INTRODUCTION TO SOFTWARE ENGINEERING

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VLU

Introduction To Software Engineering

Carnegie Mellon University
The Practical Software Engineering Series

Software Engineers & Software Organization

Course Objective

☐ Upon completion of this course, students will have the ability to:

- Understand the discipline and principles of Software Engineering.

- Understand the evolution of software in industry and the global competitive trends.

- Understand software process, product and services.

- Understand software modeling & techniques.

- Demonstrate an appreciation for the breadth of software engineering.

Lecture Learning Objectives

☐ Upon completion of this lecture, students will be able to:

■ Understand the people issues.

■ Appreciate the principle of managing technical people.

☐ Outcomes:

■ Demonstrate an understanding of knowledge, skills and process abilities and how they can contribute to business success.

■ Be able to apply principles in this lecture to a real world environment to manage and motivate technical people.

Contribution to the Business
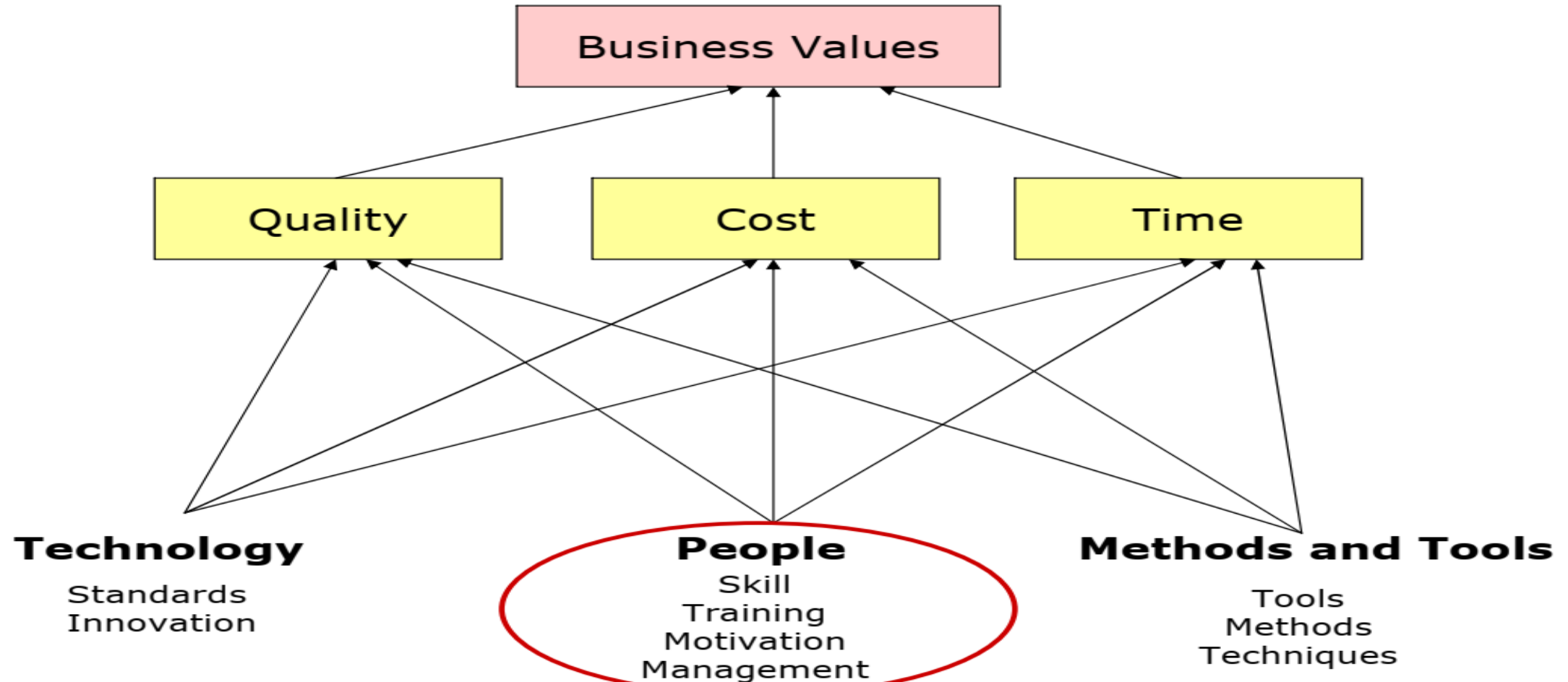
Software Organization Issues

