Object-Oriented and Classical Software Engineering

CHAPTER 4

TEAMS

Overview

- Team organization
- Democratic team approach
- Classical chief programmer team approach
- Beyond chief programmer and democratic teams
- Synchronize-and-stabilize teams
- Teams for agile processes
- Open-source programming teams
- People capability maturity model
- Choosing an appropriate team organization

4.1 Team Organization

- A product must be completed within 3 months, but 1 person-year of programming is still needed

- Solution:
  - If one programmer can code the product in 1 year, four programmers can do it in 3 months

- Nonsense!
  - Four programmers will probably take nearly a year
  - The quality of the product is usually lower

Task Sharing

- If one farm hand can pick a strawberry field in 10 days, ten farm hands can pick the same strawberry field in 1 day

- One elephant can produce a calf in 22 months, but 22 elephants cannot possibly produce that calf in 1 month

Task Sharing (contd)

- Unlike elephant production, it is possible to share coding tasks between members of a team

- Unlike strawberry picking, team members must interact in a meaningful and effective way

Programming Team Organization

- Example:
  - Sheila and Harry code two modules, `m1` and `m2`, say
- What can go wrong
  - Both Sheila and Harry may code `m1`, and ignore `m2`
  - Sheila may code `m1`, Harry may code `m2`. When `m1` calls `m2` it passes 4 parameters; but `m2` requires 5 parameters
  - Or, the order of parameters in `m1` and `m2` may be different
  - Or, the order may be same, but the data types may be slightly different

Programming Team Organization (contd)

- This has nothing whatsoever to do with technical competency
  - Team organization is a managerial issue

Communications Problems

- Example
  - There are three channels of communication between the three programmers working on a project. The deadline is rapidly approaching but the code is not nearly complete

- “Obvious” solution:
  - Add a fourth programmer to the team

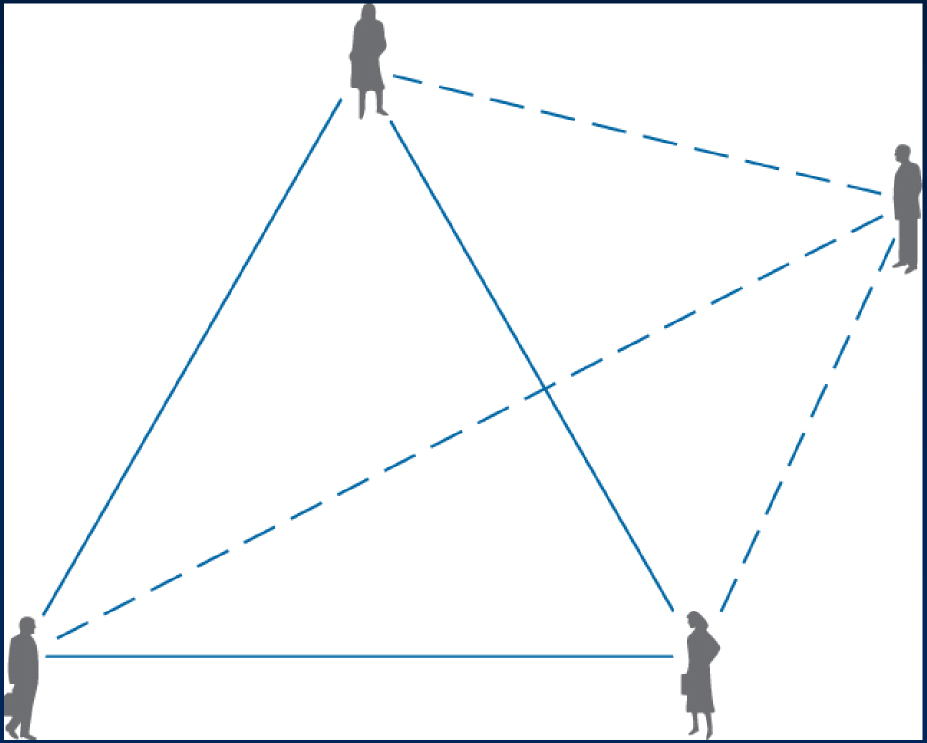


Figure 4.1

Communications Problems (contd)

- But other three have to explain in detail
  - What has been accomplished
  - What is still incomplete

- Brooks’s Law
  - Adding additional programming personnel to a team when a product is late has the effect of making the product even later

Team Organization

- Teams are used throughout the software production process
  - But especially during implementation
  - Here, the discussion is presented within the context of programming teams

- Two extreme approaches to team organization
  - Democratic teams (Weinberg, 1971)
  - Chief programmer teams (Brooks, 1971; Baker, 1972)

4.2 Democratic Team Approach

- Basic underlying concept — *egoless programming*

- Programmers can be highly attached to their code
  - They even name their modules after themselves
  - They see their modules as extension of themselves

