Part Four: General Project Management

9. PMBOK - Project Management Body of Knowledge

Since several years, the Project Management Institute (PMI) offers a knowledge-based Project Management method condensed in the Project Management Body of Knowledge (PMBoK). Certificates can be achieved and yielding a Project Management Professional (PM).

Here, I can only give a brief introduction into the approaches of the PMBoK.

9.1 Project Management Knowledge Realms

The PMBoK itself defines a standard for Project Management, including the description of tools and methods like the Work Breakdown Structure (WBS), Critical Path Analysis (CPA), which have been commonly accepted to be effective for Project Management. However for a successful project, the PM Team has to have knowledge about five different realms, including the PMBoK itself (figure 54)

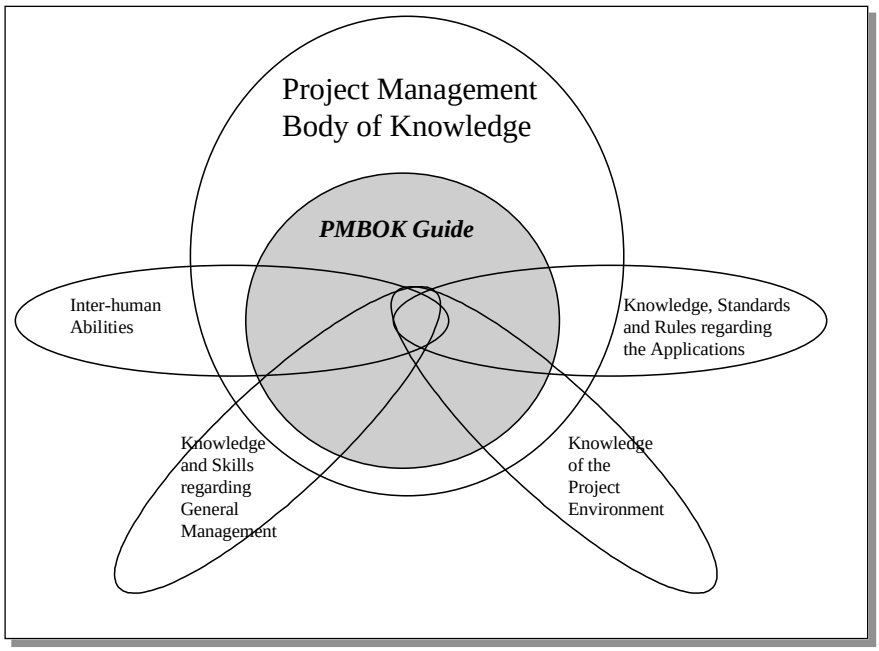

Figure 54: Project Management Knowledge Realms [PMBoK]

- Project Management know-how according to the PMBoK.
  - Definition of the Project Life Cycle-
  - Five PM Process Groups.
  - The nine Project Management Disciplines.
- Knowledge about the Standards and Rules regarding the subject of project (a product or a service) and how it will be applied.

- Supporting infrastructure, e.g. lawyers, organisation of production and delivery, marketing, logistics, Human Resources.
- Technical know-how, regarding production methods, Software development, engineering standards for the particular subject.
- Specific know how in case of businesss-to-government relationships.
- Know-how about the particular industry branch (automotive, aviation, pharmacy, financial services).

- Knowledge about the Project Environment.
  - The project's cultural and social environment and dependencies in order to build a successful project team.
  - International and political implications, eg. working hours, holidays, timezones.
  - Physical conditions for the project, office rooms, environmental considerations.
- Knowledge and Skills about General Project Management.
- Skills to Work and Communicate with people (inter-human abilities).

The PMBoK gives an outline of the five PM Process Groups:

1. Initialisation
2. Planing
3. Execution
4. Control+Steering
5. Termination

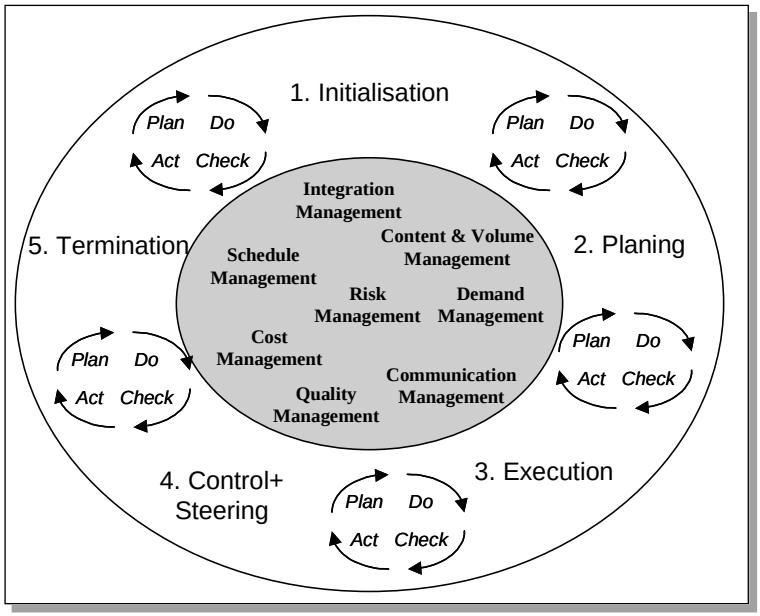

Fig. 55: PMBoK Process Groups and PM Disciplines

Further, PMBoK introduces nine PM Disciplines

- Integration Management,
- Content and Volume Management,
- Schedule Management,

- Cost Management,
- Quality Management,
- Staff Management,
- Communication Management,
- Risk Management, and
- Demand Management

which will be discussed very condensed in the next sections. Figure 55 provides a bird's view of the process groups and PM disciplines. Like PRINCE2, the PMI defines a process (as part of a process group) to be dynamic and has to be optimised according to the *Deming Circle* (Plan -> Do -> Check -> Act).

The finale result of the Project's subject is a Product, a Delivery, or perhaps a Service. Thus, the responsibility of the Project Management is to shape all processes required to derive to subject and to deliver all ingredients in time and in quality.

9.2 Project And Product Life Cycle

PMBoK differentiates between the *Project* Life Cycle and the *Product* Lifecycle. The Project Life Cycle is broken down in *phases*, and the corresponding processes are grouped together in Process Groups (figure 55).

