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Introduction to Software Engineering

9. Project Management

Roadmap

> Risk management
> Scoping and estimation
> Planning and scheduling
> Dealing with delays
> Staffing, directing, teamwork

Literature

Sources

> *Software Engineering*, I. Sommerville, 7th Edn., 2004.

> *Software Engineering — A Practitioner's Approach*, R. Pressman, Mc-Graw Hill, 5th Edn., 2001.

Recommended Reading

> *The Mythical Man-Month*, F. Brooks, Addison-Wesley, 1975

> *Peopleware, Productive Projects and Teams* (2nd edition), Tom DeMarco and Timothy Lister, Dorset House, 1999.

> *Succeeding with Objects: Decision Frameworks for Project Management*, A. Goldberg and K. Rubin, Addison-Wesley, 1995

> *Extreme Programming Explained: Embrace Change*, Kent Beck, Addison Wesley, 1999

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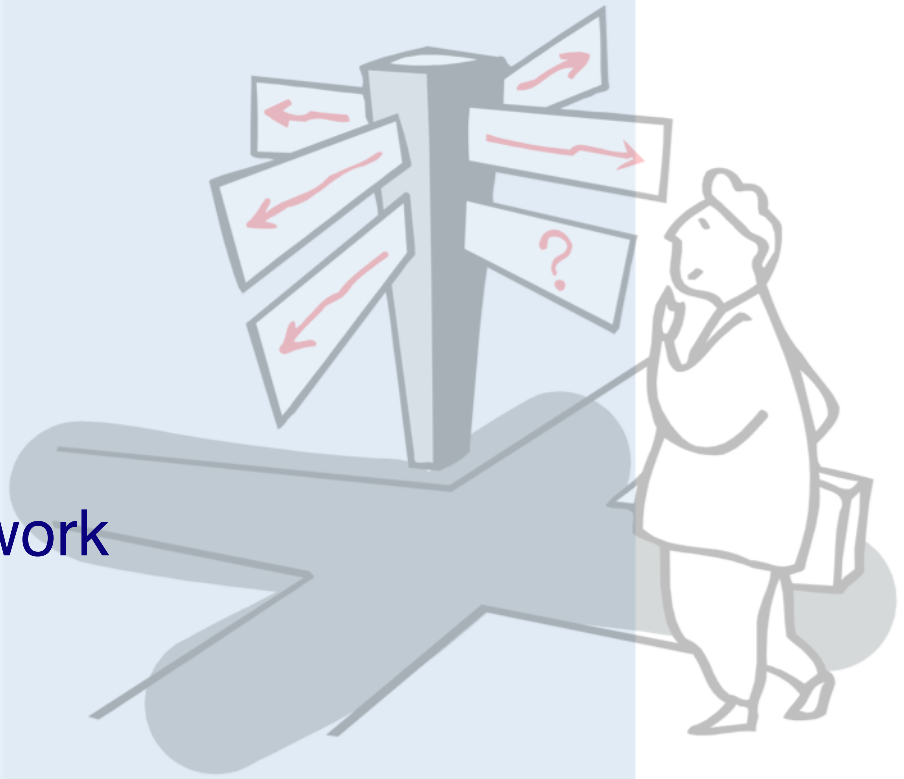
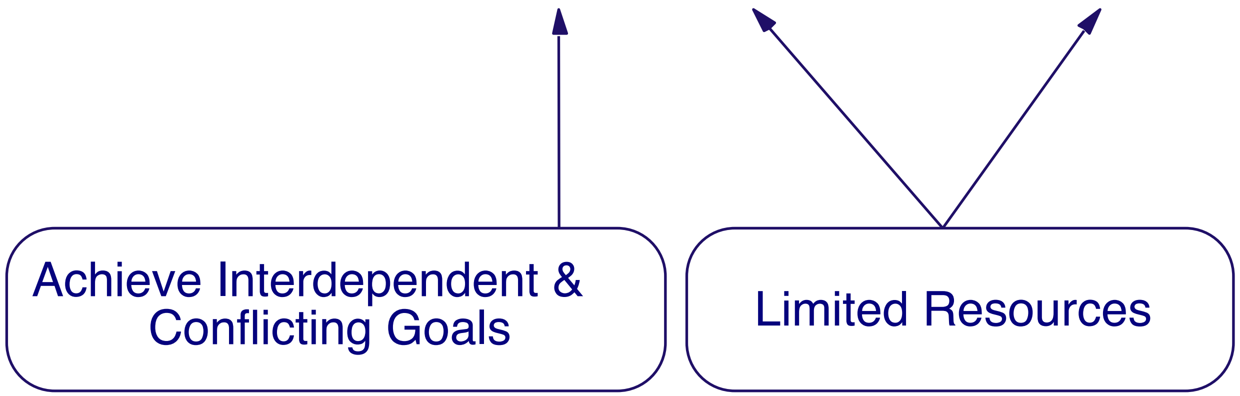


Why Project Management?

