MODULE - 4

SOFTWARE PROJECT MANAGEMENT

- Software project management is an essential part of software engineering.
- The success criteria **for project management** obviously vary from project to project, but, for most projects, **important goals are:**
    1. to deliver the software to the customer at the agreed time;
    2. to keep overall costs within budget
    3. to deliver software that meets the customer's expectations;
    4. to maintain a coherent and well-functioning development team.
- Software engineering is different from other types of engineering in a number of ways:
    1. The product is intangible.
    2. Large software projects are often "one-off" projects.
    3. Software processes are variable and organization-specific.

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- It is impossible to write a standard job description for a software project manager.
- Some of the most **important factors that affect how software projects are managed are:**
    1. Company size
    2. Software customers
    3. Software size
    4. Software type
    5. Organizational culture
    6. Software development processes

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- The **fundamental project management activities** that are common to all organizations:
  1. **Project planning** → Project managers are responsible for planning, estimating, and scheduling project development and assigning people to tasks.
  2. **Risk management** → Project managers have to assess the risks that may affect a project, monitor these risks, and take action when problems arise.
  3. **People management** → Project managers are responsible for managing a team of people. They have to choose people for their team and establish ways of working that lead to effective team performance.
  4. **Reporting** → Project managers are usually responsible for reporting on the progress of a project to customers and to the managers of the company developing the software.
  5. **Proposal writing** → The first stage in a software project may involve writing a proposal to win a contract to carry out an item of work. The proposal describes the objectives of the project and how it will be carried out. It usually includes cost and schedule estimates and justifies why the project contract should be awarded to a particular organization or team.

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RISK MANAGEMENT

- Risk management is one of the most important jobs for a project manager.
- Risk management involves anticipating risks that might affect the project schedule or the quality of the software being developed, and then taking action to avoid these risks.
- Risks can be categorized according to type of risk (technical, organizational, etc.)

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- **Classification of risks according to what these risks affect:**
  1. **Project risks** → affect the project schedule or resources. An example of a project risk is the loss of an experienced system architect.
  2. **Product risks** → affect the quality or performance of the software being developed. An example of a product risk is the failure of a purchased component to perform as expected.
  3. **Business risks** → affect the organization developing or procuring the software. For example, a competitor introducing a new product is a business risk.
- For large projects, you should record the results of the risk analysis in a risk register along with a consequence analysis. This sets out the consequences of the risk for the project, product, and business.

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Risk	Affects	Description
Staff turnover	Project	Experienced staff will leave the project before it is finished.
Management change	Project	There will be a change of company management with different priorities.
Hardware unavailability	Project	Hardware that is essential for the project will not be delivered on schedule.
Requirements change	Project and product	There will be a larger number of changes to the requirements than anticipated.
Specification delays	Project and product	Specifications of essential interfaces are not available on schedule.
Size underestimate	Project and product	The size of the system has been underestimated.
Software tool underperformance	Product	Software tools that support the project do not perform as anticipated.
Technology change	Business	The underlying technology on which the system is built is superseded by new technology.
Product competition	Business	A competitive product is marketed before the system is completed.

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Fig: Examples of common project, product, and business risks

- Effective risk management makes it easier to cope with problems and to ensure that these do not lead to unacceptable budget or schedule slippage.
- For small projects, formal risk recording may not be required, but the project manager should be aware of them.
- The specific risks that may affect a project depend on the project and the organizational environment in which the software is being developed.
- Software risk management is important because of the inherent uncertainties in software development.

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- An outline of the process of risk management is presented in Figure. It involves several **stages:**
  1. **Risk identification** → You should identify possible project, product, and business risks.
  2. **Risk analysis** → You should assess the likelihood and consequences of these risks.
  3. **Risk planning** → You should make plans to address the risk, either by avoiding it or by minimizing its effects on the project.
  4. **Risk monitoring** → You should regularly assess the risk and your plans for risk mitigation and revise these plans when you learn more about the risk.
- The risk management process is an iterative process that continues throughout a project.

