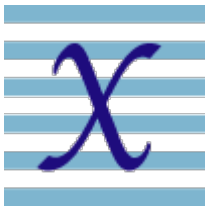


Granularity in large construction projects

Introduction

When we have to monitor large construction projects, we are often faced with the problem of setting the right granularity.
The granularity is is the lowest level of detail of which we want to track the physical progress.
The physical progress is the degree, expressed in %, of physical completion of the monitored object.
Defining the granularity is in fact defining which "atoms", the smallest grains, we want to track.
This means that we must ensure that the progress of such atom is trackable.
The granularity will define the volume of the schedule. If we chose the finest possible grain, then we will have to handle a possibly huge schedule. If we chose a grain that is too coarse, then we will end up handling a small schedule, but eventually we will have poor visibility on the project's real progress.

From now on we will take the position of a general project manager, i.e. the one that oversees the whole project. We thus do not take the position of the contractor, involved in one or more specific buildings.

Assume a large project consisting of many buildings, say a few tens.
We can chose a fine granularity, by defining the grains as the most elementary objects of every building, eg. every beam, every column, every floor, etc.
In that case we take the position of the contractor who has to use such granularity for he is responsible for the details.
We will end up with a huge schedule; we will have to set up a complex monitoring system for all buildings and spend a lot of efforts in the process of monitoring and reporting.
We risk to be swamped by details.
The result in terms of degree of control on the project processes is not even guaranteed.

We can also chose for a coarser granularity, by defining a set of "modules" of which the physical progress can be easily monitored. This will result in a smaller, more manageable schedule, a lightweight monitoring system, still providing adequate levels of control on the project processes.

The next section develops this concept further.

Modules as project grains

A module is a defined geographical area of rather limited volume.
A module is defined so that for any kind of activity, we can easily state:
"this kind of activity takes place in that module during that period of time", this is the “what-where-when” approach.
The complete set of modules must be congruent with the complete project.
Modules should not intersect, i.e. they must be geometrically separated.
Monitoring the physical progress of the complete projects then boils down to acquiring the % physical complete value of

- every kind of tasks
- for every module

in the complete project.

Let's develop these ideas a bit further.

By "kind" of activity we mean discipline like civil construction, steel, electrical, mechanical, etc.
The size of the module should be small enough, so that even when we chose a binary metric, {0%,100%}, to measure progress, the effect on the precision of the overall progress will be small.
In other words, the weight of any module in the total project should be small, e.g. in the order of a few % points.
This has yet another implication: the use of explicit weight factors is highly recommended when using modules.
The best weight factor would be the financial value of the activity (in kind) in the module.
Again, no need to set up a fine system of cost accounting for that purpose. A simple cost distribution per contract over the different modules will be sufficient for our purposes.
Let us remind that our progress recording aims at discovering the internal dynamics (progress and rate of progress) of the project processes. For that purpose there is no need for a cost distribution system with $ or € cent precision.

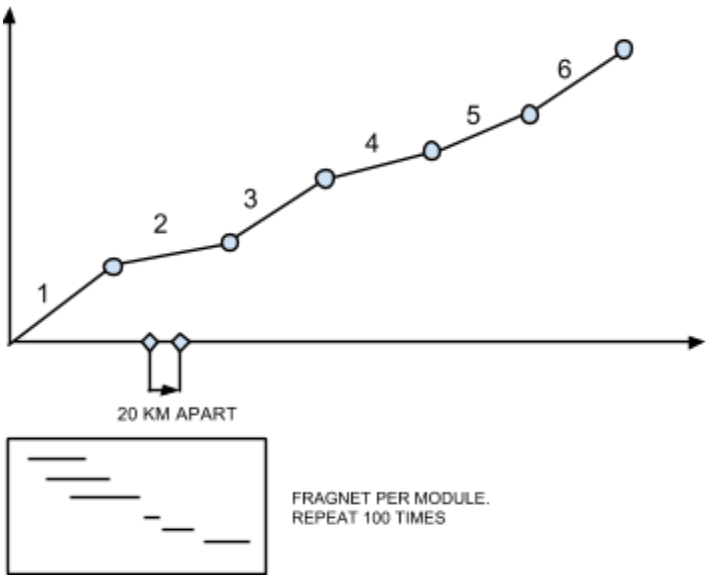
A few examples will clarify.

