the EPO button with at least 90% accuracy. | |
| **Skill Test:** The skill test for this module will be performed directly at the VTP-1500 Vertical Furnace. The participant will have a checklist of hazards that can be found in the VTP-1500. The participant must be able to locate each item on the VTP-1500, indicate the type of hazard (thermal, electrical, mechanical or chemical), and explain the safety procedure for working in the area of the potential hazard. | |
| **Additional Resources:** MSDS information for typical chemicals that are used in the processes and maintenance of semiconductor furnaces. | |

| Training Aids & Media | Tools & Materials for Practice |
|---|---|
| 1. Overhead projector and screen<br>2. Pointer and transparency markers<br>3. Flipchart and markers to take notes<br>4. Transparencies:<br>(1) course outline or map<br>(2) list of four hazard categories<br>(3) illustrations or picture of VTP-1500<br>(4) list of thermal hazards<br>(5) list of electrical hazards types<br>(6) list of mechanical hazards<br>(7) table of chemical hazards, Fig. 4.1<br>(8) subystem hazard chart, Fig. 4.2<br>(9) process chamber hazards<br>(10) gas delivery system hazards<br>(11) water flow system hazards<br>(12) exhaust pressure control hazards<br>(13) wafer transfer system hazards<br>(14) temp. control system hazards<br>(15) computer, interlock, and power distribution system hazards | 1. VTP-1500 Vertical Furnace or videotape of the VTP-1500<br>2. Safety glasses<br>3. Gloves (3 types) |

**Relevant Practice Checklist**

| |
|---|
| **Relevant Practice Description:** |
| **Conditions:** The relevant practice for this module will take place in the classroom and at the location of the VTP-1500 Vertical Furnace. |
| **Type of Modeling:** The instructor will use the transparencies provided for this module to explain the types of possible hazards that can be found in the VTP-1500 Vertical Furnace depending on process characteristics and hardware configuration. When the instructor has completed pointing out the hazards and explaining safety procedures, the instructor will verbally quiz the audience to give them practice in associating the types of hazards with hardware and process requirements. The overhead transparencies and the flipchart can be used for this type of activity. |
| **Feedback Mechanism:** The instructor will provide appropriate feedback during the practice session. The instructor can also refer students to their participant guides or reference the transparencies as needed. These materials can also serve as feedback mechanisms. |

**Module Content Description:** This module introduces participants to the various potential hazards that can be found in the Semitherm VTP-1500 Vertical Furnace. It is very important that participants complete the prerequisite courses or lessons listed on the front cover of this instructor guide before attempting this module. Or, participants should have equivalent work experience.

The instructor will use transparency #2 to introduce the four types of potential hazards that can be found in the VTP-1500. Transparency #3 is used throughout this lesson to help locate the areas in the VTP-1500 where the hazards may exist. The remaining transparencies are used to summarize the types of hazards.

The types of hazards may vary depending on the type of process and equipment configuration that has been designed into the specific furnace system. For example, a pyrogenic torch would only be found on wet oxidation systems and a bubbler can be found in a POCl3 deposition system.

Prior to the skill test students will have ample time in the classroom and at the VTP-1500 to ask pertinent questions related to hardware, processes, hazards and safety procedures.

| **Instructor Guide:** #05 | **Class:** Semitherm VTP-1500 Operations |
|---|---|
| **Module Title:** Computer Screen Interpretation | |
| **Target Audience:** Operators, Technicians, Engineers -- anyone responsible for operating the VTP-1500 | **Location:** Classroom, and/or at the VTP-1500 |
| **Prerequisite Skills:** Completion of the following courses: Modules 2 - 4 of the VTP-1500 Operations course and the SEMATECH Furnace Processes course or equivalent. Basic computer keyboarding skills is required and proficiency in the use of DOS and Windows user interfaces is helpful. | |
| **Module Objective:**<br>(1) Using a diagram of the Main screen, the RUN screen, the wafer handling screen, and the MAINT screen, the student will be able to locate and describe the different fields, icons, boxes, and drawings with an accuracy of 90%.<br>(2) Given an Intouch TM Software Main Screen, the student will be able to describe the resultant machine/software action of touching the different fields, icons, boxes, and drawings with at least 90% accuracy. | |
| **Skill Test:** | |
| **Additional Resources:** | |
| **Training Aids & Media** | |
| 1. Overhead projector (2ea) and screen (2ea) or one InTouch remote video display and one overhead projector<br>2. Pointer and transparency markers<br>3. Flipchart and markers to take notes<br>4. Transparencies:<br>(1) Main screen<br>(2) bullets for Main screen<br>(3) Main screen soft key definitions<br>(4) bullets for Main screen soft keys (pages)<br>(5) Run screen<br>(6) bullets for Run screen<br>(7) Recipe Edit screen (#1)<br>(8) bullets for Recipe Edit screen<br>(9) clear/cut/copy/paste functions<br>(10) Deviation Parameters screen (#2)<br>(11) bullets for Deviation Parameters screen<br>(12) Temp and PID Parameters screen (#3)<br>(13) bullets for Temp/PID Parameters screen | Transparencies (continued)<br>(14) Load Pattern Edit screen<br>(15) bullets for Load Pattern Edit screen<br>(16) Wafer Handling screen<br>(17) bullets for Wafer Handling screen<br>(18) Furnace Charts screen<br>(19) bullets for Furnace Charts screen<br>(20) Datalog screen<br>(21) bullets for Datalog screen<br>(22) Change Pens screen<br>(23) bullets for Change Pens screen<br>(24) Change Scales screen<br>(25) Maint screen<br>(26) bullets for Maint screen<br>(27) Digital Inputs screen<br>(29) Digital Outputs screen<br>(30) Alarm Screen<br>(31) bullets for Alarm screen |

| Tools & Materials for Practice |
|---|
| 1. VTP-1500 Vertical Furnace or videotape of the VTP-1500<br>2. InTouch remote monitor (if available)<br>3. Safety glasses<br>4. Gloves (3 types) |

**Relevant Practice Checklist**

| **Relevant Practice Description:** |
|---|
| **Conditions:** The relevant practice for this module will take place in the classroom using the InTouch remote computer system, or at the location of the VTP-1500 Vertical Furnace. |
| **Type of Modeling:** The instructor will access the InTouch software screens via the remote system. Or, if the remote is not available, the instructor may use an overhead projector and the listed transparencies to describe the screens. A second overhead projector can be used to display the bullets summarizing individual screen functions. The instructor will explain screens and related soft keys. |
| **Feedback Mechanism:** The instructor can call up specific screens on the remote system or use the available screen transparencies to verbally quiz the audience on their knowledge of the screens. The instructor will provide the immediate feedback to inform participants how well they are doing. |
| **Module Content Description:** This module describes the functions of 15 screens of the Semitherm VTP-1500 operator interface software. The module also describes the various soft keys associated with these screens. Operators will be able to interpret the information represented by these specific screens.<br><br>The instructor can use two methods to present the information from this module; (1) the best way is to have available the InTouch remote software computer station. The overhead projector can be used to display the bullets summarizing each of the related screens. (2) If the InTouch remote station is not available, use screen transparencies on one overhead projector and use a second projector to display related bullets for the screen. |

