آنالیز تاخیرات بر اساس یک مطالعه موردی و نحوه بکارگیری روشها در نرم افزار P6

بخش چهاردهم:

مطالعه موردی آنالیز تاخیرات در یک پروژه نمونه

ارائه دهنده:

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What we will learn?

- Case study: Airport terminal expansion
  - Case study
  - Tribunal planning expert's contemporaneous approach
  - Float mapping: approach and methodology
  - Demonstrating acceleration
  - Presentation skills: Demonstrative evidence

Purpose of This Section

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Purpose

- The purpose of this Section is to describe, **step by step**,
  1. **How** some of delay analysis **techniques** can be **applied**
  2. **How** the **assumptions** made by an analyst are **fundamental to the reliability** of the conclusions

     It is important to note that the **methodology demonstrated** in this case study is **not the only method**

This case study was selected to provide a better understanding of a widely used method of delay analysis

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Case Study: Airport Terminal Expansion

(Case Study)

Introduction

- This **case study demonstrates** the application of a
  1. **Time slice windows analysis** (contemporaneous update/windows analysis)
  2. In conjunction with **TIA conclusions**

- Other techniques and topics described in this case study are
  - ‘Float mapping’
  - ‘Pacing’
  - ‘Concurrent delay’
  - ‘Dominant delay’
  - ‘month-to-month’ update analysis

Let’s see the case!

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Definition

- A **joint venture consortium (JV)** was contracted to carry out **renovations** to an **existing Terminal Building** and modernize an existing **Control Tower**, as well as **Runway Extension works** to an **existing international airport**.
- The date for **commencement** was **October 1, 2006**, with a date for **completion** of **August 1, 2007**.
  - In the event, the project was **actually completed** on **January 28, 2008.**
- A **disputed time extension claim** was referred to **arbitration** and a **tribunal-appointed planning expert**

  was appointed to provide an **independent review** and analysis that would either **validate or refute** the existing analyses performed by **party-appointed experts.**

Why there was a dispute?

Dispute

- The **planning expert** for the **JV (the claimant)** undertook a TIA.

- The **planning expert** for the **employer (the respondent)** submitted a report which concluded that
  - **JV** had **not proved** its case
  - JV had **not sufficiently demonstrated** any **causal link** from the **events relied** on to the **losses** that were being **claimed**.

What conclusion employer made?

Dispute

- The **employer's expert** also concluded that:
  - The **JV failed to act on instructions** to accelerate, and thus were **not entitled to any recovery** of any **costs incurred** while attempting to **mitigate** the employer delay events.
  - The **JV** would have **finished late in any case**, due to delays on the **Runway Extension work**, which were **not varied or delayed** in any way by the employer.

What was the information available?

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Information

- The **information available** on this case was as follows:
  - Submitted and approved baseline (as-planned) programme
  - Contemporaneously updated CPM (critical path method) programmes
  - Contemporaneously prepared as-built programme
  - Agreed employer risk events (EDE fragnets)

What was the initial analysis performed by party-appointed planning experts?

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Initial analysis by party-appointed

- Although there was **agreement** between the experts as to which delay events were **employer's risk events**, and thus **'excusable' risk events**, there was a large **disagreement** between the experts regarding
  1. **Which delays** were on the **critical path** to completion from **time to time**
  2. **Which were relevant** to the **contractor's entitlement** to both **time** and **money**.
  3. **How much recovery** was achieved by the **mitigation schedules**
  4. **Whether the employer delay** events affected the **critical path to the actual completion** date in January 2008.

Which delays were identified?

Initial analysis by party-appointed

- The **employer delay events** were identified in the
  1. Terminal Building
  2. Control Tower
  3. Runway Extension

- The **Runway Extension works** were largely **completed on time**, so these were **not considered in the TIA** by the claimant's planning expert.

What programmes were available?

Initial analysis by party-appointed – Table 1

- **Project** was in **delay** from the **first updated** CPM programme dated.
- **October 1, 2006**, which reported a **28-day delay at the time** (i.e. −28 days of float).

Available programmes.

Programme file name	Data date	Projected completion date	Total float
1006	1-Oct-06	29-Aug-07	−28
1106	1-Nov-06	24-Aug-07	−23
1206	1-Dec-06	30-Sep-07	−60
0107	1-Jan-07	5-Oct-07	−65
0207	1-Feb-07	13-Oct-07	−73
0307	1-Mar-07	25-Oct-07	−85
0407	1-Apr-07	12-Sep-07	−42
0507	1-May-07	20-Sep-07	−50
0607	1-Jun-07	10-Oct-07	−70
0707	1-Jul-07	14-Oct-07	−74
0807	1-Aug-07	25-Oct-07	−85
0907	1-Sep-07	4-Nov-07	−95
1007	1-Oct-07	24-Dec-07	−145
1107	1-Nov-07	15-Jan-08	−167
1207	1-Dec-07	30-Nov-07	−121
0108	1-Jan-08	2-Dec-07	−123

What do you see from here?

What excusable risk events were identified?

Initial analysis by party-appointed – Table 2

- There were **no particularized delay events** identified by the **employer's planning expert**;

  therefore, these were the **only events considered** in the **tribunal-appointed expert analysis.**

What does that mean? What would be the problem here?

Excusable risk events.

Event	Description
A	Additional services below slab
B	Additional protection works to underground utilities
C	Shop drawing approval
D	Revised columns to control tower
E	Revised blockwork to terminal building
F	Revised curtain walling to terminal building
G	M&E revisions – first fix second level terminal building
H	M&E revisions – first fix first level terminal building
I	M&E revisions – first fix ground level terminal building
J	Terrazzo floor changes – terminal building
K	Revised curtain walling to control tower
L	Acoustic ceiling revision – control tower
M	Revised retail layout – terminal building

What method used?

Initial analysis by party-appointed

- The **TIA** carried out by the **claimant's expert**
  1. **Concluded** that **all** of the risk events **contributed to critical delay**
  2. **Demonstrated** that the claimant was entitled to a **full-time extension** when the impact of all events was **considered cumulatively**

Was that true?

Initial analysis by party-appointed

- However, **certain excusable events** were **clearly unrelated** and in **different areas** of the project.
- The **TIA** did **not offer a linear critical path** through the works, demonstrating how the impact of the **unrelated events** should be treated as additive critical delays.
  - According to the results in the TIA, the **critical path shifted** from the **Terminal Building** to the **Runway Works** and **back again**.
    - ✓ The **employer's expert** believes that it is true that **as-built critical path** is not on Runway works, but it **was during the project**!
      - The TIA did **not provide a linked chain of events**, from commencement to completion, which could be related to an **as-built programme** and the **actual costs** incurred.

What conclusions made using TIA?

Initial analysis by party-appointed – Table 3

- The **'impacted window'** in column four of **Table 3** relates to the contemporaneous updates listed in **Table 1**.

Available programmes. **Table 1**

Programme file name	Data date	Projected completion date	Total float
1006	1-Oct-06	29-Aug-07	–28
1106	1-Nov-06	24-Aug-07	–23
1206	1-Dec-06	30-Sep-07	–60
0107	1-Jan-07	5-Oct-07	–65
0207	1-Feb-07	13-Oct-07	–73
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1207	1-Dec-07	30-Nov-07	–121
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Table 3

Conclusions of time analysis.

Event Rev	Description	Delay duration (calendar days)	Impacted window
A	Additional services below slab	15	1106
B	Additional protection works to underground utilities	20	1206
C	Shop drawing approval	4	0307
D	Revised columns to control tower	33	0607
E	Revised blockwork to terminal building	12	0607
F	Revised curtain walling to terminal building	10	0707
G	M&E revisions – first fix second level terminal building	46	0707
H	M&E revisions – first fix first level terminal building	20	0707
I	M&E revisions – first fix Ground level terminal building	15	0807
J	Terrazzo floor changes – terminal building	20	0807
K	Revised curtain walling to control tower	14	1207
L	Acoustic ceiling revision – control tower	7	1207
M	Revised retail layout – terminal building	24	0108

How the duration of each delay event determined?

Initial analysis by party-appointed – Table 4

- The duration of each delay event was determined by an analysis of the **available facts** and an **agreed chronology** for each delay event. For example, **Table 4** summarizes the calculation of the revised columns to the Control Tower, **event D** in **Table 3**.

Conclusions of time analysis.

Table 3

Event Rev	Description	Delay duration (calendar days)	Impacted window
A	Additional services below slab	15	1106
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I	M&E revisions – first fix Ground level terminal building	15	0807
J	Terrazzo floor changes – terminal building	20	0807
K	Revised curtain walling to control tower	14	1207
L	Acoustic ceiling revision – control tower	7	1207
M	Revised retail layout – terminal building	24	0108

Table 4

Event D, calculations to revised columns.

Key dates	Description
1-Apr-07	Engineer advises revised loadings on control tower roof
3-Apr-07	Planned finish of strengthening columns in baseline programme
1-Jun-07	Engineer issues revised details for column strengthening
1-Jun-07	Planned commencement of strengthening in 0607 update programme
5-Jun-07	Strengthening able to commence
2-Jul-07	Planned finish of strengthening columns in 0607 update programme
4-Aug-07	Strengthening of columns completed
33 cal. days	Actual delay to strengthening columns (July 02, 2007 to August 04, 2007)

What happened here?

Initial analysis by party-appointed – Table 4

- Although the total delay from
  1. **Planned finish** of 'strengthening columns' (April 3, 2007)
  2. **Actual finish** of 'strengthening columns' (August 4, 2007)

  is **123** calendar days,

  planned finish of strengthening, at the time the **revised work** was instructed, was **July 2, 2007** in programme **0607**.

Event D, calculations to revised columns.

Key dates	Description
1-Apr-07	Engineer advises revised loadings on control tower roof
3-Apr-07	Planned finish of strengthening columns in baseline programme
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2-Jul-07	Planned finish of strengthening columns in 0607 update programme
4-Aug-07	Strengthening of columns completed
33 cal. days	Actual delay to strengthening columns (July 02, 2007 to August 04, 2007)

So, what was delay due to the revised details?

Initial analysis by party-appointed – Table 4

- **Programme 0607** is dated June 2007 and was the prevailing programme in place **when the 'Engineer issues revised details** for column strengthening'.
  - Therefore, any **delay to the commencement** of column strengthening that occurred **prior to June 1, 2007** was **not due to the revised details.**

The reason for delay to SV may be different compared to the reason to FV!