Almost all software products are obtained via *projects*. (as opposed to manufactured products)

Project Concern = *Deliver on time* and *within budget*



The Project Team is the primary Resource!

What is Project Management?

Project Management = *Plan the work* and *work the plan*

Management Functions

> *Planning*: Estimate and schedule resources
>
> *Organization:* Who does what
>
> *Staffing:* Recruiting and motivating personnel
>
> *Directing:* Ensure team acts as a whole
>
> *Monitoring (Controlling):* Detect plan deviations + corrective actions

Risk Management

If you don't actively attack risks, they will actively attack you.

— Tom Gilb

Project risks

—budget, schedule, resources, size, personnel, morale ...

Technical risks

—implementation technology, verification, maintenance ...

Business risks

—market, sales, management, commitment ...

Risk Management ...

Management must:

> *identify* risks as early as possible
> *assess* whether risks are acceptable
> take appropriate action to *mitigate and manage* risks
  — e.g., training, prototyping, iteration, ...
> *monitor* risks throughout the project

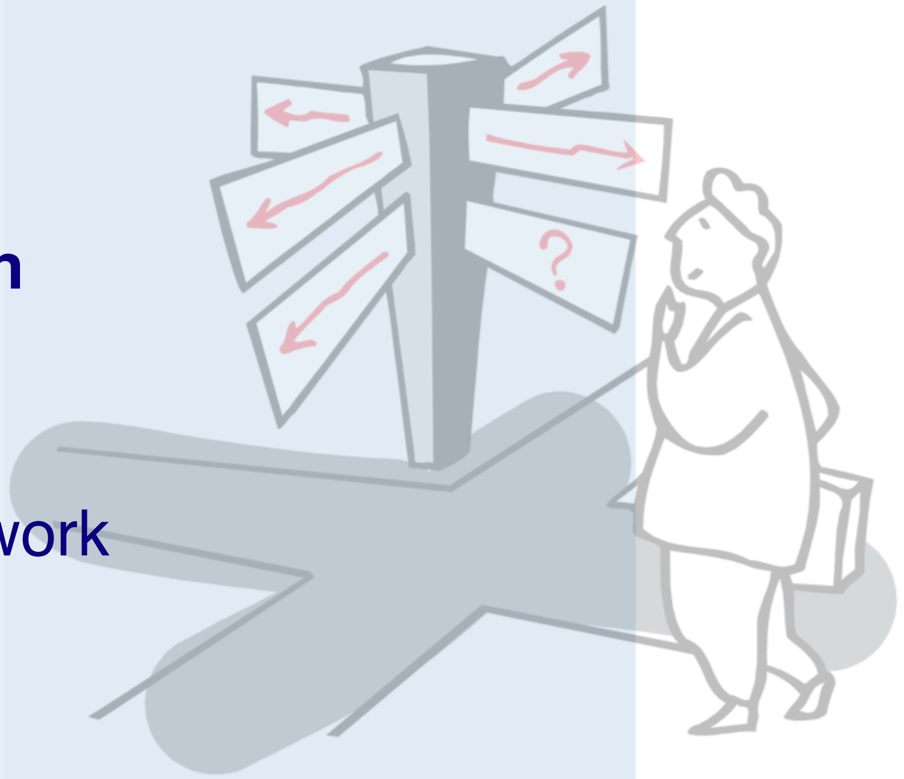
Risk Management Techniques

Risk Items	***Risk Management Techniques***
Personnel *shortfalls*	Staffing with top talent; *team building*; cross-training; pre-scheduling key people
Unrealistic schedules and budgets	Detailed multi-source cost & schedule estimation; *incremental development*; reuse; re-scoping
Developing the *wrong* software functions	User-surveys; *prototyping*; early users's manuals

Risk Management Techniques …

Risk Items	***Risk Management Techniques***
Continuing stream of *requirements changes*	High change threshold; information hiding; *incremental development*
Real time *performance* shortfalls	Simulation; benchmarking; modeling; prototyping; *instrumentation; tuning*
Straining computer science capabilities	Technical analysis; cost-benefit analysis; *prototyping*; reference checking

Roadmap



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Focus on Scope

For decades, programmers have been whining, "The customers can't tell us what they want. When we give them what they say they want, they don't like it." Get over it. This is an absolute truth of software development. The requirements are never clear at first. Customers can never tell you exactly what they want.

— Kent Beck

Myth: Scope and Objectives

Myth

“A general statement of objectives is enough to start coding.”