☐ Many software organizations are facing the following issues:

- ■ Growing global demand for software products & services.
- ■ Shortage of skilled software engineers to do the work.
- ■ Changing technology and global business.
- ■ Needs for reliability, security and quality of products.
- ■ High employee turnover.
- ■ Escalating salaries.
- ■ Increased workloads, stress and overtime.
- ■ High cost of doing business.

Success in Software Business

- ☐ Software development is intellectually intensive due to the <u>complex process</u> that requires <u>highly skilled personnel</u>.

- ☐ Many organizations focus on technology but <u>not people</u>.

- ☐ <u>High turnover rate</u> among skilled people.

- ☐ Software organizations <u>cannot sustain</u> business if they <u>Do NOT address people issues</u>.

- ☐ Maintaining a highly skilled workforce requires <u>highly skilled management</u>.

- ☐ Many organizations want to have a better way <u>in managing people, but do not know how to achieve this.</u>

The Turnover Costs ...

- ☐ Associated with recruiting and hiring people:
  - Advertising
  - Interviewing
  - Relocation
  - Administration
  - Others

- ☐ Associated with making new people contribute efforts fully:
  - Orientation
  - Training
  - Mentoring

- ☐ Associated with losing an employee with 2+years experience:
  - Training
  - Domain Knowledge
  - Administration
  - Others

To Be Successful ...

- Software organizations need:
  - Highly skilled people with deep commitment.
  - Environment that stimulates creativity and innovation.
  - Priorities focused on return on investment.
  - Customer focus.
  - Continual adaptation to changing market and globalization.
  - Flexibility through collaboration.
  - Trust as a foundation for relationship.
- Business cannot be improved if the organization:
  - Ignores the motivation of skilled people.
  - Does not know which skills to develop.
  - Cannot measure how people perform these skills.
  - Does not organize effectively and have feedback on how skilled people are being utilized.

Source: Frank K. Sonnenberg, Managing with a Conscience, McGraw-Hill, New York, 1993.

The People Issues in Software Industry

1. Poor communication
2. Limited career paths
3. Unclear performance objectives
4. Burnout/stress
5. Poor teamwork
6. Turnover/attrition
7. Pay inequities
8. Rewarding the wrong behavior
9. Limited training opportunities
10. Inadequate working conditions

High Technology Industry Survey

☐ People would like to see more:
- ■ Communication
- ■ The big picture – What is the vision, roadmap?
- ■ Training for better skills
- ■ A better review of performance
- ■ Recognition and reward (Not necessarily money)
- ■ Internal promotion

☐ People like to see less:
- ■ Meetings
- ■ Paperwork
- ■ The latest promises – buzzword!
- ■ Passing the buck
- ■ Managers who are "too busy" to manage
- ■ Organization politics

Communication - 1

- ☐ Effective communication starts with senior managers explaining company values, vision, mission, goals, and other significant information to employees.

- ☐ In addition, more sharing of information can be done by managers seeking the opinions of individuals on their work.

- ☐ Project managers should encourage more discussion between team members on information required to accomplished project work.

- ☐ Organizations need to establish formal procedures for raising and resolving concerns.

- ☐ Organizations need to promote more interpersonal communication skills necessary to maintain effective working relationships.

Communication – 2

- [ ] Organizations need to establish timely communication across the organization to ensure that people share information and coordinate their activities efficiently.

