Engineering Management BMEVITMMB03

Project management

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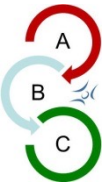
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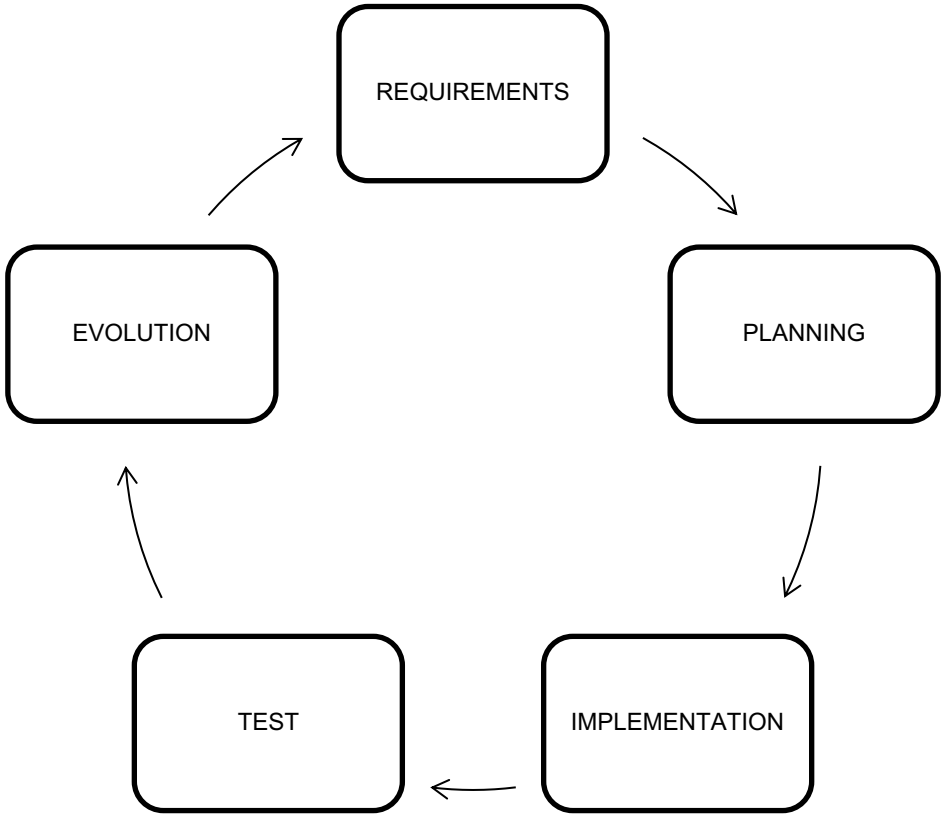
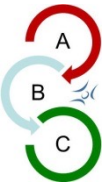

REQUIREMENTS
PLANNING
IMPLEMENTATION
TEST
EVOLUTION

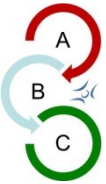


Routine or improvisation ?

- Routine procedure
- continuity;
- recurrence;
- series of tasks;
- optimalisation;
- inelastic means of production;
- examples
  - product assembly,
  - repetitive administrative work

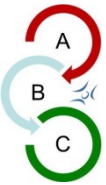
- Improvisation
- quick responses to changing situations;
- „there are no rules and procedures”;
- useful in individual situations where there are no clear goals, means, or circumstances;
- examples
  - the idea of an immediate solution to a sudden professional problem;
  - first day in school …

=> Procedures lead to the development of a routine.



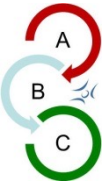
Definitions of project

- A project is a temporary endeavor with a defined beginning and end (usually time-constrained and often constrained by funding or products). /Harrison, 1993/
- A project can be defined as a temporary endeavor undertaken to create a unique product or service. /Stuckenbruck, 1993/
- Project is a unique process consisting of a set of coordinated and controlled activities with start and finish dates, undertaken to achieve an objective conforming to specific requirements including constraints of time, cost and resources. /ISO 8402, 1994/



A project

- For well-defined and documented objectives (outputs);
- Has influence on the resource portfolio of the company;
- Utilizes (limited) resources;
- Causes changes in its environment;
- Not „daily routine” in the life of a company;
- Unique (probably never repeated);
- Has given starting and ending dates;
- Usually is late to start,
- Often needs new methodology and technology;
- Well documented procedure.

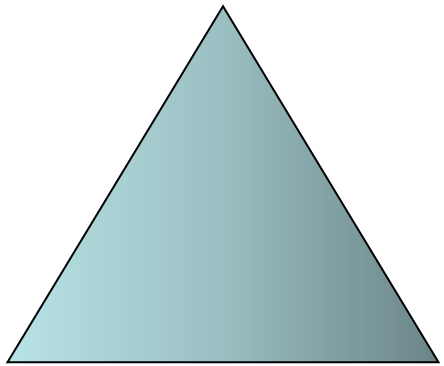


Resources of a project

- A project is a set of activities utilizing resources:
  - time,
  - money,
  - manpower (knowledge, experience),
  - material,
  - energy,
  - place
  - …

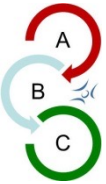
Project triangle

Scope (objectives, quality)



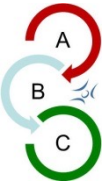
Time

Money



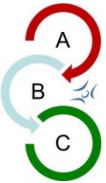
Items of project triangle

- **Scope**: requirements specified to achieve the final result (output). The overall definition of what the project is supposed to accomplish and a specific description of what the final result should be or accomplish.
  - **S.M.A.R.T.** model: the aim should be specific, measurable, attainable, relevant and time-bound.
  - there are some crucial success criteria among others.
- **Time:** required to produce the outputs (products or services). It is estimated using several techniques. One method is to identify tasks needed to produce the outputs documented in the work breakdown structure (**WBS**, see later).
- **Money:** to cover (buy) fixed and variable amount of other resources



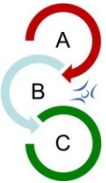
Reasons to initiate a project

- Derived from strategy (top - down)
- Development initiatives from employees (bottom - up)
- Outside of the company:
  - from business partners,
  - obligation, charge laid by law, authority,
  - constraint by the environment.
- …



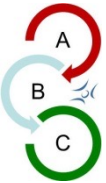
Project types (by nature)

- PRODUCT DEVELOPMENT AND MANUFACTURING (if unique)
  - real estate development
  - machine manufacturing
  - service development
- ORGANIZATION, MANAGEMENT
  - functional planning
  - realignment
  - software installation
- RESEARCH, IMPLEMENTATION
  - fundamental research
  - applied research



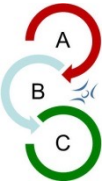
9 areas of project management 1/2

- Integration management harmonizes the different elements of the project.
- Scope management is to reach the aims of the project, furthermore to reengineer the project in case of changing the aims.
- Schedule management is to keep the original time schedule.
- Cost management is to keep the budget, furthermore to recognize the overspending and revise it.