Reality

Poor up-front definition is the major cause of project failure.

Scope and Objectives

In order to plan, you must set clear *scope & objectives*

> Objectives identify the *general goals* of the project, not how they will be achieved.
> Scope identifies the *primary functions* that the software is to accomplish, and bounds these functions in a quantitative manner.

Goals must be *realistic and measurable*

—Constraints, performance, reliability must be explicitly stated
—Customer must set *priorities*

Estimation Strategies

These strategies are simple but risky:

Expert judgement	Consult experts and compare estimates ☞ *cheap, but unreliable*
Estimation by analogy	Compare with other projects in the same application domain ☞ *limited applicability*
Parkinson's Law	Work expands to fill the time available ☞ *pessimistic management strategy*
Pricing to win	You do what you can with the budget available ☞ *requires trust between parties*

Estimation Techniques

“Decomposition” and “Algorithmic cost modeling” are used together

Decomposition	Estimate costs for components + integration ☞ *top-down or bottom-up estimation*
Algorithmic cost modeling	Exploit database of historical facts to map size on costs ☞ *requires correlation data*

Measurement-based Estimation

A. Measure

Develop a *system model* and measure its size

C. Interpret

Adapt the effort with respect to a specific *Development Project Plan*

B. Estimate

Determine the effort with respect to an *empirical database* of measurements from *similar projects*

More on this later (Metrics lecture) …

Estimation and Commitment

Example: The XP process

1. a. Customers *write stories* and
   b. Programmers *estimate stories*
   — else ask the customers to split/rewrite stories

2. Programmers *measure the team load factor*, the ratio of ideal programming time to the calendar

3. Customers *sort stories by priority*

4. Programmers *sort stories by risk*

5. a. Customers pick date, programmers calculate budget, customers pick stories adding up to that number, *or*
   b. Customers pick stories, programmers calculate date
   (customers complain, programmers ask to reduce scope, customers complain some more but reduce scope anyway) …

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Some Laws of Project Management

> A carelessly planned project will take three times longer to complete than expected. A carefully planned project will only take twice as long.

> Project teams detest progress reporting because it manifests their lack of progress.

> Projects progress quickly until they are 90% complete. Then they remain at 90% complete forever.

> If project content is allowed to change freely, the rate of change will exceed the rate of progress.

Planning and Scheduling

Good planning depends largely on project manager's intuition and experience!

> Split project into *tasks*.
  — Tasks into subtasks etc.

> For each task, *estimate* the time.
  — Define tasks small enough for reliable estimation.

> Significant tasks should end with a *milestone*.
  — Milestone = A *verifiable* goal that must be met after task completion
  — Clear unambiguous milestones are a necessity! ("80% coding finished" is a meaningless statement)
  — *Monitor progress* via milestones

Planning and Scheduling ...

> Define *dependencies* between project tasks
  - —Total time depends on longest (= critical) path in activity graph
  - —Minimize task dependencies to avoid delays

> Organize tasks *concurrently* to make optimal use of workforce

Planning is *iterative*

⇒ *monitor and revise* schedules during the project!

Myth: Deliverables and Milestones

Myth

“The only deliverable for a successful project is the working program.”

Reality

Documentation of all aspects of software development are needed to ensure maintainability.

Deliverables and Milestones

Project deliverables are results that are delivered to the customer.

> E.g.:
  - initial requirements document
  - UI prototype
  - architecture specification

> Milestones and deliverables help to *monitor progress*
  - Should be scheduled roughly every 2-3 weeks