Democratic Team Approach (contd)

- If a programmer sees a module as an extension of his/her ego, he/she is not going to try to find all the errors in “his”/“her” code
  - If there is an error, it is termed a *bug* 🕷
  - The fault could have been prevented if the code had been better guarded against the “bug”
  - “Shoo-Bug” aerosol spray

Democratic Team Approach (contd)

- Proposed solution

- Egoless programming
  - Restructure the social environment
  - Restructure programmers’ values
  - Encourage team members to find faults in code
  - A fault must be considered a normal and accepted event
  - The team as whole will develop an ethos, a group identity
  - Modules will “belong” to the team as whole
  - A group of up to 10 egoless programmers constitutes a *democratic team*

Difficulties with Democratic Team Approach

- Management may have difficulties
  - Democratic teams are hard to introduce into an undemocratic environment

Strengths of Democratic Team Approach

- Democratic teams are enormously productive
- They work best when the problem is difficult
- They function well in a research environment
- Problem:
  - Democratic teams have to spring up spontaneously

4.3 Classical Chief Programmer Team Approach

- Consider a 6-person team
  - Fifteen 2-person communication channels
  - The total number of 2-, 3-, 4-, 5-, and 6-person groups is 57
  - This team cannot do 6 person-months of work in 1 month

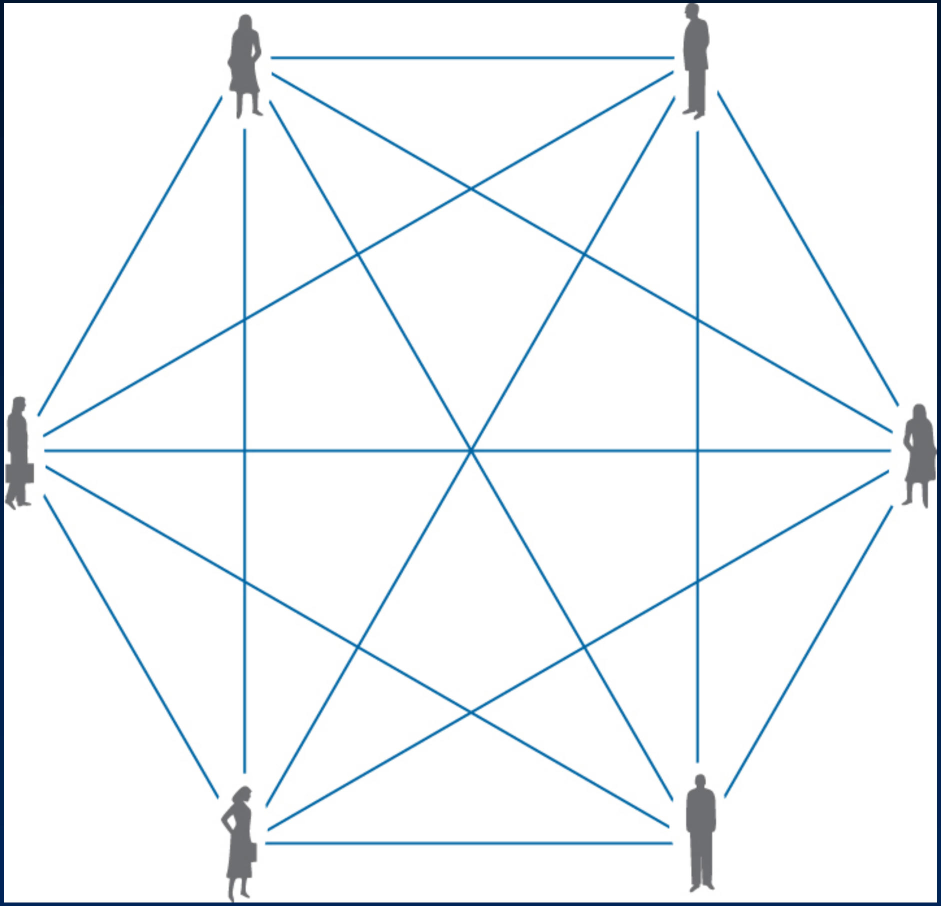


Figure 4.2

Classical Chief Programmer Team

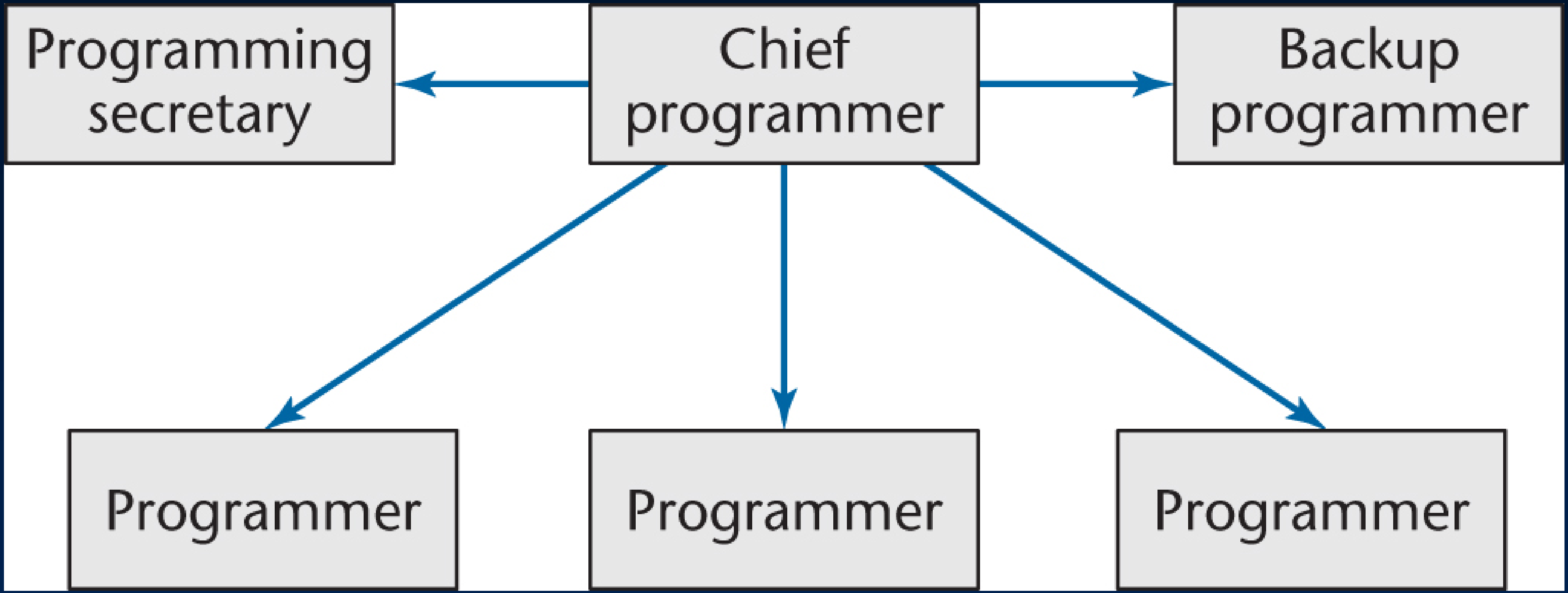


Figure 4.3

- Six programmers, but now only 5 lines of communication

Classical Chief Programmer Team (contd)

- The basic idea behind the concept
  - Analogy: chief surgeon directing an operation, assisted by
    - » Other surgeons
    - » Anesthesiologists
    - » Nurses
    - » Other experts, such as cardiologists, nephrologists
- Two key aspects
  - Specialization
  - Hierarchy

Classical Chief Programmer Team (contd)

- Chief programmer
  - Successful manager *and* highly skilled programmer
  - Does the architectural design
  - Allocates coding among the team members
  - Writes the critical (or complex) sections of the code
  - Handles all the interfacing issues
  - Reviews the work of the other team members