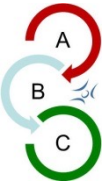
9 areas of project management 2/2

- Quality management is to achieve the project results of expected and specified parameters (quality).
- Human resource management is to utilize, improve and train the human resource optimally.
- Communication management is to plan and run different communication channels to inform all the stakeholders involved in the project frequently enough.
- Risk management is to identify, analyse, minimize and prevent from risk, to work out risk contingency plan (once risks have been identified, what kind of countermeasures to execute).
- Acquisition management is to control the cooperation with partners and suppliers.



Approaches to manage projects

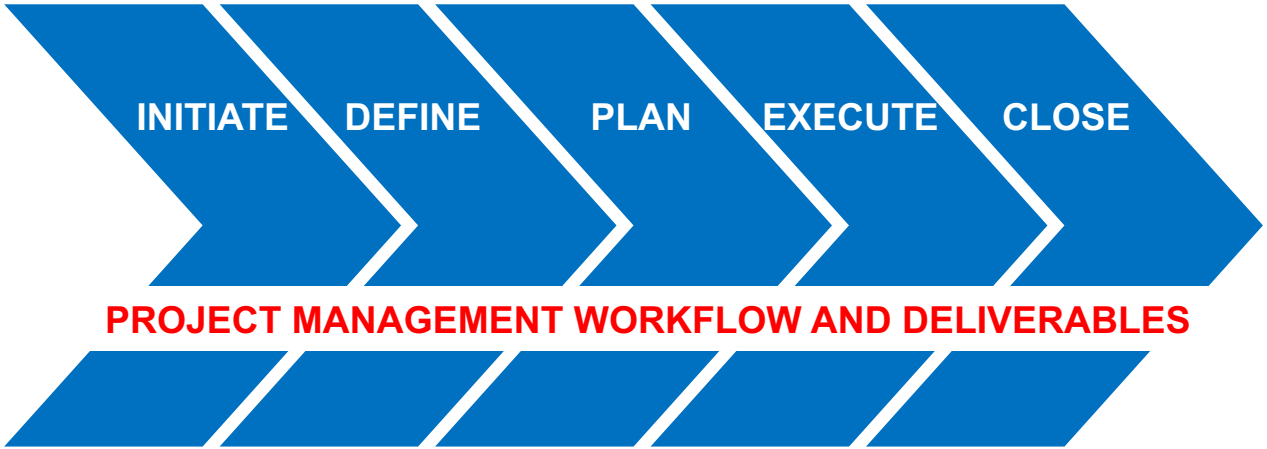
- Traditional approach: five „classical” components of a project can be distinguished (four stages plus control): initiation, planning, execution, completion and monitoring (control).
- RUP method: Rational Unified Process (RUP) is an iterative software development process framework created by the Rational Software Corporation, a division of IBM.
- PERT: the time parameters come from probability distribution (see later).
- Critical chain project management (CCPM) is a method of planning and managing project execution considering the limited availability of resources (physical, human skills, as well as management and support capacity) needed to execute the project. This is useful for multi-project management with resource leveling.

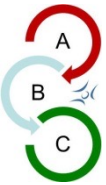


Multi-project management

- Aggregation of projects, joint projects
- Planning (construction) and execution a group of projects together
- Managing independent projects of common resources simultaneously

Project in Time

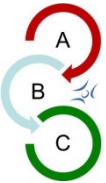




DEFINE a project

- Problem: the reason of the project (5W)
- Functional / technical targets
- Expected results in effecticiency or in ecopnomy
- Expected deliverables
- Beginning assumptions
- Risk factors
- Resource requirements and limits

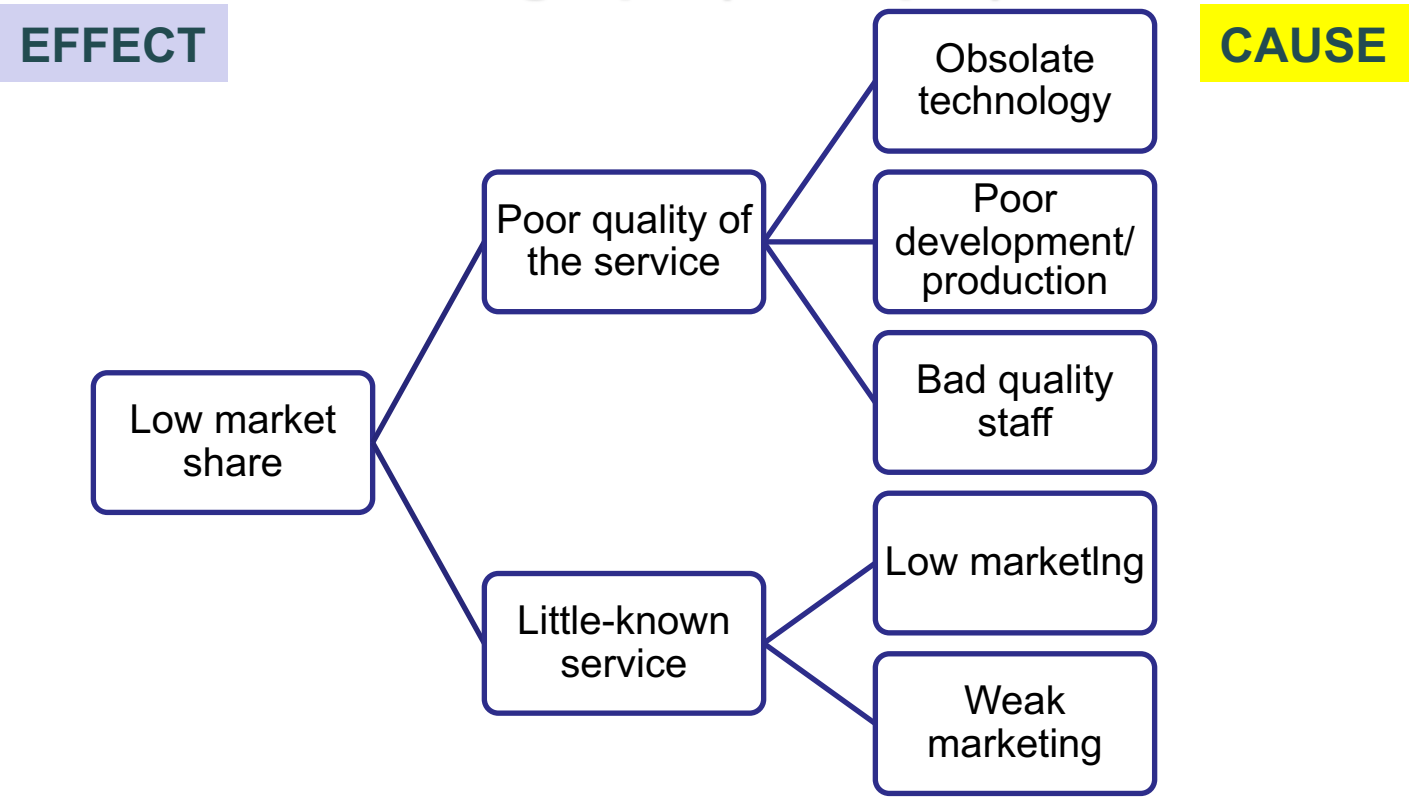
- (output: Feasibility study, project founding document)