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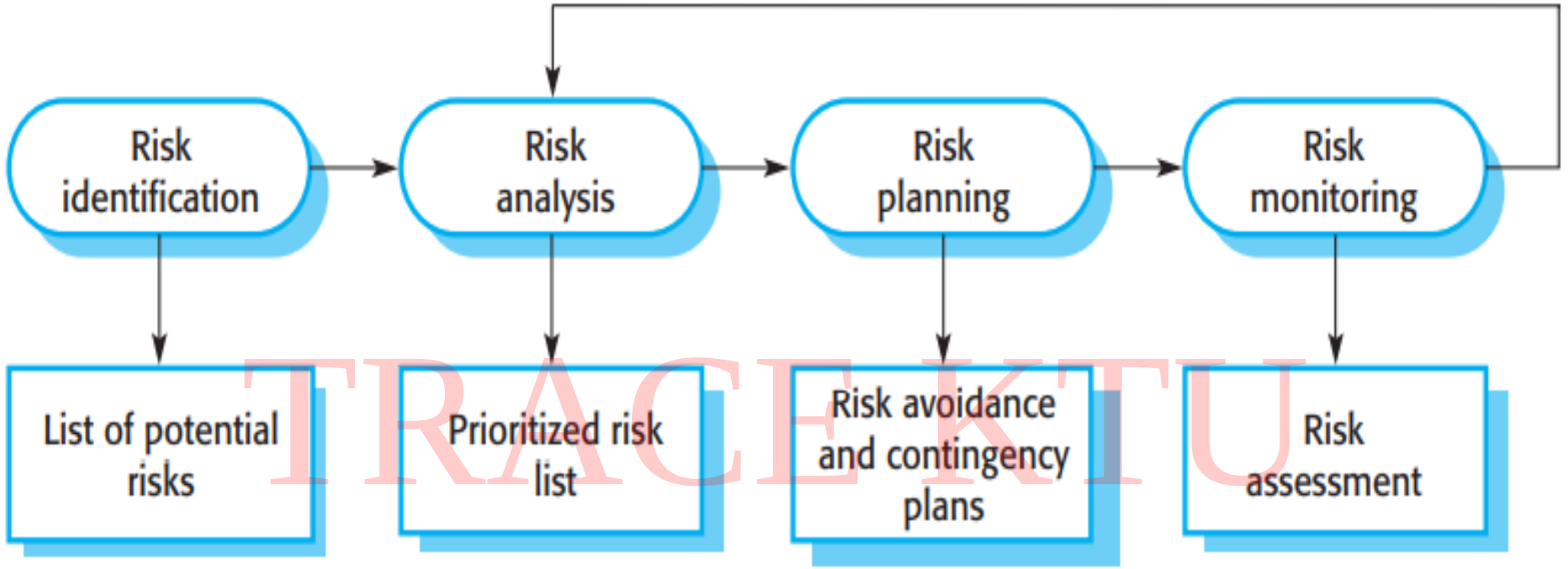

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Fig: The Risk Management Process

Risk Identification:

- Risk identification is the first stage of the risk management process.
- It is concerned with identifying the risks that could pose a major threat to the software engineering process, the software being developed, or the development organization.
- Risk identification may be a team process in which a team gets together to brainstorm possible risks.
- As a starting point for risk identification, a checklist of different types of risk may be used.

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- **6 types of risk** may be included in a risk checklist:
  1. **Estimation risks** → arise from the management estimates of the resources required to build the system.
  2. **Organizational risks** → arise from the organizational environment where the software is being developed.
  3. **People risks** → are associated with the people in the development team.
  4. **Requirements risks** → come from changes to the customer requirements and the process of managing the requirements change.
  5. **Technology risks** → come from the software or hardware technologies that are used to develop the system.
  6. **Tools risks** → come from the software tools and other support software used to develop the system.