Conclusions of time analysis.

Table 3

Event Rev	Description	Delay duration (calendar days)	Impacted window
A	Additional services below slab	15	1106
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4-Aug-07	Strengthening of columns completed
33 cal. days	Actual delay to strengthening columns (July 02, 2007 to August 04, 2007)

So, what was delay due to the revised details?

Initial analysis by party-appointed – Table 4

- The **measurement of delay** was based on the date the work **was actually carried out** and the **most recently submitted programme** at the time the **revised work was instructed.**
  - This translated into a **critical delay of 33 days** in the TIA.

Conclusions of time analysis.

Table 3

Event Rev	Description	Delay duration (calendar days)	Impacted window
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4-Aug-07	Strengthening of columns completed
33 cal. days	Actual delay to strengthening columns (July 02, 2007 to August 04, 2007)

So, what was the problem?

Initial analysis by party-appointed

- While the **discrete delay of 33** days is **logical**, as **demonstrated from an analysis** of the brief chronology provided,

  it was **not agreed** that the event was on the **critical path at the time**.

  - The method of carrying out the **TIA by the previous expert** was simply to **'set the clock to zero'** by **updating the status** of the programme (e.g. by **inserting progress data**)

    for all activities in progress up to the date **immediately prior to each delay event**.

So, why there is an issue here?

Initial analysis by party-appointed

- While the **discrete delay of 33** days is **logical**, as **demonstrated from an analysis** of the brief chronology provided,

  it was **not agreed** that the event was on the **critical path at the time**.

  - This **process** was performed for **each event**,

    independent of one another, with only o**ne event analyzed at a time**,

    even when those **events occurred in the same update period**

What happened then?

Initial analysis by party-appointed

- This method was **relied on by the claimant** to prove its entitlement to an extension of time and presented **before an arbitration tribunal** of **three arbitrators**.
- It was **agreed** between the **experts** that this method provided a measure of the **likely impact of delays** from time to time,

  as measured against an updated version of the **contractor's most recent contemporaneous programme**,

  but it was argued by the **employer's expert** that this approach did **not provide assistance** in demonstrating **compensable periods** of delay to assist in **pricing prolongation** entitlement for each delay event.

What they decided next?

Initial analysis by party-appointed

- **Further submissions** were **made** and an **additional hearing** was deemed necessary by the **tribunal**.
- A **tribunal-appointed expert** was **agreed** to by **all parties to**
  1. **Assist** the **arbitration tribunal** in understanding the **complex set of analyses** before it
  2. **Assist** in deciding whether **any entitlement** for additional **time or money** could be demonstrated **when considering only** the **facts** and analyses relied on by the **parties' planning experts**.
- This case study is focused on the **tribunal-appointed expert's approach.**
  - This approach will be deemed **'the tribunal expert's approach'.**

But why TIA does not account for prolongation cost?

Using TIA for prolongation

- It is **not universally accepted** that the **TIA method** of delay analysis can be used for **linking causation** to the **resulting prolongation**.
  - For example, the AACEI 29R-03 expressly states:

    *"An **additive-modelled schedule** by itself does not account for concurrent delays and is therefore unsuitable for determining compensability"*

    - ✓ The problem with TIA is that it relies on the **calculations of a prospective programme** and is therefore seen to be **theoretical**.
    - ✓ Like the impacted as-planned programme, the conclusions **may or may not hold true when viewed** in **retrospect**.

What could have been done?

Using TIA for prolongation

- The **responding party's expert** did **not provide a positive case** in the form of an independent programme analysis, other than
  1. **Questioning** the **reliability** of the **contemporaneous programmes**
  2. **Refuting** the **credibility** of the TIA approach **adopted by the claimant**

Case Study: Airport Terminal Expansion

(Tribunal Planning Expert's Contemporaneous Approach)

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Introduction

- Because it was important to **rely on evidence** which was relied on by the **party appointed experts**, and **facts that were already before the tribunal**,

  the tribunal expert's intention was **not to carry out an approach**,

  but to provide **assistance to the tribunal**, in **interpreting the evidence already presented** by the **party-appointed planning experts**.

- While the approach described here could be deemed simply a **'windows' analysis, or a contemporaneous update/windows analysis**,

  it is, like most forms of analysis, a **hybrid**.

  - The name of the analysis is **not as important as understanding the raw materials** that were considered in analyzing the impact of each event.

What steps carried out?

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Steps

- The steps carried out comprised the following:
  1. An analysis of the **contemporaneous programmes**.
  2. Analysis of the **as-built programmes**.
  3. Identification of an **as-built critical path**, from commencement to completion.
  4. Identification of **concurrent as-built critical paths**.
  5. Determination of **which of the employer delay events** are relevant to **actual delay** (by reference to the as-built critical path(s)).
  6. Determining **how much excusable critical delay** resulted along each as-built critical path.

Why these steps carried out?

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Steps

- This approach assisted in determining:
  1. How much **delay was reported** in each window, **contemporaneously**.
  2. **Which activities** were **driving the critical path**, in each window.
  3. **Whether concurrent** (or near critical) **paths** existed through the project.
  4. **Who was responsible** for that critical, and near critical, delay.

What did they do first?

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Float deterioration curve

- This timeline, **based purely on raw float values**, indicates that the **Terminal Building** was **initially in the most critical delay**, in October and November of 2006.
- In December 2006, and January and February 2007, the Control Tower took over, with the greatest negative float values.

Available programmes.

Programme file name	Data date	Projected completion date	Total float
1006	1-Oct-06	29-Aug-07	−28
1106	1-Nov-06	24-Aug-07	−23
1206	1-Dec-06	30-Sep-07	−60
0107	1-Jan-07	5-Oct-07	−65
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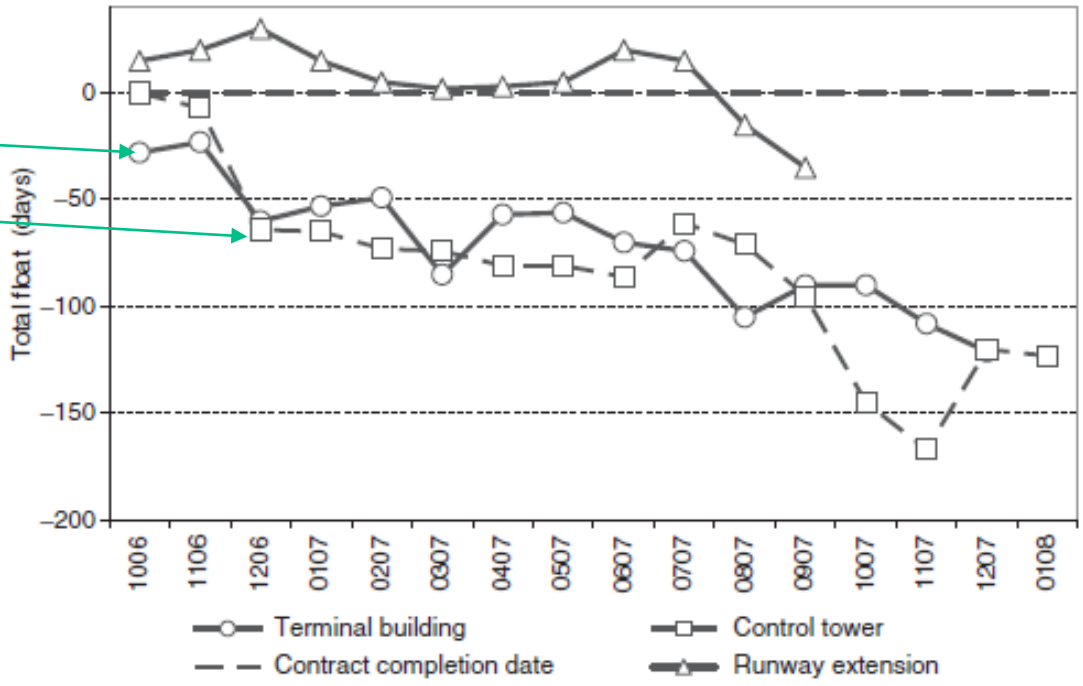
1107	1-Nov-07	15-Jan-08	−167
1207	1-Dec-07	30-Nov-07	−121
0108	1-Jan-08	2-Dec-07	−123

Planned finish date: August 1, 2007



Float deterioration curve

- The **two areas** continued to **compete** for **dominance** throughout the balance of the project until the **Terminal Building** was completed in December 2007.
  - Although it was **not driving the critical path** throughout the project, the **last item of work completed** was the **Control Tower** in January 28, 2008.

Available programmes.

Programme file name	Data date	Projected completion date	Total float
1006	1-Oct-06	29-Aug-07	–28
1106	1-Nov-06	24-Aug-07	–23
1206	1-Dec-06	30-Sep-07	–60
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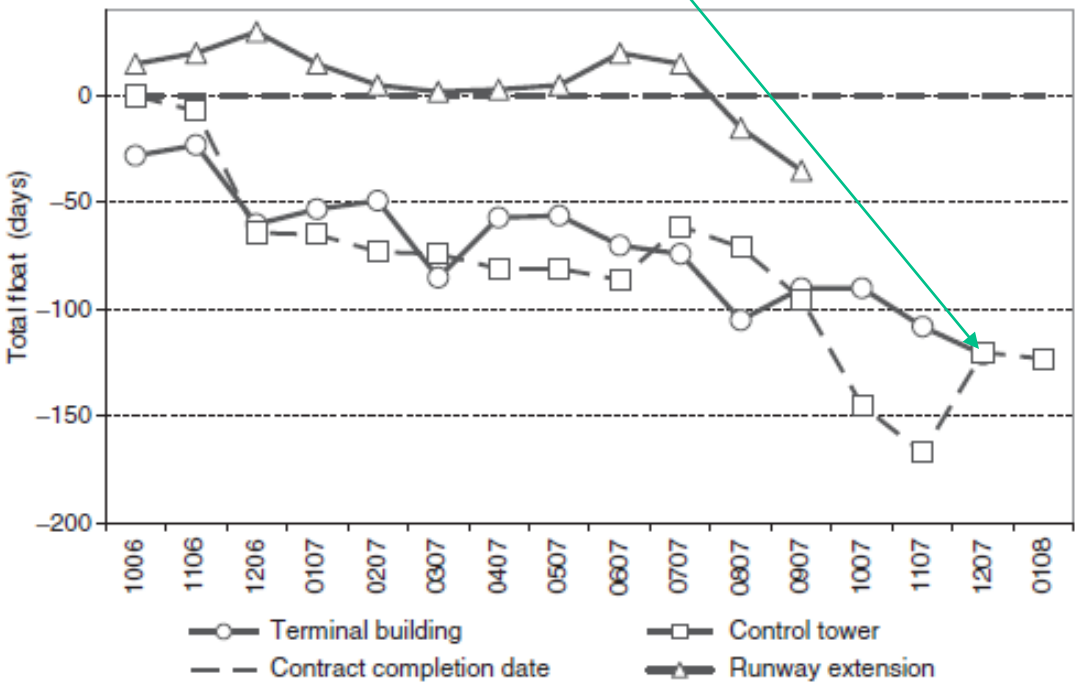


Why this analysis performed?