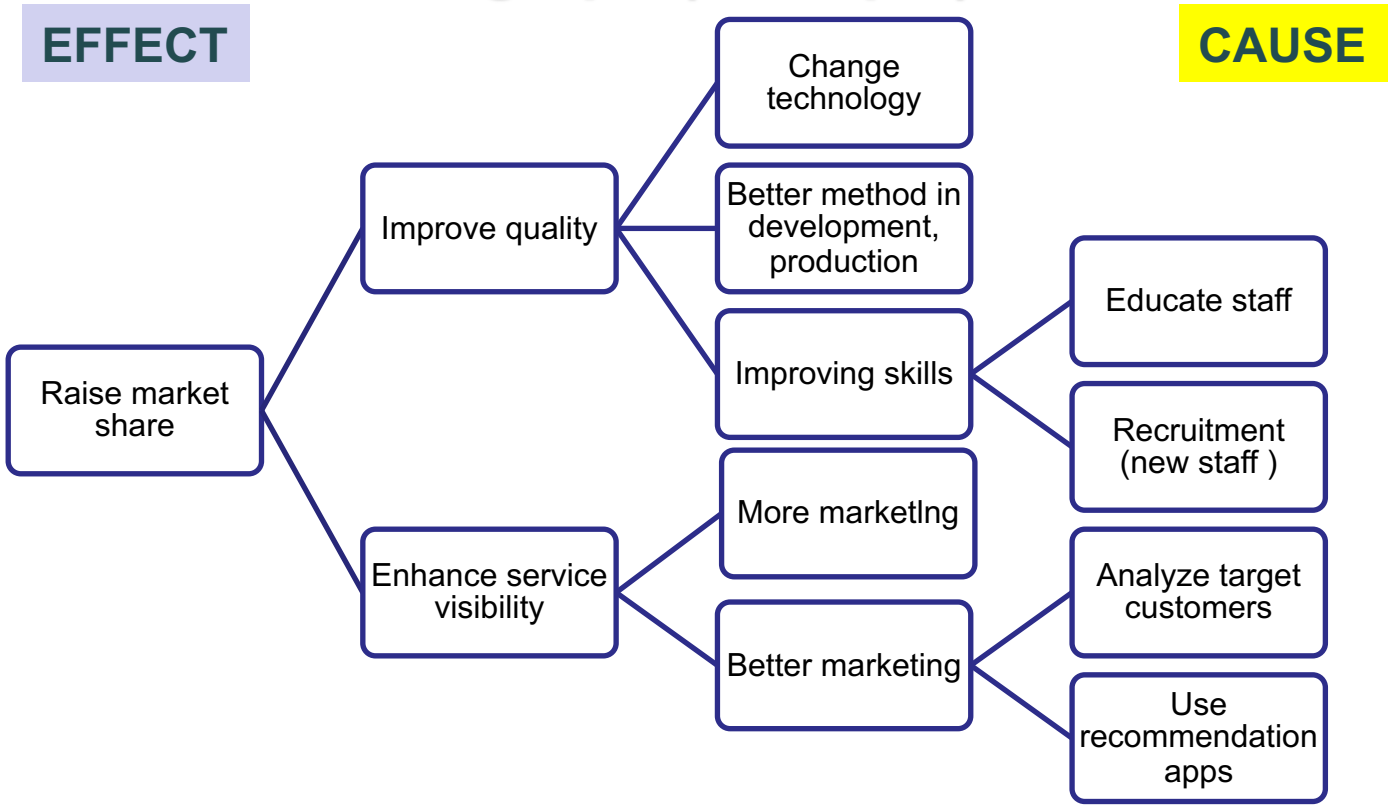
Define: the problem

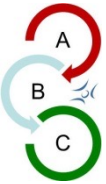
- Problem graph
- This method places the problems in a causal context (causes / effects)
- First identifies problem(s). Why we are looking for the answer to a specific question (why that effect occured?).
- Than we build a problem graph. We establish a hierarchical order by examining causal relationships. Problems encountered need to be evaluated, placed in the hierarchy. In case
  - A is the reason for B, then we place it under B,
  - A is a consequence of B, it is placed above B.
  - neither cause nor effect, it is placed at the same level
- Result: tree structure, decomposed into several branches, top is the main problem.
- Goal graph
- The goal graph describes that by what interventions can be used to change the causes of an effect.

Problem graph (example)



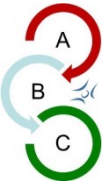
Goal graph (example)





5W in preparing problem graph

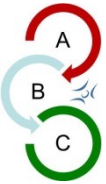
- What / What happened? (detailes, circumstances)
- Where / Where happened? (location can be a reason of the problem)
- When / When happened? (date, season, shit, time of day)
- How / How happened? (what was before / after)
- Why / Why happened? (find reasons)
- Who / Who are involved in managing the problem?



PLAN a project

- Determination of work breakdown structure (WBS)
  - broken down into tasks
  - calculation the time requirements of tasks
  - determination the order of tasks
- Time planning (schedule)
  - calculation the time parameters of activities (start, finish, spare time)
  - estimation the shortest time possible to complete the project
- Resource planning
  - resource inventory
  - determination the resource necessities of activities
  - resource allocation (necessities and capacities, resource leveling)
- Cost planning
- Quality and risk planning
- Communication and security planning

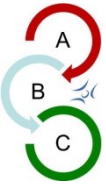
- OUTPUT: project plan



Break the whole into small(er) „pieces”

