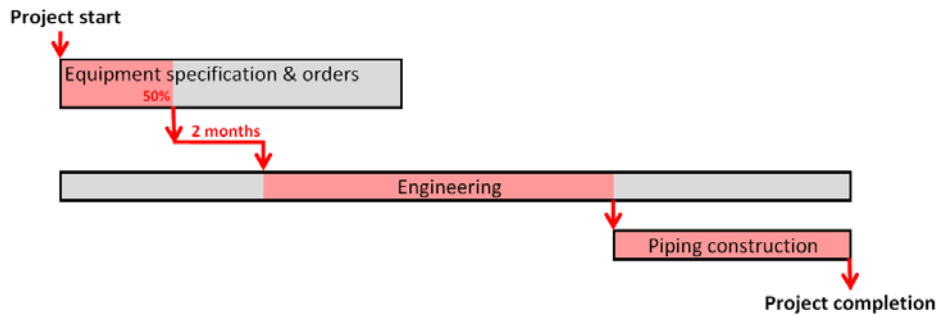


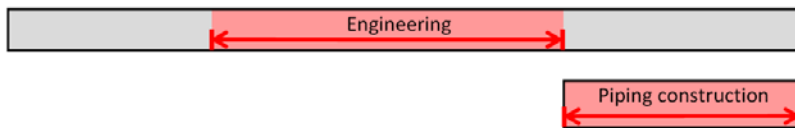
Project Critical Path (CP) law

“The time it takes to build an Oil & Gas facility is the time it takes to build its pipework. Pipework construction effectively starts once engineering is nearly completed. Engineering effectively starts 2 months after half the equipment have been ordered.” (Illustr 16_8)



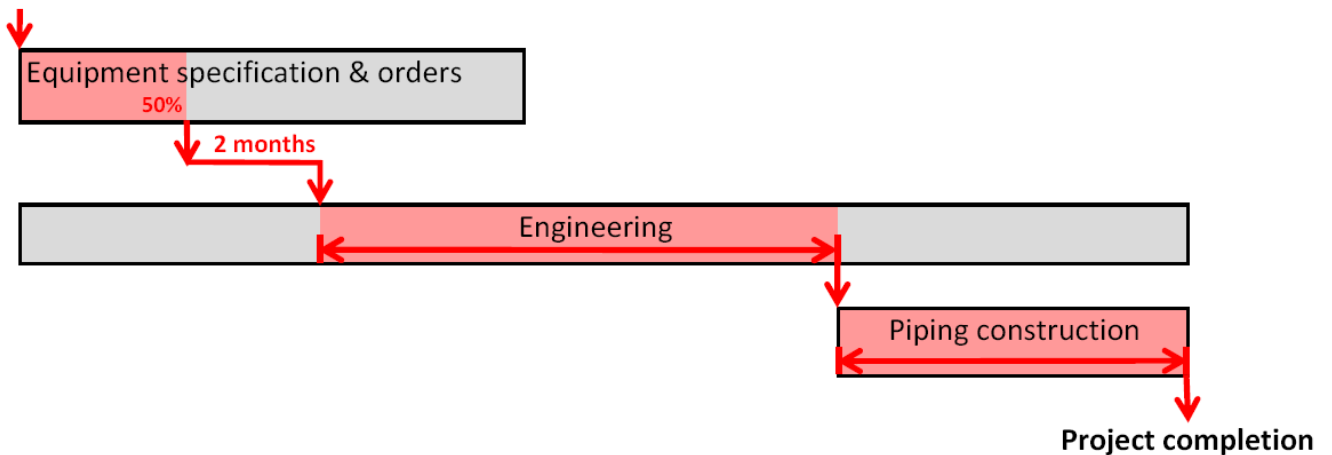
Project Duration (PD) law

“The duration of piping construction cannot be reduced below a certain minimum deriving from the facility’s piping tonnage. The duration of engineering cannot be reduced below a certain minimum deriving from the number of engineering manhours”. (Illustr 16_9)



Combining the 2 above laws yields that the Project completion date is directly determined by the date at which 50% of the equipment is ordered.

Project start



The **Project Critical Path law** can be explained as follows:

Piping is, first of all, engineered rather late. Piping design indeed only starts once the Process design is completed and the Plant Layout (equipment location) is set.

Plant and Piping layout cannot proceed without information from equipment vendors: general arrangement drawing, position of piping connections.

Vendor drawings start coming a couple of months after orders have been placed. It will take a much longer time to get them finalized.

To be able to issue piping isometric drawings, certified final vendor drawings showing the exact positions of piping connections on equipment and packages must have been received. Certified final vendor drawings of in-line instrumentation (ON/OFF valves, control valves, PSVs) must have been received as well.

Once piping isometric drawings are issued, spooling needs to be done by the construction sub-contractor. Piping construction follows, which entails numerous labour intensive activities: pre-fabrication, erection, fit-up, welding, post-weld heat treatment, non-destructive examination, supports, test, painting, reinstatement, insulation, cleaning.

It is therefore not surprising to find that Piping is the critical path of the Project.

A couple additional activities shall be added to the above critical path to truly reflect likely show stoppers. These two activities are:

- Supply of Piping materials,
- Equipment erection,

Piping materials are very numerous. They vary in Type (straight length, fittings: tees, elbows, flanges, o-lets etc.), Material (carbon, stainless steels etc.), Diameter, Thickness.

Piping materials procurement take a lot of time, typically 6-8 months depending on the type of items, to which shall be added transport, typically 2 months.

Every piping isometric drawing includes materials of several types. It can only be fabricated once all the materials shown on the drawing have been delivered.

Obtaining sufficient matches between drawings issued and materials received requires a large quantity of materials received and isometric drawings issued.