  - Is personally responsible for every line of code

Classical Chief Programmer Team (contd)

- Back-up programmer
  - Necessary only because the chief programmer is human
  - The back-up programmer must be in every way as competent as the chief programmer, and
  - Must know as much about the project as the chief programmer
  - The back-up programmer does black-box test case planning and other tasks that are independent of the design process

Classical Chief Programmer Team (contd)

- Programming secretary
  - A highly skilled, well paid, central member of the chief programmer team
  - Responsible for maintaining the program production library (documentation of the project), including:
    - » Source code listings
    - » JCL
    - » Test data
  - Programmers hand their source code to the secretary who is responsible for
    - » Conversion to machine-readable form
    - » Compilation, linking, loading, execution, and running test cases (this was 1971, remember!)

Classical Chief Programmer Team (contd)

- Programmers
  - Do nothing but program
  - All other aspects are handled by the programming secretary

The *New York Times* Project

- Chief programmer team concept
  - First used in 1971
  - By IBM
  - To automate the clippings data bank (“morgue“) of the *New York Times*

- Chief programmer — F. Terry Baker

The *New York Times* Project (contdj)

- 83,000 source lines of code (LOC) were written in 22 calendar months, representing 11 person-years

- After the first year, only the file maintenance system had been written (12,000 LOC)

- Most code was written in the last 6 months

- Only 21 faults were detected in the first 5 weeks of acceptance testing

The *New York Times* Project (contd)

- 25 further faults were detected in the first year of operation
- Principal programmers averaged one detected fault and 10,000 LOC per person-year
- The file maintenance system, delivered 1 week after coding was completed, operated 20 months before a single failure occurred
- Almost half the subprograms (usually 200 to 400 lines of PL/I) were correct at first compilation

The New York Times Project (contd)

- But, after this fantastic success, no comparable claims for the chief programmer team concept have been made

Why Was the *NYT* Project Such a Success?