Vision
Goals
Values
Issues

Organizational communication

Announcements

Procedures & Processes

Policy & Direction

Sharing information on committed work

Discuss opinions and concerns

Business performance

Work Environment -1

- ☐ Organizations must identify a physical environment and resources needed for people to perform their work.
- ☐ A productive work environment is a place where skilled personnel are fully able to exercise their capabilities.
- ☐ A productive environment ensures a flow of information within the group, incorporates knowledge of individuals into decision-making processes, and gains their support.
- ☐ People need information about organizational performance, and how they contribute based on defined roles, responsibilities, and authorities.
- ☐ Once decisions are made by appropriate individuals, they are supported by others in the group.
- ☐ Individuals and teams use a defined process for making decisions and resolving conflicts and disputes.

Work Environment - 2

☐ Software organizations must establish and maintain physical working conditions that allow people to perform tasks efficiently and concentrate on the tasks without unnecessary or inappropriate distractions.
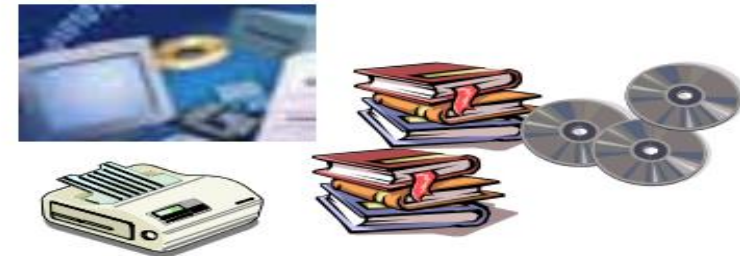
Adequate resources

Adequate physical environment

Adequate individual workspace

No distraction

Productive environment

Workforce Competency

- ☐ Organizations must identify the knowledge, skills, and process abilities required to conduct business.

- ☐ Senior managers must review business activities to identify the workforce competency required.

- ☐ The workforce competencies are analyzed to identify the essential knowledge, skills, and abilities.

- ☐ The workforce competencies are periodically reassessed to ensure that they remain current with the market demands and technology changes.

- ☐ Competency information on individuals is collected and maintained to build a personal profile for career development.

Competency Analysis

☐ Identify the knowledge, skill, and process abilities required to perform business activities to develop and use as a basis for organization hiring and future capability to grow.
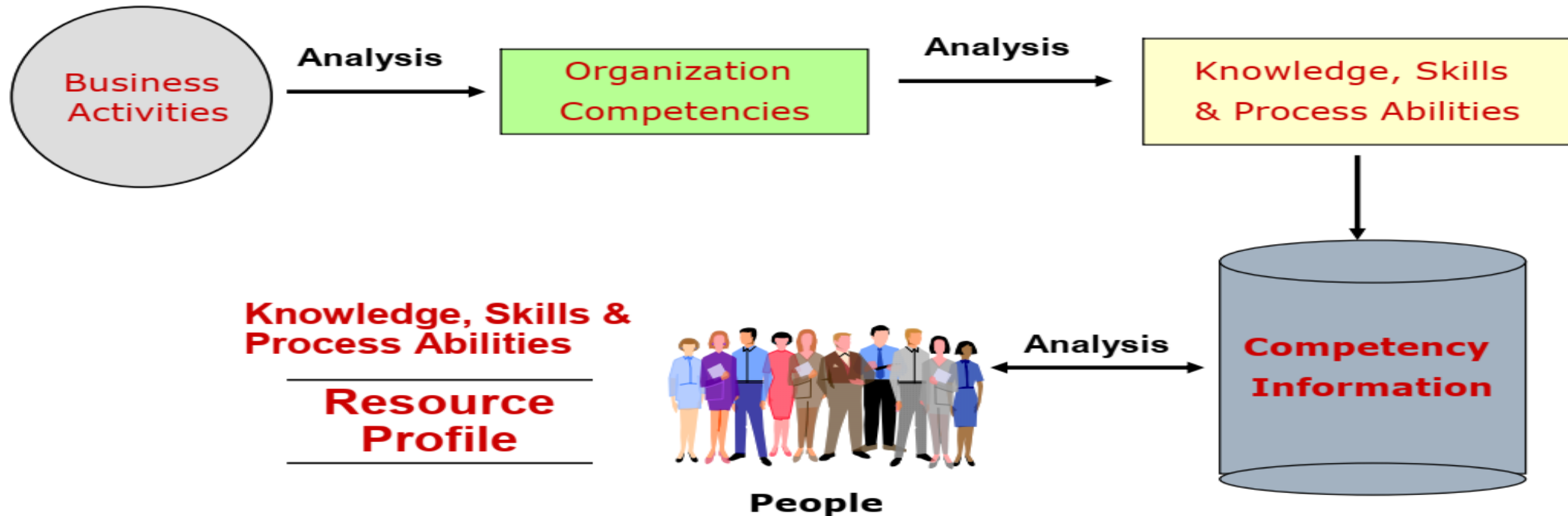
Competency