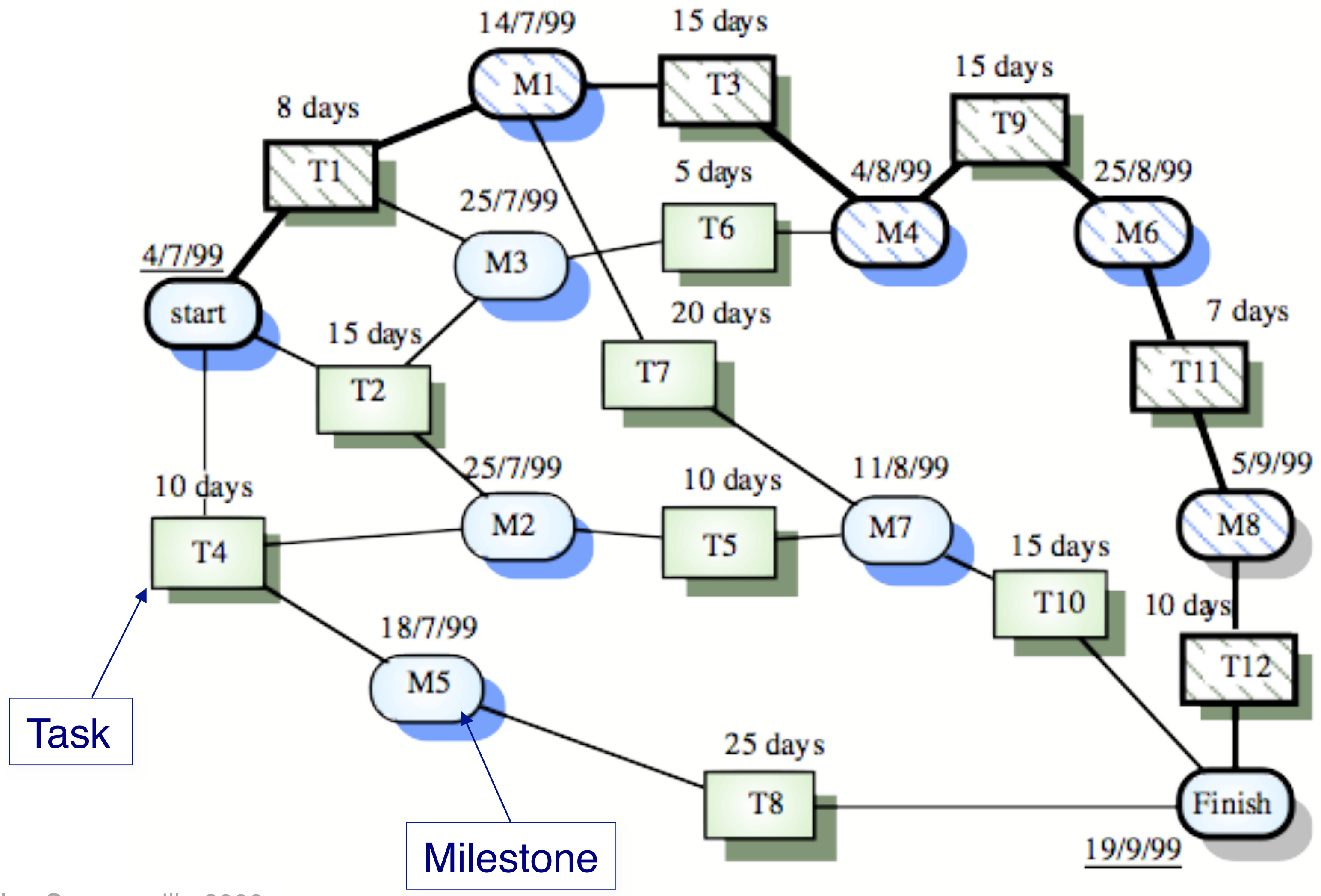
NB: Deliverables must evolve as the project progresses!