How the Project life cycle is structured, depends on the project's subject, of course but are typically organised sequentially. In PMBoK's terminology, *Milestones* are called *PM Output Values* and are pre-defined (figure 65). Initially, the Project Manager has not only to determine the work packages (the tasks) for the project which is required for any resource planning, but rather has assign risks and costs too.

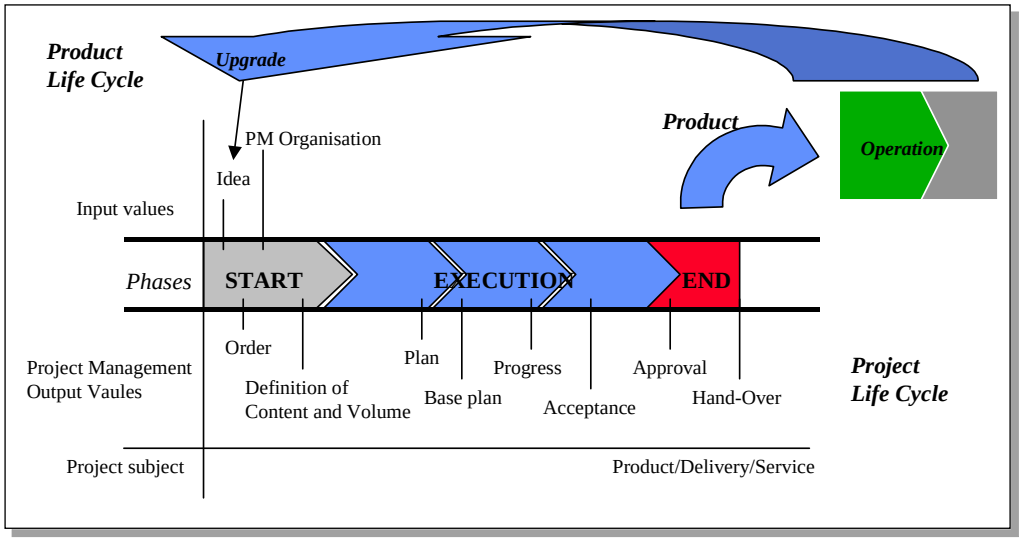

Fig. 56: Project and PMBoK Process Groups and PM Disciplines [PMBoK]

9.3 Project Management Processes And Process Groups

According to the PMBoK, Project Management is "applying knowledge, skills, tools and methods to fulfil the project's requirements." Project management is realised by a shaped and controlled processes, which uses input values and on return produce output values.

One particular output values are commonly referred to as Milestones (figure 56), however PMBoK has a very generic approach to processes (figure 57) and introduces specific diagrams and a workflow to couple the individual PM processes. For every PM process PMBoK defines line-by-line

- a list of necessary Input Values and
- a set of expected Output Values.

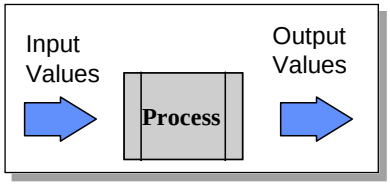

Figure 57: PMBoK's Process Diagram

The actual process is considered as ***event***. The process is fed from the input values and generates finally the output values. Typically, processes are repetitious, thus they don't occur just once but rather more often. In this case, every process is subject of standardized ***process improvement***, which commonly is known as 'Demming Circle' (figure 55). It is one essential task of PM to stoke this process improvement circle and thus to achieve constant process improvements.

Processes are grouped together by Process Groups (PG) which are shown in figure 58:

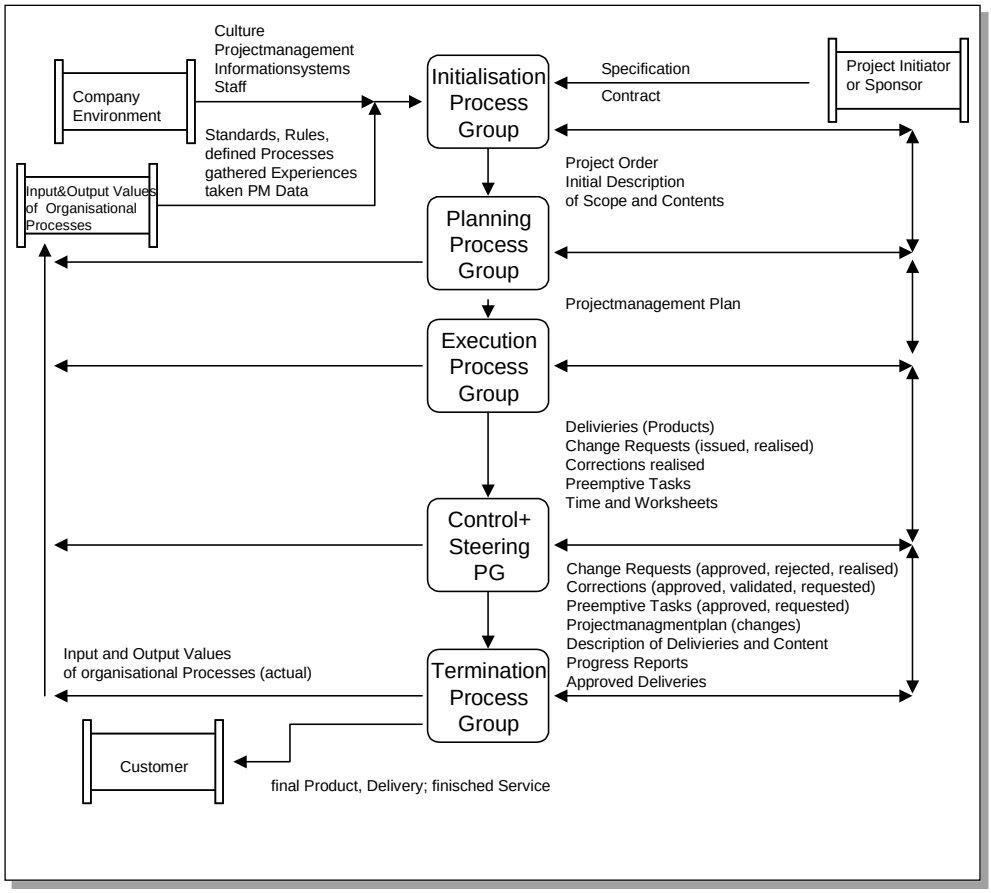

Figure 58: PMBoK's Process Groups and their interrelationships

We can consider

- Initialisation,
- Termination

as none-recurring Project Management Groups, where typically every process is only executed once, while within

- Planning and
- Execution

PG (sets of) processes are run often. Further, the

- Control and Steering

PG can be understood as 'meta' Process Group.