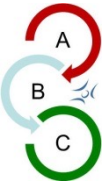
i.e. You can define for those pieces

- implementation time
- resource
- responsible persons



WBS: work breakdown structure

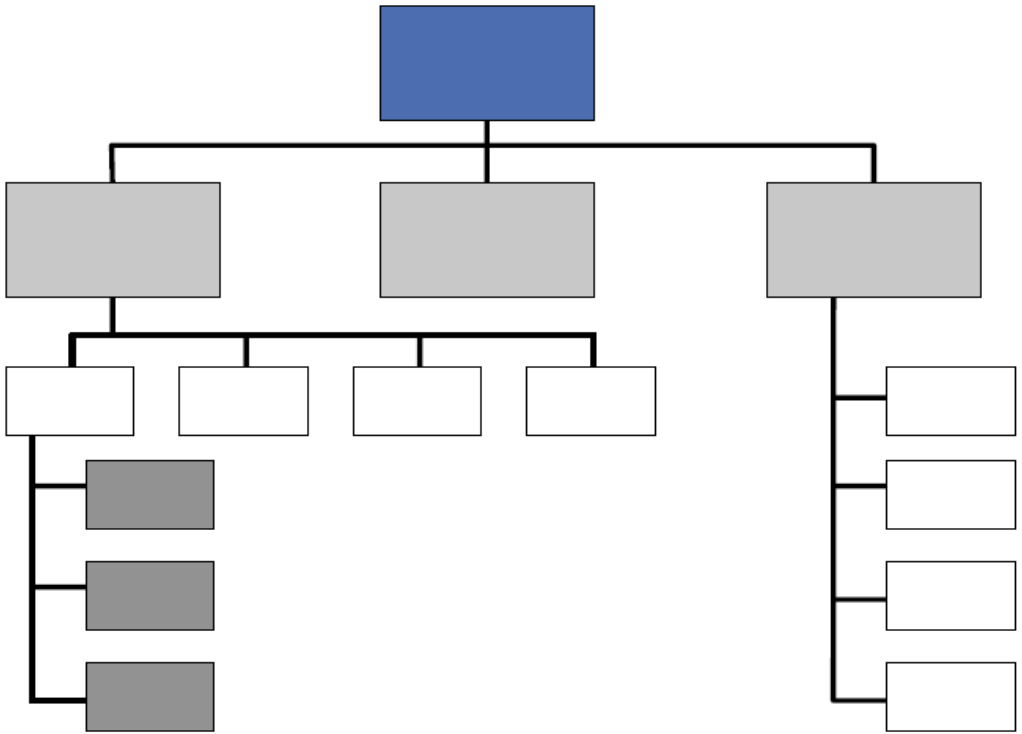
- WBS is developed by starting with the final objective and successively subdividing it into manageable components in terms of size, duration, and responsibility (e.g., systems, subsystems, components, tasks, subtasks, and work packages) which include all steps necessary to achieve the objective.
- Levels of WBS:
    - project
    - sub-project
    - group of tasks
    - task
    - (...)

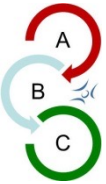


Interdependence - relationships among activities

- Spreading
  - activities use same resource(s)
  - an error occuring in one of the activities can influence other ones using common resource(s)
- Sequential
  - an activity depends on another one
  - two types: simple and overlapping
    - simple: first activity should be finished to start the second one
    - overlapping : it is enough to execute only a part of the first activity to start the second one
- Reciprocal
  - Solution (execution) of a task is iterated among participants until the end of the project.
  - e.g.: negotiation between the customer and supplier

1. Level of the (whole) Project
2. Level of sub-projects
3. Level of the task groups
4. Level of tasks



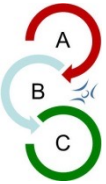


Time planning techniques – Gantt-diagram

- Advantage:
  - schedule is in a clearly arranged form
- Disadvantages:
  - in complex projects of too many activities can be chaotic (not transparent enough)
  - relationships can not be clear
- Elimination of disadvantages:
  - introduction of slippage time
  - plotting of dependence arrows

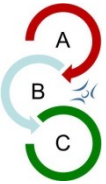
Gantt-diagram

WORKS	TIME (Day)
Examine the chair as a new product	
Planning and drawing	
Purchasing of metal tube	
Purchasing of chair cover	
Purchasing of castor-wheel	
Completion of frame	
Painting of elements	
Assembling	
Quality assessment	



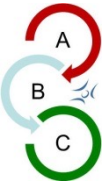
Time planning techniques – Network planning

- Essential part is a network diagram, where internal relationships (e.g. sequences, conditions) of tasks and activities represented.
- Two classical methods:
  - **CPM** (Critical Path Method): duration of activities are defined, so the time parameters are fixed (deterministic method)
  - **PERT** (Program Evaluation and Review Technique): the time parameters come from probability distribution (stochastic method)



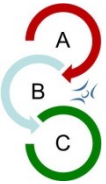
Steps of CPM 1/2

1. Identification of tasks
   (lists of tasks, subtasks and activities)
2. Determination of predecessor/successor (logical) relationship among tasks
   (identification of logical relationships and visualization)
3. Determination of time parameters of activities
   - early start time (ES)
   - early finish time (EF)
   - late start time (LS)
   - late finish time (LF)



Steps of CPM 2/2

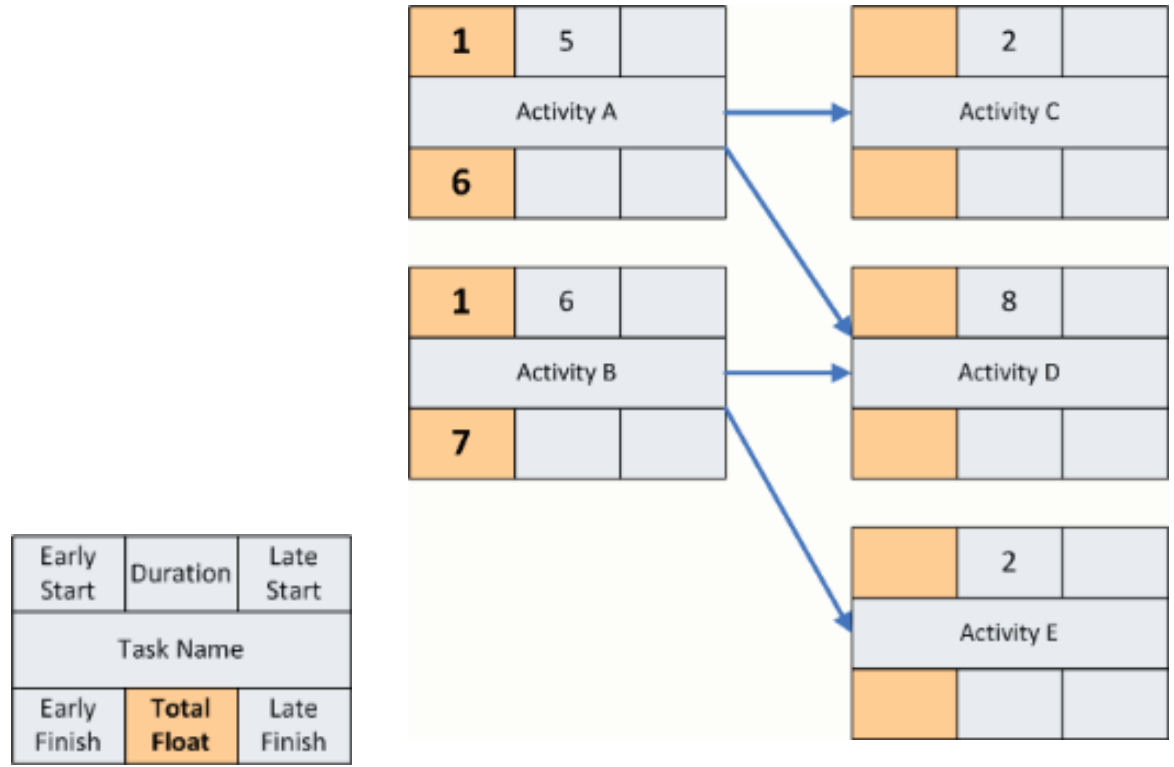
4. Determination of critical path
   - critical path: the longest possible continuous pathway (consisting of critical activities) from the initial event to the terminal one. It determines the total calendar time required for the project.
   - critical activity: an activity whose total floating time is zero.
   - total floating time (TFT) (or slack): the amount of time by which a project task can be delayed without causing a delay in any subsequent tasks (free floating time) or the whole project.
   - free floating time: there is no critical delay



