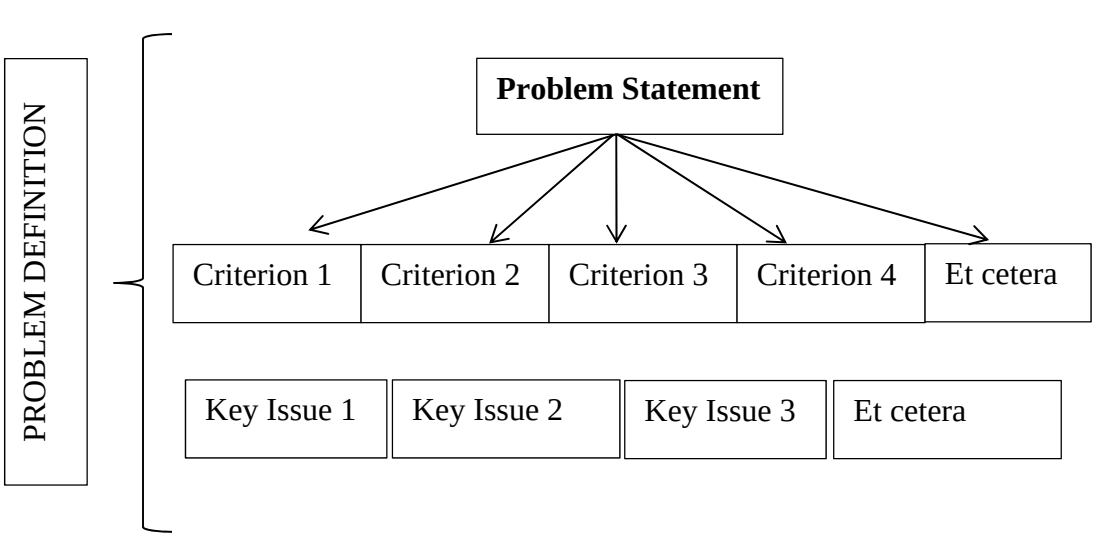
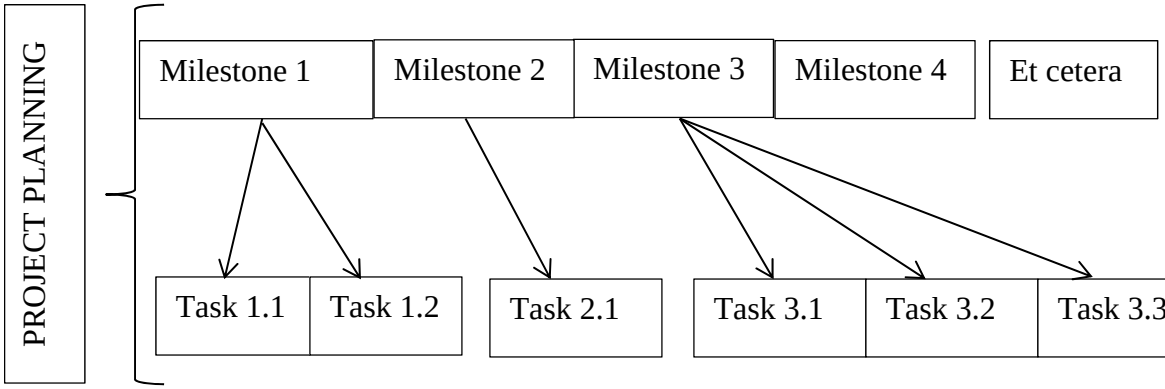


Problem Statement – a clear, concise description of the problem that avoids suggestion of a solution.

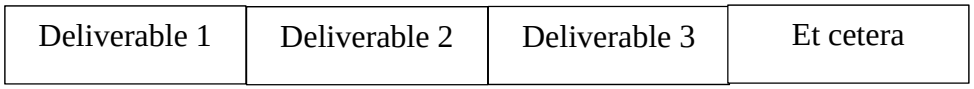
Criteria Table – criteria should be listed in the order of importance; most important at the top

Key Issues – these are the important problems to be solved (areas of "unacceptable ignorance")



Milestones (M/S)– milestones should be listed in the order of completion dates. Milestones are NOT tasks.

Task Table – Each milestone requires one or more tasks in order to be achieved.



Deliverables: the purpose of a project is to produce "deliverables" (such as reports, drawings, prototypes, etc.). Each deliverable requires one or more task to be produced (such writing reports). You may consider completing a deliverable as a milestone.

Project Planning – where to start?

Engineering Design may be defined as the process by which an engineer goes from a state of ignorance to a state of knowledge. For example, to fully define (design) a single structural part, the engineer must first know what the loading condition will be, what the environment it must function in, the manufacturing options, etc. The engineer also needs to know what materials are available. Then he or she can bring this knowledge together with their expertise to make good engineering decisions which will result in a defined (designed) part. It is CRITICAL to not rush through the planning phase!