- ☐ Competency:
  - ■ The knowledge and skill of an <u>individual</u> that is related to effective or superior <u>performance</u>, as determined by measurable objective criteria.

- ☐ Workforce Competency:
  - ■ A cluster of <u>knowledge</u>, <u>skills</u>, and <u>process abilities</u> that an individual should develop to perform a particular type of work in the organization. A capability that gives an organization a competitive advantage.

- ☐ Career Development:
  - ■ The activities designed to help individuals see the organization as a vehicle for achieving career aspirations and improving their skills, knowledge and process abilities to meet business demands for advanced opportunities.

The Importance of Skills

☐ Highly skilled people are the organization's most important asset. They originate creative ideas, solve key problems, and produce the most successful products.

☐ The major difference between a highly skilled software person and an average one, was demonstrated by an experiment where each was given two identical areas to implement, using the same tool:

☐ **Results:**

	Problem Solving	Programming
Program Size	6:1	5:1
Design	5:1	13:1
Development	16:1	25:1
Debugging	28:1	26:1

Software Development Time

Skills & programming time:
Programming tests for 250 Software students at the Software Engineering Institute (SEI). All used C++ language to write 10 programs, results are checked for correct answers (output).

All participants used the same technique (PSP) in this study with completion time measured in minutes.

There are wide performance variations among students, but overall value is between 15 and 30 for all 10 programs.

Conclusion:
Outstanding performance depends on the skill of people.

	Longest Time	Shortest time	Ratios
Program 1	1355	50	27:1
Program 2	996	64	15:6
Program 3	1379	88	15:7
Program 4	1336	59	22:6
Program 5	1820	94	19:4
Program 6	1420	94	15:1
Program 7	1140	83	13:7
Program 8	1275	46	27:7
Program 9	2715	120	22:6
Program 10	1980	152	13:0

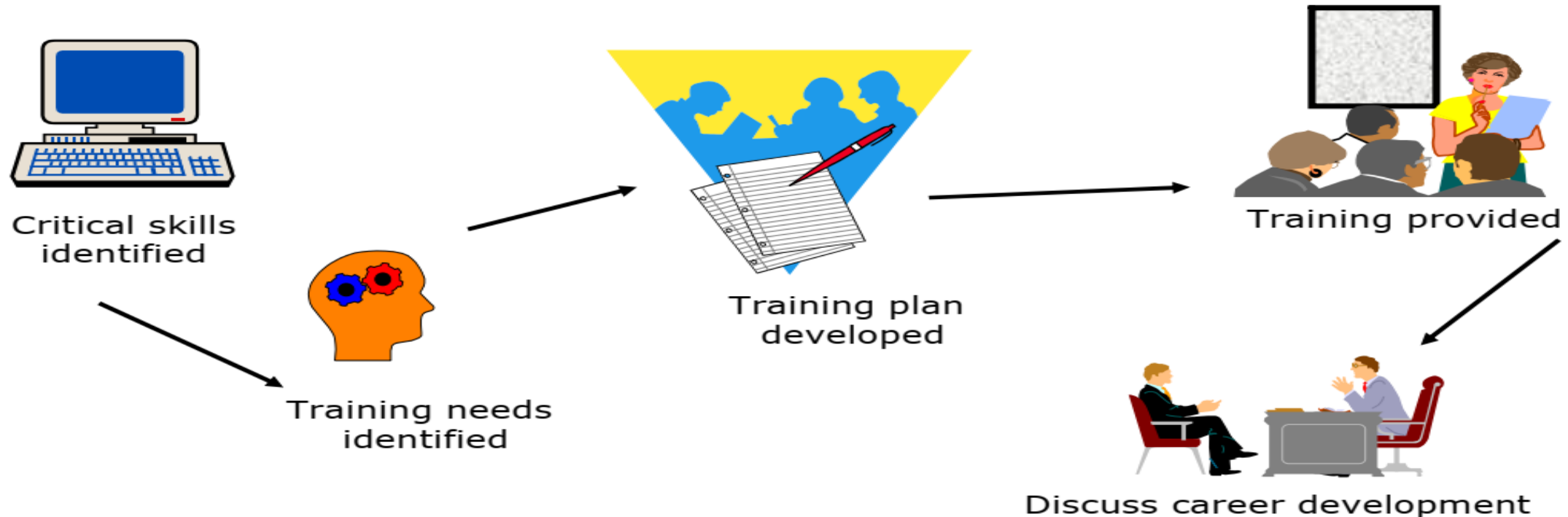Source: Watt Humphrey's PSP Class – SEI 2005