<table>
<tr><td>Instructor Guide: #06</td><td>Class: Semitherm VTP-1500 Operations</td></tr>
<tr><td colspan="2">Module Title: Alarm Screen Interpretation</td></tr>
<tr><td>Target Audience: Operators, Technicians, Engineers -- anyone responsible for operating the VTP-1500</td><td>Location: Classroom, and/or at the VTP-1500</td></tr>
<tr><td colspan="2">Prerequisite Skills: Completion of the following courses: Modules 2 - 5 of the VTP-1500 Operations course and the SEMATECH Furnace Processes course or equivalent. Basic computer keyboarding skills is required and proficiency in the use of DOS and Windows user interfaces is helpful.</td></tr>
<tr><td colspan="2">Module Objective:<br>(1) Given a VTP-1500 Vertical Furnace in a random alarm state, the student will be able to use the alarm screen display and a list of alarm definitions provided by the instructor to describe the effect the alarm will have on the operation of the tool. The student's responses must be within 90% accuracy.<br><br>(2) Given an active alarm scenario, the student will be able to describe the correct procedure/action to take at an operations level in order to prevent damage to the tool or product or injury to personnel.</td></tr>
<tr><td colspan="2">Skill Test: The instructor will induce a random alarm scenario on the VTP-1500. The student must be able to call up the Alarm Screen and interpret the alarm type and locate the alarm definition in the alarm message list. The student must be able to describe the correct procedure/action to take at an operations level in order to prevent damage to the tool or product or injury to personnel.</td></tr>
<tr><td colspan="2">Additional Resources: None required</td></tr>
<tr><th>Training Aids & Media</th><th>Tools & Materials for Practice</th></tr>
<tr><td>1. Overhead projector (2ea) and screen (2ea) or one InTouch remote video display and one overhead projector<br>2. Pointer and transparency markers<br>3. Flipchart and markers to take notes<br>4. Transparencies:<br>(1) Course map or course outline<br>(2) Alarm screen<br>(3) Alarm soft key definitions<br>(4) Table of Alarm warnings (sample)<br>(5) Practice alarm scenario exercises</td><td>1. VTP-1500 Vertical Furnace or videotape<br>of the VTP-1500<br>2. InTouch remote monitor (if available)</td></tr>
</table>

**Relevant Practice Checklist**

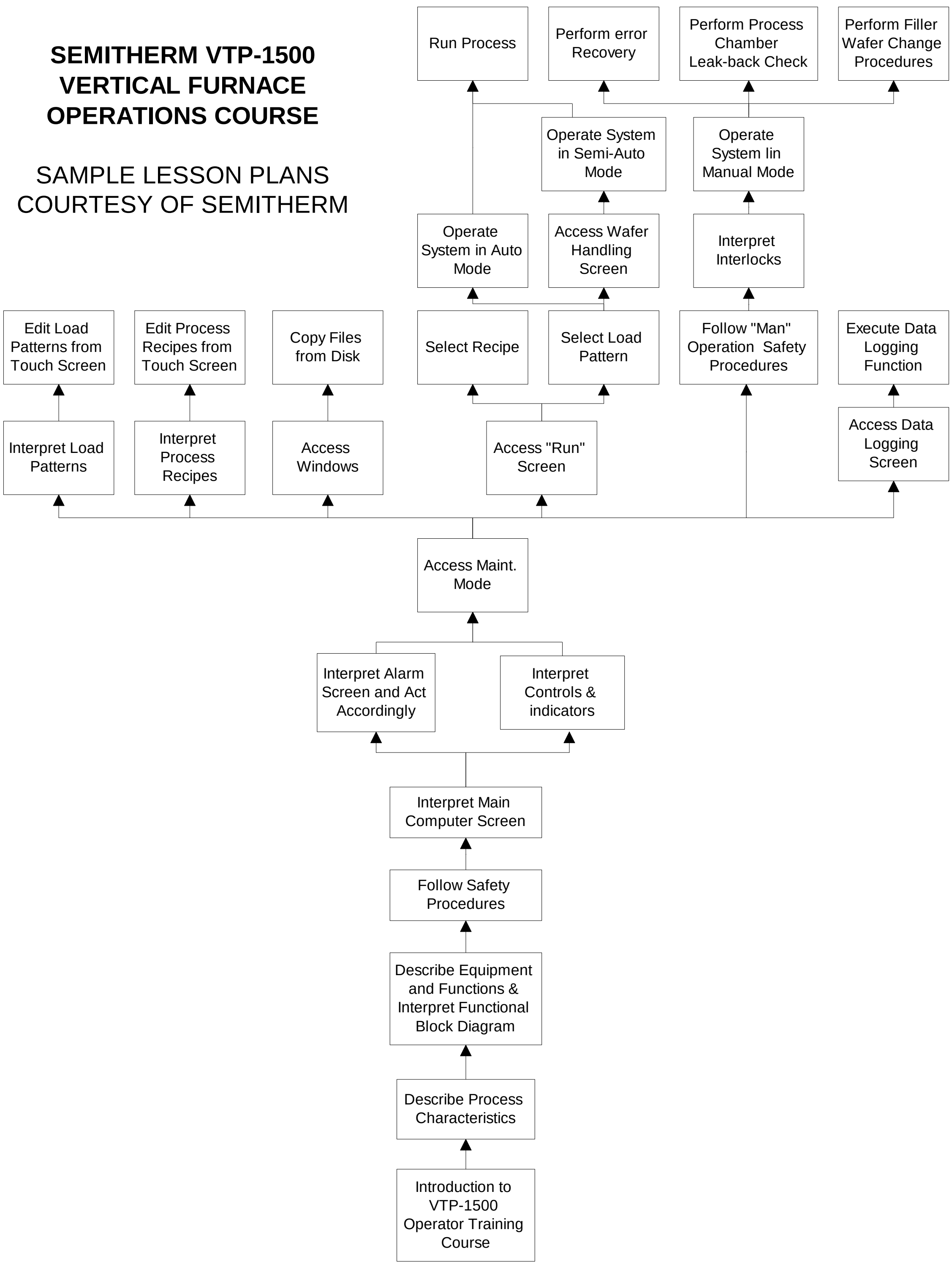
| |
|---|
| **Relevant Practice Description:** |
| **Conditions:** The relevant practice for this module can be accomplished by three possible methods: (1) by using the InTouch software (SIC) at the location of the VTP-1500 Vertical Furnace, (2) by using the InTouch remote computer system in the classroom, or (3) by simply creating alarm condition scenarios on paper, transparencies, or by other means. |
| |
| **Feedback Mechanism:** The instructor can call up specific screens on the remote system or use the available screen transparencies to verbally quiz the audience on their knowledge of the alarm screens and relevant remedial action. The instructor will provide the immediate feedback to inform participants how well they are doing. |
| **Module Content Description:** This module describes the functions of the alarm screen of the Semitherm VTP-1500 operator interface software. Operators will be able to interpret the information represented by these specific alarm screens.<br><br>The instructor can use one or a combination of three methods to present the information from this module; (1) the best way is to have available the InTouch remote software computer station. The overhead projector can be used to display the transparency tables summarizing the alarm messages, (2) if the InTouch remote station is not available, use screen transparencies on one overhead projector and use a second projector to display related bullets for the screen, and (3) if the VTP-1500 is available, use the furnace computer interface (SIC). |

<table>
<tr><td>Instructor Guide: #07</td><td>Class: Semitherm VTP-1500 Operations</td></tr>
<tr><td colspan="2">Module Title: External Controls and Indicators</td></tr>
<tr><td>Target Audience: Operators, Technicians, Engineers -- anyone responsible for operating the VTP-1500</td><td>Location: Classroom, and/or at the VTP-1500</td></tr>
<tr><td colspan="2">Prerequisite Skills: Completion of the following courses: Modules 2 - 6 of the VTP-1500 Operations course and the SEMATECH Furnace Processes course or equivalent. Basic computer keyboarding skills is required and proficiency in the use of DOS and Windows user interfaces is helpful.</td></tr>
<tr><td colspan="2">Module Objective:<br>(1) Using system drawings, photos, and a list of external controls and indicators, the student will be able to locate and explain the purpose of all external controls and indicators on the VTP-1500 Vertical Furnace to at least 90% accuracy.<br><br>(2) Using an operational VTP-1500 Vertical Furnace, the student will be able to locate all external controls and indicators and describe to the instructor their purpose and/or operation with at least 90% accuracy.</td></tr>
<tr><td colspan="2">Skill Test: The instructor will provide the student with a checklist of controls and indicators to be located. The student will point at each control and indicator according to the list provided. The student must then explain the purpose of each respective control and indicator. The student must respond with a minimum of 90% accuracy.</td></tr>
<tr><td colspan="2">Additional Resources: None required</td></tr>
<tr><td colspan="2" align="center">Training Aids & Media</td></tr>
<tr><td>1. Overhead projector (2ea) and screen (2ea) or one InTouch remote video display and one overhead projector<br>2. Pointer and transparency markers<br>3. Flipchart and markers to take notes<br>4. Transparencies:<br>(1) Course map or course outline<br>(2) Fig. 7.1 location of controls & indicators<br>(3) Fig. 7.2 watchdog/temp. control drawer<br>(4) Fig. 7.3 power distribution drawer panel<br>(5) Fig. 7.4 SIC drawer front panel</td><td>Transparencies (continued)<br>(6) Fig. 7.5 SFC drawer front panel<br>(7) Fig. 7.6 EPO button<br>(8) Fig. 7.7 robot EMO, Enable, Front door enable/disable switch<br>(9) Fig. 7.8 Ampstack front panel<br>(10) Fig. 7.9 Patlite™ signal tower<br>(11) Fig. 7.10 CAL 9000 temp controller<br>(12) Fig. 7.11 lift speed control needle valves</td></tr>
</table>