Example: Task Durations and Dependencies

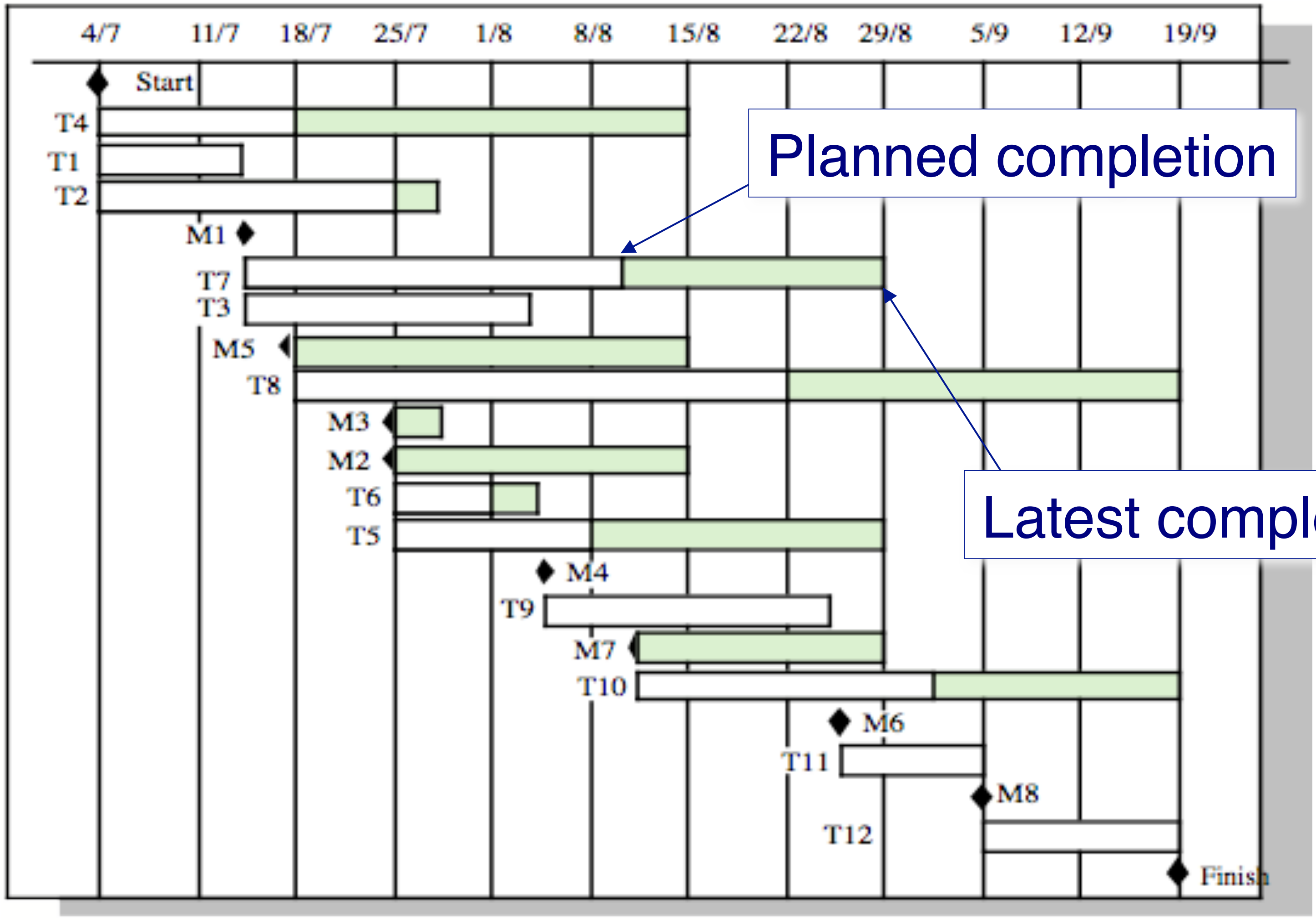
Task	*Duration (days)*	*Dependencies*
T1	8	
T2	15	
T3	15	T1
T4	10	
T5	10	T2, T4
T6	5	T1, T2
T7	20	T1
T8	25	T4
T9	15	T3, T6
T10	15	T5, T7
T11	7	T9
T12	10	T11

What is the minimum total duration of this project?