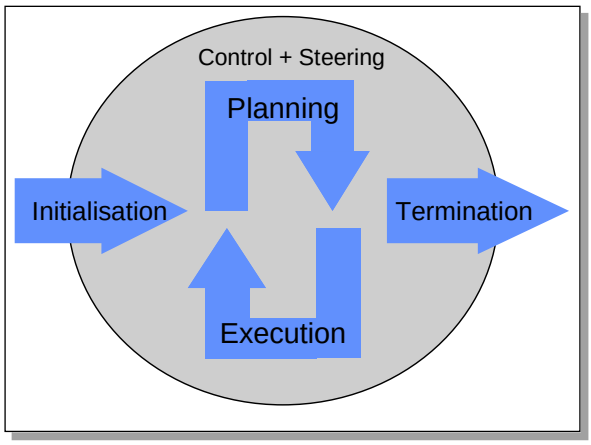

Figure 59: Project Management Groups and process shaping

9.3.1 Initialisation

The processes during the PG Initialisation are limited, but rather important, as can be seen be the following subjects:

- Development of the Mission statement for the project and how to achieve the project's approval.
- Defining the project's brief, providing information about content and volume of the project.

9.3.2 Planning

During the PG Planning, the following processes have to realised:

- Development of a Project Management Plan.
  This defines, how the PM is set-up for the current project.
- Planning the Project's Content and Volume providing an estimate about the size of the project and the required resources.
- Definition of the Content Volume, on the other side, details the deliverables.
- Setting up the Work Breakdown Structure (WBS).
  Splitting the deliverable into small sets of packages, in order to make them more manageable.
- Definition of Tasks builds up the logic to deliver and couple and individual packages.
- Determination of Task Orders considering and describing the dependencies between the packages.
- Estimation of Resources of individual tasks and process steps.
- Estimation of Duration for the individual tasks.
- Determing the elements for the Schedule of the tasks including order, duration and required resources.
- First breakdown and guess of costs for individual steps.
- Cost planning, while summing up the costs for logical groups and estimating to total project costs.
- Planning the Quality requirements for the project.
- Determing the Staffing and Reporting structures.

- Planning the Communication chains.
- Setting up a Risk planning.
- Identifying the risks of the project.
- Provide a Risk analysis based on an probability and impact.
- Numerical Risk analysis.
- Planning the Risk management.
- Planning Risk recovery activites/requirements.
- Planning Suppliers and Ordering
- Setting up Contract Planning

9.3.3 Project Execution

In the PG Execution, many recurring processes take place. In particular, we have the standard processes (figure 60):

- Steering and Management of project Execution
- Realisation of Quality Management.
- Setting up Project Teams
- Continuously developing Project Teams
- Distribution of Information, in particular towards the project's Stakeholder.
- Requesting potential Suppliers and finally
- Chose the Suppliers and set-up contracts with those.

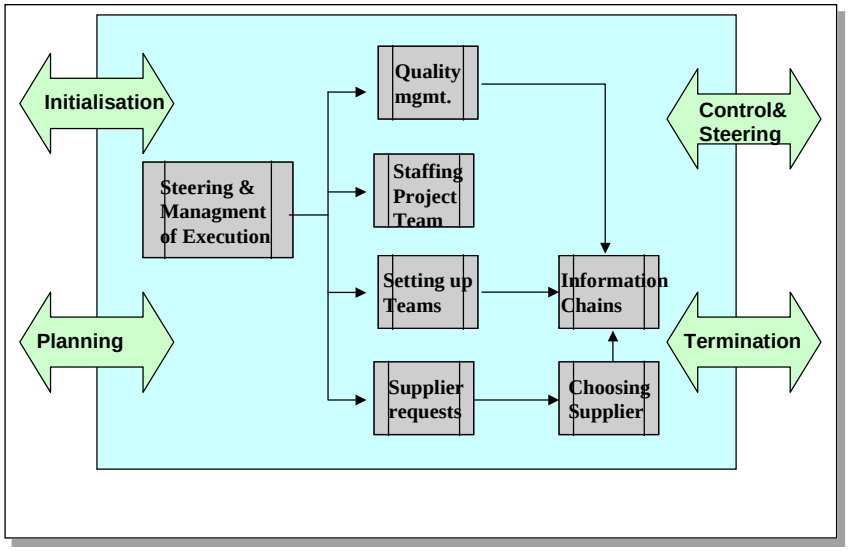

Figure 60: Processes in the Project Group Execution [PMBoK]

9.3.4 Control+Steering

Processes in the Control+Steering PG are set-up in order to watch and report activities in other processes, to identify potential problems and to allow corrective actions. In addition, all processes during the project's execution have to be compared against the original planning, and the plans have to be adjusted to the identified needs.

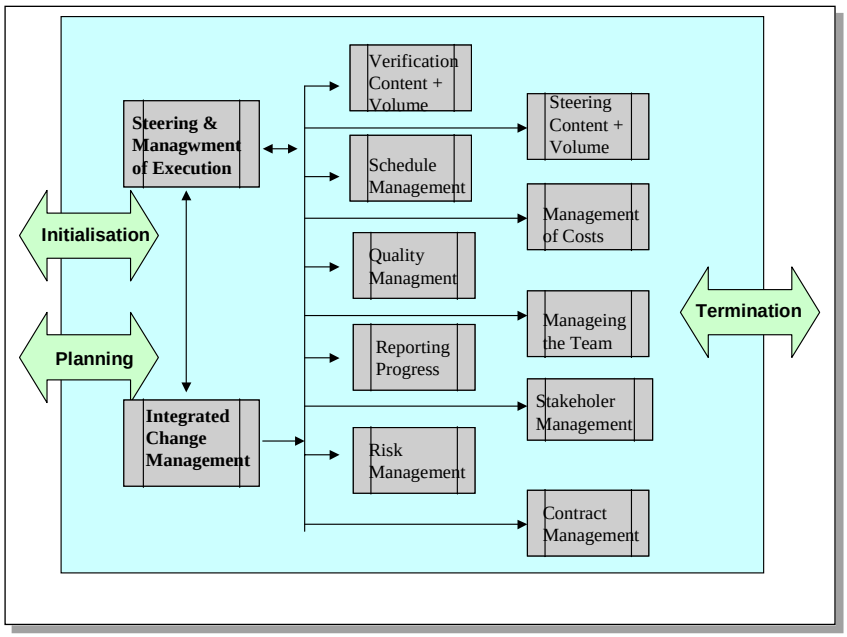

Figure 61: Element of the Process Group Control + Steering

In particular the following processes need to be considered:

- Supervision and Steering of the project work including Time Sheets control, evaluating trends, improving processes and preparing status and progress reports.
- Integrated Change Management filling and approving Changes and validating their result.
- Verification Content and Volume allowing the final Acceptance of the project's deliveries.
- Steering of Content and Volume which may be required if changes in any of both aspects are necessary.
- Management the Schedules and Time Tables, thus any changes can be included in a co-ordinated manner.
- Steering the Costs means to spot additional costs and to adjust the budget planning.
- Realisation of Quality Management is to measure the achieved quality and to provide means to improve those and/or set up corrective actions.
- Managing the Project Team includes co-ordination, supervision and other tasks to improve the efficiency of the team.
- Progress Reports are required to identify the current state of the project, to provide an estimate of progress and perhaps a trend.
- Stakeholder Management is for informing the Stakeholders about the current project situation and to pick up their demands and perhaps including those into the project.

9.3.5 Termination

During the Termination Process Group, the project will be firmly finished and all ongoing processes are terminated. Here, only two processes are relevant

- Termination of the Project including the final documentation of the project, which is required to

- Close all Pending Contracts due to the achieved approvals.

9.4 Project Management Disciplines - The Know-How Groups

The PMBoK refers to sets of documents which are important for any project:

- *Project Mission Statement*: Includes the formal approval of the project.
- *Project Brief*: Including the project's content and volume and specific consideration of the tasks and the products/deliveries.
- *Project Management Plan*: Description of the individual steps of the project and how they will be realised and including:
  - Plan for Content and Volume Management.
  - Schedule Management.
  - Cost Management.
  - Quality Management
  - Team Management.
  - Communication Management.
  - Risk Management.
  - Order and Demand Management.

9.4.1 Integration Management

The Integration Management is responsible to integrate the different elements of project management, which are located in different Process Management Groups (PG). Specifically it's tasks are:

- Developing the Project mission statement,
- developing the preliminary definition of project content and volume (Project Brief)
- development of the Project Management Plan,
- steering and co-ordination of the project execution,
- controlling and management of the individual project tasks while
- integrating Change Management and termination of the project.

The Integration Management is thus responsible to set up the projects management framework. In particular, here decisions have to be carried out, about the specific means and tools for Project Management, for instance a dedicated Project Management System. Often it is required to ask for external support, perhaps from inside the existing organisation or from outside by skilled and experienced consulters.

The main papers and proposals are the

- Preliminary definition of the project's content and volume, including
  - project and product goals in the context of the demand, standards, usage, and restrictions
  - specification of the resulting product or service and the required level of (formal) approval,
  - initial project organisation, risks, and estimated costs,
  - time-line and milestones with a first WBS,
  - requirements for Communication and Quality Management,

  - reporting chains and approval process.
- Project Management Plan (PMP) including the already known depended Management Plans under consideration of
  - the identified Project Management Processes and at which level they need to be implemented,
  - definition of required tools and methods for the processes,
  - identification of Process dependencies,
  - how tasks are executed and supervised,
  - communication needed, in particular to and from the Stakeholders,
  - the foreseen project life cycle and the adjacent phase planning,
  - reviews and reports for management in order to support decisions.

Another important outcome is a common understanding about the steering and managing the actual project execution among the project management team. The focus is to apply the same approaches (= how to do something) regarding the different tasks. In particular project management has to agree on

- approved correction methods to adjust the project results with the PMP
- approved preventive actions to reduce potential risks and negative impacts,
- approved error correction means, to eliminate mistakes/bugs identified during quality assurance.

The Integration Management has additionally to care about Controlling and Supervision of the ongoing project. Processes have to be defined (and later set up and realised) to

- allow a comparison between the current realisation and the PMP
- estimate of efficiency in order to predict potential corrections or preventive actions not to run out-of schedule,
- analysis and determination of project risks, in order to make sure, risks are well identified and controlled,
- maintenance of an up-to-date project database supporting the creation of status and progress reports and allowing an calculation of further costs and schedule adjustments,
- supervising approved changes.

The last item is also part of the integrated Change Management, which is also part of the Integration Management.

9.4.2 Content and Volume Management

Content and Volume Management touches two separate issues:

- Regarding the achieved Product (as a result of the project) it determines the characteristics and functions of the delivery and or service.
- Regarding the current Project itself, it tells which steps have to be undertaken to realise the Product with the defined characteristics.

Figure 62 tries to visualise the relationship between Project and Product.

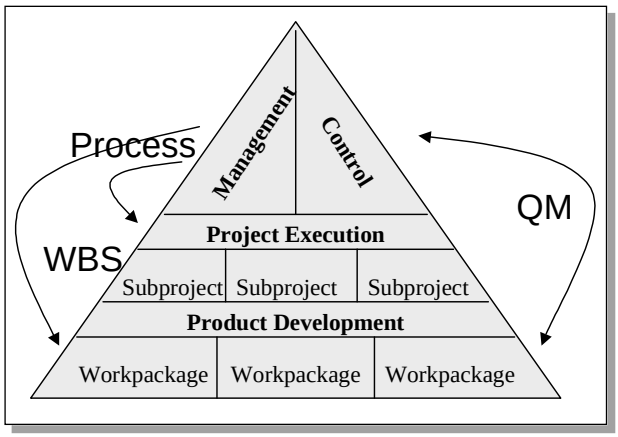

Figure 62: Relationship between Product and Project

While the product is statically broken into ***work packages*** (by means of the WBS) the actual realisation of a work package (under quality control) is a ***work unit*** under process control. These two scopes yield the following results:

Content and Volume of the Project

- Project set-up: goals, requirements, and limits.
- Product definition: content and volume, final deliveries and acceptance cirterions.
- Project execution: organisation, milestones, risks, costs, efforts and requirements, infrastructure, reporting chains.

