

4D Project Planning and H&S Management

A. Ciribini & G. Galimberti

Dipartimento di Ingegneria Civile, Università degli Studi di Brescia, Italy

ABSTRACT: A The European Client Organisations must face huge responsibilities by 92/57/EC Directive when the Health and Safety Management System has to be built in. Moreover, Public Client Organisations are trying, in different ways, to cope with such duties in modifying their Project Execution Plans over time so to update project schedules and reports complying with H&S Plan-related measures. The researchers have performed a detailed analysis which should allow Project Sponsors and Project Managers to deal with Time Management following a safety-oriented approach.

1 INTRODUCTION

1.1 Type area

The EC Directive 92/57 (concerning H&S Management on Construction Sites) has been enforced in Italy in 1996.

The Directive, due to come in force in 1992, and postponed several times, was vainly expected to cause a huge impact from a legal point of view, despite all the serious attempts and efforts made by H&S Specialists in changing their own attitudes.

However, new practices have been introduced during the design and construction stages: appointed by Client Organisations, H&S Coordinators suddenly became driving players within the building and construction processes.

Project Planning and Control-related tools were reckoned apt to improve the H&S performances on construction sites.

When appointing a H&S Coordinator, the Client believed to be allowed to transfer him the risks to be born.

The H&S Managers and Coordinators, unfortunately, are often forced to waffle on about the legal meaning of the Directive's words rather than solve bad real practices.

Moreover, following the new approach, H&S Coordinators were trying to look at Spatial Factors which could affect the behaviours of the crews and equipments on site.

Unfortunately, a 3D-based design approach was needed, but designers usually prefer 2D CAD models in a scantily consistent way.

Indeed, they did not realise that 3D models could support a better H&S Planning practice.

The largest amount of available CAD techniques (80%) involve a 3D model to be prepared, whilst a Design Team could gain a huge profit in detecting conflicts.

Spatial Planning had to be undertaken by Client's Designers, during the pre-tender construction phase, through an agreement with Client's H&S Consultants, waiting for the contribution of the Building Contractor.

Likewise, General Contractors and Specialist Package Contractors should not be left with the main executive powers about H&S Management.

Otherwise, they could act as the ultimate owners of the decision-making process concerning the construction site-related occurrences, whilst being not allowed to negotiate prior to tendering.

Unfortunately, a few Contractors are used to apply the 4D CAD techniques or the Spatial Planning-oriented tools, too.

On the other hand, any late delivery caused by poor suppliers could barely trouble the whole and rigid Project Schedule: the H&S Planning System is to be improved from such a viewpoint, too.

Therefore, 4D Planners could visualize the sequencing of the work packages to be performed (and the components to be built or cast) whilst Spatial Analysts will optimise the space use on site.

The widespread of the subcontracting (reaching three or four tiers) is troubling a manageable process.



The parcelling out of the decision-making points causes a fragmented way of doing on site.

Because of changing working conditions on site, Client Organisations should be careful in devising the Breakdown Structures (PBS, WBS, OBS, ABS, RBS, CBS) during the design stages, waiting for a further investigation to be provided by the Contractor prior to the commencement of the works.

One major difficulty is to be found in structuring the sub-contracted work packages following a stated approach, as well as in the United States-widespread CSI classification system.

The Main Contractors are seldom able to find a viable sequence of starting as far as Subcontractors are asked to perform their tasks from the spatial point of view.

Otherwise, OBS, ABS, and WBS should be timely structured by H&S Coordinators so to be later verified and modified by Contractors and Subcontractors.

When taking into account such a purpose, the 2006 Winter Olympic Games Agency (a large Awarding Organisation) prepared a set of guidelines (concerning such topics and matters) to be closely followed by designers.

Such an approach encompassed spatial locations, physical components, schedules of rate, and activities.

Nonetheless, that is sometimes easier said than done: also the Design Teams are seldom able to realise the consistent sequencing of the activities to be included into the schedules.

It is important to consider contractual conditions because many activities are to be performed by different Contractors, following different payment criteria.

Coping with unreliable and unfinished schedules, Contractors are neglecting their duties: in other words, master plan schedules and look-ahead plans are often meaningless.

Eventually, the Pre-Tender H&S Plan issued by the H&S Coordinator sounds to be not consistent with the Construction H&S Plans provided by Contractors and Subcontractors.

The Spatial Planning should be linked with the productivity rates, so to balance working areas and physical advancements on site.