Float deterioration curve

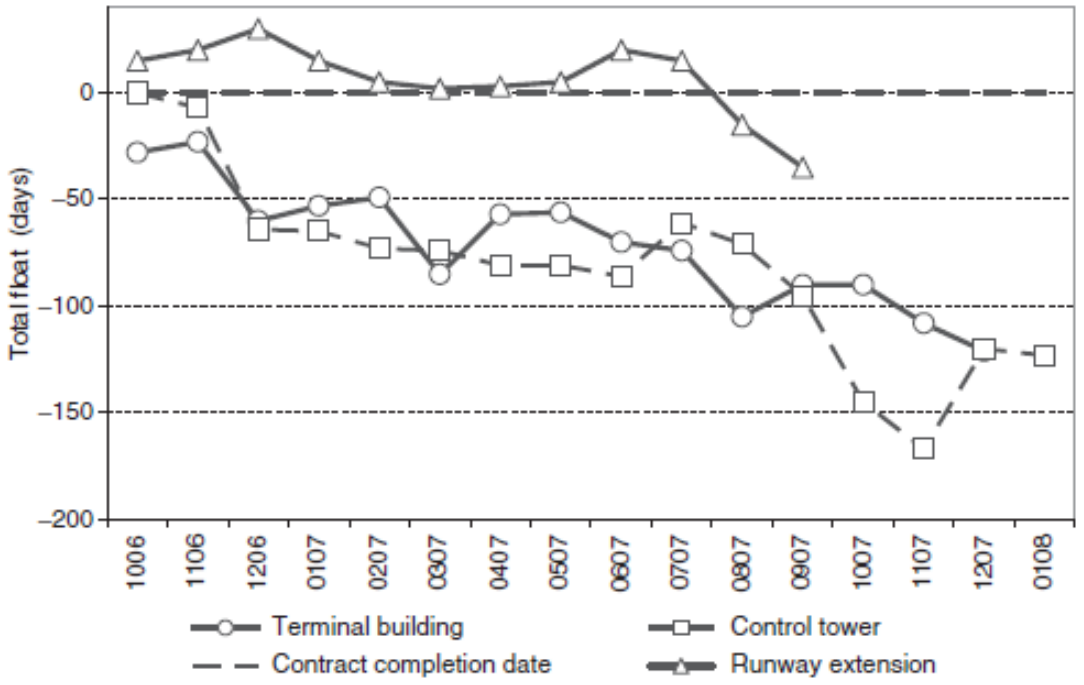
- This analysis raised **two important issues** such as:

1. **Whether concurrent delays** to the **Terminal Building** are relevant,
   when the **ultimate task** completed was the **Control Tower**.
2. **Whether delays** to the **Runway Extension** are relevant;
   when the balance of the work was **completed so much later**.

What was the answer?

Float deterioration curve – Concurrent paths

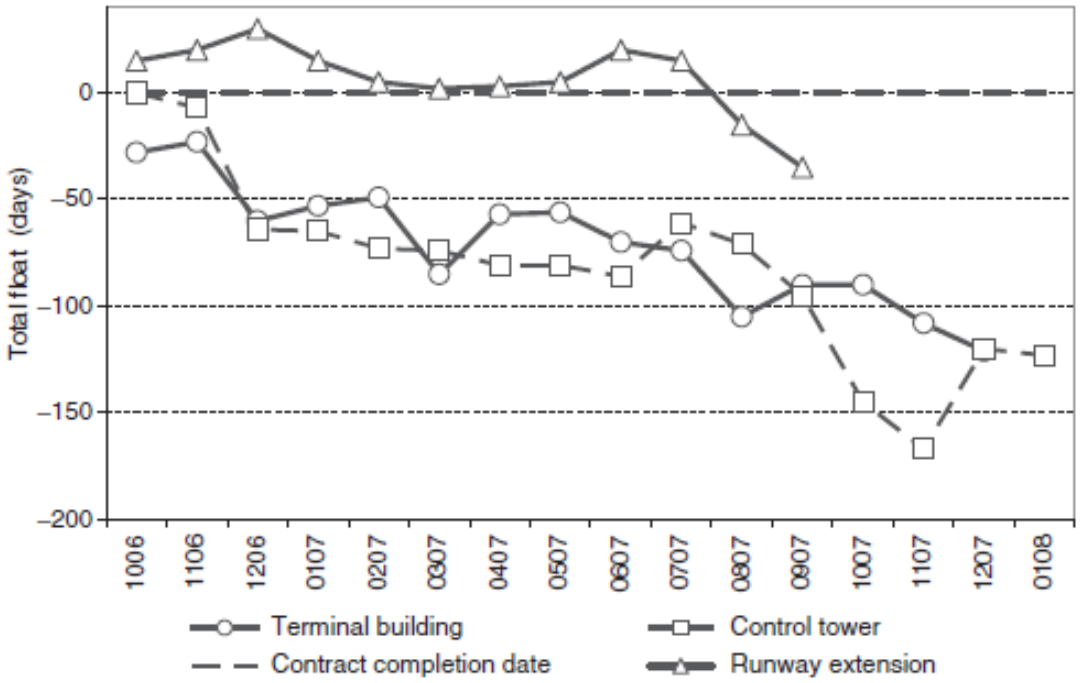
- When the **'dominant delay approach'** to delay analysis is argued, **concurrent delays are irrelevant**, and the answer may be 'no', they are **not relevant**.
  - However, when one looks at **where the contractor was placing resources** from time to time, it may be established that the **Terminal Building** was in fact **critical** and was treated as critical at the time.



What this would explain?

Float deterioration curve – Concurrent paths

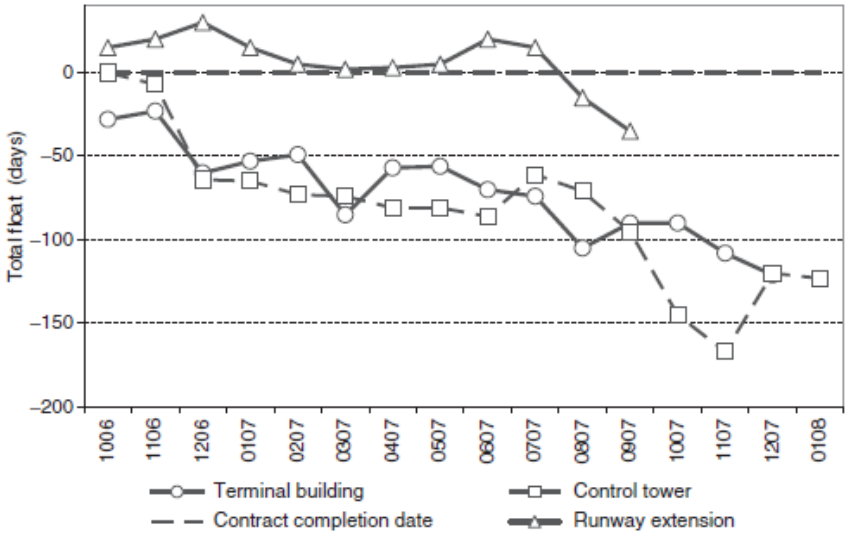
- This **would explain** why the contractor focused resources on **reducing delays** to the **Terminal Building**,
  resulting in the **Control Tower** work **slipping beyond** the date by which the **Terminal Building** was **complete**.



How about Runway extension?

Float deterioration curve – Are delays to the runway extension relevant?

- To determine if the delayed **Runway Extension** was relevant the contemporaneous programmes, **correspondence and monthly reports** were **reviewed**.
  - There was **supporting evidence** to show that the **claimant did not cause** any **non-excusable delay events** to the **Runway Extension**.
  - This was established on the basis that the **claimant was aware** of the **extent of delay** being experienced to both the **Terminal Building** and **Control Tower** as early as **March 2007**.
    - ✓ This is **supported by the float deterioration** analysis illustrated in Figure



So what is called in delay analysis?

Float deterioration curve – Are delays to the runway extension relevant?

- This approach is referred to as **'pacing.'**
- **Pacing** can **only be demonstrated** when there is evidence of a **conscious** and **contemporaneous** decision to **pace progress** against the more critical delay to other works.
  - There must also be an **implied** or **expressed** **intention and ability** to **restore** the works being paced,

    to **avoid those delays** **causing critical delay** to the work.

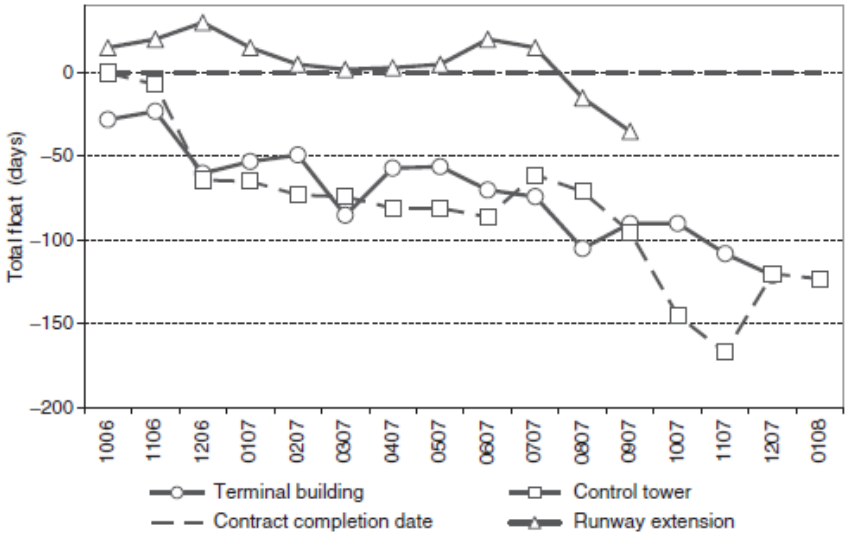
Pacing is usually implemented to save money, but can be implemented for many reasons

So, how tribunal expert could find out whether pacing or concurrent delays exist?