- Prestige project for IBM
  - First real trial for PL/I (developed by IBM)
  - IBM, with superb software experts, used its best people

- Extremely strong technical backup
  - PL/I compiler writers helped the programmers
  - JCL experts assisted with the job control language

Why Was the *NYT* Project Such a Success?

- F. Terry Baker
  - Superprogrammer
  - Superb manager and leader
  - His skills, enthusiasm, and personality “carried” the project

- Strengths of the chief programmer team approach
  - It works
  - Numerous successful projects have used variants of CPT

Impracticality of Classical CPT

- The chief programmer must be a highly skilled programmer *and* a successful manager

- There is a shortage of highly skilled programmers

- There is a shortage of successful managers

- The qualities needed to be a highly skilled programmer are unlikely to be found in a successful manager, and vice versa

Impracticality of Classical CPT **(contd)**

- The *back-up programmer* must be as good as the chief programmer
  - But he/she must take a back seat (and a lower salary) waiting for something to happen to the chief programmer
  - Top programmers, top managers will not do that

- The *programming secretar*y does nothing but paperwork all day
  - Software professionals hate paperwork

- Classical CPT is impractical

4.4 Beyond CP and Democratic Teams

- We need ways to organize teams that
  - Make use of the strengths of democratic teams and chief programmer teams, and
  - Can handle teams of 20 (or 120) programmers

- A strength of democratic teams
  - A positive attitude to finding faults

- Use CPT in conjunction with code walkthroughs or inspections

Beyond CP and Democratic Teams (contd)

- Potential pitfall

- The chief programmer is personally responsible for every line of code
  - He/she must therefore be present at reviews

- The chief programmer is also the team manager
  - He/she must therefore *not* be present at reviews!

Beyond CP and Democratic Teams (contd)