Experience shows that, for pre-fabrication to start, the following two conditions must be met:

- 50% of the total number of isometrics need to be issued,
- 70% of the total quantity of piping materials (all types, grades etc.)

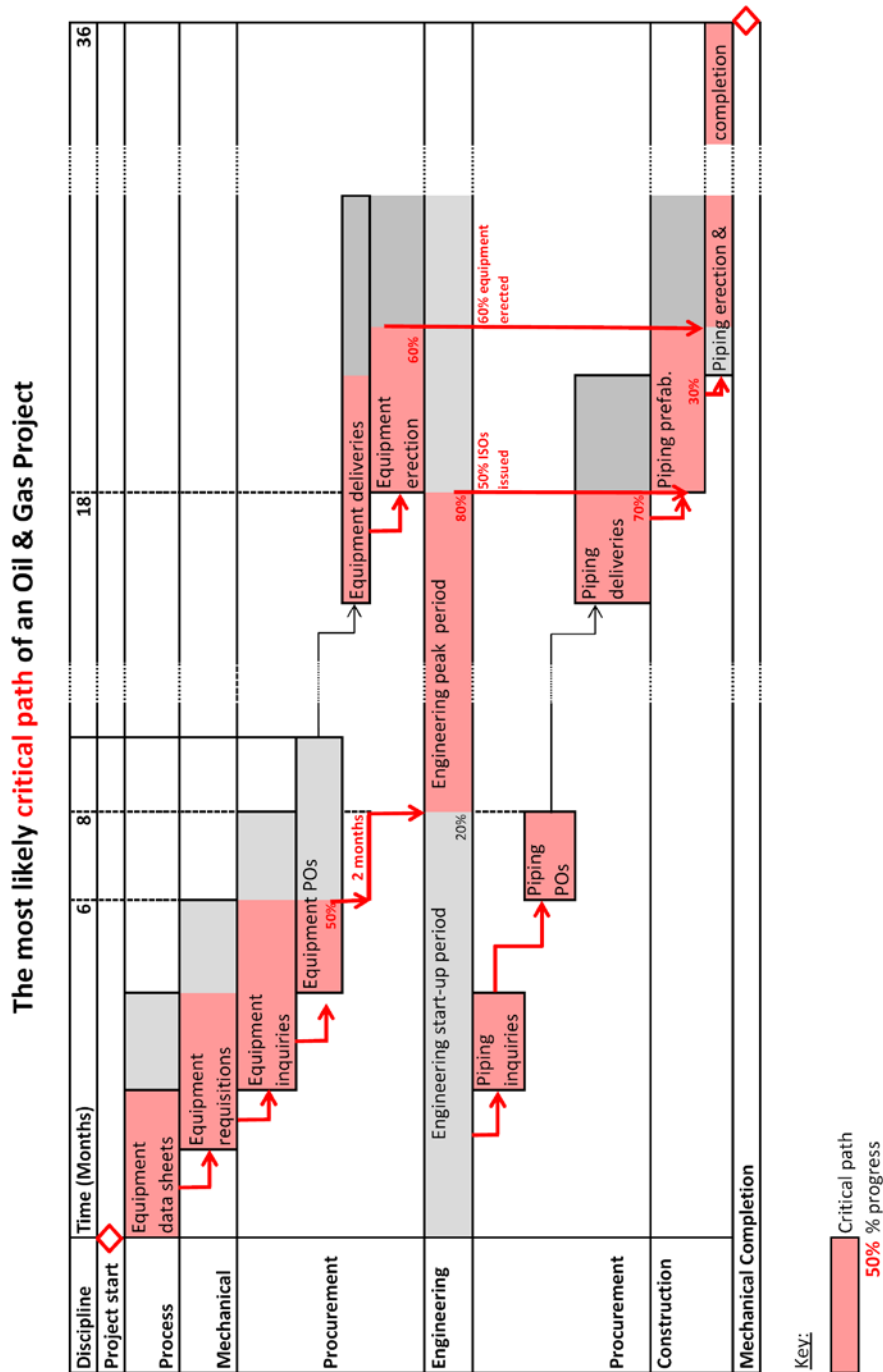
Note that when the above conditions are reached, 35% of the total number of piping isometrics only have matching materials available hence can be fabricated.

The requirement to deliver piping materials at an early stage and their long delivery time shows the necessity to add the Piping Material Requisition and Procurement on the critical path of the schedule, as shown on the next page.

Once piping spools have been fabricated, they can only be installed if equipment have been erected. Pipes are indeed connected to equipment nozzles.

We must therefore add the equipment erection on the critical path. Experience shows how: Piping erection is known to reach a good efficiency once 60% of equipment nozzles are available.

This equipment erection milestone is added to the critical path schedule shown on the next page, which is now complete. Critical activities are shown in red.



One would think that the duration of Engineering activities would be the same on any project, provided that resources employed are adjusted to the amount of Engineering work, as it derives from the Engineering work sequence. This is known to be wrong. Engineering productivity falls when the Project size increases.

This **Project Duration law** can be explained by the fact that the increased number of people involved lead to additional interfaces, delay in communication and stand-by. The same is experienced for the duration of Piping construction, which increases with the overall quantity of piping, whatever the resources employed. Again, this can be explained by the fact that with the Project getting bigger, more labour is involved which becomes less easy to coordinate and results in interferences and downtime affecting productivity.

The **Project Critical Path law** shows that the critical path is made of the 3 sequential activities: Equipment specification and purchase followed by Engineering followed by Piping construction,

The **Project Duration law** shows that the duration of the duration of Engineering and Piping construction cannot be reduced below a minimum duration.

Hence, to reduce the Project duration one can only act on the **date at which the Equipment are ordered**.