Float deterioration curve – Are delays to the runway extension relevant?

- There was **evidence** in the **JV's files** and **monthly reports** in which it **expressly stated** that it was **going to alter** the timing and sequence of the **Runway work** to coincide with **more favorable weather conditions**,

  but, **in any event**, well **in advance of the completion** of the **Control Tower**.



Is contractor allowed to do that?

Float deterioration curve – Are delays to the runway extension relevant?

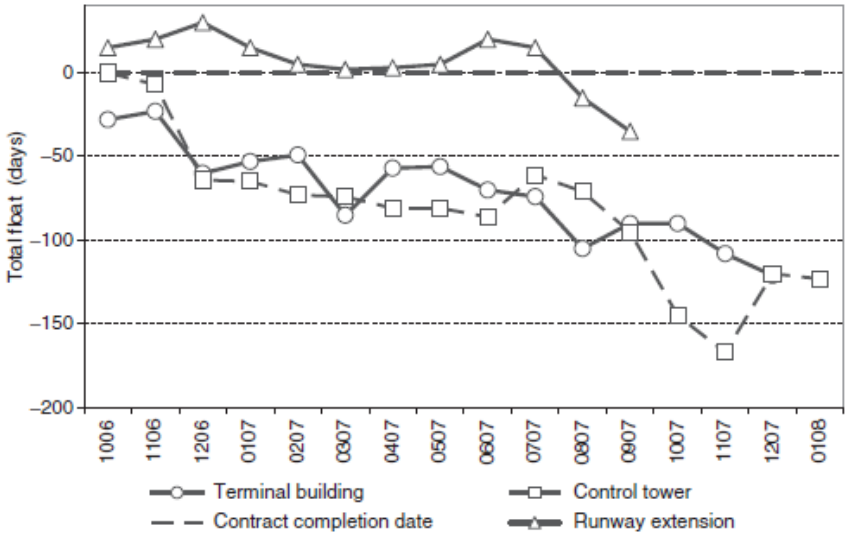
- In the United States, a **contractor's right** to **pace** the works in **response to a more critical delay** is an **accepted concept**.
  - Thus, when accepted, the contractor is not being penalized for pacing the works to avoid unnecessary costs.

1. The **reasons must be clearly expressed**, and
2. The **ability** to **restore outputs to normal** conditions must be **demonstrated**.

So, what was the conclusion?

Float deterioration curve – Are delays to the runway extension relevant?

- **The late completion** of the **Runway Extension** was deemed **irrelevant** because it was an elective, or **voluntary**, form of resequencing.
  - In any event, it was found that the **Runway Extension did not contribute** to any delay to completion and was **not on the critical path at any time**.



How about terminal building?

Float deterioration curve – Are delays to the terminal building relevant?

- The **float deterioration chart** indicated that there were **concurrent competing paths** along the **Control Tower** and **Terminal Building**, and that **neither** of these was **delayed**
  1. **Voluntarily** through pacing or
  2. Otherwise by any **contractor risk events**

What happened to check this?

Float deterioration curve – Are delays to the terminal building relevant?

- To **determine** whether each delay event was truly on the **as-built critical path** from time to time,

  the **tribunal-appointed expert** carried out an exercise to determine

  1. **Location** of the **critical path** from time to time,
  2. **Whose delays** were **driving that critical path**, based on the **best available evidence**

  The method the expert used was a form of **'Float Mapping'**

What is float mapping?

Case Study: Airport Terminal Expansion

Float Mapping: Approach and Methodology

Approach and methodology

- The approach to **float mapping** can also be described as a form of **time slice windows analysis (window analysis):**

> 'Window analysis is especially helpful when a critical path programme which was updated on a regular basis was employed on the project. To delay project completion, the critical activities of the project must have been delayed. The window analysis only analyses critical activities occurring during specific periods of time on a project. The periods analysed are the same periods of time as those when the project was updated. For instance, if the project was updated monthly then the window analysis would be monthly.[2]'

[2] Kris R. N. and Patricia D. G., 'Proof Development for Construction Litigation', *American Journal of Trial Advocacy* 7, 433 (1984).

- This reference was relied on by the **tribunal expert** to support his 'argument(s)' that the **monthly windows analysis** was an **appropriate breakdown** to use for this project.

Should we consider all activities here?

Approach and methodology

- The activities in the schedule which
  1. Had the **least amount** of **total float**
  2. Were also on the **longest path** of activities in the schedule

  were deemed to be **critical** to the completion of the project.
- When describing the process of identifying the **as-built critical path**, the **AACEI RP-FSA** states that:

  *Even in a **modelled collapsible as-built (3.8)**, **float** is not a **relevant indicator** of criticality because the late dates are not used in modeling the as-built schedule.*

So, how the analyst can come to the conclusion?

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Approach and methodology

- The **closest** the analyst can come to a **direct computational determination** is to **cumulatively collect** from **successive schedule updates** the activities that reside on the critical path between the **data date** and the data date of the **subsequent update**.

So, what happens when updates are available?

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Approach and methodology

- If the **updates are available**, the following is the recommended protocol:
  - a) Use all the critical and near-critical activities in the **baseline schedule**.
    - If **modifications** were made to the **baseline** for analysis purposes, use **both sets** of critical activities, before and after the **modification**.
  - b) For each **schedule update**, use the **critical and near-critical chains** of activities starting immediately to the **right of the data date**.
  - c) Also, use the **predecessor activities** to the **left of the data date** that precede the chains found in **(b) above**.

Was it float mapping?

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Approach and methodology

- This approach is consistent with the **'float mapping'** approach used in this case study.
  - **Float mapping**, put simply, is the
    1. **Process of extracting** the **float values** for each activity from each of the **contemporaneous CPM programme updates,**
    2. Then **grouping** and **filtering** those **activities** that
       1. Were driving the **longest path**
       2. Had the **least amount of float**

       to determine the **as-built critical path**.

How float values extracted?

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STEP 1: Extracting float values

- The **first step** in this exercise was to **extract the raw data** for the float values for all activities in **every schedule update**.
- This can be done **manually**, from
  1. **Hard-copy programmes**, or
  2. Exchange of **programming data** from most available planning software into a **database or spreadsheet package**.

Which method was selected?

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STEP 1: Extracting float values

- **Spreadsheets** were used for **this case study** due to the
  1. **Number of CPM activities** in each programme
  2. **Small number** of programme **updates**
- This allows for the sorting, grouping and filtering of activities when identifying and demonstrating the **as-built critical path**.

What happened next in this step?

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STEP 1: Extracting float values

- During this step,
  - **All activity data** should be **extracted** for ease of reference, including durations, constraints, start and finish dates and other relevant progress.

    Activity data for all activities *in the programme should be extracted at this stage to* ***ensure there is no bias*** *away from, or towards, any* ***potentially critical areas****.*

How float map created?

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STEP 2: Creating a float map

- The **second step** in this exercise is to **construct a table**
  1. **Listing all activities** in **every CPM programme**,
  2. **Listing** their respective **float values** from **month to month**, and
  3. **Identify** which activities are **potentially critical** (i.e. **Largest negative float**).
     - This can be performed **directly from step one**.
       - ✓ However, it is more likely that this will **require careful data management**, to

         ensure all float values are **aligned** with the **correct activity**.

Let's see the table!

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STEP 2: Creating a float map – Table 5

- **Minus** to the right of a float value = activity has been completed
- **Asterisk** in a cell to the left of a float value = activity did not exist until a later schedule

Raw data for the float map.

	Title	2006			2007							
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Act	CPM Programme File Name	1006	1106	1206	0107	0207	0307	0407	0507	0607	0707	0807
C11400017	Submit and obtain approval first shop drawings	17	2	–64	–65	–73	–74	–	–	–	–	–
C11400018	Manufacture and deliver first shipment to site	17	2	–64	–65	–73	–74	–81	–81	–86	–50	–49
C1B544210	E-M first fix conduit/cabling second level 35–43/E-J	–8	–18	–40	–33	37	23	–42	–40	–46	–38	–
C1B730090	Final decoration to first level	–27	–23	–40	–33	–14	–62	–57	–56	–70	–74	–85
C1B733056	Lath and plaster ceiling first level grid 35-46/J-RA	*	*	*	*	*	–37	–43	–35	–48	–55	–105
C1C320200	Duct bank/cabling to temp control rm in w jetty	*	*	*	*	*	*	*	*	*	*	–71
C1C3A0210	Construct two lifts columns fourth to fifth level control tower	0	–7	–11	–16	–33	–85	–	–	–	–	–
C1C4F0045	Fix curtain wall to control tower vcr level	*	*	*	*	*	–31	–31	–31	–47	–49	–63
C1C560010	E-M first fix services installation to control	10	3	–1	–6	–19	–27	–23	–30	–54	–51	–71
C1C660020	Plaster control tower walls internally	6	–1	–5	–10	–27	–26	–22	–14	–25	–45	–69
C1C860010	Figrst fix installation/ cabling for tower equipment	10	3	–1	–6	–19	–27	–23	–30	–54	–51	–71
C1C860050	Install/test and commission tower equipment	0	–7	–11	–16	–27	–31	–31	–31	–59	–61	–71
C1C900099	New control tower operational	0	–7	–11	–16	–27	–31	–31	–31	–59	–61	–71
C1C900100	Decommission existing control tower by others	*	*	*	*	*	*	*	*	*	*	–71

Can we only conclude based on the float values?

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STEP 2: Creating a float map

- **Float values** can be **manipulated** by a planner in many ways and should therefore **never be used as the sole indicator** of determining the **location of the driving path** or the **as-built critical path**.
  - For example, float values are affected by **constraints** imposed on activities in the programme, differences in **calendar assignments** between activities and the use of **optional constraints**, such as zero total float constraints.
    - ✓ **Altering network calculation options** by using 'progress override' instead of 'retained logic' will also affect the amount of float, and the **longest path** to completion from time to time.