Training & Development

☐ The primary focus of training is to remove the gap between the knowledge and skill required to perform the work (workforce competency) and the current skill of individuals.

☐ Individuals must receive timely training that is needed to perform their assigned work according to the training plan.

☐ Organizations must offer career opportunities that provide growth in workforce competencies, where individuals can pursue increased value of knowledge, skill and process abilities.

SKILLS

Security Engineer Development Plan

Software Engineer Development Plan

System Engineer Development Plan
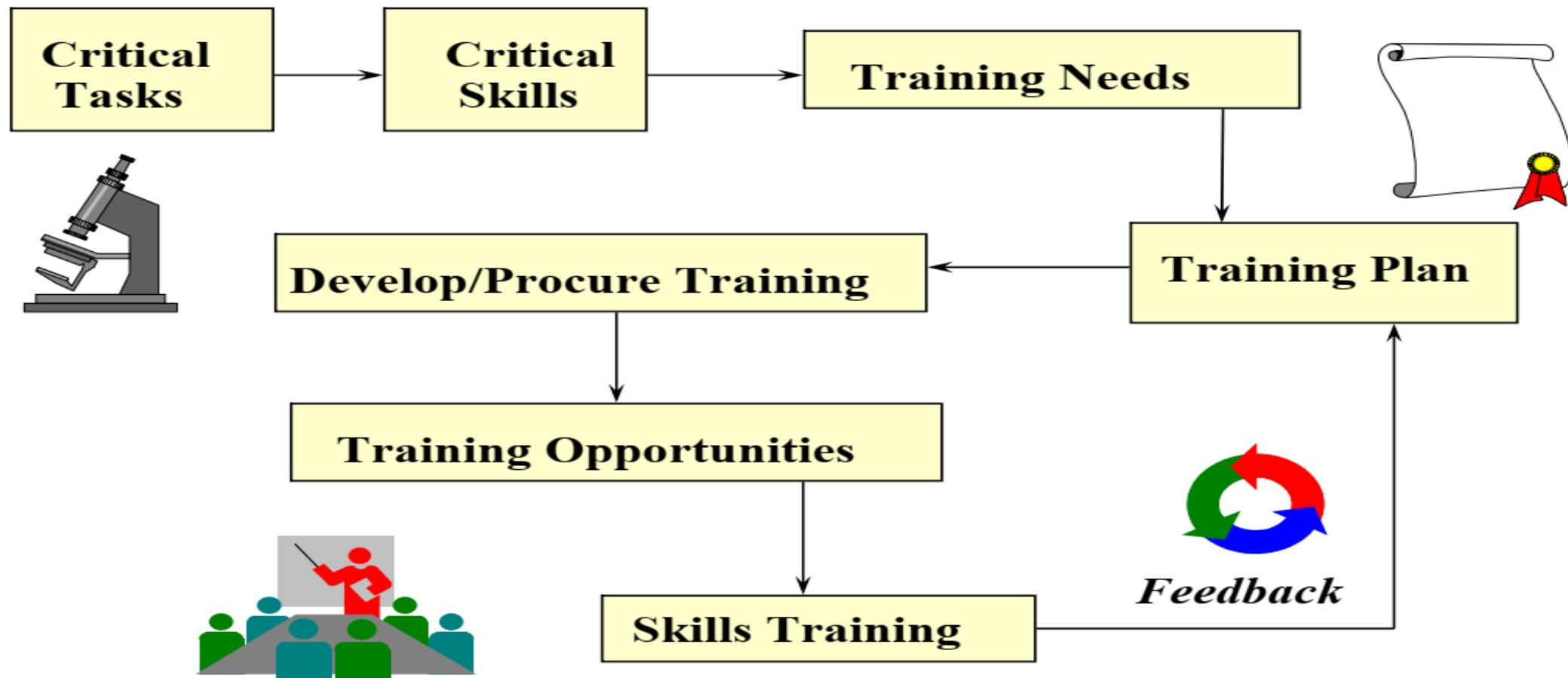
Training