Examples

1. A linear project

Consider a one trillion $ pipeline project
The pipeline will cross different types of environments.
In sequence: sand, rock, sand, rock, water, soil (6 in total)
For every kind of environment there will be different average rates of progress
So we define 6 module (segments in this case), one per environment.
For every segment we set a number of geographical milestones.
Say the total length of the pipeline is 2000 km, and assume that the cost is linear with the length (not necessarily true), then a milestone every 20 km will define a subsegment of about 1% of the total project.

We have our modules: 100 segments of 20 km.
The list of activities in kind is: excavation, pipe welding, pipe protection,pipe laydown, instrumentation, refill (6 in total)
The schedule will thus contain about 600 task.
The monitoring could be limited to a binary system: task i in module j is 0 or 100%. As every task (in kind) would be weighted with its own value, the error on the total progress would be much less than 1%. We would get perfectly interpretable progress curves, where the differentiation between the different soils would be clearly visible.

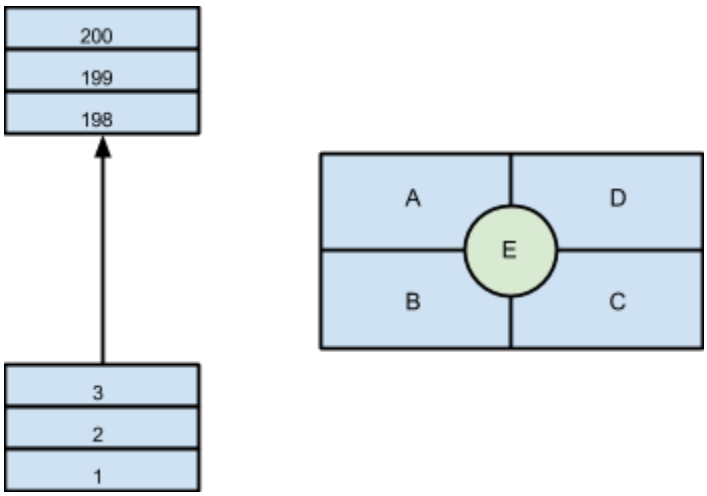


Segments numbered 1-6
Modules defined by milestones 20 km apart
Gant per module, to repeat 100 times

2. Another (semi-) linear project

Consider a one trillion $ skyscraper.
We say that such project is semi-linear because obviously there are two major parts: the foundations, which are not so linear and the above ground building which normally will be quite linear.
We will handle the aboveground part only.
The obvious module is the level, or the floor.
If we want to, we can refine the modules by defining areas on every floor.
We could also modulate the modules (pun not intended): for floors of simple structure, the floor is the module. For complex floors, we define areas, these become the modules.
For some kinds of activities, dividing a floor in areas could be meaningless, eg. civil construction. For other kinds of tasks, on the contrary, using areas as modules could be interesting, eg. HVAC, Lighting, etc.
Assuming a 200 levels building and say 8 disciplines, then the complete schedule would contain about 1600 task (+ some general tasks). Even if we use a binary metric for every task (eg, HVAC on floor 85 is {0,100} %), the error on the global progress would be less than 0.5 %. Indeed as we have 200 levels, every level weighs on average 0.5%.
With this simple system we would perfectly be capable to produce relevant progress curves per discipline for the whole project without falling into the trap of trying to keep track of every

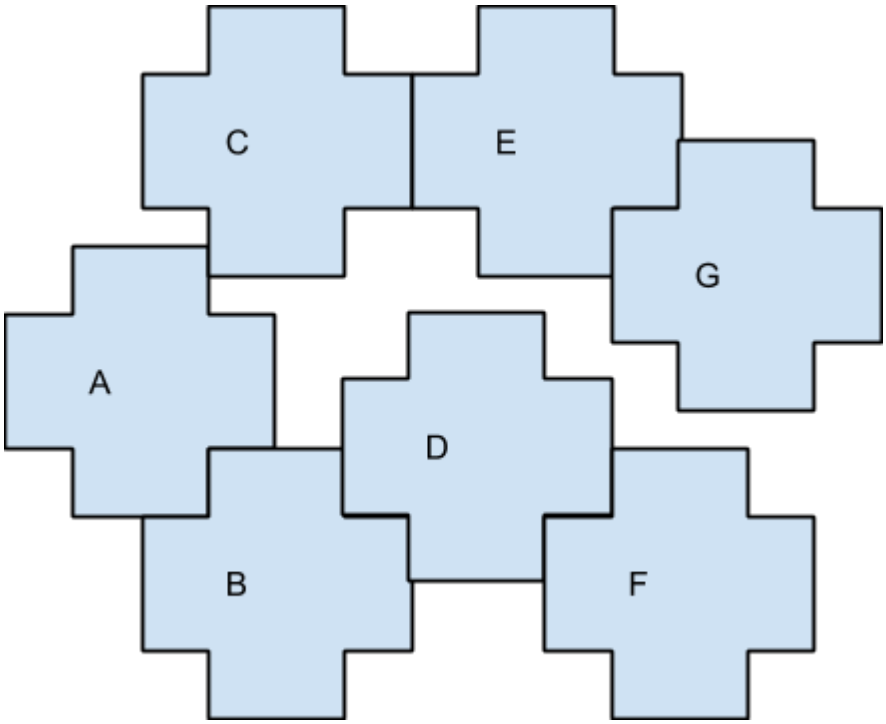
grain of sand in the desert in the midst of a sand storm.
We take a helicopter view at the right altitude.