Pert Chart: Activity Network



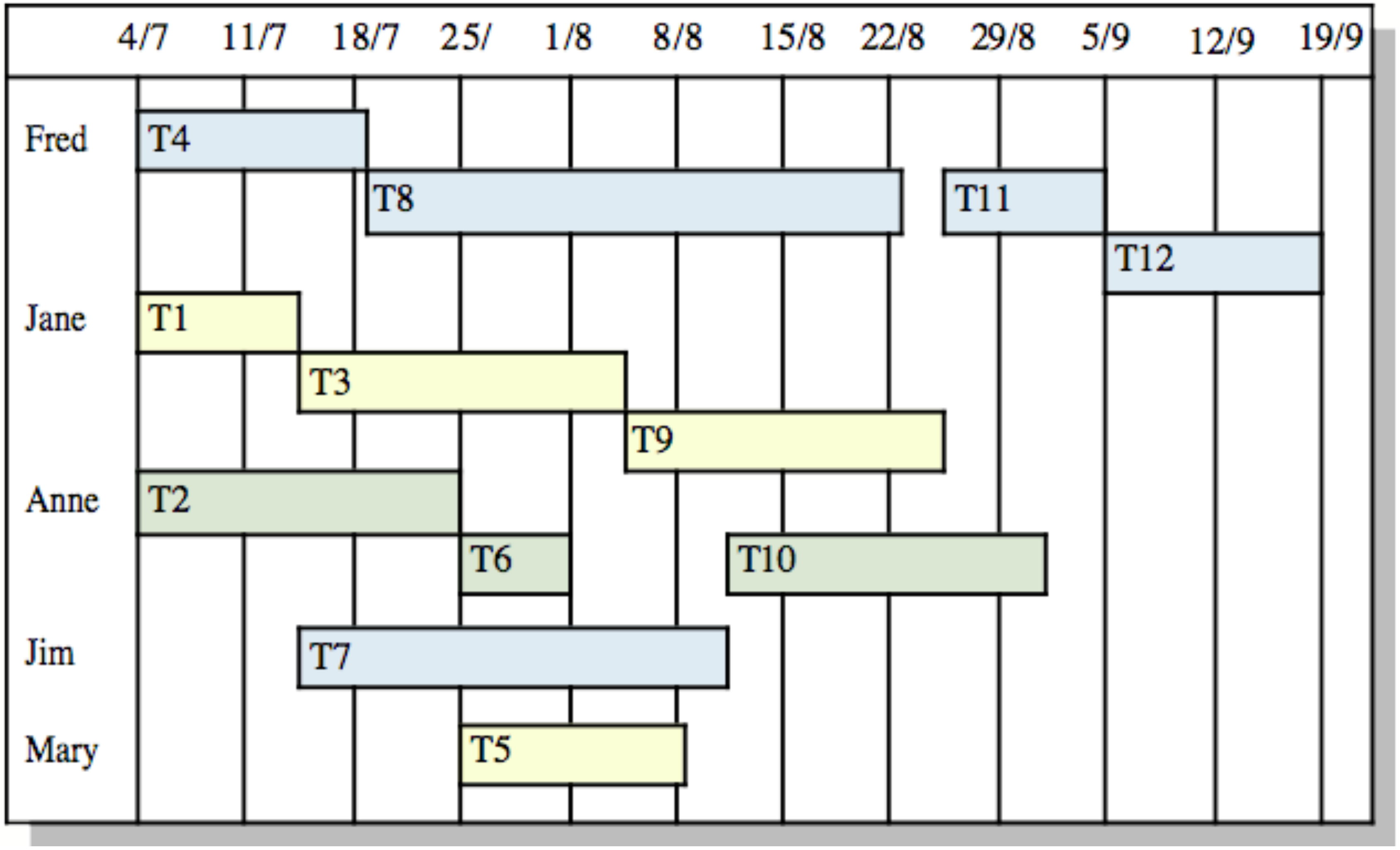
Gantt Chart: Activity Timeline



Planned completion

Latest completion

Gantt Chart: Staff Allocation



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Myth: Delays

Myth

“If we get behind schedule, we can add more programmers and catch up.”

Reality

Adding more people typically slows a project down.

Scheduling problems

> Estimating the difficulty of problems and the cost of developing a solution is *hard*

> Productivity is *not proportional* to the number of people working on a task

> Adding people to a late project *makes it later* due to communication overhead

> *The unexpected always happens*. Always allow contingency in planning

> Cutting back in testing and reviewing is *a recipe for disaster*

> *Working overnight?* Only short term benefits!

Planning under uncertainty

> State clearly *what you know and don’t know*
> State clearly *what you will do* to eliminate unknowns
> Make sure that *all early milestones* can be met
> Plan to *replan*

Dealing with Delays

Spot potential delays as soon as possible

... then you have more time to recover

How to spot?

> Earned value analysis
  — planned time is the project budget
  — time of a completed task is credited to the project budget

...

Dealing with Delays ...

How to recover?

A combination of following 3 actions

- *Adding senior staff* for well-specified tasks
  - outside critical path to avoid communication overhead
- *Prioritize requirements* and deliver incrementally
  - deliver most important functionality on time
  - testing remains a priority (even if customer disagrees)
- *Extend the deadline*