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Risk type	Possible risks
Estimation	1. The time required to develop the software is underestimated. 2. The rate of defect repair is underestimated. 3. The size of the software is underestimated.
Organizational	4. The organization is restructured so that different management are responsible for the project. 5. Organizational financial problems force reductions in the project budget.
People	6. It is impossible to recruit staff with the skills required. 7. Key staff are ill and unavailable at critical times. 8. Required training for staff is not available.
Requirements	9. Changes to requirements that require major design rework are proposed. 10. Customers fail to understand the impact of requirements changes.
Technology	11. The database used in the system cannot process as many transactions per second as expected. 12. Faults in reusable software components have to be repaired before these components are reused.
Tools	13. The code generated by software code generation tools is inefficient. 14. Software tools cannot work together in an integrated way.

Figure 22.3 Examples of different types of risk

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Risk Analysis:

- During the risk analysis process, you have to consider each identified risk and make a judgment about the probability and seriousness of that risk.
- It is not possible to make precise, numeric assessment of the probability and seriousness of each risk.
- You should assign the risk to one of a number of bands:
    1. The probability of the risk might be assessed as insignificant, low, moderate, high, or very high.
    2. The effects of the risk might be assessed as catastrophic (threaten the survival of the project), serious (would cause major delays), tolerable (delays are within allowed contingency), or insignificant.
- You may then tabulate the results of this analysis process using a table ordered according to the seriousness of the risk.

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Risk	Probability	Effects
Organizational financial problems force reductions in the project budget (5).	Low	Catastrophic
It is impossible to recruit staff with the skills required (6).	High	Catastrophic
Key staff are ill at critical times in the project (7).	Moderate	Serious
Faults in reusable software components have to be repaired before these components are reused (12).	Moderate	Serious
Changes to requirements that require major design rework are proposed (9).	Moderate	Serious
The organization is restructured so that different managements are responsible for the project (4).	High	Serious
The database used in the system cannot process as many transactions per second as expected (11).	Moderate	Serious
The time required to develop the software is underestimated (1).	High	Serious
Software tools cannot be integrated (14).	High	Tolerable
Customers fail to understand the impact of requirements changes (10).	Moderate	Tolerable
Required training for staff is not available (8).	Moderate	Tolerable
The rate of defect repair is underestimated (2).	Moderate	Tolerable
The size of the software is underestimated (3).	High	Tolerable
Code generated by code generation tools is inefficient (13).	Moderate	Insignificant

Figure 22.4 Risk types and examples

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- Both the probability and the assessment of the effects of a risk may change as more information about the risk becomes available and as risk management plans are implemented. You should therefore update this table during each iteration of the risk management process.
- Once the risks have been analyzed and ranked, you should assess which of these risks are most significant.
- In general, catastrophic risks should always be considered, as should all serious risks that have more than a moderate probability of occurrence.

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Risk Planning:

- The risk planning process develops strategies to manage the key risks that threaten the project.
- For each risk, you have to think of actions that you might take to minimize the disruption to the project if the problem identified in the risk occurs.
- You should also think about the information that you need to collect while monitoring the project so that emerging problems can be detected before they become serious.

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- In risk planning, you have to ask “what-if” questions that consider both individual risks, combinations of risks, and external factors that affect these risks. For example, questions that you might ask are:
    1. What if several engineers are ill at the same time?
    2. What if an economic downturn leads to budget cuts of 20% for the project?
    3. What if the performance of open-source software is inadequate and the only expert on that open-source software leaves?
    4. What if the company that supplies and maintains software components goes out of business?
    5. What if the customer fails to deliver the revised requirements as predicted?
- Based on the answers to these “what-if” questions, you may devise strategies for managing the risks.