☐ Ensure that all individuals have the skill required to perform their assignments and are provided relevant development opportunities.

Critical skills identified

Training needs identified

Training plan developed

Training provided

Discuss career development

Training Process Flow

Critical Tasks → Critical Skills → Training Needs → Training Plan → Develop/Procure Training → Training Opportunities → Skills Training → Feedback → Training Plan

Career Development

John Doe: Career development plan

Career objectives:
Competencies needed
Experience needed
Current assignment
Knowledge, skill, and process ability needs
Training needs
Other development actions
Potential next assignment
Knowledge and skill needs
Training needs
Other
Professional growth:
Salaries
other

Career Counseling

Development Opportunities

Special Assignments

Performance Management

- ☐ Organizations must establish objectives related to project work to compare with individual performance to be measured and evaluated.

- ☐ Managers compare performance with these objectives on a periodic basis with employees to determine progress and manage performance problems or provide recognition and rewards.

- ☐ Managers encourage employees to continuously improve their performance and use this information to determine the status of an individual's career development.

- ☐ Managers organize work around project teams with strong skills and process abilities to optimize their performance.

- ☐ Managers compensate people based on their contribution and value to the organization.
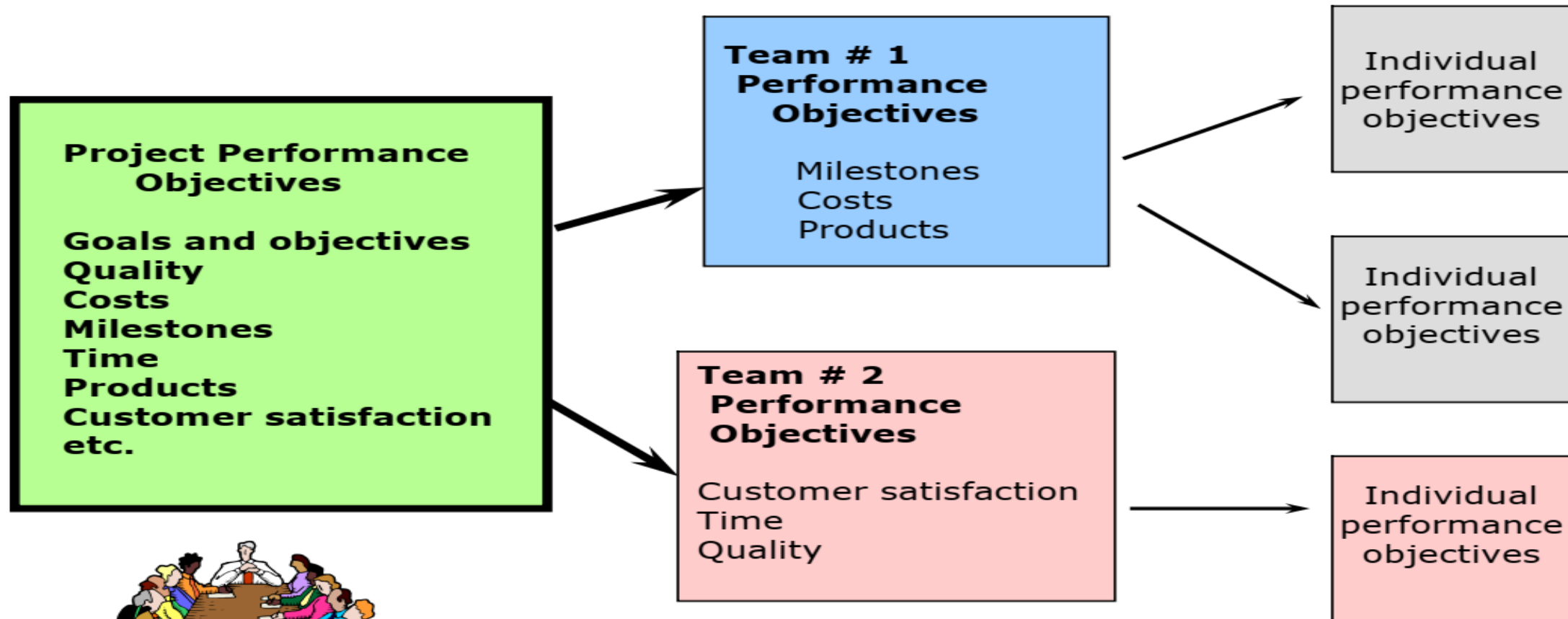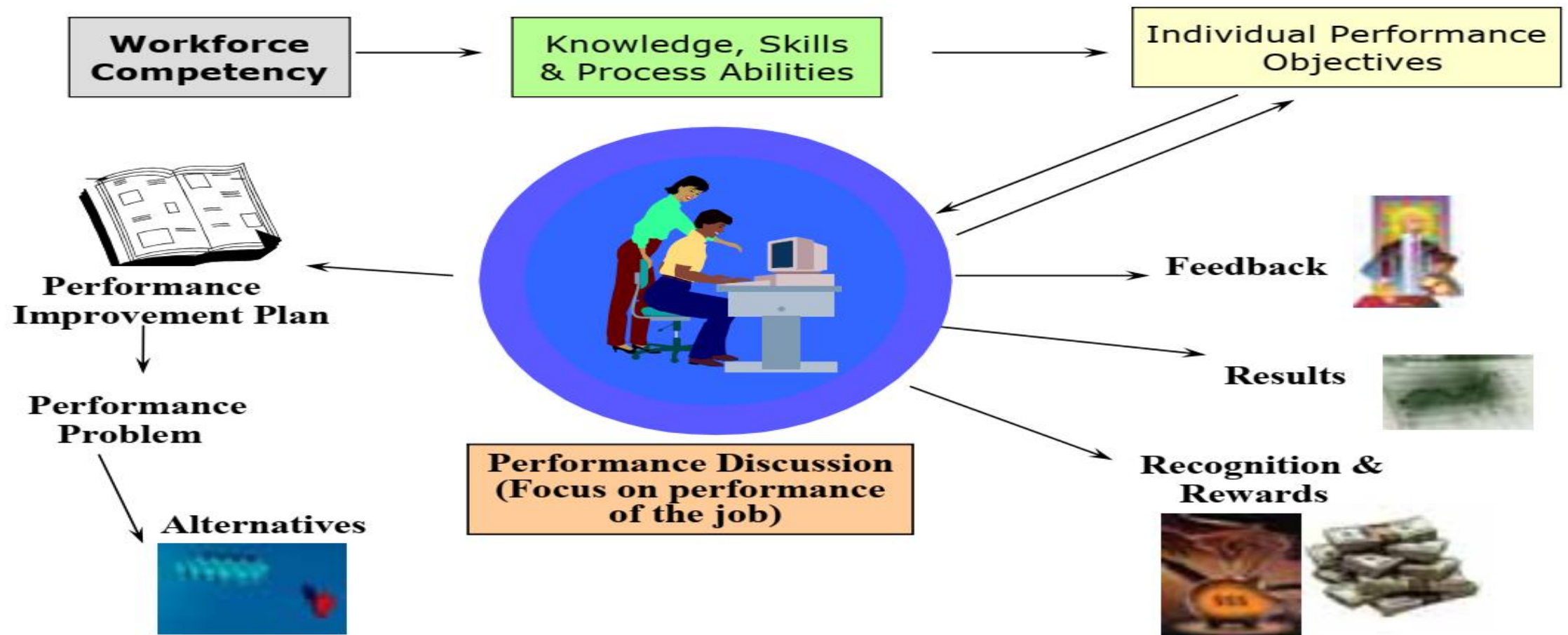
Performance Management