Every floor can be a module.
Complex floors can be segmented in areas.
Every area is a module.
For every module, create a small Gantt of the activities in the module, one bar per kind.

3. Linearize a non-linear project

This example is a bit more abstract.
Many, eventually huge, buildings can be decomposed into modules by discovering patterns, often repetitive, in the building layout. Constructions that consist of random sets of shapes and elements are rare, and probably belong to the sphere of art rather than engineering.
Such patterns are the ideal basis to define the modules.
Again, it may be interesting for some kinds of activities, to refine the primary modules into areas (sub-modules).
In general any module should act as a geographical (i.e. real world, physical) milestone, that will act as witness point: activity i of module j, "has arrived".
When organising the modules so that they represent only a small fraction of the total project value, and weighing the task with their (approximate) value, will allow for a precise tracking of the project progress.
Remember: all project progress reporting is driven by the observation of the physical accomplishment.



The modules are the patterns A,B,C,D,E,F
For every module set up a Gantt of the activities in the module, one bar per kind.
If justified, subdivide the patterns in areas.

4. A multiple building project

Assume a one trillion $ multiple building project. The question is now how to monitor such project.
Going down to the construction detail grains would result in a zillion tasks schedule.
And so we rightfully say “no thank you”.

We would organize one schedule
The large buildings would be decomposed into modules along the lines set out in the previous sections.
One schedule summary per building

The smaller buildings, or highly specialised buildings - services, power distribution, security, etc - would be handled as one module.
One schedule summary per building.

Common infrastructure - undergrounds, roads, firefighting lines, etc. - would be handled as linear projects: define the modules using geographical milestones.
Use the (approximate) financial value as weight factor.

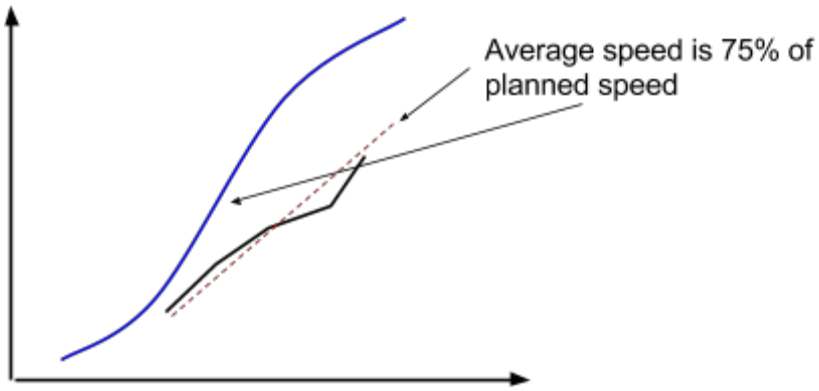
When thinking of any task think in terms of: “ we do this (task in kind), there (the module), in that time period (link, duration, date constraints)”.

Comments on re-baselining

To reschedule, or re-baseline, schedules set up in the manner explained in the previous sections, becomes quite simple.
We sketch the method hereafter.

Assume that a given sub-contractor, responsible for say painting, is not progressing as scheduled, but put up a performance that accumulates delays. Assume that this situation cannot be corrected and that the pm has decided to reschedule.

From the dynamic analysis we know that the performance of this contractor accounts to only 75% of scheduled.
We know this from this diagram (obtained with the Nav Chart tool).



Now that we discovered that the real performance of that contractor is only 75% of what was scheduled, we can easily rebaseline by applying a factor 1/0.75, or 1.33, to the durations of all the tasks of that contractor. This can be done as a bulk modification of the schedule.
This is far easier and more efficient and more correct, than the usual cut-and-shift of the tasks. In which case the real cause of the delay, loss of productivity, is not taken into account.

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