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- The **possible risk management strategies** fall into 3 categories:
  1. **Avoidance strategies** → Following these strategies means that the probability that the risk will arise is reduced. An example of a risk avoidance strategy is the strategy for dealing with defective components.
  2. **Minimization strategies** → Following these strategies means that the impact of the risk is reduced. An example of a risk minimization strategy is the strategy for staff illness.
  3. **Contingency plans** → Following these strategies means that you are prepared for the worst and have a strategy in place to deal with it. An example of a contingency strategy is the strategy for organizational financial problems.
- The strategies used in critical systems ensure reliability, security, and safety, where you must avoid, tolerate, or recover from failures.

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- It is best to use a strategy that avoids the risk.
- If this is not possible, you should use a strategy that reduces the chances that the risk will have serious effects.
- Finally, you should have strategies in place to cope with the risk if it arises. These should reduce the overall impact of a risk on the project or product.

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Risk	Strategy
Organizational financial problems	Prepare a briefing document for senior management showing how the project is making a very important contribution to the goals of the business and presenting reasons why cuts to the project budget would not be cost-effective.
Recruitment problems	Alert customer to potential difficulties and the possibility of delays; investigate buying-in components.
Staff illness	Reorganize team so that there is more overlap of work and people therefore understand each other's jobs.
Defective components	Replace potentially defective components with bought-in components of known reliability.
Requirements changes	Derive traceability information to assess requirements change impact; maximize information hiding in the design.
Organizational restructuring	Prepare a briefing document for senior management showing how the project is making a very important contribution to the goals of the business.
Database performance	Investigate the possibility of buying a higher-performance database.
Underestimated development time	Investigate buying-in components; investigate use of automated code generation.

Figure 22.5 Strategies to help manage risk

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Risk Monitoring:

- Risk monitoring is the process of checking that your assumptions about the product, process, and business risks have not changed.
- You should regularly assess each of the identified risks to decide whether or not that risk is becoming more or less probable.
- You should also think about whether or not the effects of the risk have changed.
- To do this, you have to look at other factors, such as the number of requirements change requests, which give you clues about the risk probability and its effects. These factors are dependent on the types of risk.

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Risk type	Potential indicators
Estimation	Failure to meet agreed schedule; failure to clear reported defects.
Organizational	Organizational gossip; lack of action by senior management.
People	Poor staff morale; poor relationships among team members; high staff turnover.
Requirements	Many requirements change requests; customer complaints.
Technology	Late delivery of hardware or support software; many reported technology problems.
Tools	Reluctance by team members to use tools; complaints about software tools; requests for faster computers/more memory, and so on.

Figure 22.6 Risk indicators

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- You should monitor risks regularly at all stages in a project.
- At every management review, you should consider and discuss each of the key risks separately.
- You should decide if the risk is more or less likely to arise and if the seriousness and consequences of the risk have changed.

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MANAGING PEOPLE

- The people working in a software organization are its greatest assets.
- It is expensive to recruit and retain good people.
- Software managers have to ensure that the engineers working on a project are as productive as possible.
- It is important that software project managers understand the technical issues that influence the work of software development.
- Software engineers often have strong technical skills but may lack the softer skills that enable them to motivate and lead a project development team.
- As a project manager, you should be aware of the potential problems of people management and should try to develop people management skills.

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- **4 critical factors that influence the relationship between a manager and the people** that he or she manages:
    1. **Consistency** → All the people in a project team should be treated in a comparable way. No one expects all rewards to be identical, but people should not feel that their contribution to the organization is undervalued.
    2. **Respect** → Different people have different skills, and managers should respect these differences.
    3. **Inclusion** → People contribute effectively when they feel that others listen to them and take account of their proposals. It is important to develop a working environment where all views, even those of the least experienced staff, are considered.
    4. **Honesty** → As a manager, you should always be honest about what is going well and what is going badly in the team. You should also be honest about your level of technical knowledge and be willing to defer to staff with more knowledge when necessary.