Identifying driving activities

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STEP 3: Identifying driving activities

- The **third step** in the process is to **highlight** all of the activities meeting the following **two factors** that determine the **'driving' activities** within each of the programmes:
  1. The activity must be on the **'longest path'** to completion.
  2. The activity must be ongoing or scheduled to begin **within** the **update period**.
  - It is important to note that the **longest path often changes** throughout the project and for this reason it is analyzed on a month by month or update by update basis.
    - ✓ While it is **possible** that the **critical path shifts daily**, in **this case** study **no daily-update regime** was employed.

So, when to use more accurate analysis?

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STEP 3: Identifying driving activities

- When

1. **Accurate progress data** is available,
2. **Size and nature** of the **dispute** warrants the precision
3. **Concurrent delays** are important

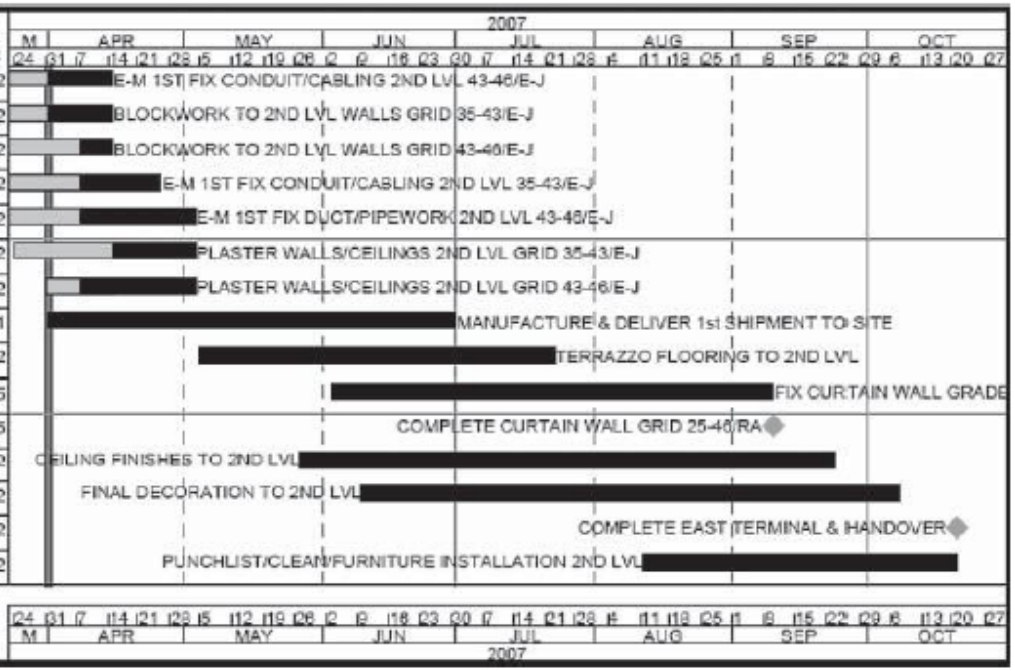
   it is possible to prepare **daily progress programmes** which can identify how the **critical path shifted on a daily** basis.

STEP 3: Identifying driving activities

- In **April 2007**, for example the **driving critical path** has a float value of **minus 42 days** to completion.

Case study – driving critical path (April 2007).

Activity ID	Activity Description	Total Float
C1B545210	E-M 1ST FIX CONDUIT/CABLING 2ND LVL 43-46/E-J	-42
C1B644010	BLOCKWORK TO 2ND LVL WALLS GRID 35-43/E-J	-42
C1B645010	BLOCKWORK TO 2ND LVL WALLS GRID 43-46/E-J	-42
C1B544210	E-M 1ST FIX CONDUIT/CABLING 2ND LVL 35-43/E-J	-42
C1B545310	E-M 1ST FIX DUCT/PIPEWORK 2ND LVL 43-46/E-J	-42
C1B644210	PLASTER WALLS/CEILINGS 2ND LVL GRID 35-43/E-J	-42
C1B645210	PLASTER WALLS/CEILINGS 2ND LVL GRID 43-46/E-J	-42
C11400018	MANUFACTURE & DELIVER 1st SHIPMENT TO SITE	-81
C1B740030	TERRAZZO FLOORING TO 2ND LVL	-42
C1B450040	FIX CURTAIN WALL GRADE-3RD LVL GRID 25-46/RA	-75
C1B450090	COMPLETE CURTAIN WALL GRID 25-46/RA	-75
C1B740050	CEILING FINISHES TO 2ND LVL	-42
C1B740090	FINAL DECORATION TO 2ND LVL	-42
C1A900000	COMPLETE EAST TERMINAL & HANDOVER	-42
C1B940095	PUNCHLIST/CLEAN/FURNITURE INSTALLATION 2ND LVL	-42



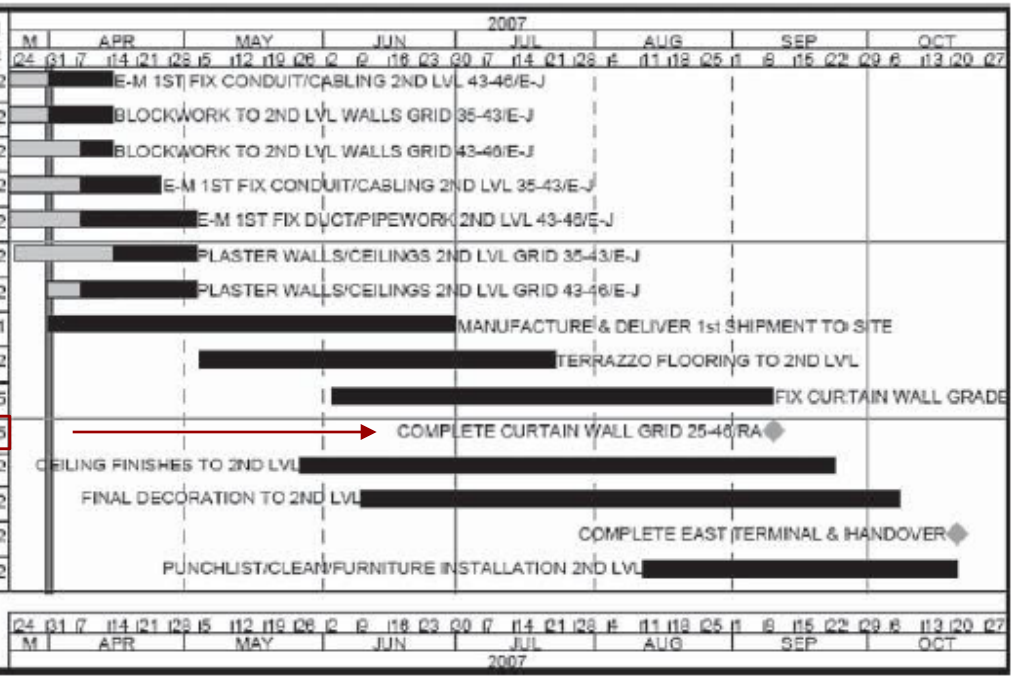
Although the majority of the activities on the driving critical path in April 2007 have a total float value of −42, there are three activities (C11400018, C1B450040 and C1B450090) with greater negative float values. Are they on critical path?

STEP 3: Identifying driving activities

- **Rudimentary analysis** indicates that these are being **constrained** with a **'finish no later than' (FNLT) constraint**, as illustrated by the **intermediate milestone activity C1B450090**, 'complete curtain wall grid 25–46/RA'.

Case study – driving critical path (April 2007).

Activity ID	Activity Description	Total Float
C1B545210	E-M 1ST FIX CONDUIT/CABLING 2ND LVL 43-46/E-J	-42
C1B644010	BLOCKWORK TO 2ND LVL WALLS GRID 35-43/E-J	-42
C1B645010	BLOCKWORK TO 2ND LVL WALLS GRID 43-46/E-J	-42
C1B544210	E-M 1ST FIX CONDUIT/CABLING 2ND LVL 35-43/E-J	-42
C1B545310	E-M 1ST FIX DUCT/PIPEWORK 2ND LVL 43-46/E-J	-42
C1B644210	PLASTER WALLS/CEILINGS 2ND LVL GRID 35-43/E-J	-42
C1B645210	PLASTER WALLS/CEILINGS 2ND LVL GRID 43-46/E-J	-42
C11400018	MANUFACTURE & DELIVER 1st SHIPMENT TO SITE	-81
C1B740030	TERRAZZO FLOORING TO 2ND LVL	-42
C1B450040	FIX CURTAIN WALL GRADE-3RD LVL GRID 25-46/RA	-75
C1B450090	COMPLETE CURTAIN WALL GRID 25-46/RA	-75
C1B740050	CEILING FINISHES TO 2ND LVL	-42
C1B740090	FINAL DECORATION TO 2ND LVL	-42
C1A900000	COMPLETE EAST TERMINAL & HANDOVER	-42
C1B940095	PUNCHLIST/CLEAN/FURNITURE INSTALLATION 2ND LVL	-42



What should be done here?