Work Breakdown Structure (WBS)

- Disassembling the product in work packages and assign work units to it. The work package defines the functional aspects (including interfaces) while the work unit is used to determine efforts, development duration, risks and costs.
- The relationship between work packages might be complex and none-linear. A WBS with the least interfaces (= dependencies) between the packages is believed to be (functionally) the best breakdown for the product.
- Typically, a hierarchical breakdown can be achieved, and each work package should be identified regarding it's order and hierarchy level.
- Once the dependencies between the packages has been determined, a Critical Path Algorithm (CPA) can be used to achieve an optimal resource planning.
- As input for the WBS the following information is crucial:
  - Structure of the project organisation (teams), this is the O*rganisational Breakdown Structure* (OBS).
  - List of components required to build the product.
  - *Risk Breakdown Structure* (RBS) detailing the project risks according to identified category.
  - *Resource Breakdown Structure* telling what resources have to be used at each step for the product.

9.4.3 Schedule Management

Schedule Management determines when a particular step has to be started, how long it will take, when it has to be finished and what are the dependent predecessors and successors.

The actual time line can be arrived from the WBS. However, at that level, the Schedule includes the aggregated efforts and costs. The PMBoK does not require a certain method here, but typically for smaller projects, a (linear) Gantt representation is sufficient, while lager projects require a more complex representation in terms of the NetPlan technique, allowing the inclusion and representation of alternate paths.

As a result of the Schedule one achieves:

- To-do lists of activies necessary for each step.
- The dependencies of the different steps including the required transition activities.
- The milestones, whether mandatory or optional to be achieved at a certain time.
- A potential reschedule of activies, subject of Change Management.

A main part of project management is to constantly adjust the Schedule with the current project progress and thus to determine the dates of the forthcoming milestones.

The adjustments are not necessarily considered negative, but they allow us:

- To precisely determine duration, costs, efforts for the particular step.
- Additionally, they are the base to do a numeric calculation of these respective values. While the first 'assigned number' in the Schedule may be educated guesses, the first correction can be used to allow a much more precise determination for the relevant values.
- By analogy, we can now use the derived numbers and do a projection even on still ongoing (similar) activities.

Regarding the whole Schedule, we achieve in addition:

- The possibility to determine the efficiency of the team.
- An estimate of the *Schedule Variance* (*SV*), that means measuring the impact on individual Working Packages regarding duration, costs, and efforts.
- Evaluating an *Schedule Progress Indicator* (*SPI*) as a function of time, allowing to assess the quality of our planning with respect to the achieved project progress.

9.4.4 Cost Management

Cost Management has the main tasks

- to estimate the gross costs for the (sub-)projects
- to provide the input for a detailed cost and budget planning,
- to define methods to allow cost control and a strategy in case of over-spending.
- Cost estimates can be achieved while correlating the amount of work with costs.

Lets assume Microsoft Windows 2000 with 40 MLoC. One real good programmer writes 100 LoC/day and costs 500 $/day. To finish W2K requires 400 programmers in 4 years. Development costs: 200 mio $, project costs roughly 500 mio $ (including management and marketing efforts).

The PMI uses for the cost calculation the *Earned Value (EV)* Method . The EV couples Milestones and the completion of the Work Packages with the costs.

The initial key data are the

- *Budget at Completion BAC*, which determines the initially assigned costs of the project.
- Currently *Estimated* costs *at Completion EAC*.
- Currently *Estimated* residual costs *to complete ETC*.

During the projects evolution, Project Management needs to control the following important individual financial key data:

- The *Budgeted Cost of Work Scheduled BCWS*, which is the *Planned Value PV*.
- The *Budgeted Cost of Work Performed BCWP*, which is the *Earned Value EV*.
- The *Actual Cost of Work Performed ACWP* and thus the *Actual Costs AC*.

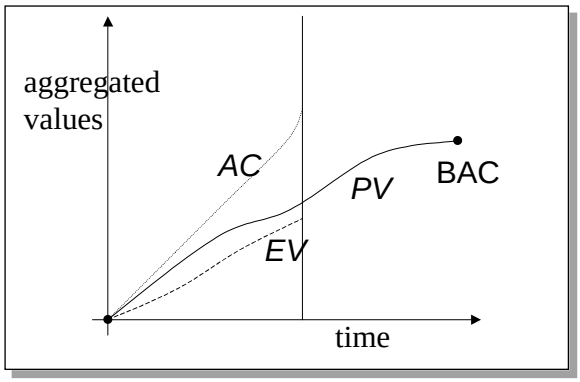

Figure 63: Time line of a project progress report in terms of cost development

The project managers task is to balance the *Planned Value* (PV) and the realised *Earned Value* (EV) for every Work Unit with the *Actual Costs* (AC) for that component (figure 63). To estimate the *Estimated Costs to complete ETC* and the *Estimated Costs at Completion* (EAC) three methods are commonly used:

	ETC	**EAC**
Sliding Estimates	From the efforts and spendings *Actual Costs* (current) AC^C a prognosis for the cost developments is possible. Based on those number, a new *Estimate to Complete ETC* (again in terms of costs) can be facilitated.	Use the newly derived ETC and the current AC^C to calculate the *Estimated Costs at Completion* EAC: EAC = AC^C + ETC
Rough Estimates	Use the current *Earned Value* EV^C as guess for the ETC: ETC = (BAC - EV^C)	Consider the rest budgt and the *Earned Value* (EV): EAC = AC^C + BAC - EV
Corrected Estimates	The ratio between BCWS (= PV) and BCWP (= EV) is considered as *Cost Perfomance Index* CPI and evaluated for the individual milestones/work packages. The mean of the CPI is used as CPI^C (current) to detemine a correced estimate: ETC = (BAC - EV^C)/CPI^C	Apply corrections as indicated by the CPI into the calculation: EAC = AC^C + ((BAC - EV)/CPI^C)

Table 1: PMBoK cost calculation approaches

Those estimates are typically used to provide Project Management a mean, whether the project is still in budget. A qualified PM software is able to determine those numbers in case the AC are correctly assigned to the work packages.

A good knowledge of the project's costs w.r.t. to it's progress SPI will not only show, whether the project is well understood in terms of content and volume but also provide the required input values to potentially allocate additional budgets needed and serve as a qualified discussion base with stakeholders and sponsors.

9.4.5 Quality Management

The quality approach of the PMBoK follows the definition of the ISO. According to the American Society of Quality (2000), quality is seen as "how far a group of intrinsic characteristics fulfils the requirements". Quality management, on the other side, is always determined by the expectations of the Stakeholders.