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Motivating People:

- As a project manager, you need to motivate the people who work with you so that they will contribute to the best of their abilities.
- In practice, **motivation** means organizing work and its environment to encourage people to work as effectively as possible.
- To provide this encouragement, you should understand a little about what motivates people.
- People are motivated by satisfying their needs. These needs are arranged in a series of levels, as shown in Figure.

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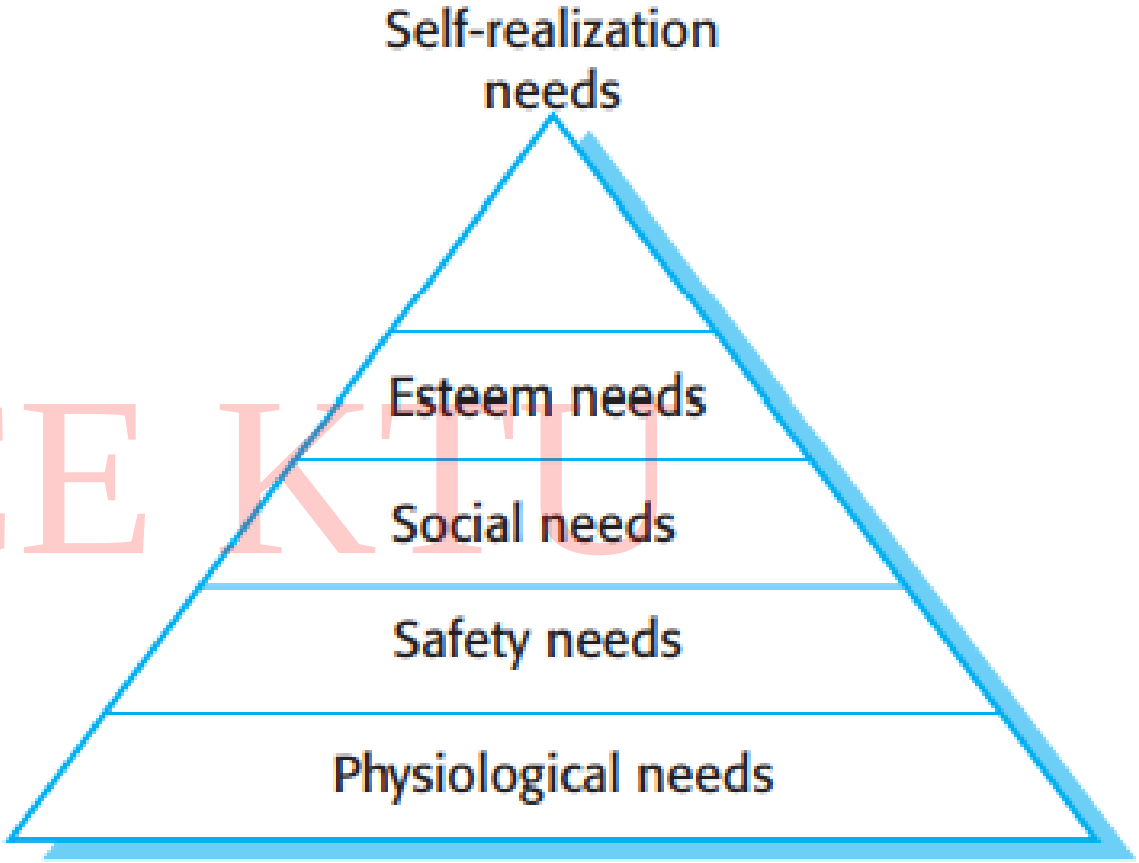

Figure 22.7 Human needs hierarchy

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- The lower levels of this hierarchy represent fundamental needs for food, sleep, and so on, and the need to feel secure in an environment.
- **Social need** is concerned with the need to feel part of a social grouping.
- **Esteem need** represents the need to feel respected by others, and **self-realization need** is concerned with personal development.
- People need to satisfy lower-level needs such as hunger before the more abstract, higher-level needs.
- People working in software development organizations are not usually hungry, thirsty, or physically threatened by their environment. Therefore, making sure that peoples' social, esteem, and self-realization needs are satisfied is most important from a management point of view.