STEP 3: Identifying driving activities – Driving activities

- The **driving activities** in the above **'driving path'** are those which satisfy our **two tests** set out above. The **most critical path** is −42 (after the FNLT constraint is **dismissed**).
- The activities which are either ongoing or scheduled to commence in **each update**

Act	Title	2006			2007												08
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
	CPM programme file name	1006	1106	1206	0107	0207	0307	0407	0507	0607	0707	0807	0907	1007	1107	1207	0108
	Maximum delay (total float)	-28	-23	-64	-65	-73	-85	-81	-81	-86	-74	-105	-95	-145	-167	-121	-123
C11400017	Submit & obtain approval 1st shop drawings	17	2	-64	-65	-73	-74	-	-	-	-	-	-	-	-	-	-
C11400018	Manufacture & deliver 1st shipment to site	17	2	-64	-65	-73	-74	-81	-81	-86	-50	-49	-75	-	-	-	-
C1B115030	Protection works to ex fuel line grid 42-46/A-B	-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C1B115040	Protection works to ex fuel line grid 35-42/A	-15	-23	-60	-	-	-	-	-	-	-	-	-	-	-	-	-
C1B215310	Construct strip found grid 42-46/A	-13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C1B215450	Construct 1st lift columns grid 35-41/A	-15	-23	-60	-	-	-	-	-	-	-	-	-	-	-	-	-
C1B215570	Construct 1st lift wall grid 41-43/A-B	-15	-6	-42	-	-	-	-	-	-	-	-	-	-	-	-	-
C1B215610	Backfill/blind lwr lvl slab grid 43-46/A-E	-27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C1B216060	Install services below grade slab grid 43-46/E-J	-28															
C1B328220	Construct grnd beams grade lvl grid 35-43/A-D	-15	-23	-60	-53	-	-	-	-	-	-	-		-	-	-	-
C1B328230	Construct columns grade 1st lvl grid 37-43/-D,E	5	-23	-60	-53	-	-	-	-	-	-	-	-	-	-	-	-
C1B534210	E-M 1st fix conduit/cabling 1st lvl 35-43/E-J	-27	-21	-32	-36	-49	-57	-57	-50	-70	-	-	-	-	-	-	-
C1B534310	E-M 1st fix duct/pipework 1st lvl 35-43/E-J	-14	-21	-32	-36	-49	-50	-51	-50	-70	-	-	-	-	-	-	-
C1B544210	E-M 1st fix conduit/cabling 2nd lvl 35-43/E-J	-8	-18	-40	-33	37	23	-42	-40	-46	-38	-	-	-	-	-	-
C1B544310	E-M 1st fix duct/pipework 2nd lvl 35-43/E-J	-8	-18	-34	-27	45	23	-40	-43	-52	-42	-16	-	-	-	-	-
C1B545210	E-M 1st fix conduit/cabling 2nd lvl 43-46/E-J	24	24	28	13	4	-2	-42	-47	-67	-	-	-	-	-	-	-
C1B545310	E-M 1st fix duct/pipework 2nd lvl 43-46/E-J	8	9	3	-13	-1	-17	-42	-41	-61	-	-	-	-	-	-	-
C1B634210	Plaster walls/ceilings 1st lvl grid 35-43/E-J	-27	-21	-32	-33	-14	-57	-57	-56	-70	-	-	-	-	-	-	-
C1B644010	Blockwork to 2nd lvl walls grid 35-43/E-J	-8	-18	-40	-33	37	23	-42	-41	-	-	-	-	-	-	-	-
C1B644210	Plaster walls/ceilings 2nd lvl grid 35-43/E-J	-8	-18	-40	-33	-14	-42	-42	-42	-	-	-	-	-	-	-	-
C1B645010	Blockwork to 2nd lvl walls grid 43-46/E-J	24	24	28	13	-1	-17	-42	-41	-61	-	-	-	-	-	-	-
C1B710090	Final decoration to lower lvl grids 35-46/A-J	-28	-9	-15	8	-8	-24	-24	-4	-22	-31	-81	-81	-90	-106	-121	-
C1B715059	Fix acoustic ceiling lwr lvl	*	*	*	*	*	*	*	*	*	*	*	-81	-74	-97	-121	-
C1B729010	Reinstatement & Marking E Terminal Apron Area															-97	-121
C1B730090	Final decoration to 1st lvl	-27	-23	-40	-33	-14	-62	-57	-56	-70	-74	-85	-90	-90	-108	-120	-
C1B731040	Terrazzo floor tiling 1st lvl grid 25-35/J-RA														-108		
C1B733056	Lath & plaster ceiling 1st lvl grid 35-46/J-RA	*	*	*	*	*	-37	-43	-35	-48	-55	-105	710	-69	-108	-	-
C1C320200	Duct bank/cabling to temp control rm in w jetty	*	*	*	*	*	*	*	*	*	*	-71	-73	-73	-144	-118	-123
C1C3A0210	Construct 2 lifts columns 4th-5th lvl cont tower	0	-7	-11	-16	-33	-85	-	-	-	-	-	-	-	-	-	-
C1C4F0045	Fix curtain wall to control tower vcr lvl	*	*	*	*	*	-31	-31	-31	-47	-49	-63	-74	-145	-167	-	-
C1C560010	E-M 1st fix services installation to control	10	3	-1	-6	-19	-27	-23	-30	-54	-51	-71	-95	-144	-167	-120	-
C1C660020	Plaster control tower walls internally	6	-1	-5	-10	-27	-26	-22	-14	-25	-45	-69	-71	-134	-167	-	-
C1C860010	1st fix installation/cabling for tower equipment	10	3	-1	-6	-19	-27	-23	-30	-54	-51	-71	-95	-144	-167	-	-
C1C860050	Install/test & commission tower equipment	0	-7	-11	-16	-27	-31	-31	-31	-59	-61	-71	-81	-145	-167	-118	-109
C1C900099	New control tower operational	0	-7	-11	-16	-27	-31	-31	-31	-59	-61	-71	-81	-103	-119	-118	-123
C1C900100	Decommission existing control tower by others	*	*	*	*	*	*	*	*	*	*	-71	-81	-103	-119	-118	-123

STEP 3: Identifying driving activities

Why tasks with greater negative float were not on the critical path?

STEP 3: Identifying driving activities

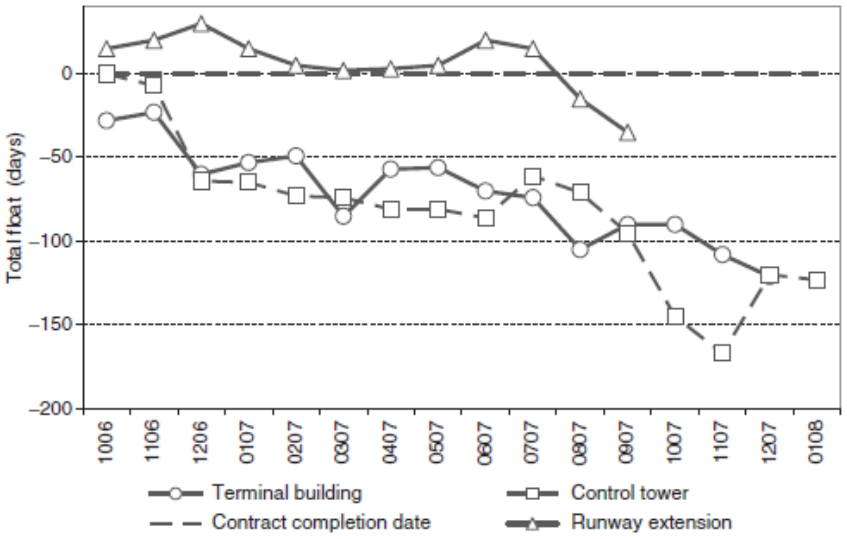
- Tasks with **greater negative float** were **discounted** because they failed to meet the criteria set. Either they
  1. Were **not** on the **driving path** or
  2. Were **not scheduled to commence** in the **next 30 day window**

- Now that all driving activities are **identified**,
  - expert judgement and experience are required to **link the driving activities**, thus **concluding** an **'as-built critical path'** (or paths) from **commencement to completion**.

So, do we need to consider concurrent paths?

STEP 4: As-built critical path and concurrent paths

- In this case study, the **tribunal expert** determined that the **Control Tower** and **Terminal Building** were competing for dominance, as indicated in the float deterioration analysis provided



- To **identify the activities** which were driving these **competing**, **concurrent driving paths**, the activities were **coded** and **grouped** according to **their location**.

STEP 4: As-built critical path and concurrent paths

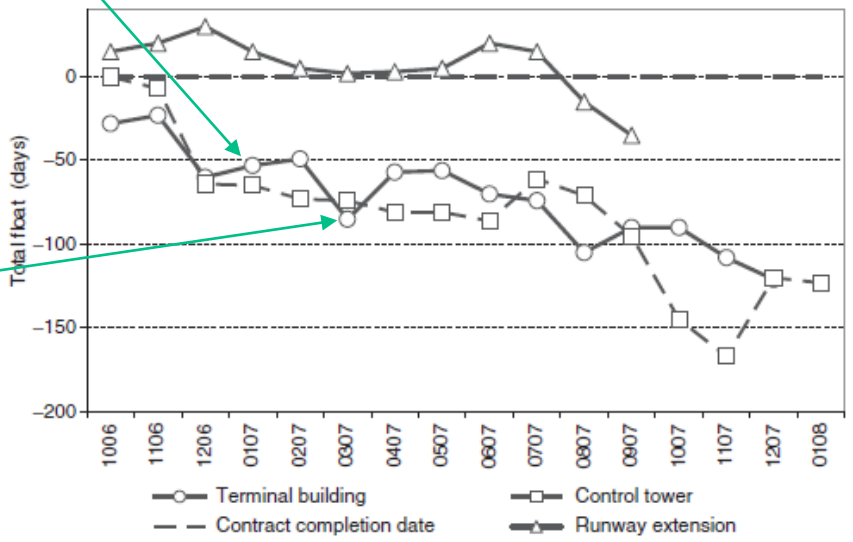
- It is obvious that when the **critical path shifts** from the **Terminal Building** to the **Control Tower** in **January 2007**,

  Terminal Building is **still in delay**, and is deemed to be a **'near-critical'** path.

- **Near-critical paths** have the **potential to become critical**, and delays which force near-critical paths to overtake as the most critical path are **also relevant**.

  For this reason, an **understanding of concurrent effect** is important

- In our example, the **Terminal Building** was **'near critical'** in January and February 2007, but **overtook** as critical in **March 2007**.



STEP 4: As-built critical path and concurrent paths

Case study – concurrent driving critical paths.