| Training Aids & Media |
|---|
| 1. VTP-1500 Vertical Furnace or videotape of the VTP-1500<br>2. InTouch remote monitor (if available) |

**Relevant Practice Checklist**

| **Relevant Practice Description:** |
|---|
| **Conditions:** The practice session can be accomplished very easily in the classroom with transparencies that can be displayed via the overhead projector. |
| **Modeling Methods:** The instructor will use overhead transparencies in the classroom to point our the location and purpose of specific controls and indicators on the VTP-1500. The participants will have a list of the controls and indicators they will be responsible for locating and describing. |
| **Feedback Mechanism:** The instructor can provide the feedback indicating correct or incorrect responses on the part of the participants or they can refer to their student guides for the appropriate responses. |
| **Module Content Description:** The instructor can use overhead transparencies to show the location of the controls and indicators that the participants are responsible for locating and describing. The modeling and practice can be done in the classroom, but the skill test should be performed on the actual VTP-1500. |


**SEMITHERM VTP-1500**
**VERTICAL FURNACE**
**OPERATIONS COURSE**
SAMPLE LESSON PLANS
COURTESY OF SEMITHERM
Run Process
Perform error Recovery
Perform Process Chamber Leak-back Check
Perform Filler Wafer Change Procedures
Operate System in Semi-Auto Mode
Operate System Iin Manual Mode
Operate System in Auto Mode
Access Wafer Handling Screen
Interpret Interlocks
Edit Load Patterns from Touch Screen
Edit Process Recipes from Touch Screen
Copy Files from Disk
Select Recipe
Select Load Pattern
Follow "Man" Operation Safety Procedures
Execute Data Logging Function
Interpret Load Patterns
Interpret Process Recipes
Access Windows
Access "Run" Screen
Access Data Logging Screen
Access Maint. Mode
Interpret Alarm Screen and Act Accordingly
Interpret Controls & indicators
Interpret Main Computer Screen
Follow Safety Procedures
Describe Equipment and Functions & Interpret Functional Block Diagram
Describe Process Characteristics
Introduction to VTP-1500 Operator Training Course

# APPENDIX E

**Examples of Evaluation Systems**

## *SEMATECH COURSE EVALUATION*

Rev. 01.05

Course ____________________

Instructor ____________________

Date ____________________

**AFFILIATION / CATEGORY**

- ▭ Member Co.
- ▭ Contractor
- ▭ Supplier
- ▭ Temp.
- ▭ Assignee
- ▭ Direct Hire
- ▭ Other
- ▭ Exempt
- ▭ Non-exempt

**DEPARTMENT CODE**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

**COURSE DESIGN:**

**This section determines the effectiveness of the course structure and design:**

1. The title and course description match the course content.
   ❍ Yes ❍ No
2. I understood the course objectives as they were presented.
   ❍ Agree ❍ Strongly Agree
   ❍ Disagree ❍ Strongly Disagree (please explain)
3. The content matched the course objectives.
   ❍ Agree ❍ Strongly Agree
   ❍ Disagree ❍ Strongly Disagree (please explain)
4. The topics presented in this course are relevant to my job.
   ❍ Agree ❍ Strongly Agree
   ❍ Disagree ❍ Strongly Disagree (please explain)
5. The course was organized in an “easy to learn” sequence.
   ❍ Agree ❍ Strongly Agree
   ❍ Disagree ❍ Strongly Disagree (please explain)
6. The pace of the course was...
   ❍ Just right ❍ Too fast ❍ Too slow
7. The length of the course was...
   ❍ Just right ❍ Too short ❍ Too long
8. I had enough opportunity to practice my new skills.
   ❍ Always ❍ Usually
   ❍ Seldom ❍ Not at all (please explain)
9. The course examples, activities, simulations, or demonstrations enhanced my learning.
   ❍ Agree ❍ Strongly Agree
   ❍ Disagree ❍ Strongly Disagree (please explain)

**COMMENTS** ____________________

**COURSE MATERIALS:**

**This section addresses the participant's satisfaction with the <u>WRITTEN</u> materials used in the course.**

10. The participant materials consistently supported the course.
    ❍ Always ❍ Usually ❍ Seldom
    ❍ Not at all ❍ No materials provided
11. The appearance and format of the participant materials were...
    ❍ Outstanding ❍ Good
    ❍ Needs Improvement ❍ No materials provided
12. The participant materials were easy to read.
    ❍ Agree ❍ Strongly Agree
    ❍ Diasgree ❍ Strongly Disagree
    ❍ No materials provided
13. The participant materials will be useful to me on the job.
    ❍ Agree ❍ Strongly Agree
    ❍ Disagree ❍ Strongly Disagree
    ❍ No materials provided
14. The audio/visual aids (foils, flipcharts, video, music, etc.) enhanced the course.
    ❍ Agree ❍ Strongly Agree
    ❍ Disagree ❍ Strongly Disagree
    ❍ No audio/visual aids

**COMMENTS** ____________________

**INSTRUCTOR:**

**In this section, the participants rate the instructor(s) effectiveness in leading this course.**

15. The instructor was knowledgeable about the topics.
    ❍ Agree ❍ Strongly Agree
    ❍ Disagree ❍ Strongly Disagree
    ❍ This was a self-study course
16. The instructor consistently presented information to support the course objectives.
    ❍ Always ❍ Usually
    ❍ Seldom ❍ Not at all

**INSTRUCTOR, Cont.:**

17. The instructor effectively used examples relevant to SEMATECH and the semiconductor industry.
   - ❍ Always ❍ Usually
   - ❍ Seldom ❍ Not at all

18. The instructor(s) ability to communicate the material was
   - ❍ Outstanding ❍ Good
   - ❍ Needs Improvement ❍ This was a self-study course

19. The instuctor's ability to encourage participation, provide clear feedback, and summarize the main points was...
   - ❍ Outstanding ❍ Good
   - ❍ Needs Improvement

20. The instructor(s) ability to organize and manage the class was...
   - ❍ Outstanding ❍ Good
   - ❍ Needs Improvement ❍ No materials provided

COMMENTS

**PARTICIPANT READINESS:**
**This section deals with the participant's readiness to take the course.**

21. This course is in my Development Plan.
   - ❍ Yes ❍ No
   - ❍ No Development Plan yet

22. I had the prerequisite knowledge and skills for this course.
   - ❍ Strongly Agree ❍ Agree
   - ❍ Disagree ❍ Strongly Disagree (please explain)

23. With respect to my current or future job needs, this course was available to me...
   - ❍ Too early ❍ Just in time
   - ❍ Too late

24. I am a member of the target audience for this course as stated in the course description.
   - ❍ Yes ❍ No

COMMENTS

**SKILL/KNOWLEDGE IMPROVEMENT:**
**This section addresses the participant's own perception of competence with the knowledge and skills learned in the class.**