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1. **To satisfy social needs**, you need to give people time to meet their co-workers and provide places for them to meet. This is relatively easy when all of the members of a development team work in the same place. Social networking systems and teleconferencing can be used for remote communications.
2. **To satisfy esteem needs**, you need to show people that they are valued by the organization. Public recognition of achievements is a simple and effective way of doing this.
3. Finally, **to satisfy self-realization needs**, you need to give people responsibility for their work, assign them demanding (but not impossible) tasks, and provide opportunities for training and development where people can enhance their skills. Training is an important motivating influence as people like to gain new knowledge and learn new skills.

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- Maslow’s model of motivation takes an exclusively personal viewpoint on motivation.
- It does not take adequate account of the fact that people feel themselves to be part of an organization, a professional group, and one or more cultures.
- Being a member of a cohesive group is highly motivating for most people.
- Therefore, as a manager, you also have to think about how a group as a whole can be motivated.

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Case study: Motivation

Alice is a software project manager working in a company that develops alarm systems. This company wishes to enter the growing market of assistive technology to help elderly and disabled people live independently. Alice has been asked to lead a team of six developers that can develop new products based on the company's alarm technology.

Alice's assistive technology project starts well. Good working relationships develop within the team, and creative new ideas are developed. The team decides to develop a system that a user can initiate and control the alarm system from a cell phone or tablet computer. However, some months into the project, Alice notices that Dorothy, a hardware expert, starts coming into work late, that the quality of her work is deteriorating, and, increasingly, that she does not appear to be communicating with other members of the team.

Alice talks about the problem informally with other team members to try to find out if Dorothy's personal circumstances have changed and if this might be affecting her work. They don't know of anything, so Alice decides to talk with Dorothy to try to understand the problem.

After some initial denials of any problem, Dorothy admits that she has lost interest in the job. She expected that she would be able to develop and use her hardware interfacing skills. However, because of the product direction that has been chosen, she has little opportunity to use these skills. Basically, she is working as a C programmer on the alarm system software.

While she admits that the work is challenging, she is concerned that she is not developing her interfacing skills. She is worried that finding a job that involves hardware interfacing will be difficult after this project. Because she does not want to upset the team by revealing that she is thinking about the next project, she has decided that it is best to minimize conversation with them.

Figure 22.8 Individual motivation

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- Psychological personality type also influences motivation.
- Bass and Dunteman (Bass and Dunteman 1963) identified **3 classifications for professional workers:**
    1. **Task-oriented people** → who are motivated by the work they do. In software engineering, these are people who are motivated by the intellectual challenge of software development.
    2. **Self-oriented people** → who are principally motivated by personal success and recognition. They are interested in software development as a means of achieving their own goals. They often have longer-term goals and they wish to be successful in their work to help realize these goals.
    3. **Interaction-oriented people** → who are motivated by the presence and actions of co-workers.

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- Research has shown that interaction-oriented personalities usually like to work as part of a group, whereas task-oriented and self-oriented people usually prefer to act as individuals.
- **People Capability Maturity Model (P-CMM)** → is a framework for assessing how well organizations manage the development of their staff. It highlights best practice in people management and provides a basis for organizations to improve their people management processes. It is best suited to large rather than small, informal companies.

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TEAMWORK

- As it is impossible for everyone in a large group to work together on a single problem, large teams are usually split into a number of smaller groups.
- Each group is responsible for developing part of the overall system.
- The best size for a software engineering group is 4 to 6 members, and they should never have more than 12 members.
- When groups are small, communication problems are reduced.