Act	Title	2006			2007												08
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
	CPM programme file name	1006	1106	1206	0107	0207	0307	0407	0507	0607	0707	0807	0907	1007	1107	1207	0108
	Critical path delay	-28	-23	-60	-65	-73	-85	-42	-50	-70	-74	-85	-95	-145	-167	-121	-123
	Maximum delay (Total float)	-28	-23	-64	-65	-73	-85	-81	-81	-86	-74	-105	-95	-145	-167	-121	-123
	Concurrent critical path 1 - terminal building																
C1B115030	Protection works to ex fuel line grid 42-46/A-B	-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C1B215310	Construct strip found grid 42-46/A	-13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C1B215570	Construct 1st lift wall grid 41-43/A-B	-15	-6	-42	-	-	-	-	-	-	-	-	-	-	-	-	-
C1B215610	Backfill/blind lwr lvl slab grid 43-46/A-E	-27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C1B216060	Install services below grade slab grid 43-46/E-J	-28															
C1B115040	Protection works to ex fuel line grid 35-42/A	-15	-23	-60	-	-	-	-	-	-	-	-	-	-	-	-	-
C1B215450	Construct 1st lift columns grid 35-41/A	-15	-23	-60	-	-	-	-	-	-	-	-	-	-	-	-	-
C1B328220	Construct grnd beams grade lvl grid 35-43/A-D	-15	-23	-60	-53	-	-	-	-	-	-	-		-	-	-	-
C1B328230	Construct columns grade 1st lvl grid 37-43/-D,E	5	-23	-60	-53	-	-	-	-	-	-	-	-	-	-	-	-
C1C3A0210	Construct 2 lifts columns 4th-5th lvl cont tower	0	-7	-11	-16	-33	-85	-	-	-	-	-	-	-	-	-	-
C1B544210	E-M 1st fix conduit/cabling 2nd lvl 35-43/E-J	-8	-18	-40	-33	37	23	-42	-40	-46	-38	-	-	-	-	-	-
C1B545210	E-M 1st fix conduit/cabling 2nd lvl 43-46/E-J	24	24	28	13	4	-2	-42	-47	-67	-	-	-	-	-	-	-
C1B545310	E-M 1st fix duct/pipework 2nd lvl 43-46/E-J	8	9	3	-13	-1	-17	-42	-41	-61	-	-	-	-	-	-	-
C1B644010	Blockwork to 2nd lvl walls grid 35-43/E-J	-8	-18	-40	-33	37	23	-42	-41	-	-	-	-	-	-	-	-
C1B645010	Blockwork to 2nd lvl walls grid 43-46/E-J	24	24	28	13	-1	-17	-42	-41	-61	-	-	-	-	-	-	-
C1B644210	Plaster walls/ceilings 2nd lvl grid 35-43/E-J	-8	-18	-40	-33	-14	-42	-42	-42	-	-	-	-	-	-	-	-
C1B544310	E-M 1st fix duct/pipework 2nd lvl 35-43/E-J	-8	-18	-34	-27	45	23	-40	-43	-52	-42	-16	-	-	-	-	-
C1B534210	E-M 1st fix conduit/cabling 1st lvl 35-43/E-J	-27	-21	-32	-36	-49	-57	-57	-50	-70	-	-	-	-	-	-	-
C1B534310	E-M 1st fix duct/pipework 1st lvl 35-43/E-J	-14	-21	-32	-36	-49	-50	-51	-50	-70	-	-	-	-	-	-	-
C1B634210	Plaster walls/ceilings 1st lvl grid 35-43/E-J	-27	-21	-32	-33	-14	-57	-57	-56	-70	-	-	-	-	-	-	-
C1B730090	Final decoration to 1st lvl	-27	-23	-40	-33	-14	-62	-57	-56	-70	-74	-85	-90	-90	-108	-120	-
C1B731040	Terrazzo floor tiling 1st lvl grid 25-35/J-RA														-108		
C1B733056	Lath & plaster ceiling 1st lvl grid 35-46/J-RA	*	*	*	*	*	-37	-43	-35	-48	-55	-105	710	-69	-108	-	-
C1B710090	Final decoration to lower lvl grids 35-46/A-J	-28	-9	-15	8	-8	-24	-24	-4	-22	-31	-81	-81	-90	-106	-121	-
C1B715059	Fix acoustic ceiling lwr lvl	*	*	*	*	*	*	*	*	*	*	*	-81	-74	-97	-121	-
	Concurrent critical path 2 - control tower																
C11400017	Submit & obtain approval 1st shop drawings	17	2	-64	-65	-73	-74	-	-	-	-	-	-	-	-	-	-
C11400018	Manufacture & deliver 1st shipment to site	17	2	-64	-65	-73	-74	-81	-81	-86	-50	-49	-75	-	-	-	-
C1C4F0045	Fix curtain wall to control tower vcr lvl	*	*	*	*	*	-31	-31	-31	-47	-49	-63	-74	-145	-167	-	-
C1C560010	E-M 1st fix services installation to control	10	3	-1	-6	-19	-27	-23	-30	-54	-51	-71	-95	-144	-167	-120	-
C1C660020	Plaster control tower walls internally	6	-1	-5	-10	-27	-26	-22	-14	-25	-45	-69	-71	-134	-167	-	-
C1C860010	1st fix installation/cabling for tower equipment	10	3	-1	-6	-19	-27	-23	-30	-54	-51	-71	-95	-144	-167	-	-
C1C860050	Install/test & commission tower equipment	0	-7	-11	-16	-27	-31	-31	-31	-59	-61	-71	-81	-145	-167	-118	-109
C1C320200	Duct bank/cabling to temp control rm in w jetty	*	*	*	*	*	*	*	*	*	*	-71	-73	-73	-144	-118	-123
C1C900099	New control tower operational	0	-7	-11	-16	-27	-31	-31	-31	-59	-61	-71	-81	-103	-119	-118	-123
C1B729010	Reinstatement & Marking E Terminal Apron Area															-97	-121
C1C900100	Decommission existing conrol tower by others	*	*	*	*	*	*	*	*	*	*	-71	-81	-103	-119	-118	-123

Are we ready to add delay events against driving paths identified?

STEP 4: As-built critical path and concurrent paths

- **Before evaluating** the **excusable delay events** against the **driving paths identified**, there was **one final step** in the process of **concluding the as-built critical** path from our float data.
  - **Near-critical paths** were identified by **linking** the successors and predecessors of driving critical activities in the months in which either path (**terminal building or control tower**) were near critical.

Let's see what near critical paths found in concurrent paths!

STEP 4: As-built critical path and concurrent paths

- To illustrate this point more clearly, near critical paths have been found.
- These months are indicated in **'grey'** in Figure

Illustration of critical paths.

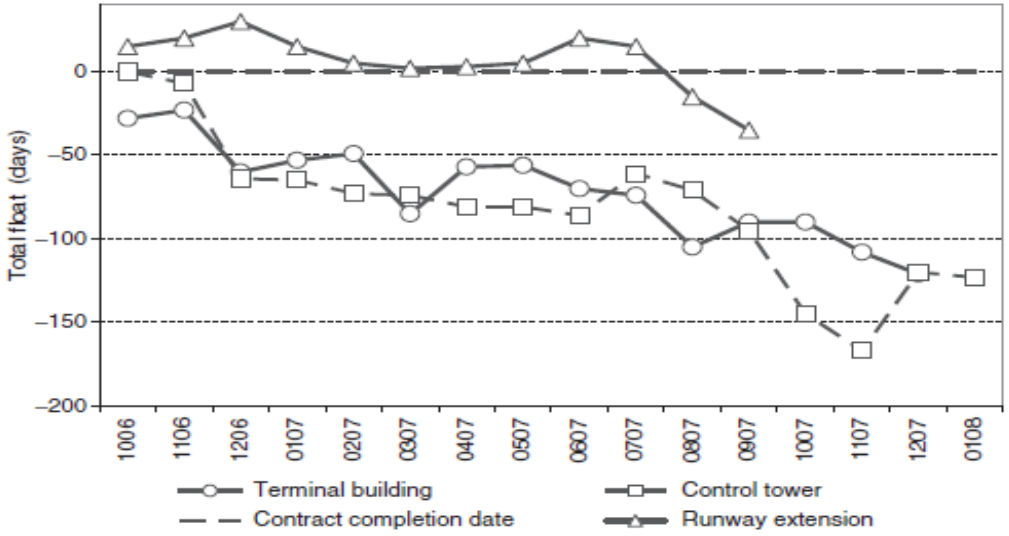
Act	Title	2006			2007												08
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
	CPM programme file name	1006	1106	1206	0107	0207	0307	0407	0507	0607	0707	0807	0907	1007	1107	1207	0108
	Maximum delay (total float)	-28	-23	-64	-65	-73	-85	-81	-81	-86	-74	-105	-95	-145	-167	-121	-123
Concurrent critical path 1 - terminal building																	
C1B115030	Protection works to ex fuel line grid 42-46/A-B	-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C1B215310	Construct strip found grid 42-46/A	-13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C1B215570	Construct 1st lift wall grid 41-43/A-B	-15	-6	-42	-	-	-	-	-	-	-	-	-	-	-	-	-
C1B215610	Backfill/blind lwr lvl slab grid 43-46/A-E	-27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C1B216060	Install services below grade slab grid 43-46/E-J	-28															
C1B115040	Protection works to ex fuel line grid 35-42/A	-15	-23	-60	-	-	-	-	-	-	-	-	-	-	-	-	-
C1B215450	Construct 1st lift columns grid 35-41/A	-15	-23	-60	-	-	-	-	-	-	-	-	-	-	-	-	-
C1B328220	Construct gmd beams grade lvl grid 35-43/A-D	-15	-23	-60	-53	-	-	-	-	-	-	-		-	-	-	-
C1B328230	Construct columns grade 1st lvl grid 37-43/-D,E	5	-23	-60	-53	-	-	-	-	-	-	-	-	-	-	-	-
C1C3A0210	Construct 2 lifts columns 4th-5th lvl cont tower	0	-7	-11	-16	-33	-85	-	-	-	-	-	-	-	-	-	-
C1B544210	E-M 1st fix conduit/cabling 2nd lvl 35-43/E-J	-8	-18	-40	-33	37	23	-42	-40	-46	-38	-	-	-	-	-	-
C1B545210	E-M 1st fix conduit/cabling 2nd lvl 43-46/E-J	24	24	28	13	4	-2	-42	-47	-67	-	-	-	-	-	-	-
C1B545310	E-M 1st fix duct/pipework 2nd lvl 43-46/E-J	8	9	3	-13	-1	-17	-42	-41	-61	-	-	-	-	-	-	-
C1B644010	Blockwork to 2nd lvl walls grid 35-43/E-J	-8	-18	-40	-33	37	23	-42	-41	-	-	-	-	-	-	-	-
C1B645010	Blockwork to 2nd lvl walls grid 43-46/E-J	24	24	28	13	-1	-17	-42	-41	-61	-	-	-	-	-	-	-
C1B644210	Plaster walls/ceilings 2nd lvl grid 35-43/E-J	-8	-18	-40	-33	-14	-42	-42	-42	-	-	-	-	-	-	-	-
C1B544310	E-M 1st fix duct/pipework 2nd lvl 35-43/E-J	-8	-18	-34	-27	45	23	-40	-43	-52	-42	-16	-	-	-	-	-
C1B534210	E-M 1st fix conduit/cabling 1st lvl 35-43/E-J	-27	-21	-32	-36	-49	-57	-57	-50	-70	-	-	-	-	-	-	-
C1B534310	E-M 1st fix duct/pipework 1st lvl 35-43/E-J	-14	-21	-32	-36	-49	-50	-51	-50	-70	-	-	-	-	-	-	-
C1B634210	Plaster walls/ceilings 1st lvl grid 35-43/E-J	-27	-21	-32	-33	-14	-57	-57	-56	-70	-	-	-	-	-	-	-
C1B730090	Final decoration to 1st lvl	-27	-23	-40	-33	-14	-62	-57	-56	-70	-74	-85	-90	-90	-108	-120	-
C1B731040	Terrazzo floor tiling 1st lvl grid 25-35/J-RA														-108		
C1B733056	Lath & plaster ceiling 1st lvl grid 35-46/J-RA	*	*	*	*	*	-37	-43	-35	-48	-55	-105	710	-69	-108	-	-
C1B710090	Final decoration to lower lvl grids 35-46/A-J	-28	-9	-15	8	-8	-24	-24	-4	-22	-31	-81	-81	-90	-106	-121	-
C1B715059	Fix acoustic ceiling lwr lvl	*	*	*	*	*	*	*	*	*	*	*	-81	-74	-97	-121	-
Concurrent critical path 2 - control tower																	
C11400017	Submit & obtain approval 1st shop drawings	17	2	-64	-65	-73	-74	-	-	-	-	-	-	-	-	-	-
C11400018	Manufacture & deliver 1st shipment to site	17	2	-64	-65	-73	-74	-81	-81	-86	-50	-49	-75	-	-	-	-
C1C4F0045	Fix curtain wall to control tower vcr lvl	*	*	*	*	*	-31	-31	-31	-47	-49	-63	-74	-145	-167	-	-
C1C560010	E-M 1st fix services installation to control	10	3	-1	-6	-19	-27	-23	-30	-54	-51	-71	-95	-144	-167	-120	-
C1C660020	Plaster control tower walls internally	6	-1	-5	-10	-27	-26	-22	-14	-25	-45	-69	-71	-134	-167	-	-
C1C860010	1st fix installation/cabling for tower equipment	10	3	-1	-6	-19	-27	-23	-30	-54	-51	-71	-95	-144	-167	-	-
C1C860050	Install/test & commission tower equipment	0	-7	-11	-16	-27	-31	-31	-31	-59	-61	-71	-81	-145	-167	-118	-109
C1C320200	Duct bank/cabling to temp control rm in w jetty	*	*	*	*	*	*	*	*	*	*	-71	-73	-73	-144	-118	-123
C1C900099	New control tower operational	0	-7	-11	-16	-27	-31	-31	-31	-59	-61	-71	-81	-103	-119	-118	-123
C1B729010	Reinstatement & Marking E Terminal Apron Area															-97	-121
C1C900100	Decommission existing conrol tower by others	*	*	*	*	*	*	*	*	*	*	-71	-81	-103	-119	-118	-123