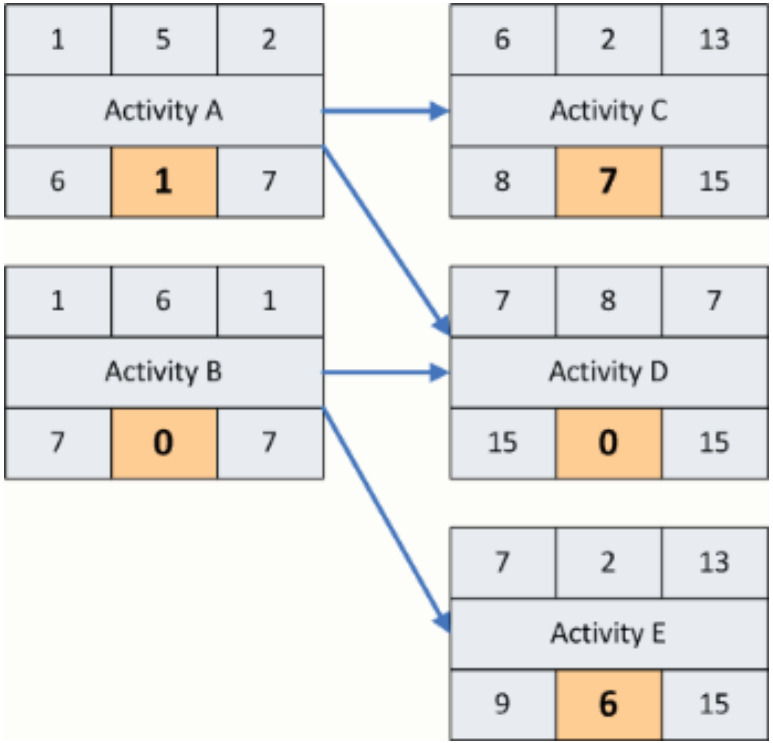
Determination of critical path

- Steps:
  - Determination of ES, EF, LS, LF values of activities
  - Calculation of total floating time of each activity
    TFT = LS – ES; TFT = LF – EF
  - Joining the critical activities we can get the critical path

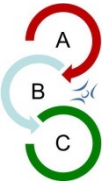
Determination of critical path (example)



Determination of critical path: EXAMPLE (Solution)

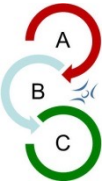


Early Start	Duration	Late Start
Task Name		
Early Finish	**Total Float**	Late Finish



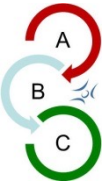
Shortening of critical path 1/2

- More resources for critical activities:
  - more own human resource (more people),
  - lease-work,
  - overtime,
  - more tools (eg.: IT) to replace human resource.



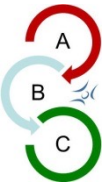
Shortening of critical path 2/2

- Move resources from non-critical activities to critical ones.
- Change the project network introducing:
  - parallel activities,
  - overlapping the activities on the critical path.
- Focus on earliest and longest activities.



PERT

- Similar to CPM, but ...
- in case the duration of the activities cannot be determined because of random (uncertain) factors.
- Two requirements for the use:
  - duration of the activities should be independent random variables
  - expected values and standard deviations of independent random variables should be well estimated

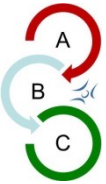


PERT

- Estimations:
  - optimistic time (to): the minimum possible time required to accomplish a task, assuming everything proceeds better than is normally expected
  - most likely time (tm): the best estimate of the time required to accomplish a task, assuming everything proceeds normally.
  - pessimistic time (tp): the maximum possible time required to accomplish a task, assuming everything goes wrong (but excluding major catastrophes).
- Calculation:

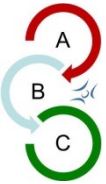
$$t_e = \frac{t_o + 4t_m + t_p}{6} \text{ and } \mathrm{v} = \left(\frac{t_p - t_o}{6} \right)^2$$

- te = expected time; the best estimate of the time required to accomplish a task
- v = variance of time



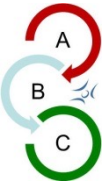
Cost management

- Methods and tools to accomplish the project in the predetermined cost plan.
- Elements:
    - Resource planning
    - Cost estimation
    - Budget calculation
    - Cost verification



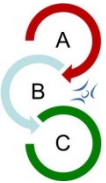
Resource planning

- Determination of resources (human, tool, equipment, material) and their quantity and quality for the project.
- Required:
  - WBS – resource usage
  - A priori information – experience
  - List of resources – real demand
  - Policy in organization – human resources and tools
  - When are the resources available?



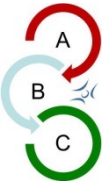
Planning the load of resources

- The resource allocation is a distribution involving eg. manpower. In resource loading each employee is assigned to a task in a percentage of a project (x% of the whole).
- The total load of resource is the summary of resources in all parallel activities.



Steps of resource planning

- For each activity:
  - gathering the resources into resource inventory.
  - determining the resource needs (norms)
- For each resource:
  - investigation of the cumulative resource demands as a function of time
  - use of resource leveling if required
    - exploitation of free float
    - modification of norms
    - more delay (modification of original time schedule)

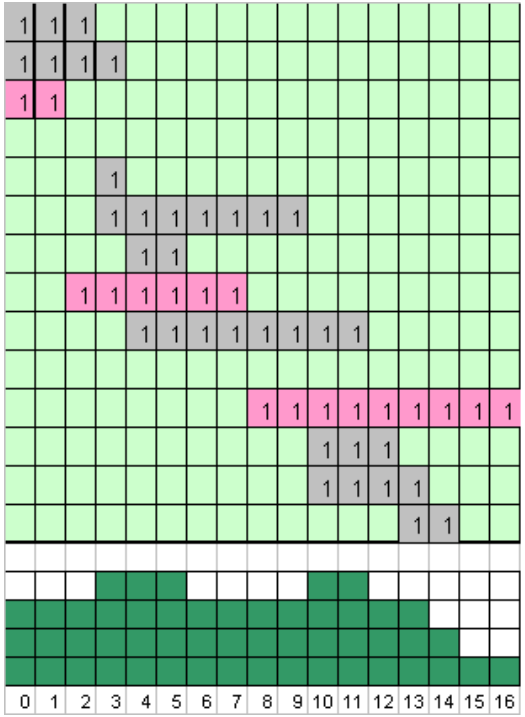


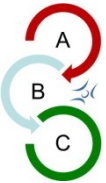
Resource allocation

- How to manage the resources of the project?
- What is the resource need in function of time during the project?
- What should be done when the demand exceeds our capacities?
- „Time is money”. Why?
  - more salaries
  - indemnity (penalty)
  - worse deals
  - consequences of damages

Resource allocation

- Each activity starts at earliest time in the Gantt diagram.
- The dark green diagram shows the cumulative demands of the concerned resource as a function of time.