Individual performance objectives

On-going discussion of performance of job

Problems managed

Formal performance feedback

Compensation based on performance

Recognition and reward

Measurement Performance Objectives

Project Performance Objectives

Goals and objectives
Quality
Costs
Milestones
Time
Products
Customer satisfaction
etc.

Team # 1 Performance Objectives

Milestones
Costs
Products

Team # 2 Performance Objectives

Customer satisfaction
Time
Quality

Individual performance objectives

Individual performance objectives

Individual performance objectives

Individual Performance Process Flow

Workforce Competency → Knowledge, Skills & Process Abilities → Individual Performance Objectives

Performance Improvement Plan

Performance Problem

Alternatives

Performance Discussion (Focus on performance of the job)

Feedback

Results

Recognition & Rewards

Organize For Success

□ Project Teams are built around complementary skills.

□ Organization sets quantitative objectives for:
   1) Effectiveness of management.
   2) Growth of knowledge and skills.
   3) Alignment of performance to business objectives.

□ Data are analyzed then compared to plan and strategy for senior management decisions.

□ Appropriate actions are taken on unexpected results.

□ Business performance is improving and growing because the organization knows its workforce capability quantitatively and makes plans to take advantage of it.

Challenging Goals

☐ Managers need to carefully match people with their work assignments. This involves more than a technical assignment, but also a challenging work environment where people can be productive.

☐ In Microsoft, the work environment is highly creative due to the compact, highly motivated community of skilled people from many areas interacting with each other with a single challenging goal: to put a PC with Microsoft software in every household in the world.

☐ Highly skilled people want to be productive, therefore they seek the satisfaction of accomplishment and recognition.

☐ Highly skilled people drive themselves to overachieve, while others accomplish less because they have less motivation.

Managing Technical People

- Management is successful when technical people are:

  - Encouraged to come up with better ways to perform their work.
  - Involved in decision making.
  - Recognized for doing a good job.
  - Working in a physical environment to be productive.
  - Receiving information to do their jobs.
  - Having opportunities to improve their skills and abilities.
  - Being appreciated for contributing.
  - Cooperating to get the work done.
  - Believing they can make a difference.
  - Rewarded according to their performance.

Process Driven Organization Perspective

☐ **<u>People:</u>**

> Must have the skills, training, and motivation necessary to do the work. They must be managed in a way that will increase their effectiveness.

☐ **<u>Technology:</u>**

> Must be selected to enhance the business and support the product needs.

☐ **<u>Methods & Tools</u>:**

> Must be defined to guide people and the application of technology in the business of providing products and services to the customers.

Summary

- [ ] An organization's success in business is determined by its ability to attract, recruit, maintain and develop highly skilled people.
- [ ] The capability of an organization can be defined as the level of knowledge, skill, and motivation of their people to perform the software work.
- [ ] Organization's capability is a competitive advantage in the highly competitive global business.
- [ ] Organizations should invest in the development of their people both in technical and managerial aspects.
- [ ] Until recently, most organizations ignored people issues and focused on technology, but the high cost of project failures due to high employee turnover, has changed the equation of success.
- [ ] Today, all successful companies are relying on the knowledge and skill of their people.