25. I will be able to apply what I learned in this course.
   - ❍ Right away ❍ Within 90 days
   - ❍ After 90 days ❍ Not at all (please explain)

26. The course improved my skills and/or my understanding of the course concepts.
   - ❍ Strongly Agree ❍ Agree
   - ❍ Disagree ❍ Strongly Disagree (please explain)

COMMENTS

**OVERALL SATISFACTION:**
**This category determines the participant's level of satisfaction associated with their learning experience and their registration process.**

27. I received the correct course information in a timely manner after registering for the course.
   - ❍ Yes ❍ No
   - ❍ Did not register for this class

28. The registration process was easy to use.
   - ❍ Yes ❍ No
   - ❍ Did not register for this class

29. Overall, I was satisfied with this course.
   - ❍ Yes ❍ No (please explain)

30. I would recommend this course to others.
   - ❍ Yes ❍ No (please explain)

31. I learned about this course through (select all that apply)
   - ❍ SEMATECH Learning resource Guide (SLeRG)
   - ❍ VTX System on the computer
   - ❍ Learning by Design Quarterly Newsletter
   - ❍ All-hands Information Items
   - ❍ My manager
   - ❍ Co-workers
   - ❍ Others (please specify)

COMMENTS

**Thank you for completing this form. Your information will be used to measure the level of satisfaction with this course and to determine areas for improvement.**

# Level 1

## COURSE EVALUATION SUMMARY

Acceptable levels: 90% and above; bars below 70% are not shown

Attendance= 29 Evaluations= 23

Start Date: 8/30/94

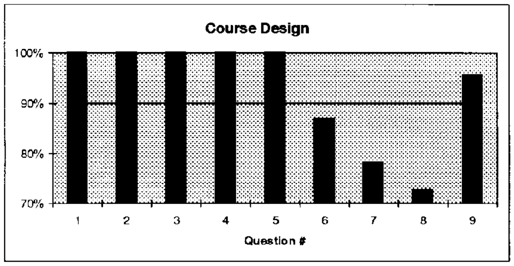
Class: Furnace Processes & Related Issues

Instructor: Dennis Villar

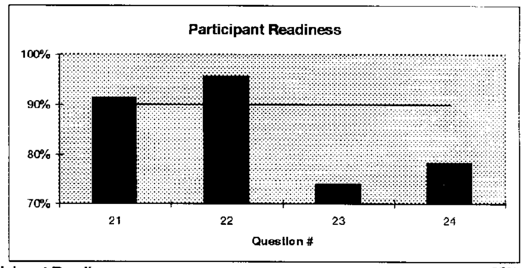
78% were members of the target audience

91% had this course in their development plan

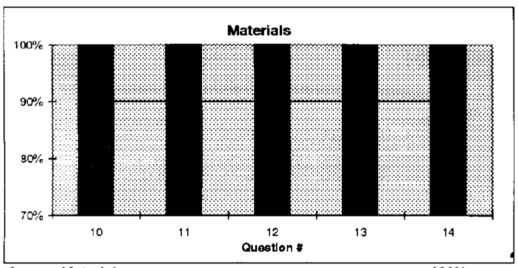
9% had no development plan



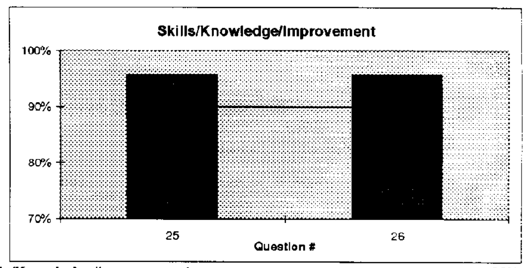

**Course Design: 93%**



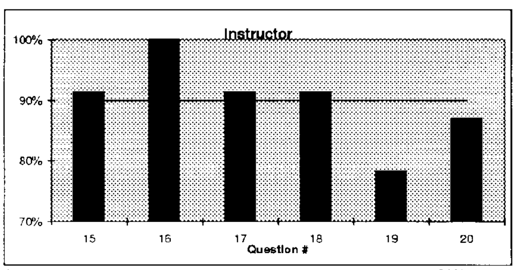

**Participant Readiness 85%**



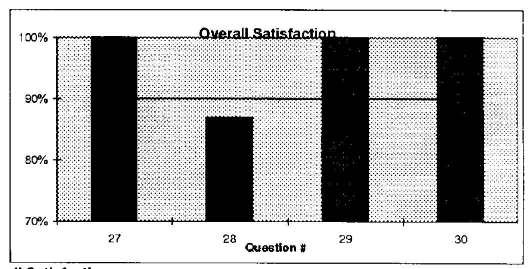

**Course Materials: 100%**



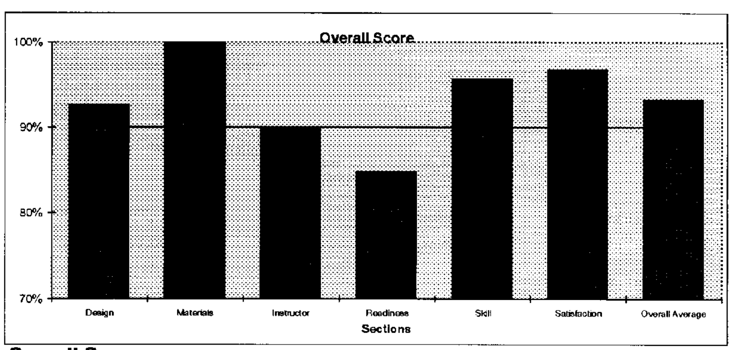

**Skills/Knowledge/Improvement 96%**




**Instructor 90%**




**Overall Satisfaction: 97%**




**Overall Score: 93%**

## Level 3

Evaluation Flow

1. Write performance-based objectives for the whole course.
2. Determine the metrics that the performance-based objectives should influence.
3. Integrate the performance-based objectives into a matrix to show the relationships between the objectives and the metrics.
4. Get customer agreement regarding the metrics and the training's relationship to influence the metrics.
5. Develop the course to support the objectives.
6. Utilize Level 3 check sheet for customer indication of level of importance, i.e., H, M, L.
7. Perform Level 2 evaluation to check students' mastery of skills as stated in the course objectives.
8. Utilize Level 3 check sheet for follow-up evaluation of supervisor's and students' perception of whether student is applying learned skills on the job after 3-4 months.
9. For skills being applied, cross-reference to original level of importance rating.
10. For skills being applied, cross-reference the matrix to see which of the metrics should have been affected.
11. Gather the data on the metrics and look for delta on pre-training data vs. post-training data.
12. Report the findings.

## MATRIX SHOWING RELATIONSHIP BETWEEN LEARNING OBJECTIVES AND PERFORMANCE METRICS

| PERFORMANCE OBJECTIVES | REDUCTION IN # OF ON-SITE FOLLOW-UP CALLS | REDUCTION IN # OF FIELD SERVICE LABOR HOURS | REDUCTION IN TYPE OF FIELD SERVICE CALLS | REDUCTION IN PARTS REPLACEMENT SCHEDULED/ REPAIR |
|---|---|---|---|---|
| **SECTION 3 PM's** | | | | |
| Daily - Perform all daily preventive maintenance tasks using a checklist provided by SEMITHERM | | | | |
| Weekly - Perform all Weekly preventive maintenance tasks using a checklist provided by SEMITHERM | | | | |
| Monthly - Perform all Monthly preventive maintenance tasks using a checklist provided by SEMITHERM | | | | |
| Semi-annual - Perform all Semi-annual preventive maintenance tasks using a checklist provided by SEMITHERM | | | | |
| **Module 7 - Quartz install/removal** | | | | |
| Using specialty tools and knowledge gained in this course, perform a complete quartz install on any configuration of the VTP-1500 Vertical Furnace when furnace is cold | | | | |
| Using specialty tools and knowledge gained in this course, perform a process tube change with the furnace at standby temperature (400C - 600C) | | | | |
| Perform an external torch installation and test on a VTP-1500 set up for wet oxidation | | | | |
| **Module 8 - Cassette stand removal and installation** | | | | |
| Completely remove and install the cassette stand of the VTP-1500 Vertical Furnace Load Station | | | | |
| **Module 9 - Genmark Robot Teaching** | | | | |
| Perform a complete robot teaching that allows wafers to be transferred between all stations without rubbing, mis-picks, or dropping of wafers | | | | |
| **Module 10 - VTP-1500 Calibrations and Adjustments** | | | | |
| Perform all necessary calibrations or adjustments on the following areas: Manometers, Butterfly valve, Needle valves, Wafer Transfer Robot | | | | |
| **Module 11 - Process Chamber Leak-back Check Techniques** | | | | |
| Using the Touch screen of the VTP-1500 Vertical Furnace in manual mode, Perform a process chamber leak-back check. | | | | |
| **Module 12 - Vacuum Tree Breakdown and Reassembly** | | | | |
| Completely disassemble, clean, reassemble, and leak check a VTP-1500 Vertical Furnace vacuum system | | | | |