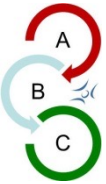




Project documents 1/3

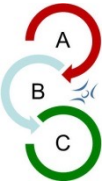
Documents containing the tasks, expectations of the project:

- Feasibility study
- Document of foundation
- Requirements specification
- Changing management procedure
- Plan for risk management
- Communication plan
- Project plan
- Project terminating document
- Database of conclusions



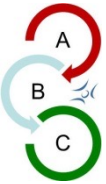
Project documents 2/3

- Feasibility study (business case) describes the needs and solution alternatives to the problem.
- Document of foundation is the constitution of the project. It contains the framework, expectations, scope, deadlines and the project team.
- Requirements specification describes the aims in details.
- Change management procedure describes how to modify the original project plan if necessary.
  Escalation procedure: to invest additional resources in an apparently losing situation, influenced by effort, money and time already invested.



Project documents 3/3

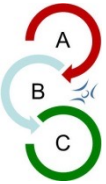
- Plan for risk management: describes how to identify and evaluate different types of risk, assign responsible persons and cover areas of activities.
- Communication plan: communication strategy among the stakeholders. Notification to whom, about what, how often, through which channel?
- Project plan: contains the tasks, deadlines, responsibilities. The resource plan can also be outlined in this document.
- Project terminating document: summary, conclusion of the project, open to all stakeholders.
- Database of conclusions: here the project manager enters the conclusions, methods, solutions learnt during the project on record (for internal use only).



Planning budget 1/2

Starting with fix cost: TOP-DOWN

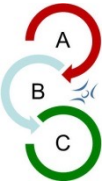
- The budget is
  - fixed or
  - it is the largest restriction factor and the subtasks are not clear.



Planning budget 2/2

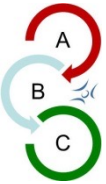
Starting with activities: BOTTOM-UP

- The cumulated budget will be the sum of the costs of subtasks. This type of planning can be used if there is no serious limit for budget, the aim is clear and the team can break it down into subtasks.



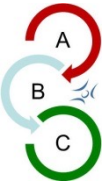
Project cost elements

- Resource dependent costs
  - Norm(al) costs
  - Overtime costs
- Stress costs: constant costs independent of activities, eg.: rent.
- Activity dependent costs: correspond to work packages.



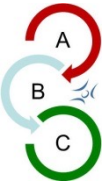
Risk analysis

- Assessment of
  - probabilities of problems (dangers) and
  - effects of problems to the project.
- Assessment starts with problem identification and classification.
- Action plan:
  - how to prevent risks,
  - what to do if something wrong happens (BRP, BCP)



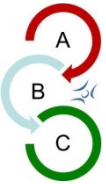
Summary of the planning phase

- Work Breakdown Structure (WBS).
- Precedence Diagram (network plan with logical relationships).
- Estimation of resource needs and times.
- Critical path analysis and determination of total float.
- Schedule in calendar or Gantt diagram.
- Resource loading diagrams.
- Budget.



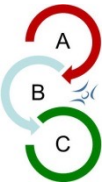
Scopes of project controlling

- Scope of the project
- (Time) Schedule
- Resource usage
- Costs
- Risks



Steps of project controlling

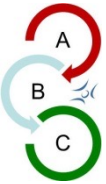
- Monitoring: collecting information from actual project status.
- Comparison of actual state with the original plan.
- Difference analysis: the aim is to reveal, explore the effects and causes of the difference.
- Determination of interventions: the aim is to decrease the difference.
- Revision of plan: the original plan should be revised if necessary.



Estimation of execution time and work expenditures

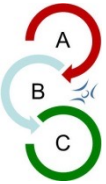
Inaccuracy because of:

- Inaccessible data and resources;
- Training programs or holidays can occur in the project;
- Effectiveness is not the same of different colleagues;
- Different abilities and learning time;
- Private problems and motivations;
- ...



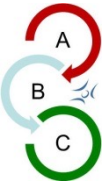
Closing project

- Looking at the final project data.
- The project team should verify whether terminating criteria and indicators of success factors are achieved.
- The aim of projectmanagement is to develop and improve the enterprise or organization via serving satisfied clients.



Expected software functionalities to support projectmanagement

- All calculation from the basic data
- Flexible activity modeling
- Results visualized in several aspects
- Software recalculates output online after any modification
- Calendar, work schedule for resources
- Automatic or manual resource leveling
- Comparison between plan and reality (for controlling purpose)
- Relationship to other projects (for multiproject management purpose)

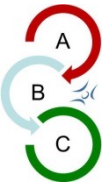


What if ...

the project is to be managed in a rapidly changing business and technological environment?

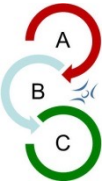
- E.g. keeping mobile apps up to date, extending the period of business success.

- Agile Project Management (APM)