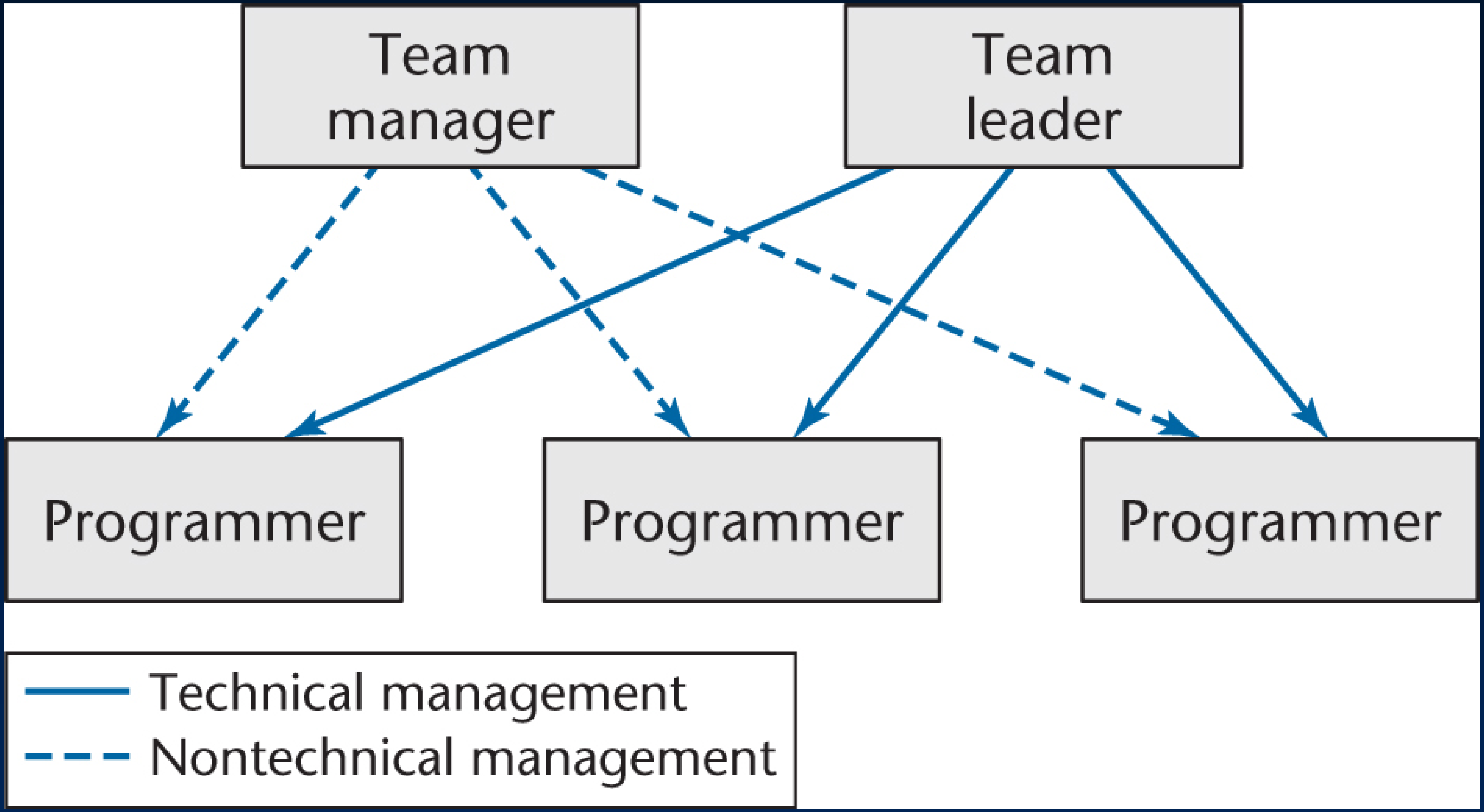


Figure 4.4

- Solution
  - Reduce the managerial role of the chief programmer

Beyond CP and Democratic Teams (contd)

- It is easier to find a team leader than a chief programmer
- Each employee is responsible to exactly one manager — lines of responsibility are clearly delineated
- The team leader is responsible for only technical management

Beyond CP and Democratic Teams (contd)

- Budgetary and legal issues, and performance appraisal are not handled by the team leader

- The team leader participates in reviews — the team manager is not permitted to do so

- The team manager participates in regular team meetings to appraise the technical skills of the team members

Larger Projects

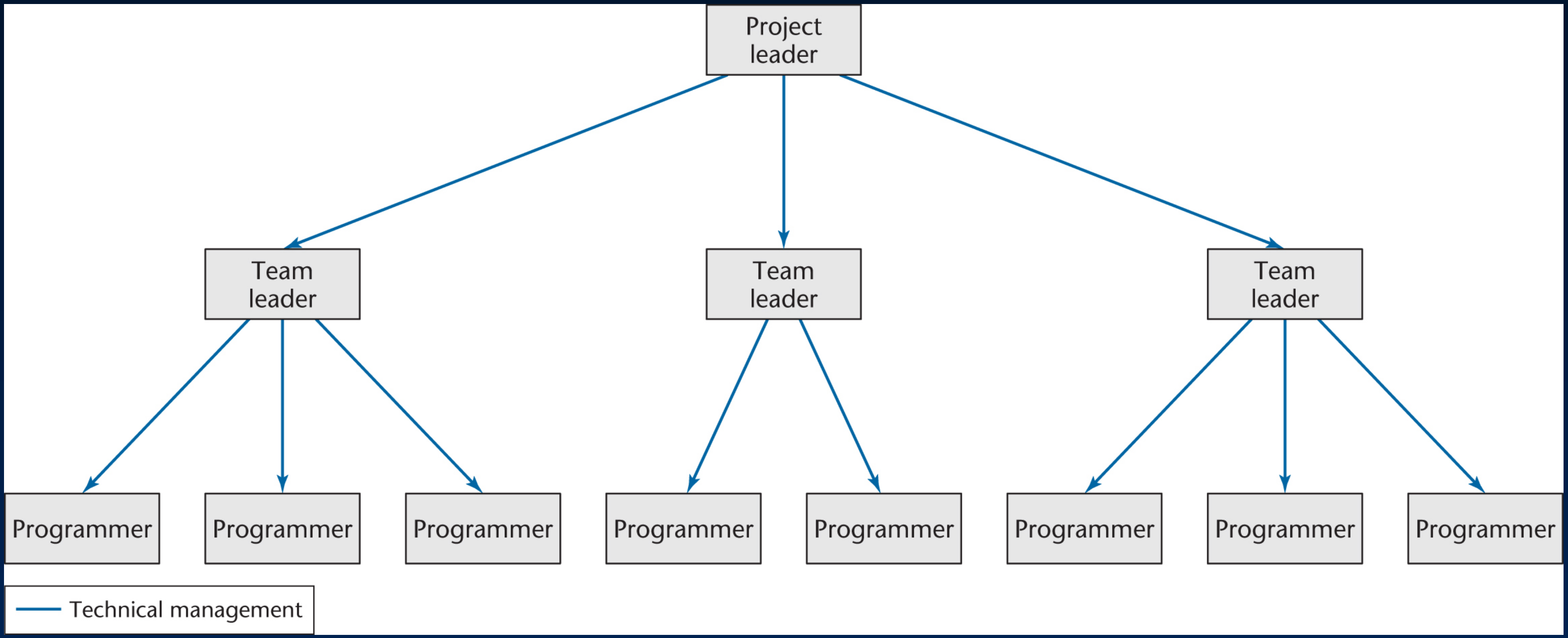


Figure 4.5

- The nontechnical side is similar
  - For even larger products, add additional layers