The term "intrinsic quality" tells already, that ***quality*** is not necessarily related to ***functionality***. A product might be simple from the functional point of view, but achieve a high quality standard. On the other side, complex products exist, which fail to achieve high quality. A good example is a simple text editor compared to complex word processing software.

For industrial processes, the PMBoK uses a differentiation between ***precision*** and ***predictability***. Typical mechanical products for instances, are never 100% precise, however their mechanical parameters (like length, diameter, strength) will vary due to production circumstances. A good production chain is able to predict the achieved values on a statistical base and provide a uniform distribution of those parameter according to known distributions (Gauss'ian or Normal distribution, Poisson distribution and others). In order to improve the achieved quality parameters (on a process related or selection base) several quality 'programs' are know: Total Quality Management (TQM), Six Sigma, Voice of Customer, Cost of Quality (COQ) and others.

The PMBoK identifies the following important inputs for quality management:

- Planning the quality: Any planning has be streamlined with the initial expectations of the product. According to this, the quality standards of the product have to be defined and need to be balanced with efforts and costs. Further, here the (quality) transition criterion's are provided which are required to achieve a certain milestone.
- QM methods and tools: This depends of course on the product itself. Industrial production requires us of statistical methods, whereas software development often uses simple 'defect' counters.
- Realising QM: This might be an organisational question, since often already a QM department exist, which is responsible for Quality Assignment QA. One important issue is, that progress is 'trackable'. This means, any changes in the product, subject for QA, needs to be documented and reported.
- Managing quality: For industrial products, a quality chart (run chart) has to be assigned/attached to the product. For software, currently no corresponding scheme exits.

A common scheme for error assessment is to analyse the errors/defects and to sum them up per category or (software) module. A diagram showing such a distribution is known as ***Pareto chart*** (figure 64).

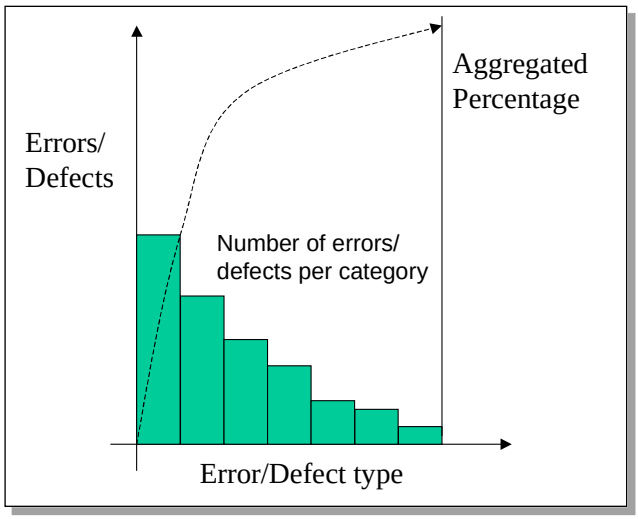

Figure 64: Pareto chart of error/defect distribution per category/module

9.4.6 Team Management

Team Management requires technical means to size and to plan and to control the team, and personal skills to lead and to manage the team members. Among the technical means, the following means are useful (figure 65):

- Templates: Descriptions of positions, rating sheets, and sheets for conflict management.
- Checklists: Description of rôles, competences, certificates of team members, security rules.
- Organigrams: Structural breakdown of the organisation in terms of rôles and competences (organisation chart).
- RACI matrix: Breakdown of rôles in terms of Responsibility, Accountability, Consultancy and Informabiltiy of groups and individual persons regarding specific tasks.

Starting point for sizing the team is the WBS. After the PL has identified the required skills and qualifications for a task/rôle, the Human Resource (HR) department will publish an advertisement to start recruiting. Depending on the need and urgency, the job advertisement is directed towards (1) internal staff members, (2) some dedicated tenders, or perhaps will be (3) open invitation to tender in a defined bid form.

After qualified tenders have been selected (based on their resumes), it is task to the PL or perhaps the sub PLs to interview the individual persons and finally to propose the chosen ones for contracting to the HR department.

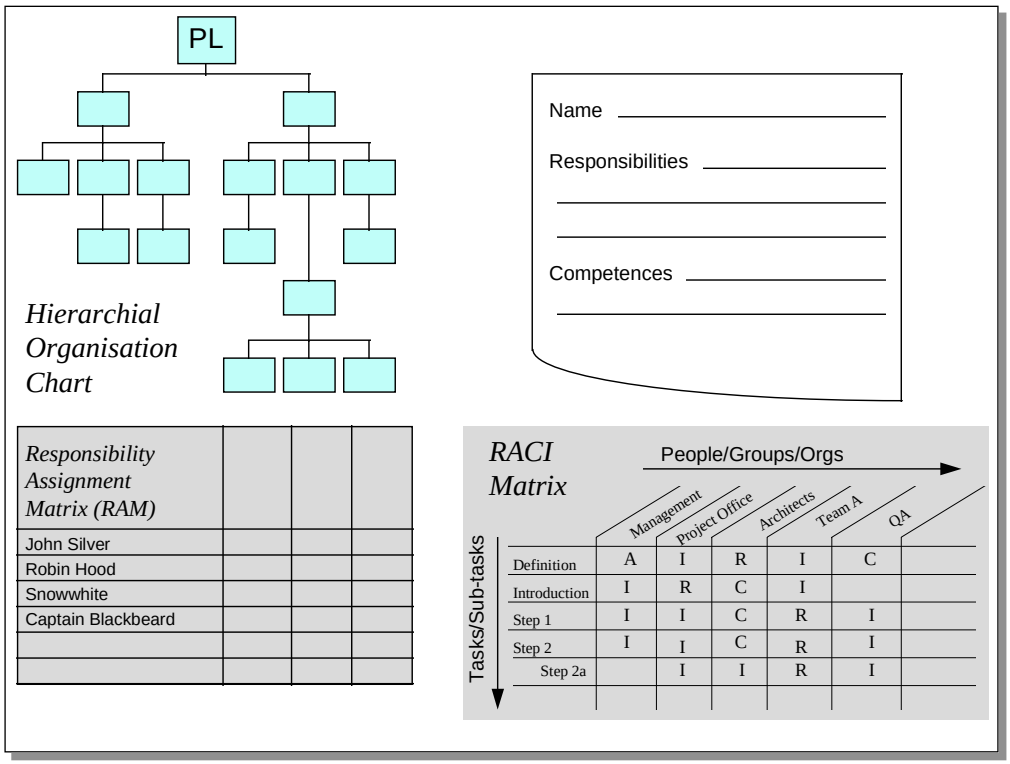

Figure 65: Tools for the PM to support Team management

Leading and controlling the team is subject of the personal skills of the PL. Main 'tools' are observation of and talks with the individual project members. Based on the achieved impressions (in comparison with the other group members), rating sheets can be a useful tool to monitor the persons and the group. For internal staff members it is common to finalise the rating sheet together the respective persons ("360° feedback"). However, this might not be the task of the PL itself (as project supervisor), but rather for disciplinarian superior in terms of line manager.