**Semitherm VPT-1500 Operations Course**
**Level III Evaluation**

| Major Course Objectives | Is objective important? (High, Medium, Low) (Supv) | Student Evaluation - Was objective achieved? (Instructor/ Student) | Did supervisor provide opportunity for student to perform objective (Supv) | Did supervisor provide opportunity for student to perform objective (Student) | Did student perform objective (Supv) |
|---|---|---|---|---|---|
| | H M L | N\Y I N\Y | N \ *Y | N \ *Y | N \ *Y |
| 2.1) Given a functional block diagram and pictorial drawings, the student will be able to locate and describe the function of the eight specific major subsystems in the VTP-1500 Vertical Furnace to 90% accuracy. | | | | | |
| 2.2) Using a normally operating VTP-1500 Vertical Furnace and an instructor provided checklist, the student will be able to locate and describe the components of each of the following major subsystems to items on the checklist to 90% accuracy: | | | | | |
| a) Process Chamber/Heater Element System | | | | | |
| b) Temperature Control System | | | | | |
| c) Gas Delivery System | | | | | |
| d) Exhaust/Pressure Control System | | | | | |
| e) Computer Control System | | | | | |
| f) Water flow Control System | | | | | |
| g) Interlock System | | | | | |
| h) Wafer Transfer System | | | | | |
| 2.3) Using instructor provided documentation, the student will be able to identify wafer transfer movement designations and wafer station designations of the VTP-1500 Vertical Furnace to 90% accuracy. | | | | | |

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**Semitherm VPT-1500 Operations Course**
**Level III Evaluation**

| M ajor Cou se Objec ves | Is ol jective imp rtant? (I igh, Me lium, L ow) (S ıpv) | Student E 'aluation - Wa s objective a chieved? ( nstructor/ Student) | Did supervis or provide opportun ity for student to perfor m objectiv e (Supv) | Did supervisor prov de opportunity for student to per orm objective (Student) | Did student perform objective (Supv) |
|---|---|---|---|---|---|
| | H M L | N \ Y I N \ Y | N \ 'Y | N \ *Y | N \ *Y |
| 3. .1) Given list of prc esses ava lable on t e VTP-15 0 V ertical Fu ace and list of spe ific proce s cl aracteris cs, the st dent will b able to m tch the cl aracteris cs to the ocess to 0% accur cy. | | | | | |
| 4. .1) From emory, th student v ll be able identify the fc ur classif ations of afety haz ds associ ted with w orking on or around ne VTP-1 0 Vertica Furnace t 1( 00% accu acy. | | | | | |
| 4. .2) Given list of the 3 major fu ctional su systems d escribed i Module 2 the stude t will be a le to ident fy w hich of th 4 classifi ations of h zards are associated with e ach of the subsyster s and cite t least on example of e ach to 10 % accura | | | | | |
| 4. .3) Given safety vi ation scer ario by the instructor, the st udent wil be able to describe v hat conse uences m ay/will oc ur due to e safety v olation. | | | | | |
| 4. .4) Using normally perating TP-1500 ertical fur ace, th e studen will be abl to locate and opera all EPO nd E MO switc es and gi an exam le of a sc nario in w ich th ey might e used. | | | | | |

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# LEVEL 4 EVALUATION STRATEGY

**A. What will be measured:**

Reduction in installation time
Reduction in number of on-site follow-up calls
Reduction in number of emergency requests
Reduction in Field Service labor hours
Reduction in type of Field Service calls
Reduction in damaged warranteed part replacement

**B. Sources of Data:**

Field Service reports (and Database?)

| | |
|---|---|
| 199_ - 199_ | Reduction in installation time |
| 199_ - 199_ | Reduction in number of on-site follow-up calls |
| 199_ - 199_ | Reduction in number of emergency requests |
| 199_ - 199_ | Reduction in Field Service labor hours |
| 199_ - 199_ | Reduction in type of Field Service calls |
| 199_ - 199_ | Reduction in damaged warranteed part replacement |

**C. Accounting system to be used:**

Excel spreadsheet

**D. How data will be analyzed:**

Reduction in installation time will be *measured in hours*
Reduction in *number* of on-site follow-up calls
Reduction in *number* of emergency requests
Reduction in Field Service labor *hours*
Reduction in *type* of Field Service calls
Reduction in *damaged warranteed part replacement*

**E. When and how results will be reported and to whom:**

A formal written report will be generated and an information briefing will be held to communicate results of the study to:

R. Thompson
S. Thompson
T. Manley

**F. Collect and reduce the data:**

Cost of Training system (actual or projected)
Benefits accruing from Training (actual or projected)

**G. Analyze the data:**

Compare costs and benefits
Develop conclusions and recommendations

**H. Report findings:**

Prepare a formal written report
Present an information briefing

## NOTES FOR MATRIX/TECHNICAL SERVICE SUMMARY REPORT

The purpose of the matrix is to show correlation of course/module learning objectives to the metrics which have been selected as indicators of performance.

> Subject matter experts should complete the matrix by marking the DOWNTIME CODE SHEET associated with the objective in the respective column only if a student's mastery of the given performance objective would favorably impact the metric.

This information will be used in conjunction with the Level 3 evaluation check sheet for those performance objectives (skills/behaviors) which have transferred from training to "on-the-job" application. Pre and post training data from the Technical Service Monthly Summary Report will be compared. This data will be collected by the Field Service Representative at the time of repair and reported on the "Technical Service Summary Report."

NOTE: The "Reason for Downtime" should be selected from those which are most common and which are related to the course performance objectives from the matrix. Again, the subject matter experts should be the persons to select these.

# DOWNTIME CODE SHEET

| REASON FOR DOWNTIME | CODE |
|---|---|
| | |
| SYSTEM WILL NOT PUMP DOWN TO SETPOINT | A |
| PROCESS GAS WILL NOT FLOW / INCORRECT FLOW | B |
| ROBOT WILL NOT LOAD WAFERS | C |
| ROBOT WILL NOT PREALIGN WAFERS | D |
| SYSTEM WILL NOT CONTROL PROCESS PRESSURE | E |
| QUARTZ REMOVAL & REPLACEMENT | F |
| PYRO TORCH REMOVAL & REPLACEMENT | G |
| ELEMENT WILL NOT RAISE & LOWER | H |
| JAR WILL NOT RAISE & LOWER | I |
| FURNACE WILL NOT MAINTAIN TEMPERATURE SETPOINT | J |
| ELEMENT WILL NOT ENABLE | K |
| PROCESS GAS VALVE WILL NOT OPEN | L |
| CASSETTE NOT IN POSITION | M |
| COOLING WATER FAILURE | N |
| BASEPLATE TEMPERATURE CONTROL FAILURE | O |
| THERMOCOUPLE FAILURE | P |
| WEEKLY PM | Q |
| MONTHLY PM | R |
| SEMIANNUAL PM | S |
| OTHER | T |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