The traditional CPM method does not consider the effects of overcrowding: crews involved in non critical tasks might impair the completion of other critical activities.

Within a Dynamic Spatial Planning-oriented framework the space, conceived as a driving resource, mitigate the risks concerning the productivity's loss.

H&S Coordinators and Managers have to remember that reducing a task durations does mean to cause overlapping activities and overloaded working spaces.

It must be better to make efforts to avoid this conflicting conditions through a timely analysis of the forecast locations of the crews and equipments.

2 4D PROJECT PLANNING AND H&S MANAGEMENT

The H&S Management has widely to deal with working areas and space conflicts, trying to realise crew workflow directions, space requirements, and spatial buffers between activities (the so-called safety lags).

The H&S Coordination lies, above all, in realising physical flows on construction sites over months and years.

Sequences of crews (workflows and production rates) could be optimised from the point of view affected by work locations.

The H&S Planning should not neglect the space occupation rates: it happens that available and delivered resources could not be used due to an interference.

Shortages of space availability are often causing hazards or increase the risk levels, as well as planning and construction phases are quite often separated.

Moreover, the concurrent configuration of many tasks will increase the meaning of critical space.

Building Contractors are more and more seeking at reducing the time span through a huge compression of the task duration.

In so doing, working areas become overloaded and overwhelming activities could engender hazards and casualties. 4D models seem very useful in realising and avoid the overlaps.

Whenever criticalities are dealing with spatial constraints rather than time management, 4D Project Planning and its dedicated tools seem to be very useful.

Spatial constraints (due to overcrowding and restricted accesses) have to be considered also when looked to Procurement Planning.

Indeed, walkways, plant/equipment routes, procurement paths, storage areas and space requirements are the main factors to identify criticalities.

While some methodologies, as Last Planner and Critical Chain Scheduling, seek at manage activities to be started following short-term review of the allocated resources and the use of shielding tasks, the spatial loading has to be looked at with special care. Likewise, a bad resource usage could engender hazards and casualties because of space conflicts and overloads.

Resources need space to be stored and to be handled, but, unfortunately, such a space-demand is often un-



derestimated as scheduled activities are linked each other following the CPM time-oriented constraints. Delivered supplies could really affect the viability of the project schedule, when Contractors and Subcontractors are bearing the transferred risks.

Indeed, the authors were focused upon space (and safety lags) as driving resource to prepare and fill a H&S Plan.

When trying to reduce the original risks (leaving only the residual ones), H&S Coordinators (Planning Supervisors and Principal Contractors) evaluate spatial parameters to ascertain the sustainable thresholds.

They have to define the restricted areas and regulate the shared resources, considering a dynamic layout planning of the construction site.

Critical Space Analysis will be conceived in a tied way with the time sequencing of the scheduled activities. Genetic algorithms and stochastic search techniques have been employed to find the best resource distribution profiles, taking into account the potential space conflicts.

Equipment Performance simulators have been proposed, too.

A recently proposed multi-constraint scheduling (concerning with space, contract, resource, and information) tool could help to solve a lot of problems from the H&S Coordinator's point of view.

3 4D MODELS

It is a very hard task to define a close logic of the construction schedule because of a large amount of unknown variables. It has been acknowledged that a set scope of works to achieve should require a comprehensive realization of resource assignments.

Above all, spatial implications affecting the storage and handling systems could become very critical.

Moreover, a shortage of working areas often affect the sequencing of the tasks to be performed.

Therefore, a dynamic approach to the site layout and to the scheduling should be consistent with the routing of materials and gangers.

Considering constraints coming from the site surveys should provide the Planner with the ability to highlight the correct sequencing of the activities to be performed.

The main difficulties lie with the change management that is affecting the refurbishment works.

Moreover, such works could be performed on different floors during the same lapse of time.

4 4D PROJECT PLANNING

The traditional and widespread software packages are only able to allow Project Planners to look mainly at the resource curves and profiles, without spatial constraints.

Moreover, even if it could be possible to deal with space availability as a standard resource, H&S Coordinators and Project Planners themselves prefer to avoid to do it in a selfish way of thinking.