Beyond CP and Democratic Teams (contd)

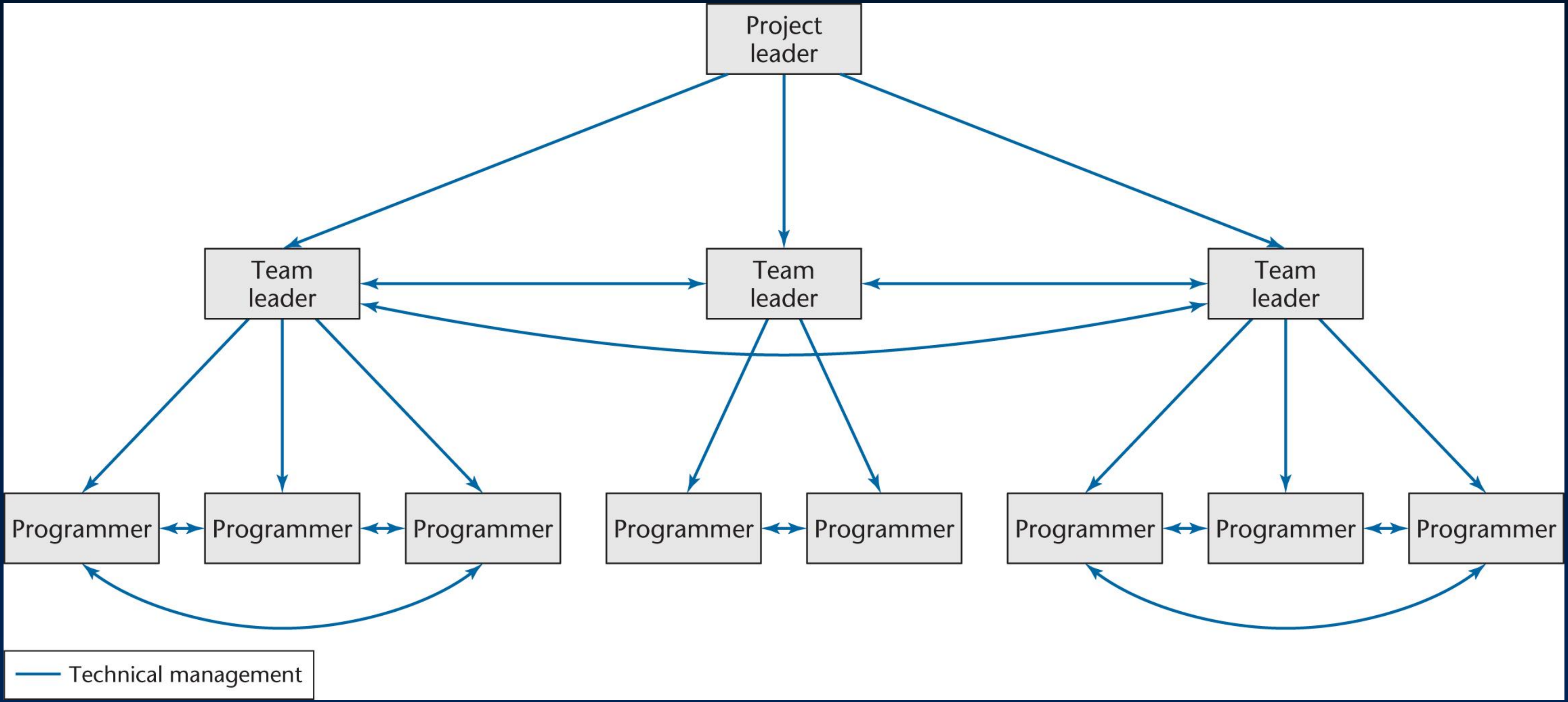


Figure 4.6

- Decentralize the decision-making process, where appropriate
  - Useful where the democratic team is good

4.5 Synchronize-and-Stabilize Teams

- Used by Microsoft
- Products consist of 3 or 4 sequential builds
- Small parallel teams
  - 3 to 8 developers
  - 3 to 8 testers (work one-to-one with developers)
  - The team is given the overall task specification
  - They may design the task as they wish

Synchronize-and-Stabilize Teams (contd)

- Why this does not degenerate into hacker-induced chaos?
  - Daily synchronization step
  - Individual components always work together