Improvement of teams means to improve the members individually and the inter-team relationships and behaviours. Under the second category we can include:

- a 'code of conduct' for the team ('team spirit')
- defining the proper team positions for the individuals.
- organising team-building work shops,
- setting up the working conditions (office spaces) of the team such, an optimal inter-action is achieved. However, concerning today's communication possibilities there is a trend to construct 'virtual teams' which are coupled by Internet.

Improving the team per individual may include

- additional qualification: internally, externally, or based on CBT (computer based training),
- bonus system: overspending hours, finishing in schedule,
- mediation and conflict solution strategies.

9.4.7 Communication Management

Known from computer communication, in order to achieve a revisable and reliable transmission of information, the recipient of the message has to confirm its reception.

Correct reception, however does not mean, that the message has been understood. It is task of the project management to use those means for communication which assures a maximum of understanding. This includes:

- The way of presenting a message by means of concise design and phrasing, proper gestual presentation and other visual means.
- The adoption of the message presentation according to the recipient. Thus the same message may be differently phrased whether it is directed towards the team members, the upper management or the Stakeholders.
- Whether the message is been transmitted over a 'formal' or 'informal' communication channel, and/or
- is due to a regular schedule, e.g. a progress or weekly report for which an 'incremental' message form could be suitable.

Further, the

- the subject and content, and the
- severity/priority of the message has a direct impact on it's presentation, as well as it is
- triggered by exceptional circumstances.

For project management regarding the PMBoK approach, Progress Reports are indispensable. Those formal reports have to include information about

- the realisation status of a task or subtasks
- a performance measurement (see 9.4.4)
- the proposed termination date (see 9.4.3)
- QA status and means to improve quality (see 9.4.6)
- impact on the Project Management Plan PMP (see 9.4.1)
- approved changes,
- delivered products.

The reported values have to be included into the Schedules and into the Planning Tools (Gantt charts).

One important part of Communication Management is the Stakeholder Management. Apart from condensed progress reports, exceptional reports are import here. In order to achieve transparency in the current project realisation, these reports should describe the open items and challenges and how they have been solved or how solutions are proposed.

9.4.8 Risk Management

There is an ongoing discussion, whether Risk Management (RM) belongs to Project Management, or Project Management is a particular part of Risk Management. In the context of the PMBoK, the following issues belong to the Risk Management:

- Risk Management Planning - decide, where and for what tasks RM shall be considered.
- Risk Identification - determine and describe, which risks are important for the project's outcome.

- Risk qualification - prioritising risks according to impact and category, estimate probability for happening.
- Risk quantification - numerical risk analysis for each task and impact on the whole project.
- Risk fighting strategies - how to react on situation in which the 'risk' becomes apparent.
- Risk management - follow up identified risks, controlling open risks, and act on apparent risks according to the risk fighting strategies.

Risks are unavoidable for projects; if no particular risk exist, the task can be executed by line activities. Risk identification, qualification (in terms of impact) and quantification are the most important tasks of Project Management.

According the WBS, it is necessary to develop a risk assessment in terms of a Risk Project Plan (RPP). This assessment could be broken down in terms of (1) milestones and (2) impact. The impact can be subdivided in (a) costs, (b) schedule, (c) quality, and (d) completeness.

How this assessment checklist is derived, depends on the contents of the project. Known approaches are:

- Brainstorming: The project team tries to identify the risk, maybe accompanied by a moderator.
- Delphi-Method: Particular Experts are involved to identify the risks anonymously.
- Questionnaire: Team members, Stakeholders, and external Experts are asked for particular risks.
- Determing the Reasons: While the potential risks are grouped in categories, the risk assessment is refined and the risk sources are determined.
- SWOT Analysis: Here, the Strength, Weaknesses, Opportunities and Threats are taken into account analyse the project under those conditions.

Those qualifying parameters have to accompanied by a quantitative risk analysis:

- Impact: Identifying the most important risks for the project in terms of completion.
- Expected Monetary Value (EMV): Chances are treated as positive values, while risks are taken as negative values multiplies by their expectation values. The resulting sum is the EMV, which might not particular useful.
- Decision-Tree Analysis (DTA): Here, two-dimensional calculations take place and allowing a diversification of results (for each decision chain).
- Modelling and Simulation: The outcome of individual steps are estimated in terms of a Monte-Carlo simulation.

As a result of an apparent risk, the Project Management has to act in terms of

- (i) internal changes - restructuring the teams
- (ii) requiring additional support

which are both subject of Integration Management.

9.4.9 Demand Management

Demand Management within the PM deals with purchasing or acquiring particular parts of the project from an external party, whether in terms of products or services. Three major steps are involved:

- Planning what to purchase/acquire.
- Setting up the bidding (tendering) for the particular product/service and choosing a vendor.
- Setting up and establishing the contracts with the chosen vendor and perhaps terminating it.

Certainly, the first step is to evaluate the 'Make-or-Buy' analysis. Here, PM has to investigate

- what are the costs of buying/leasing/renting/licensing + maintaining a product/software/service
- in contrast to building/developing/establishing the product/software/service as part of the project.

Often this turns out to be a political questions and answers are only determined by the costs but rather, whether this decision is aligned with the strategy of the company or the stakeholders.

In case contract with third-party companies (the chosen vendors) are settled, the commercial framework has to be mutually agreed upon:

- Cost Plus Fee (CPF): The product is priced on the actual costs.
- Cost-Plus-Percentage of Cost (CPPC): The product is price on the actual costs plus a cost-dependend fee.
- Cost-Plus-Fixed-Fee (CPFF): The product is priced on the actual costs plus constant fee.
- Cost-Plus-Incentive-Fee (CPIF): Parts of the expected costs (and fees) will be paid in advance, while the final price depends on quality and schedule.
- Time And Material (T&M): Here, the product -- as deliverable - is not defined yet and costs will be covered based on activity confirmations.