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## MATRIX SHOWING RELATIONSHIP BETWEEN LEARNING OBJECTIVES, PERFORMANCE METRICS AND DOWNTIME CODES

| | PERFORMANCE OBJECTIVES | REDUCTION IN # OF FIELD SERVICE LABOR HOURS TO PERFORM TASK | REDUCTION IN FIELD SERVICE CALLS | REDUCTION IN PARTS REPLACEMENT (SCHEDULED/ REPAIR) |
|---|---|---|---|---|
| **MAINTENANCE COURSE: Module xx** | | | | |
| 7.4 | Using documentation provided by the instructor and a normally operating VTP-1500 Vertical Furnace Wafer Transfer System, the student will be able to calibrate (teach) the Genmark Gencobot IV robot to transfer wafers between all wafer stations without damage to the stations, furnace, or the wafers. | C, D | C, D | C, D |
| 8.1 | Given a written procedure from Genmark, the student will be able to perform all preventative maintenance procedures on the Gencobot IV Robot to 100% accuracy. | C, D | C, D | C, D |
| 9.2 | Using a normally operating VTP-1500 Vertical Furnace and knowledge gained in the class, the student will be able to check the operation of the element shroud seal and confirm correct operation. | H | H | H |
| 9.3 | Using a normally operating VTP-1500 Vertical Furnace and documentation outlining jar/element lift speed adjustment, the student will be able to adjust the vertical speed of the jar or element up or down so the element travels at a speed between 30~60 seconds from top to bottom and the jar travels between 15~30 seconds from top to bottom. | H, I | H, I | |
| 11.2 | Using an instructor provided procedure and a normally operating VTP-1500 Vertical Furnace, the student will be able to remove, check, and replace any O-ring in the system without damage to the O-ring or injury to personnel. | A, E | A, E | A, E |
| 12.2 | Using an instructor provided procedure and a normally operating VTP-1500 Vertical Furnace, the student will be able to locate, remove and replace the process chamber thermocouples (three spike, one profile) without damage to the thermocouples, furnace, or wafers, and without injury to personnel. | J, O, P | J, O, P | J, O, P |

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| | | | | |
|---|---|---|---|---|
| 13.3 | Using specialty tools, a normally operating VTP-1500 Vertical Furnace at room temperature, and an instructor provided procedure, the student will be able to perform a <u>complete</u> quartz removal and installation on the VTP-1500 Vertical Furnace without damage to the quartz or furnace, or without injury to personnel. | F | F | F |
| 15.3 | Using an instructor provided procedure and a normally operating VTP-1500 Vertical Furnace configured for steam oxidation, the student will be able to perform a complete pyrogenic torch install, set-up, and test so the torch operates normally without damage to any furnace components or injury to any personnel. | G | G | G |
| 17.2 | Using knowledge gained in Module 13 and instructor provided specifications, the student will be able to set the base plate cooling water flow rate, the base plate temperature setpoint, and baseplate overtemp setpoint so the baseplate temperature control system operates correctly. | N, O | N, O | N, O |
| 18.2 | Using an instructor provided procedure, knowledge gained in Module 13 , and a normally operating VTP-1500 Vertical Furnace, the student will be able to set and test the process chamber over temperature setpoints so the proper sequence of events occurs when an individual zone overtemp condition occurs. | K | K | |
| 20.1 | Using an instructor provided procedure and a normally operating VTP-1500 Vertical Furnace, the student will be able to calibrate the vacuum system throttle valve so the process chamber pressure is within spec. when the throttle valve is used to control pressure. | E | E | E |
| 23.1 | Using gas pressure specs, a procedure provided by the instructor, and a normally operating VTP-1500 Vertical Furnace, the student will be able to correctly set all process and non-process gas pressures so the furnace operates correctly. | B, L | B, L | B, L |
| 23.2 | Using an instructor provided procedure, the student will be able to locate, check, and adjust the $H_2$:$O_2$ Ratio Board so the board generates an alarm whenever the $H_2$ to $O_2$ gas flow ratio exceeds 1.85:1. | B | B | B, F |

# TECHNICAL SERVICE SUMMARY REPORT

| # | DOWN TIME CODE | DATE OF REPAIR/ SERVICE | # HOURS TO REPAIR/ SERVICE | $ PARTS SCHEDULED P/M | $ PARTS FAILED OR DAMAGED | NAME OF FSE | COMMENTS (include symptoms & corrective action) |
|---|---|---|---|---|---|---|---|
| 1 | E | 1/3/94 | 2 | | | John Doe | Cleaned butterfly valve and leak checked |
| 2 | C | 1/4/94 | 2 | | | John Doe | Mispick wafer #25 re-leveled cassette stage m3 & m4 |
| 3 | T | 1/5/94 | 1 | | | John Doe | Uniformity has been high the last 5 runs. Found the DCS injector loose |
| 4 | T | 1/6/94 | 2 | | | John Doe | High particles. Found that night shift had 2 fillers break from thermal. Replaced fillers and vac.d FS area |
| 5 | O | 1/7/94 | 1 | | | John Doe | Baseplate overtemp repeatedly. Found TC to Cal 9900 loose connection |
| 6 | E | 1/7/94 | 4 | | | John Doe | Jar overpressure. House exhaust fluctuation. Installed Tee inline exhaust for a venturi on exhaust line |
| 7 | Q | 1/7/94 | 2 | | | John Doe | Weekly pm. Cleaned butterfly valve & foreline |
| 8 | T | 3/29/94 | 10 | | | John Doe | Dep rate per min jump up 2 Ang. Checked temp., manometer, Tws and metrology. Also refractive index, found old manometer 1Torr span drifted high. Replaced 1 Torr. |
| 9 | A | 3/15/94 | 2.5 | | | John Doe | Vacuum vent alarm. Nitride build-up around bellows/base of Hi Vac valve. |
| 10 | A | 3/11/94 | 2.5 | | | John Doe | Pump down failure. Soft needle valve clogged up cleaned/leak checked |
| 11 | A | 3/4/94 | 2.5 | | | John Doe | Pump down failure. Nitride buildup around bellows/base of High Vac valve |
| 12 | O | 3/3/94 | 1 | | | John Doe | Base plate overtemp. Increased water flow |
| 13 | A | 1/9/94 | 4 | | | John Doe | Abort for pump failure. Pump silencer clogged up. Cleaned muffler |
| 14 | E | 1/11/94 | 5 | | | John Doe | Aborted for pressure control. Cleaned butterfly valve, rebuilt exhaust valve V2 leak |
| 15 | T | 1/17/94 | 1.5 | | | John Doe | Front door would not close. Chain broke. Replaced |
| 16 | B | 1/18/94 | 3 | | | John Doe | Aborted for no gas flow. Replaced gate valv+H36e |
| 17 | C | 1/19/94 | 14 | | | John Doe | Prealigner would turn 1/4 turn and servo off. Bad prealigner motor. Replaced robot and controller |
| 18 | T | 1/23/94 | 0.5 | | | John Doe | SIC/SFC not communicating. Reset SFC & SIC |

# TECHNICAL SERVICE SUMMARY REPORT

**MONTH** ____________

**CUSTOMER/LOCATION** ____________

| DOWN TIME CODE | DATE OF SERVICE/ REPAIR | # HOURS TO REPAIR/ COMPLETE | $ PARTS SCHEDULED P/M | $ PARTS FAILED/ DAMAGED | FRACUS CODE | NAME OF FSE | COMMENTS (Include corrective action) |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

# APPENDIX F

*SEMATECH Learning Resource Guide*

# Chapter 5: Transfer of SEMATECH Courses

Technology Transfer #92061162D-TRG

## Introduction to Course Transfers

**Purpose**

The SEMATECH technology transfer process makes technology and knowledge available to SEMATECH and SEMI/SEMATECH member companies.  Materials for many courses developed or acquired by SEMATECH are available through this process. Course materials are provided for internal review or for internal instruction to employees, suppliers, and customers.