Agile Project Management

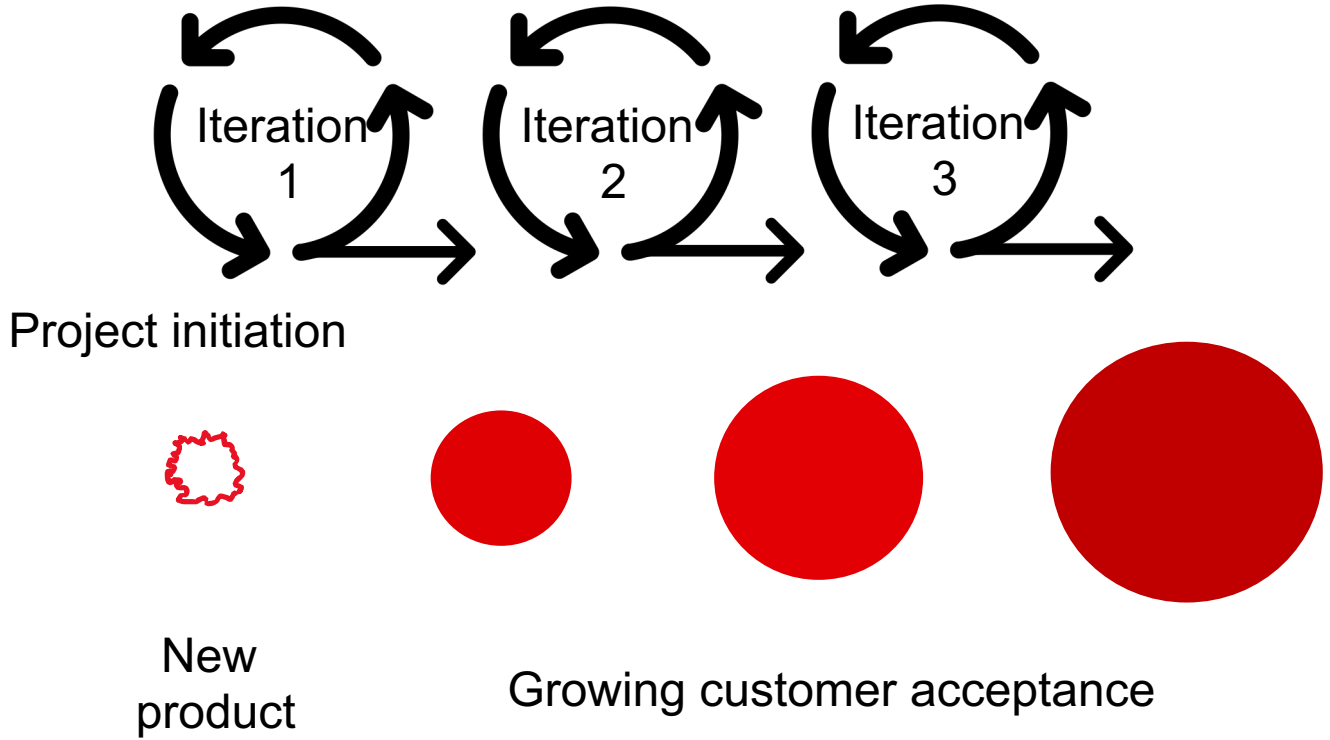
- http://agilemanifesto.org
- Leading project teams in creating and responding to change through:
  - small batches, sprints
  - small, integrated teams
  - small, continuous improvements
- leadership: energizing and empowering project team members to rapidly and reliably deliver customer value:
  - by engaging customers,
  - learning and adapting to their changing needs and environments

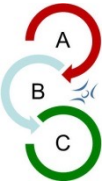


Agile Project Management

- Uses iterations (“time boxes”) to develop a workable product that satisfies the customer and other key stakeholders.
- Stakeholders and customers review progress and re-evaluate priorities to ensure alignment with customer needs and company goals.
- Adjustments are made and a different iterative cycle begins that subsumes the work of the previous iterations and adds new capabilities to the evolving product.

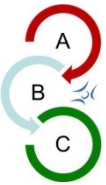
Iterative, incremental product development





APM principles

- Focus on customer value
- Iterative and incremental delivery
- Experimentation and adaptation
- Self-organization
- Continous improvement



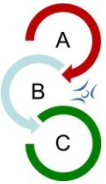
Manifesto for Agile Software Development

We are uncovering better ways of developing software by doing it and helping others do it.

Through this work we have come to value:

- Individuals and interactions over processes and tools
- Working software over comprehensive documentation
- Customer collaboration over contract negotiation
- Responding to change over following a plan

(see: http://agilemanifesto.org)



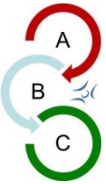
Traditional PM vs. Agile

Traditional PM

- Concentrates on thorough, upfront planning of the entire project.
- Requires a high degree of predictability to be effective.

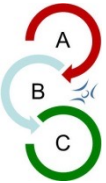
Agile PM

- Relies on incremental, iterative development cycles to complete less-predictable projects.
  - E.g for exploratory projects, where requirements need to be discovered and/or new technology tested.
- Active collaboration between the project team and customer representatives.



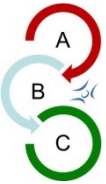
Advantages of APM

- Useful in developing with new technology or defining new features
- Continuous integration, verification, and validation of the evolving product.
- Frequent demonstration of progress to customers
  - helps to meet customer needs
  - early detection of problems



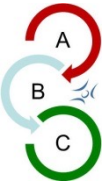
APM methods

- Scrum
- Rapid Product Development
- Lean Development
- Agile Modeling
- Extreme Programming
- ...
- ...



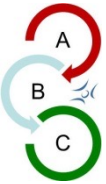
Scrum method

- Holistic approach for use by a cross-functional team collaborating to develop a new product.
- Defines product features as deliverables and prioritizes them (by their perceived highest value to the customer).
- Re-evaluation of priorities in iterations.
- 4 phases: analysis, design, build, test