The Authors have listed a set of stages to be complied with when considering Project Scheduling and H&S Planning:

- 1 Analysis of working areas and paths;
- 2 Allocation of the working areas and plant/equipment to the listed activities;
- 3 Allocation of storage areas to the needed resources;
- 4 Control of the potential space overloads;
- 5 Review of the Project Schedule and the resource profiles;
- 6 Introduction of the safety lags (between activities);
- 7 Review of the driving resources;
- 8 Analysis of the site layout to be designed;
- 9 Linking of the H&S measures and specifications to the working areas and 3D objects (parts to be built and site equipments);
- 10 Site induction through the reviewed 4D models;
- 11 Management of the H&S site meetings through the 4D models;
- 12 Update of Project Scheduling and H&S Planning through the 4D models.

When tendering on a competitive base, Building Contracting Firms are often preparing their bids in a short time, because of the legal rules, providing unreliable bids.

Moreover, the lump sum contracts could cut dramatically margins of gain, urging the Contractor to recover such edges, in spite of their Subcontractors.

Such Subcontractors will be scarcely involved in the Project Planning and H&S Management .

A tender to be awarded on a lump sum criterion implies a detailed design.

The amount of the contract price to be spent in H&S measures will be sacrificed, too.

In Italy the H&S Coordinator has to fill the completion certificates only after the assessment of the H&S-related costs committed by Contractors.

During the tender stage, planners are often bored by temporary works, which need an accurate estimation.

Although H&S Coordinators seek at stimulate the best practices in the H&S Management, they are not succeeding in changing the usual way of thinking of the self employers, gangers and foremen.



The authors applied 4D CAD Techniques to building and construction projects, from the parking building to the hydraulic infrastructures.

The construction of a set of check dams in a mountain river proves that the morphology of the landscape could affect the availability of working areas.

It was featured by heavy slopes and restrictions in accessing, so that spatial constraints could not have been taken into account with traditional scheduling methods.

5 4D PROJECT CONTROL

4D models, prepared during the pre-construction stage, could be used in monitoring and controlling performed works.

Planners and H&S Coordinators should analyse and make comparisons amongst the original schedule and the updated ones.

When a delay occurs, it is easy to find missing objects, which are showing dropping productivity rates or others events.

Planners at every opportunity do not risk to be noted for consistency: frequent changes always pose a problem and weaken the dependability of the H&S Plan.

It is generally assumed that project schedules, as have been known for several years, cannot possess a power that practical experiences struggle to match.

As the Planners and H&S Coordinators undertake the hazardous task of owning a proactive approach to unforeseen events, the focus will remain on realising dynamic flows and physical conflicts due to changed relationships or risky overlaps.

Despite complaints from many H&S Coordinators, there is unfortunately little likelihood of a major adjustment in the behaviours of Contractors and Subcontractors.

When works are progressing and closely monitored, 4D Project Planning is promising to bring a new style in searching for a safe trade off between the needs of H&S Coordinators and Contractor's Representatives.

If works are behind of schedule, the collision about between H&S Coordinators and Site Managers could be bruising for the fulfilment of the contract to be signed. 4D Project Planning provide the possibility to analyse and visualize different ways to amend the original schedules.

Otherwise, the full reliability of the updated H&S Plan will remain a distant goal.

The first task will be to avoid superseded documents and schedules to be available on site.

The toughest effort to be made will be handling Project Schedules and H&S Schedules so to increase the awareness of the gangers and the crews.

The induction of newcomers on site is more powerful and learning curves seem to be crucial.

Several choices could loom during the site meetings (when discussing and debating about time changes) and the outcome will spread on site.

An oddity could happen: the most important factor, the spatial availability and usage, is neglected, although the safety-related results are set to become more and more required by the Large Client Organisations.

Everything else will pale compared with the difficulty of reduce and mitigate H&S-oriented risks.

6 CONCLUSIONS

H&S Planners and Coordinators need to deal with spatial constraints and resource usage.

These topics are hardly debated in the Client Organisations and Contractors.

And even if they were, it is unlikely that H&S Coordinators and Managers would be able to change the figures concerning hazards and casualties without effective criteria and tools.

In Italy, spending on H&S-focused Project Scheduling is low compared with a British average.

There are many reasons for this, from low revenues to unskilled Planners.

The large Building Contractors are only required from their Clients to provide a detailed schedule including chiefly tasks to be performed.

Clients are neglecting the procurement issues and the resources to be allocated.

They reckon that any uncertainty will affect the original schedule or believe that too many accidents will trouble the forecast CPM-related Plan to envisage a proactive way.

Moreover, 4D Models will compel Clients and Contractors to act as partners instead of counterparts, in a cooperative contractual framework.