9.4.10 PMBoK Glossary

Abbreviation	English Term	German Terminology
AC	Actual Cost	Ist-Kosten
ACWP	Actual Cost of Work Performed	Ist-Kosten der geleisteten Arbeit
AD	Activity Description	Beschreibung des Vorgangs
ADM	Arrow Diagramming Method	Vorgangspfeilnetzplan
AE	Apportioned Effort	Zugeteilter Aufwand
AF	Actual Finish Date	Tatsächlicher Endzeitpunkt
AOA	Activity-on-Arrow	Vorgangspfeilnetzplan
AON	Activity-on-Node	Vorgangsknotennetzplan
AS	Actual Start Date	Tatsächlicher Anfangszeitpunkt
BAC	Budget at Completion	Ursprünglich geplante Gesamtkosten
BCWP	Budgeted Cost of Work Performed	Fertigstellungswert
BCWS	Budgeted Cost of Work Scheduled	Budgetkosten der geplanten Arbeit
BOM	Bill of Material	Stückliste
CA	Control Account	Kontrollkonto
CAP	Control Account Plan	Kontrollkontenplan
CCB	Change Control Board	Steuerungsgremium für Änderungen
COQ	Cost of Quality	Qualitätskosten
CPF	Cost-Plus-Fee	Selbstkostenbasis plus Honorar
CPFF	Cost-Plus-Fixed-Fee	Selbstkostenbasis plus Pauschalbetrag (Werkverträge)
CPI	Cost Performance Index	Kostenentwicklungsindex
CPIF	Cost-Plus-Incentive-Fee	Selbstkostenbasis plus Leistungshonorar (Werkverträge)
CPM	Critical Path Method	Methode des kritischen wegs
CPPC	Cost-Plus-Percentage of Cost	Selbstkostenbasis plus prozentualer Kostenanteil (Werkverträge)
CV	Cost Variance	Kostenabweichung
CWBC	Contract Work Breakdown Structure	Vertragsgegenständlicher Projektstrukturplan
DD	Data Date	Datum des aktuellen Stands
DTA	Decision Tree Algorithm	Entscheidungsbaum-Struktur
DU/DUR	Duration	Dauer
EAC	Estimate at Completion	Erwartete Gesamtkosten zum aktuellen Zeitpunkt
EF	Early Finish Date	Frühester Endzeitpunkt
EMV	Expected Monetary Value	Erwarteter Geldwert
ES	Early Start Date	Frühester Anfangszeitpunkt
ETC	Estimate to Complete	Erwartete Restkosten zum aktuellen Zeitpunkt
EV	Earned Value	Fertigstellungswert
EVM	Earned Value Management	Management des Fertigstellungswertes
EVT	Earned Value Technique	Fertigstellungswertmethode
FF	Finish-to-Finish	Endfolge
FF	Free Float	Freie Pufferzeit
FFP	Firm-Fixed-Price	Festpreisbasis

Abbreviation	English Term	German Terminology
FMEA	Failure Mode and Effect Analysis	Fehlermöglichkeits und Einflussanalyse
FPIF	Fixed-Price-Incentive-Fee	Festpreisbasis plus Leistungshonorar
FS	Finish-to-Start	Normalfolge
IFB	Invitation for Bid	Ausschreibung
LF	Late Finish Date	Spätester Endzeitpunkt
LOE	Level of Effort	Unterstützungsfunktion
LS	Late Start Date	Spätester Anfangszeitpunkt
OBS	Organizational Breakdown Structure	Organisationsorientierter Strukturplan
OD	Original Duration	Ursprüngliche Dauer
PC	Percent Complete	Fortschrittsgrad
PCT	Percent Complete	Fortschrittsgrad
PDM	Precedence Diagramming Method	Vorgangsknotennetzplan
PF	Planned Finish Date	Geplanter Endzeitpunkt
PM	Project Management	Projektmanagement
PM	Project Manager	Projektleiter
PL	Project Leader	Projektleiter
PMBOK	Project Management Body of Knowledge	Project Management Body of Knowledge
PMIS	Project Management Information System	Projektmanagement Informationssystem
PMO	Program Management Office	Programmmanagementbüro
PMO	Project Management Office	Projektmanagementbüro
PMP	Project Management Professional	Project Management Professional
PS	Planned Start Date	Geplanter Anfangszeitpunkt
PSWBS	Project Summary Work Breakdown Structure	Übersichtsprojektstrukturplan
PV	Planned Value	Geplanter Wert
QA	Quality Assurance	Qualitätssicherung
QC	Quality Control	Qualitätslenkung
RAM	Responsibility Assignment Matrix	Verantwortlichkeitsmatrix
RBS	Resource Breakdown Structure	Einsatzmittelstrukturplan
RBS	Risk Breakdown Structure	Risikostrukturplan
RD	Remaining Duration	Verbleibende Dauer
RFP	Request for Proposal	Angebotsaufforderung
RFQ	Request for Quotation	Angebotsanfrage
SF	Scheduled Finish Date	Geplanter Endzeitpunkt
SF	Start-to-Finish	Sprungfolge
SOW	Statement of Work	Leistungsbeschreibung
SPI	Schedule Performance Index	Terminentwicklungsindex
SS	Scheduled Start Date	Geplanter Anfangszeitpunkt
SS	Start-to-Start	Anfangsfolge
SV	Schedule Variance	Terminplanabweichung
SWOT	Strengths, Weaknesses, Opportunities and Threats	Stärken, Schwächen, Chancen, Risiken (SWOT-Analyse)
TC	Target Completion Date	Vorgegebener Abschlusszeitpunkt
TF	Target Finish Date	Vorgegebener Endzeitpunkt

Abbreviation	English Term	German Terminology
TF	Total Float	Gesamte Pufferzeit
T&M	Time and Material	Zeit und Material (Dienstleistungsverträge)
TQM	Total Quality Management	Total Quality Management
TS	Target Start Date	Vorgegebener Anfangszeitpunkt
VE	Value Engineer	Wertgestaltung
WBS	Work Breakdown Structure	Projektstrukturplan (PSP)

Table 2: PMBoK English/German glossary
[http://www.pm-blog.de/projektmanagement-abkuerzungen/]