Synchronize-and-Stabilize Teams (contd)

- Rules
  - Programmers must adhere to the time for entering the code into the database for that day’s synchronization

- Analogy
  - Letting children do what they like all day…
  - … but with a 9 P.M. bedtime

Synchronize-and-Stabilize Teams (contd)

- Will this work in all companies?
  - Perhaps if the software professionals are as good as those at Microsoft

- Alternate viewpoint
  - The synchronize-and-stabilize model is simply a way of allowing a group of hackers to develop large products
  - Microsoft’s success is due to superb marketing rather than quality software

4.6 Teams For Agile Processes

- Feature of agile processes
  - All code is written by two programmers sharing a computer
  - "Pair programming"

Strengths of Pair Programming

- Programmers should not test their own code
  - One programmer draws up the test cases, the other tests the code
- If one programmer leaves, the other is sufficiently knowledgeable to continue working with another pair programmer
- An inexperienced programmer can learn from his or her more experienced team member
- Centralized computers promote egoless programming

Experiment on Pair Programming

- Experiment of Arisholm, Gallis, Dybå, and Sjøberg (2007)

- A total of 295 professional programmers (99 individuals and 98 pairs) were hired to take part in a carefully conducted one-day experiment on pair programming

- The subjects were required to perform several maintenance tasks on two Java software products, one simple and one complex

Experiment on Pair Programming (contd)

- The pair programmers required 84 per cent more effort to perform the tasks correctly

- In the light of this result, some software engineers may reconsider using pair programming, and, hence, agile processes

Experiment on Pair Programming (contd)

- Also, in 2007 Dybå et al. analyzed 15 published studies comparing the effectiveness of individual and pair programming

- Conclusion:
  - It depends on both the programmer's expertise and the complexity of the system and the specific tasks to be solved

- Clearly, more research, performed on large samples of professional programmers, needs to be conducted

4.7 Open-Source Programming Teams

- Open-source projects
  - Are generally staffed by teams of unpaid volunteers
  - Who communicate asynchronously (via e-mail)
  - With no team meetings and
  - With no managers
  - There are no specifications or designs, and
  - Little or no other documentation

- So, why have a small number of open-source projects (such as Linux and Apache) attained the highest levels of success?

Open-Source Programming Teams (contd)

- Individuals volunteer to take part in an open-source project for two main reasons

- Reason 1: For the sheer enjoyment of accomplishing a worthwhile task
  - In order to attract and keep volunteers, they have to view the project as “worthwhile” at all times

- Reason 2: For the learning experience

The Open-Source Learning Experience

- Software professionals often join an open-source project to gain new skills
  - For a promotion, or
  - To get a better job elsewhere

- Many employers view experience with a large, successful open-source project as better than additional academic qualifications

Open-Source Programming Teams (contd)

- The members of the open-source team must at all times feel that they are making a contribution

- For all these reasons, it is essential that the key individual behind an open-source project be a superb motivator
  - Otherwise, the project is doomed to inevitable failure

Open-Source Programming Teams (contd)

- For a successful open-source project, the members of the core group must be top-caliber individuals with skills of the highest order

- Such top-class individuals can thrive in the unstructured environment of an open-source team

Open-Source Programming Teams (contd)

- In summary, an open-source project succeeds because of
  - The nature of the target product,
  - The personality of the instigator, and
  - The talents of the members of the core group

- The way that a successful open-source team is organized is essentially irrelevant

4.8 People Capability Maturity Model

- Best practices for managing and developing the workforce of an organization

- Each maturity level has its own KPAs
  - Level 2: Staffing, communication and coordination, training and development, work environment, performance management, coordination
  - Level 5: Continuous capability improvement, organizational performance alignment, continuous workforce innovation

People Capability Maturity Model (contd)

- P–CMM is a framework for improving an organization’s processes for managing and developing its workforce