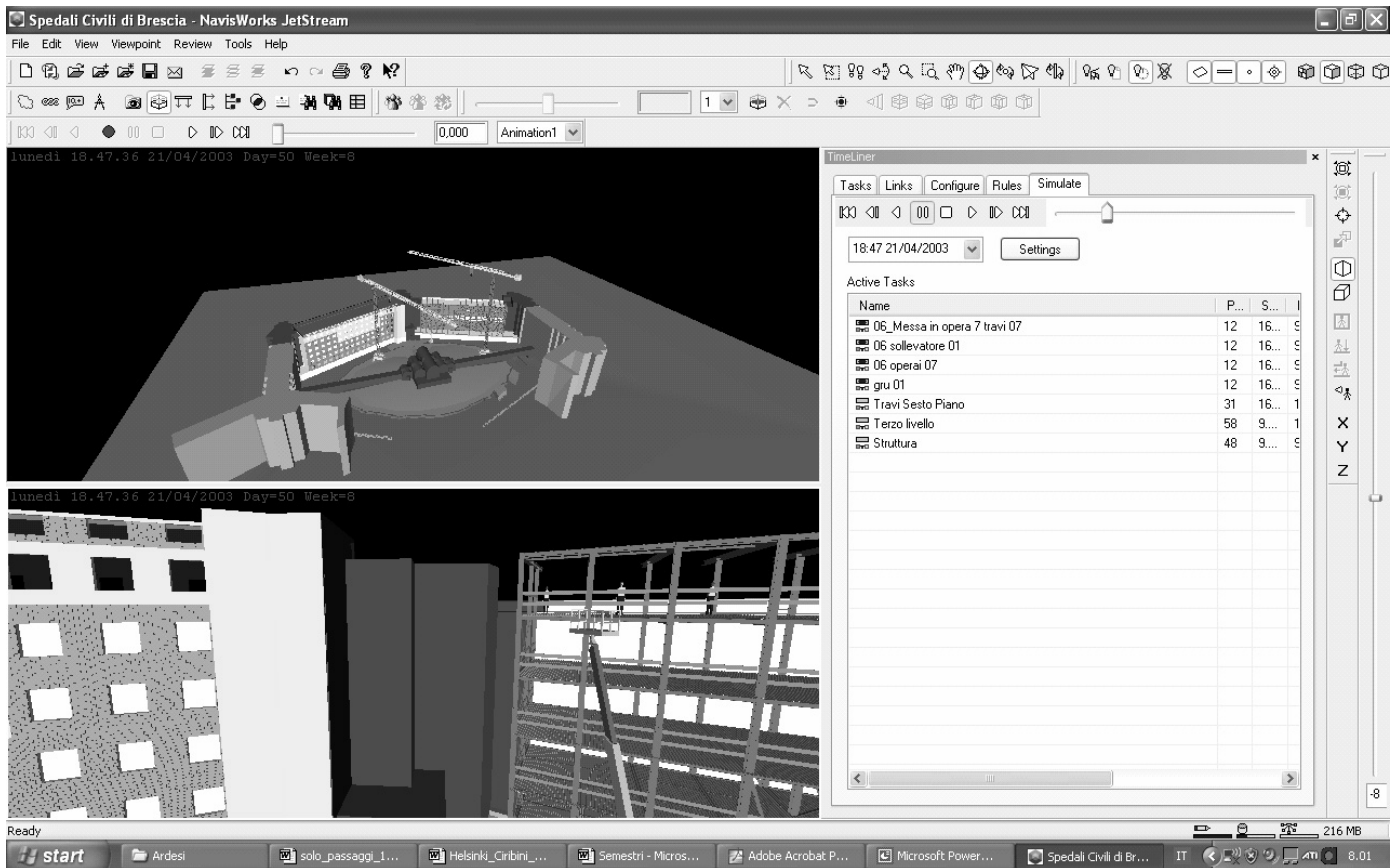
Unfortunately, Clients and Contractors are used to think in an adversarial manner, so they prefer to stay with the rooted behaviours.

Following such an approach, H&S Coordinators are forced to look at single Work Package to be performed over the time, lacking of the awareness of spatial conflicts amongst the Subcontractors and badly assessing the potential hazards due to the supplies' shortage, handling and storage.

The H&S Managers belonging to Contractors and Subcontractors try to hide what they feel as boring.

Nonetheless, 4D Techniques deserve credit and attention to be paid.





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