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- Putting together a group that has the right balance of technical skills, experience, and personalities is a critical management task.
- A good group is cohesive and thinks of itself as a strong, single unit.
- The people involved are motivated by the success of the group as well as by their own personal goals.
- In a **cohesive group**, members think of the group as more important than the individuals who are group members.
  - They are loyal to the group.
  - They identify with group goals and other group members.
  - They attempt to protect the group, as an entity, from outside interference. This makes the group robust and able to cope with problems and unexpected situations.

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- The **benefits of creating a cohesive group** are:
    1. The group can establish its own quality standards.
    2. Individuals learn from and support each other.
    3. Knowledge is shared.
    4. Refactoring and continual improvement is encouraged.
- Good project managers should always try to encourage group cohesiveness.
- They may try to establish a sense of group identity by naming the group and establishing a group identity and territory.
- One of the most effective ways of promoting cohesion is **to be inclusive** i.e., you should treat group members as responsible and trustworthy, and make information freely available.

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- An effective way of making people feel valued and part of a group is to make sure that they know what is going on.

Case study: Team spirit

Alice, an experienced project manager, understands the importance of creating a cohesive group. As her company is developing a new product, she takes the opportunity to involve all group members in the product specification and design by getting them to discuss possible technology with elderly members of their families. She encourages them to bring these family members to meet other members of the development group.

Alice also arranges monthly lunches for everyone in the group. These lunches are an opportunity for all team members to meet informally, talk around issues of concern, and get to know each other. At the lunch, Alice tells the group what she knows about organizational news, policies, strategies, and so forth. Each team member then briefly summarizes what they have been doing, and the group discusses a general topic, such as new product ideas from elderly relatives.

Every few months, Alice organizes an "away day" for the group where the team spends two days on "technology updating." Each team member prepares an update on a relevant technology and presents it to the group. This is an offsite meeting, and plenty of time is scheduled for discussion and social interaction.

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Figure 22.9 Group cohesion

- Given a stable organizational and project environment, the **3 factors that have the biggest effect on team working are:**
  1. The people in the group (**Selecting group members**)
  2. The way the group is organized (**Group organizations**)
  3. Technical and managerial communications (**Group communications**)

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Selecting Group Members:

- A manager or team leader's job is to create a cohesive group and organize that group so that they work together effectively.
- This task involves selecting a group with the right balance of technical skills and personalities.
- Technical knowledge and ability should not be the only factor used to select group members.
- People who are motivated by the work are likely to be the strongest technically.
- People who are self-oriented will probably be best at pushing the work forward to finish the job.
- People who are interaction-oriented help facilitate communications within the group.

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- The project manager has to control the group so that individual goals do not take precedence over organizational and group objectives.
- This control is easier to achieve if all group members participate in each stage of the project.
- Individual initiative is most likely to develop when group members are given instructions without being aware of the part that their task plays in the overall project.
- If all the members of the group are involved in the design from the start, they are more likely to understand why design decisions have been made. They may then identify with these decisions rather than oppose them.

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Case study: Group composition

In creating a group for assistive technology development, Alice is aware of the importance of selecting members with complementary personalities. When interviewing potential group members, she tried to assess whether they were task-oriented, self-oriented, or interaction-oriented. She felt that she was primarily a self-oriented type because she considered the project to be a way of getting noticed by senior management and possibly being promoted. She therefore looked for one or perhaps two interaction-oriented personalities, with task-oriented individuals to complete the team. The final assessment that she arrived at was:

Alice—self-oriented
Brian—task-oriented
Chun—interaction-oriented
Dorothy—self-oriented
Ed—interaction-oriented
Fiona—task-oriented
Fred—task-oriented
Hassan—interaction-oriented

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Figure 22.10 Group composition

Group Organization:

- The way a group is organized affects the group's decisions, the ways information is exchanged, and the interactions between the development group and external project stakeholders.
- Project managers are often responsible for selecting the people in the organization who will join their software engineering team.
- Getting the best possible people in this process is very important as poor selection decisions may be a serious risk to the project.
- Key factors that should influence the selection of staff are education and training, application domain and technology experience, communication ability, adaptability, and problem solving ability.