Gantt Chart: Slip Line

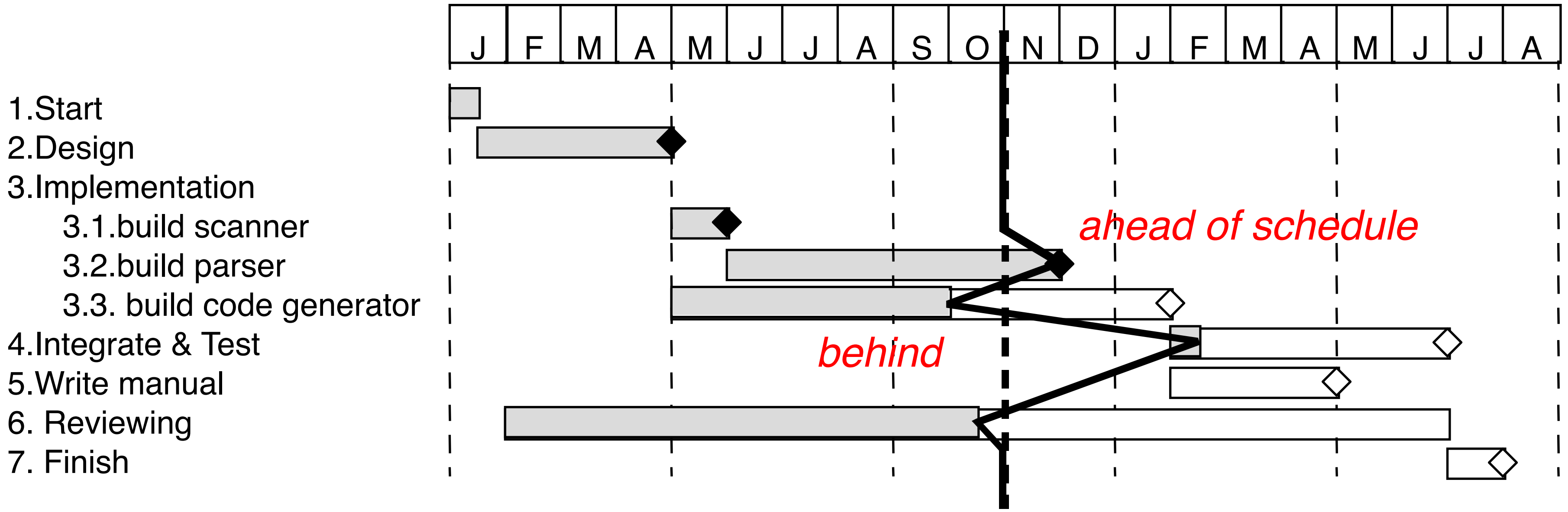
Visualize slippage

> Shade time line = portion of task completed

> Draw a slip line at current date, connecting endpoints of the shaded areas

— bending to the right = ahead of schedule

— to the left = behind schedule

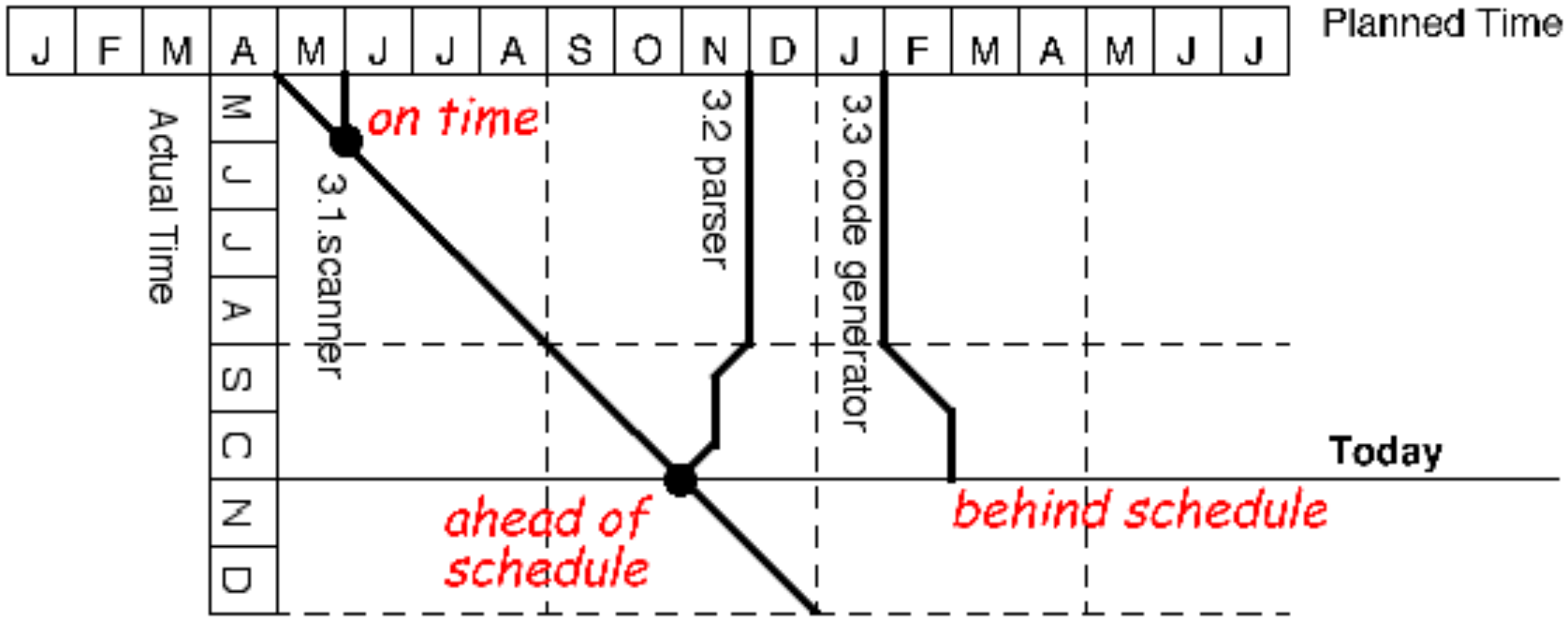


Timeline Chart

Visualise slippage evolution

> downward lines represent planned completion time as they vary in current time

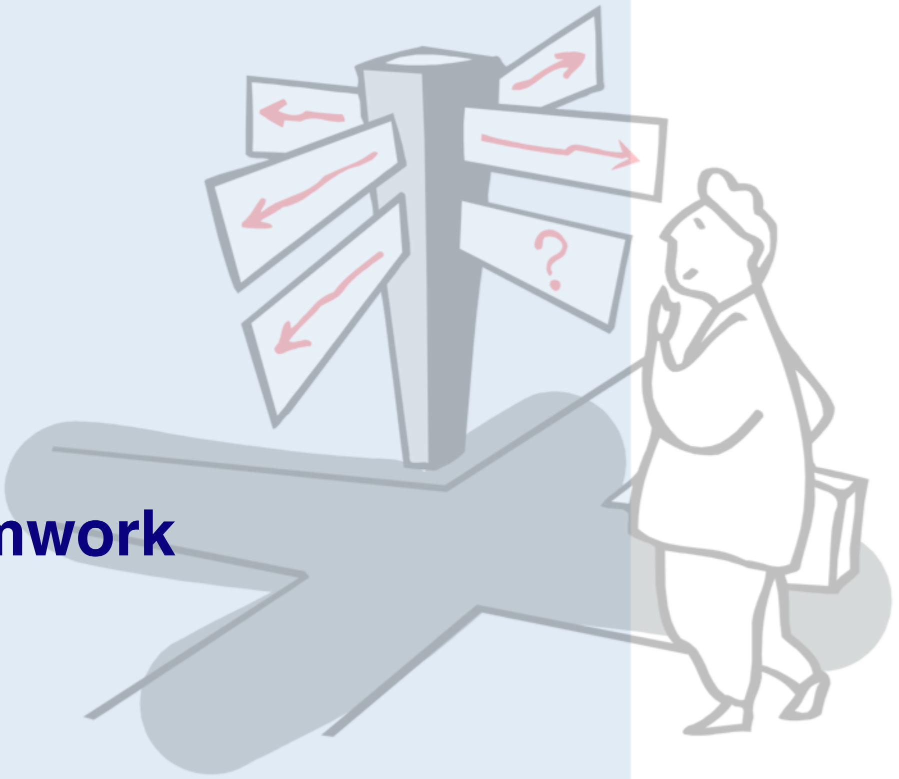
> bullets at the end of a line represent completed tasks



Slip Line vs. Timeline

Slip Line	Monitors *current slip status* of project tasks > many tasks > only for 1 point in time —include a few slip lines from the past to illustrate evolution
Timeline	Monitors how the slip status of project tasks *evolves* > few tasks — crossing lines quickly clutter the figure — colours can be used to show more tasks > complete time scale

Roadmap



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Software Teams

Team organisation

> *Teams should be relatively small* (< 8 members)
  — minimize communication overhead
  — team quality standard can be developed
  — members can work closely together
  — programs are regarded as team property (“egoless programming”)
  — continuity can be maintained if members leave
> Break big projects down into multiple smaller projects
> Small teams may be organised in an informal, democratic way
> *Chief programmer teams* try to make the most effective use of skills and experience

Chief Programmer Teams (example)

> Consist of a kernel of specialists helped by others as required
  - *chief programmer* takes full responsibility for design, programming, testing and installation of system
  - *backup programmer* keeps track of CP's work and develops test cases
  - *librarian* manages all information
  - others may include: project administrator, toolsmith, documentation editor, language/system expert, tester, and support programmers …