SEMATECH and SEMI/SEMATECH members may realize substantial savings in course development costs when they are able to apply the materials as designed.

**Non-Transferable Courses**

SEMATECH contracts with a number of training providers to develop responses to training needs.  Many of the courses described in this document are owned by external providers and are not available through Technology Transfer.

The descriptions of those courses include a notation that the course is contracted with a training provider.  Chapter 7 contains a comprehensive listing of training suppliers currently providing services to support the SEMATECH curriculum.

**Ordering Documents**

To request SEMATECH technology transfer documents, use the form on page 5-6.

## Intent to Course Transfers

**Introduction**

The technology transfer document for a given course contains the materials necessary to support the intended purpose of the transfer. The intent may be to support instruction of the course, or it may be to provide materials for benchmarking or course development.

**Course Instruction**

When the materials transfer includes the participant guide, instructor guide, and visual aids, the purpose of the transfer is to support instruction of the course.

Support materials or equipment such as videos, catapults, or calculators are not included in the transfer package. Information about the equipment and materials required, along with a source for purchasing, is included in the instructor guide provided with the course materials.

**Course Benchmarking Development**

When the transfer document includes only the participant guide, the material may be useful in benchmarking or in course development.

In these cases, SEMATECH does not intend to transfer instructional capability.

**Conditions of Transfer**

To protect SEMATECH and the copyright/license agreements with our training suppliers, some restrictions may apply to the use of the materials. The restrictions will be clearly outlined in the introductory letter that accompanies the technology transfer document.

## Materials Currently Available for Transfers

**List of Courses**

The following courses are currently available for transfer.

***Capacitance-Voltage Measurements***
Participant guide, visual aids
Transfer Number: 93021492A-TRG

***Continuous Process Improvement****
Participant guide, instructor guide, visual aids
Transfer Number: 93031543A-TRG

***Cost of Ownership***
Participant guide
Transfer Number: 91020473B-GEN

***Cycle Time Improvement****
Participant guide, instructor guide, visual aids
Transfer Number: 93011457A-TRG

***Design of Experiments***
Participant guide, instructor guide, visual aids
Transfer Number: 91120781A-ENG
Note: Course design is based on RS/1 software.

***Design Practices for Higher Equipment Reliability***
Participant guide, instructor guide, visual aids
Transfer Number: 93102065A-TRG

***Introduction to Contamination Control in Semiconductor Manufacturing Equipment***
Participant guide, instructor guide, visual aids
Transfer Number: 92101317A-TRG

***Introduction to Statistical Methods***
Participant guide, instructor guide, visual aids
Transfer Number: 91110769A-ENG
Note: Course design is based on RS/1 software.

***Introduction to Measurement Capability Analysis***
Participant guide, instructor guide, visual aids
Transfer Number: 91090709A-ENG
Note: Course design is based on RS/1 software.

***Introduction to Total Quality****
Participant guide, instructor guide, visual aids
Transfer Number: 92041045B-TRG

*From the *Partnering for Total Quality* curriculum

## Materials Currently Available for Transfers, continued

**List of Courses, continued**

***Mass Flow Control in a Semiconductor Process***
Participant guide, instructor guide, visual aids
Transfer Number: 93021493A-TRG

***Partnering****
Participant guide, instructor guide, visual aids
Transfer Number: 92081241A-TRG

***Passive Data Collection***
Participant Guide, Instructor Guide, Visual Aids
Transfer Number: 91090684A-ENG
Note: Course design is based on RS/1 software.

***Problem Solving****
Participant Guide, Instructor Guide, Visual Aids
Transfer Number: 91060578B-TRG

***Reliability Overview***
Participant guide, instructor guide, visual aids
Transfer Number: 93102064A-TRG

***Software Inspections****
Participant guide
Transfer Number: 92061180A-TRG

***Software Quality Engineering****
Participant guide
Transfer Number: 92101312A-TRG

***Software Quality Engineering for Managers****
Participant guide
Transfer Number: 92111389A-TRG

***Statistical Methods I***
Participant guide, instructor guide, visual aids Transfer Number: 92101344B-TRG

***Statistical Methods for Efficient Management***
Participant Guide and 5 videos
Transfer Numbers: 92041040A-TRG 90050253A-TRG
91060558A-TRG 91060559A-TRG
91060560A-TRG 91060561A-TRG

***Team Member Skills****
Participant Guide, Instructor Guide, Visual Aids
Transfer Number: 92041100A-TRG

*From the *Partnering for Total Quality* curriculum

## Transfers Planned for 1995

**List of Courses**

The following courses will become available for transfer in 1995.

***Capacity Utilization Bottleneck Efficiency System (CUBES)***
Participant guide

***Failure Mode and Effect Analysis (FMEA)***
Participant guide
Transfer Number: 93102063A-TRG

Instructor guide and visual aids
Transfer Number: 94122657A-TRG

***Failure Reporting, Analysis, and Corrective Action System (FRACAS)***
Participant guide
Transfer Number: 94022236A-TRG

Instructor guide and visual aids
Transfer Number: 94122656A-TRG

***Furnace Processes in Semiconductor Manufacturing***
Participant guide, instructor guide, visual aids

***Performance-Based Equipment Training***
Participant guide, instructor guide, visual aids

***Tactical Software Reliability***
Participant guide
Transfer Number: 94092525A-TRG

***Tactical Software Reliability***
Instructor guide and visual aids
Transfer Number: 94122658A-TRG

*From the *Partnering for Total Quality* curriculum

**Technology Transfer Distribution Requisition**

**Date:** ______________________

**Send to:**

Company ___________________________ Phone ________________

Name ________________________________ FAX _______________

Mailing Address _______________________ M/S _______________

_____________________________________________

City _____________________________ State _____ Zip __________

| Title | Technology Transfer # | # of copies |
|---|---|---|
| | | |

Please mail or FAX the completed form to:

Customer Service Representative
SEMATECH
2706 Montopolis Drive
Austin, TX 78741
Phone 512/356-SEMA
FAX 512/356-3081