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- **Important organizational questions for project managers** include the following:
    1. Should the project manager be the technical leader of the group?
    2. Who will be involved in making critical technical decisions, and how will these decisions be made? Will decisions be made by the system architect or the project manager or by reaching consensus among a wider range of team members?
    3. How will interactions with external stakeholders and senior company management be handled?
    4. How can groups integrate people who are not co-located?
    5. How can knowledge be shared across the group?

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Informal Groups	Hierarchical Groups
1. Small programming groups are usually organized. 2. Group leader gets involved in the software development with the other group members. 3. The group as a whole discusses the work to be carried out, and tasks are allocated according to ability and experience. 4. More senior group members may be responsible for the architectural design. 5. Detailed design and implementation is the responsibility of the team member who is allocated to a particular task. 6. Groups are very successful, particularly when most group members are experienced and competent. Such a group makes decisions which improves cohesiveness and performance. 7. With no experienced engineers to direct the work, the result can be a lack of coordination between group members and, possibly, eventual project failure.	1. Group leader is at the top of the hierarchy. 2. Group leader has more formal authority than the group members and so can direct their work. 3. There is a clear organizational structure. 4. Decisions are made toward the top of the hierarchy and implemented by people lower down. 5. Communications are primarily instructions from senior staff; the people at lower levels of the hierarchy have relatively little communication with the managers at the upper levels. 6. These groups can work well when a well-understood problem can be easily broken down into software components that can be developed in different parts of the hierarchy. 7. This grouping allows for rapid decision making.

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- In software development, effective team communications at all levels is essential:
    1. Changes to the software often require changes to several parts of the system, and this requires discussion and negotiation at all levels in the hierarchy.
    2. Software technologies change so fast that more junior staff may know more about new technologies than experienced staff. Top-down communications may mean that the project manager does not find out about the opportunities of using these new technologies. More junior staff may become frustrated because of what they see as old-fashioned technologies being used for development.
- A major challenge facing project managers is the difference in technical ability between group members.
- i.e., adopting a group model that is based on individual experts can pose significant risks.

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Group Communications:

- It is absolutely essential that group members communicate effectively and efficiently with each other and with other project stakeholders.
- Good communication also helps strengthen group cohesiveness.
- Group members:
  1. Exchange information on the status of their work, the design decisions that have been made, and changes to previous design decisions.
  2. Resolve problems that arise with other stakeholders and inform these stakeholders of changes to the system, the group, and delivery plans.
  3. Come to understand the motivations, strengths, and weaknesses of other people in the group.

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- The effectiveness and efficiency of communications are influenced by:
  1. **Group size** → As a group gets bigger, it gets harder for members to communicate effectively. The number of one-way communication links is n * (n – 1), where n is the group size.
  2. **Group structure** → People in informally structured groups communicate more effectively than people in groups with a formal, hierarchical structure.
  3. **Group composition** → People with the same personality may clash, and, as a result, communications can be inhibited.
  4. **The physical work environment** → The organization of the workplace is a major factor in facilitating or inhibiting communications.
  5. **The available communication channels** → There are many different forms of communication—face to face, email messages, formal documents, telephone, and technologies such as social networking and wikis.

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- Effective communication is achieved when communications are two-way and the people involved can discuss issues and information and establish a common understanding of proposals and problems.
- All this can be done through meetings, although these meetings are often dominated by powerful personalities.
- Informal discussions when a manager meets with the team for coffee are sometimes more effective.
- Wikis and blogs allow project members and external stakeholders to exchange information, irrespective of their location. They help manage information and keep track of discussion threads, which often become confusing when conducted by email.
- You can also use instant messaging and teleconferences, which can be easily arranged, to resolve issues that need discussion.

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