> Reportedly successful but problems are:
  - Can be difficult to find talented chief programmers
  - Might disrupt normal organizational structures
  - May be de-motivating for those who are not chief programmers

Egoless Programming (example)

- No code “ownership”
- Frequent code reviews to expose defects
  - Review the code, *not* the developer
- Promotes more “democratic”, less hierarchical team structure

Directing Teams

Managers serve their team

> Managers ensure that team has the *necessary information and resources*

"The manager's function is not to make people work, it is to make it possible for people to work"

— Tom DeMarco

Responsibility demands authority

> Managers must *delegate*

— Trust your own people and they will trust you.

Directing Teams ...

Managers manage

> Managers cannot perform tasks on the *critical path*
  — Especially difficult for technical managers!

Developers control deadlines

> A manager cannot meet a deadline to which the developers have not agreed

What you should know!

- How can prototyping help to reduce risk in a project?
- What are milestones, and why are they important?
- What can you learn from an activity network? An activity timeline?
- What's the difference between the 0/100; the 50/50 and the milestone technique for calculating the earned value.
- Why should programming teams have no more than about 8 members?

Can you answer these questions?

- What will happen if the developers, not the customers, set the project priorities?
- What is a good way to measure the size of a project (based on requirements alone)?
- When should you sign a contract with the customer?
- Would you consider bending slip lines as a good sign or a bad sign? Why?
- How would you select and organize the perfect software development team?

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