- No one specific approach to team organization is put forward

4.9 Choosing an Appropriate Team Organization

- There is no one solution to the problem of team organization

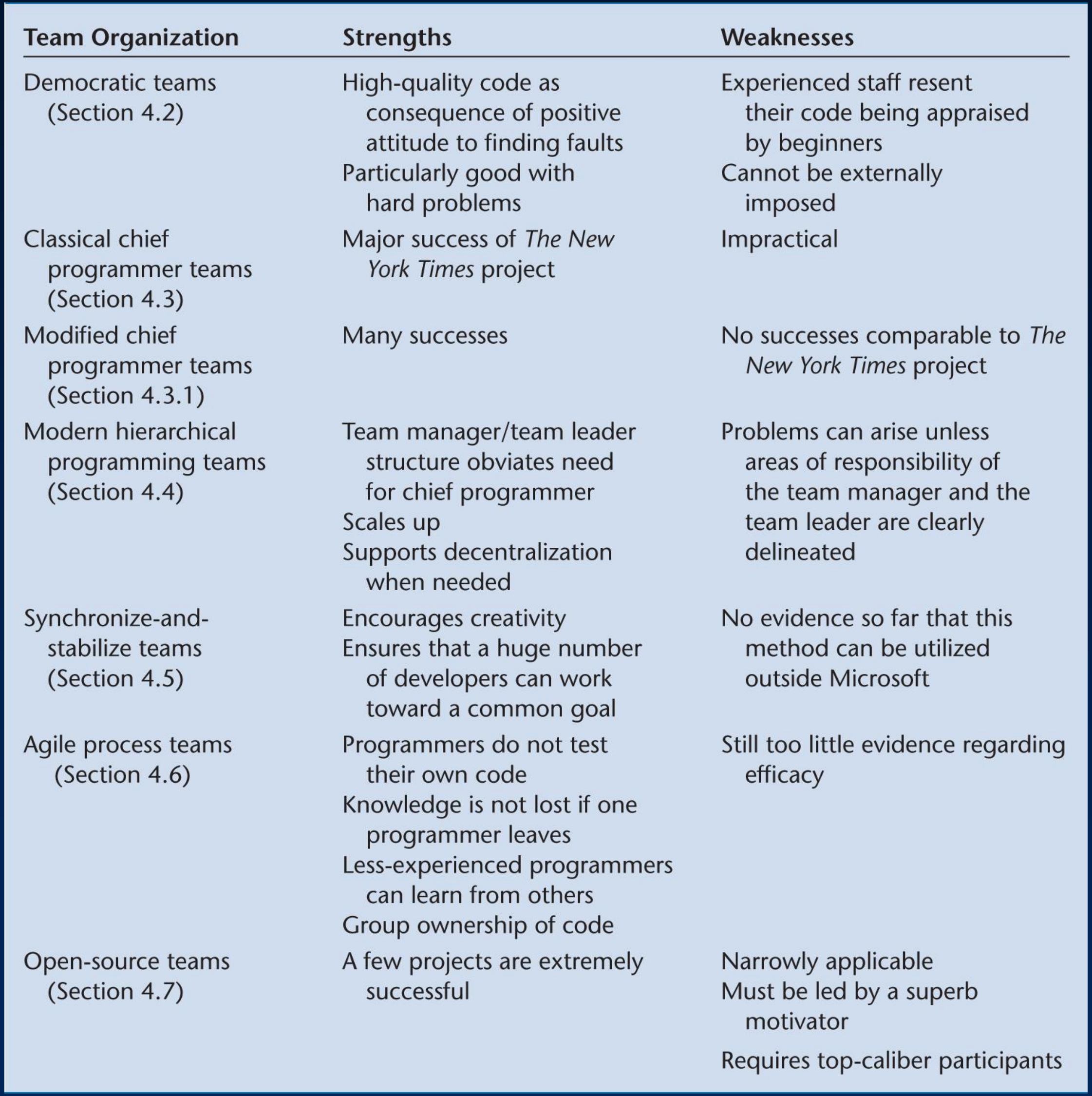
- The “correct” way depends on
  - The product
  - The outlook of the leaders of the organization
  - Previous experience with various team structures

Choosing an Appropriate Team Organization (contd)

- Exceedingly little research has been done on software team organization
  - Instead, team organization has been based on research on group dynamics in general

- Without *relevant* experimental results, it is hard to determine optimal team organization for a specific product

Choosing an Appropriate Team Organization (contd)



Team Organization	Strengths	Weaknesses
Democratic teams (Section 4.2)	High-quality code as consequence of positive attitude to finding faults Particularly good with hard problems	Experienced staff resent their code being appraised by beginners Cannot be externally imposed
Classical chief programmer teams (Section 4.3)	Major success of *The New York Times* project	Impractical
Modified chief programmer teams (Section 4.3.1)	Many successes	No successes comparable to *The New York Times* project
Modern hierarchical programming teams (Section 4.4)	Team manager/team leader structure obviates need for chief programmer Scales up Supports decentralization when needed	Problems can arise unless areas of responsibility of the team manager and the team leader are clearly delineated
Synchronize-and-stabilize teams (Section 4.5)	Encourages creativity Ensures that a huge number of developers can work toward a common goal	No evidence so far that this method can be utilized outside Microsoft
Agile process teams (Section 4.6)	Programmers do not test their own code Knowledge is not lost if one programmer leaves Less-experienced programmers can learn from others Group ownership of code	Still too little evidence regarding efficacy
Open-source teams (Section 4.7)	A few projects are extremely successful	Narrowly applicable Must be led by a superb motivator Requires top-caliber participants

Figure 4.7