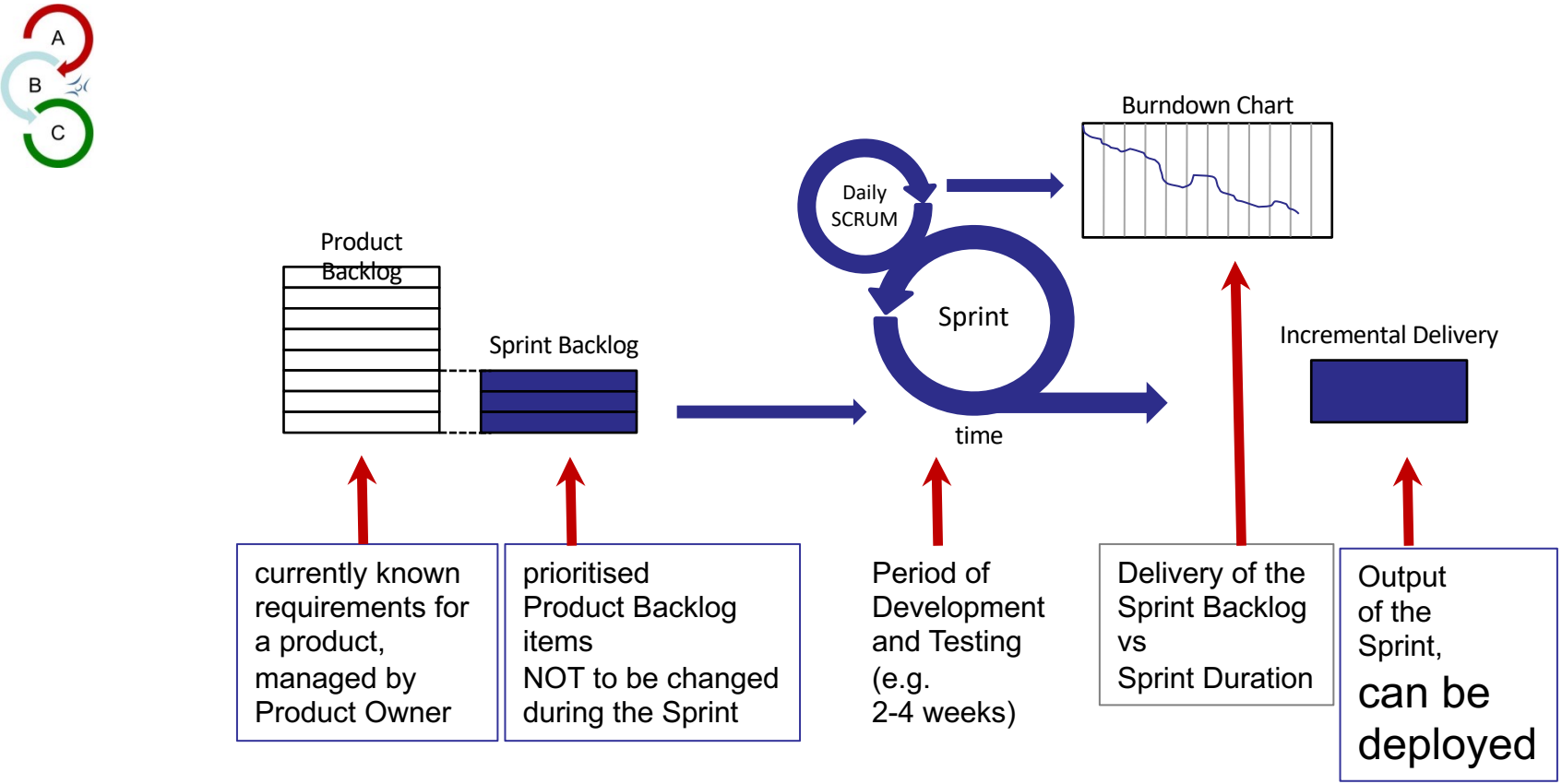
Key roles in Scrum

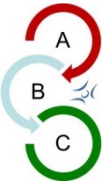
- Product Owner (represents customers interests).
- Project Manager („ Scrum Master”, facilitates scrum process, resolves conflicts in the team, interface to outside environment).
- Development Team (5-10 professionals with cross-functional skill sets).



Scrum elements

- Development Team (Scrum Team)
- Sprint (a period of work)
- Daily Stand-up Meetings
- Product Backlog of all known Requirements
- Sprint Backlog of requirements being worked on
- Burndown Chart to track progress of the Sprint
- Incremental Delivery at the end of each sprint


Burndown Chart
Daily
SCRUM
Product
Backlog
Sprint Backlog
Sprint
Incremental Delivery
time
currently known requirements for a product, managed by Product Owner
prioritised Product Backlog items NOT to be changed during the Sprint
Period of Development and Testing (e.g. 2-4 weeks)
Delivery of the Sprint Backlog vs Sprint Duration
Output of the Sprint, can be deployed

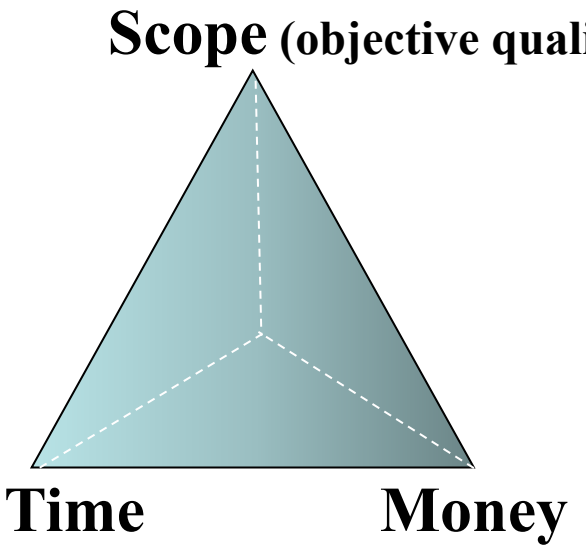


Basic limitations of APM

- Top management needs budget, scope, and schedule control – in advance.
- „Self-organization”, „team collaboration” - can be incompatible with rigid corporate cultures.
- Size limit: 5-10 people working on small projects ?
- Active customer involvement needed.

Back to project triangle

„traditional PM”

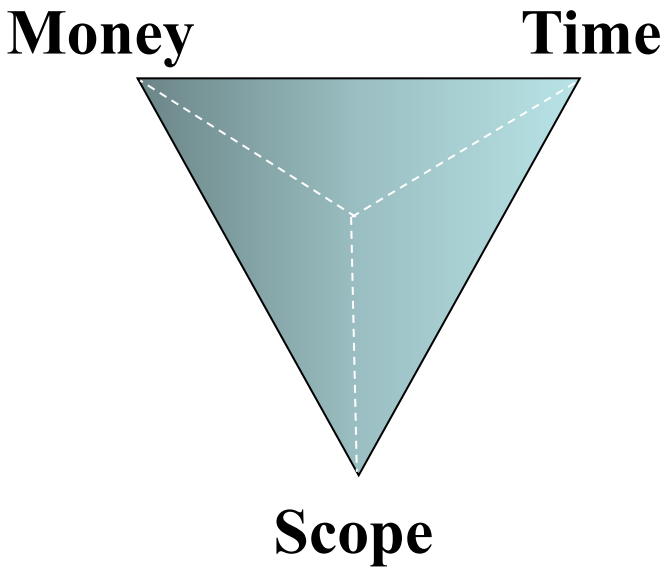


„In what time and from how much money can that scope be implemented?”

Project triangle for APM

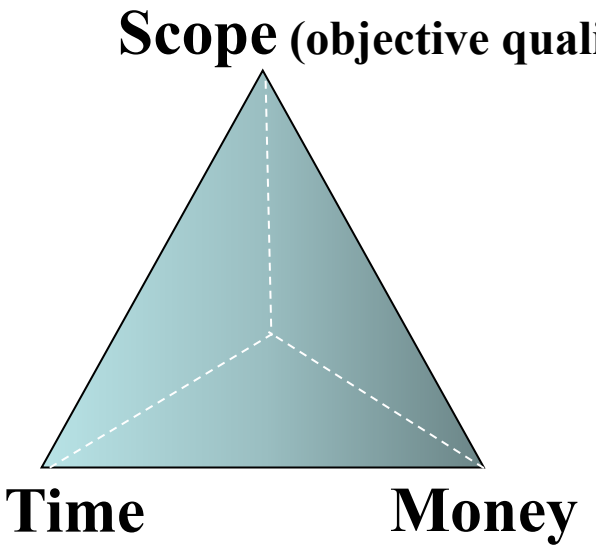
„Agile PM”

„On given money and time what can be implemented?”



Back to project triangle

„traditional PM”



„Agile PM”