To plan a project, as a team:

1) Understand the problem – keep asking questions until you are certain you really understand the problem – otherwise, you may solve the wrong problem. Do NOT rush through this process – for college sized projects, this step may take a week or more. For professional engineering projects, this step may take months and sometimes years.
2) Define the problem in writing; clearly, unambiguously, and without suggesting a solution. This too, is not to be rushed.
3) Define the criteria; describe as specifically as possible what the finished product is to achieve. **The criteria should be so well defined that if given to any group of competent engineers, they will produce a finished successful product that satisfies the customer.** The criteria, in effect, are a complete and very detailed problem definition. Be sure they are appropriate or you **will** be solving the **wrong** problem.
4) Identify the *key issues* or obstacles to producing a finished design. In other words, identify what it is you are "unacceptably ignorant" about. At the beginning of any project, you will be "unacceptably ignorant" about many things – the purpose of the project is learn (through testing, analysis, peers, etc.) so in the end you will have no areas of "unacceptable ignorance." After identifying these key issues (areas of unacceptable ignorance) determine what is needed in order to gain the knowledge required. Make a list or table of these so-called *Key Issues* and plan to address them.
5) The Key Issues are the focal point of the design work. The project plan is built upon solving or addressing each *Key Issue*.

Give serious thought to what needs to be done and then get started. Make mistakes early and often, learn from them. Mistakes at the beginning are much cheaper and easier to fix then mistakes at the end. Before designing the details of an airplane, you must be sure it will fly. It is the engineer's job to seek the simplest most effective solution. Work hard to keep the design simple, and keep making steady progress.

Problem Statement:

Do not solve the problem before defining it!!! A narrowly stated problem may limit alternative solutions; a vague statement does not provide sufficient guidance. So put thought into the statement. Examples:

Bad example: I need a new car (*too limiting definition*).
Better: I need a reliable, safe, and comfortable way to get to work.
Bad example: Develop a new airplane (*vague*).
Better: Develop a commercial airplane to transport 250-310 people 3500 miles.

Criteria:
Criteria should define the finished engineered product. Criteria should be clear enough so that if they alone were given to an engineer unfamiliar with any other details about the project, they should be able to produce a successful engineered product. The criteria, in effect, are a complete and very detailed problem definition. Criteria should be listed in order of importance, and their importance should be identified ("required", "very important" – etc.). If a criterion is considered to be "required" or "essential" it means that the project is a failure if the criterion is not satisfied.

Key Issues):
Identifying Key Issues can help us understand what it is we really need to do. Engineering design is a "knowledge acquiring" process. Key Issues define what really matters in regards to the design work; they clarify what knowledge is needed. The *criteria* define what is ultimately needed from the engineered product. *Key Issues* identify what important knowledge is required to develop a good solution for the criteria. For example, Key Issues for the design of a Ford Mustang may include (but not limited to):

- Traction: we need to know weight distribution and coefficient of friction between tire and road.
- Cornering ability: we need to determine acceptable roll characteristics, determine suspension geometry, spring rates, shock absorber characteristics, tire traction
- Etc.

At the beginning of a project, engineers are ignorant about most or all of the Key Issues. Only after you really understand all of the Key Issues can you have a successful project. Listing the Key Issues in the project plan will help the team understand what work needs to be accomplished.

Milestones:
Understanding the Key Issues of the project can be helpful in identifying milestones. Milestones define accomplishments – things that need to be completed that will contribute the final design. The milestones should include estimated completion dates or "need dates". Milestones are **not** tasks.

Tasks:
Tasks are things that require doing in order to complete the project. They are the activity required to complete the milestones. Typical engineering tasks involve testing, analyzing, modeling, literature search, etc.; in other words, "acquiring knowledge." As with all things, they should be clearly stated ("testing" is not clear by itself – what will be tested and why (purpose) of the testing needs to be included). Of course, such things as "writing the final report" is a task.

Iterate:
As you proceed through an engineering project you will typically start at the concept level and iteratively refine the details. It is likely that as you proceed you will identify new key issues, new milestones, new tasks, etc. Hopefully, you will not need to change the criteria significantly, but even those may change on projects.

Examples of tables used in project plans:

Table 1 – Criteria for xyz vehicle.

#	**Criteria**	**Priority**	**Description**
1	Safe to operate	Essential	Airbags must deploy in >15MPH head on collision.
2	Material limits	Essential	Only materials specified in the contract are permissible to be used.
3	Hill climb	High	Be able to climb a 25 degree incline on dry pavement.
4	Flat track	High	Top speed of 80MPH
5	Weight	Medium	Maximum weight target is 2560 pounds.
6	Easily serviced	Low	Routine service should possible with common tools (screwdrivers and hex-wrenches)

Key Issues: a table is not required, but a list of the *Key Issues* would be appropriate to include in a project plan. See examples for the Ford Mustang in previous page.

Table 2 – Project Milestones

#	**Milestone:**	**Due Date**
1	M/S may include both things identified as deliverables (reports, etc.) and accomplishments identified by the team during planning.	
2		
3		
..	Etc…	

Table 3 – Tasks (note to students: tasks are things done to reach a milestone so associating the task with the specific milestone is appropriate).

Milestone #	**Tasks required to complete the milestone**	**Required task completion date**
1	1.1 --- remember, **tasks contain verbs**; milestones are nouns or completed tasks.	
	1.2	
2	2.1	
	2.2	
	2.3	
3	3.1	
Etc…	Etc	