Internet Address: info@sematech.org

**Technology Transfer Distribution Requisition**

**Date:** ______________________

**Send to:**

Company ____________________________ Phone ________________

Name _________________________________ FAX _______________

Mailing Address ________________________ M/S _______________

_______________________________________________

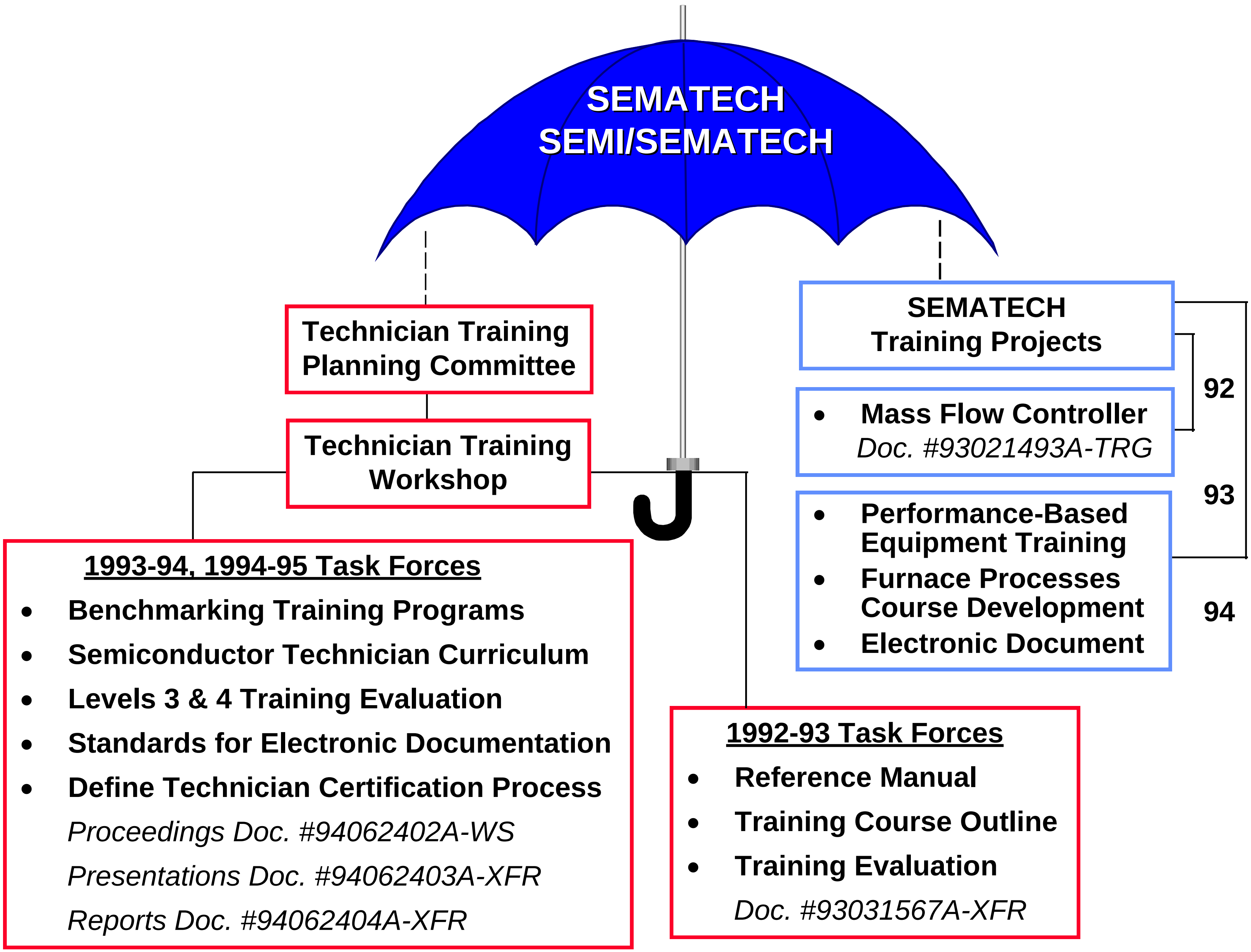
City ______________________________ State _____ Zip __________

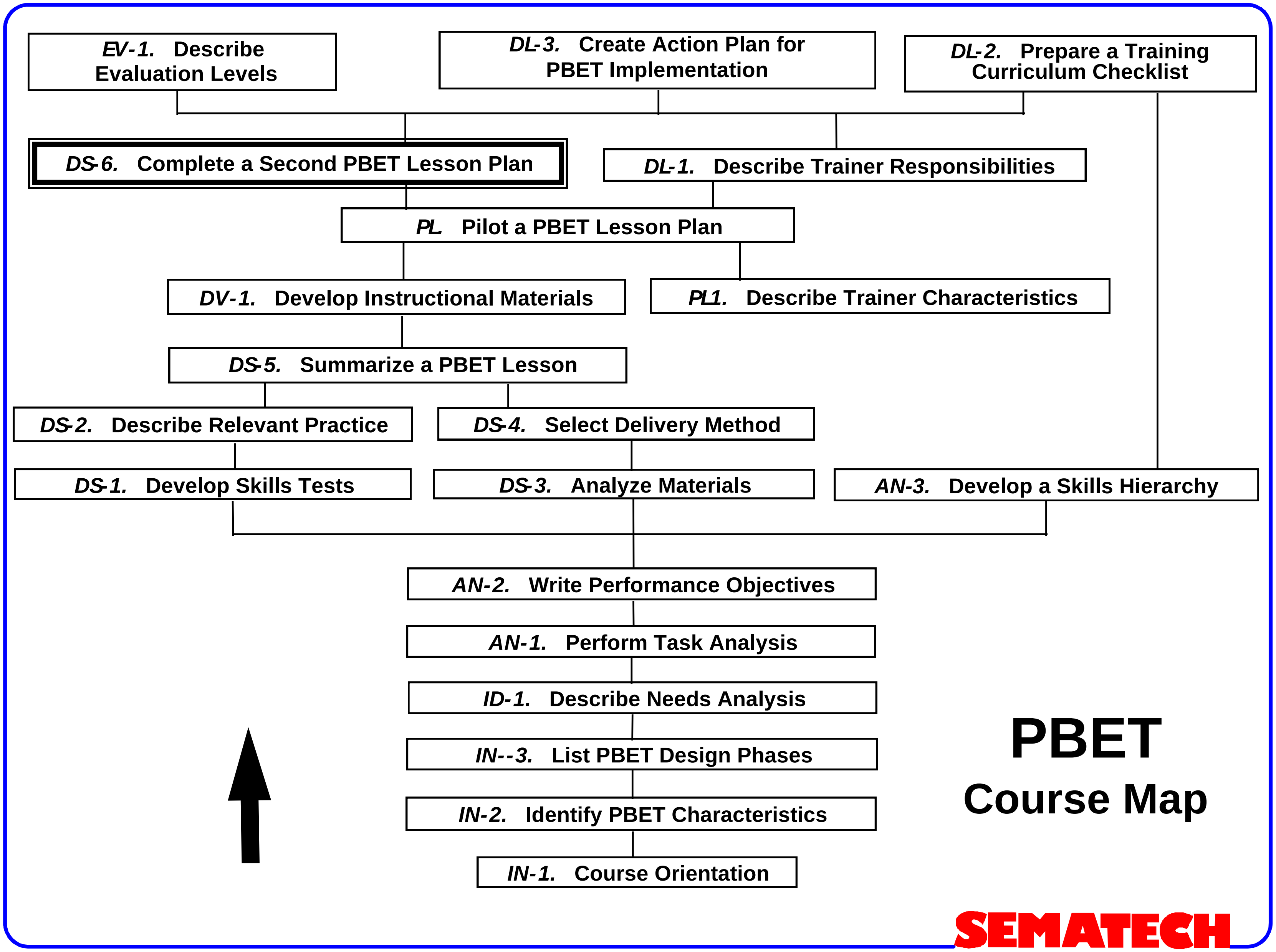
| Title | Technology Transfer # | # of copies |
|---|---|---|
| | | |

Please mail or FAX the completed form to:

Customer Service Representative
SEMATECH
2706 Montopolis Drive
Austin, TX 78741
Phone 512/356-SEMA
FAX 512/356-3081

Internet Address: info@sematech.org


SEMATECH
SEMI/SEMATECH
Technician Training Planning Committee
Technician Training Workshop
1993-94, 1994-95 Task Forces
• Benchmarking Training Programs
• Semiconductor Technician Curriculum
• Levels 3 & 4 Training Evaluation
• Standards for Electronic Documentation
• Define Technician Certification Process
Proceedings Doc. #94062402A-WS
Presentations Doc. #94062403A-XFR
Reports Doc. #94062404A-XFR
SEMATECH Training Projects
• Mass Flow Controller
Doc. #93021493A-TRG
• Performance-Based Equipment Training
• Furnace Processes Course Development
• Electronic Document
92
93
94
1992-93 Task Forces
• Reference Manual
• Training Course Outline
• Training Evaluation
Doc. #93031567A-XFR


EV-1. Describe Evaluation Levels
DL-3. Create Action Plan for PBET Implementation
DL-2. Prepare a Training Curriculum Checklist
DS-6. Complete a Second PBET Lesson Plan
DL-1. Describe Trainer Responsibilities
PL. Pilot a PBET Lesson Plan
DV-1. Develop Instructional Materials
PL1. Describe Trainer Characteristics
DS-5. Summarize a PBET Lesson
DS-2. Describe Relevant Practice
DS-4. Select Delivery Method
DS-1. Develop Skills Tests
DS-3. Analyze Materials
AN-3. Develop a Skills Hierarchy
AN-2. Write Performance Objectives
AN-1. Perform Task Analysis
ID-1. Describe Needs Analysis
IN--3. List PBET Design Phases
IN-2. Identify PBET Characteristics
IN-1. Course Orientation
PBET
Course Map
SEMATECH