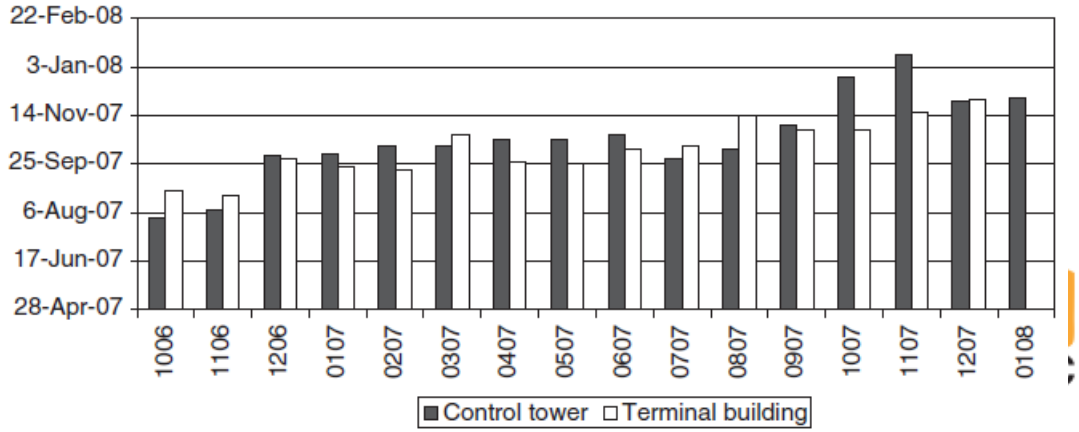
STEP 4: As-built critical path and concurrent paths

- The chart in Figure provides a **summary** of the **calculated completion date projected each month** using the **delays experienced** at both the **Control Tower**, and the **Terminal Building**.

Available programmes.

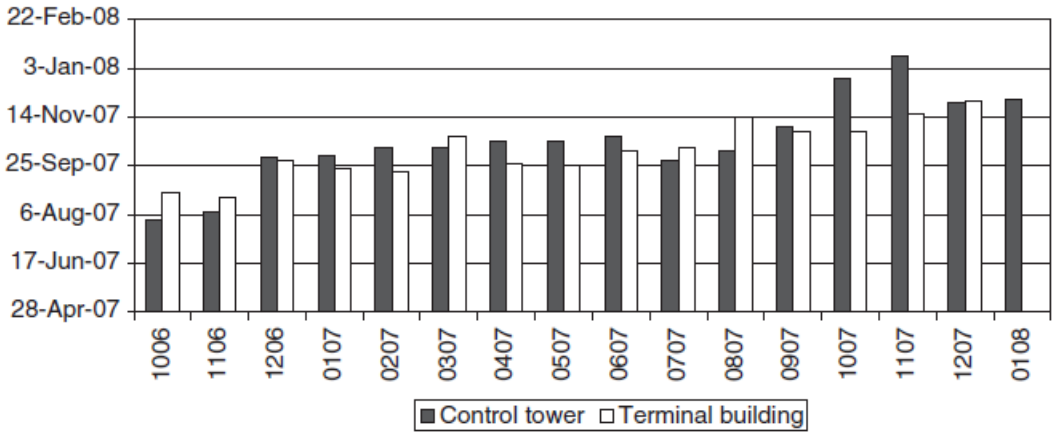
Programme file name	Data date	Projected completion date	Total float
1006	1-Oct-06	29-Aug-07	–28
1106	1-Nov-06	24-Aug-07	–23
1206	1-Dec-06	30-Sep-07	–60
0107	1-Jan-07	5-Oct-07	–65
0207	1-Feb-07	13-Oct-07	–73
0307	1-Mar-07	25-Oct-07	–85
0407	1-Apr-07	12-Sep-07	–42
0507	1-May-07	20-Sep-07	–50
0607	1-Jun-07	10-Oct-07	–70
0707	1-Jul-07	14-Oct-07	–74
0807	1-Aug-07	25-Oct-07	–85
0907	1-Sep-07	4-Nov-07	–95
1007	1-Oct-07	24-Dec-07	–145
1107	1-Nov-07	15-Jan-08	–167
1207	1-Dec-07	30-Nov-07	–121
0108	1-Jan-08	2-Dec-07	–123





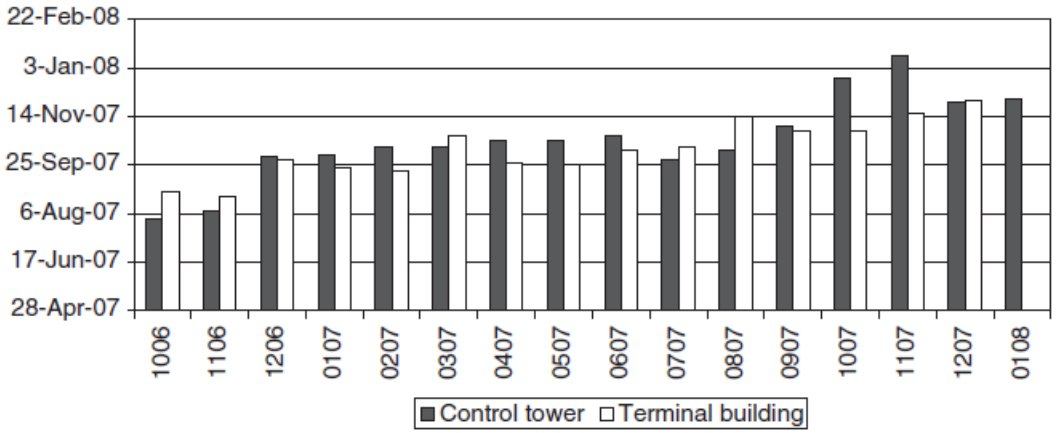
STEP 4: As-built critical path and concurrent paths

- The **contract completion date** was **August 1, 2007**.
- **Terminal Building** was completed on **December 12, 2007 (133 days late)**
- **Control Tower** was completed on **January 15, 2008 (167 days late)**



'But for' delays to the **Control Tower**, when would the project have completed?

STEP 4: As-built critical path and concurrent paths



'But for' delays to the **Control Tower**, when would the project have completed?

- The answer is that it would be **no earlier than December 12, 2007**, when the **Terminal Building** was **complete**.
- Delays to both the **Terminal Building** and **Control Tower** were therefore isolated and analyzed along **each respective driving as-built critical path**.

Now, it is time to determine "employer risk events"

STEP 5: Employer risk event

- Taking the **events agreed** to as **'employer risk events'** by the parties,

  we can **now determine** which were **truly on the critical path**,

  1. **Which contributed** to critical delay
  2. **Which** were simply **concurrent events**

Let's see the Table!

STEP 5: Employer risk event – Table 6

- **Table 6** identifies
  1. **Float** loss, or gain, in each window,
  2. **Employer risk events** (A through M), which were aligned with the **windows** in which they occurred.

Employer risk event table.

Prog-ramme File Name	Data Date	Projected Completion Date	Total Float	Float Loss/Gain In Window	Delays Pleaded In Window
1006	1-Oct-06	29-Aug-07	–28		
1106	1-Nov-06	24-Aug-07	–23	–5	
1206	1-Dec-06	30-Sep-07	–60	37	A
0107	1-Jan-07	5-Oct-07	–65	5	B
0207	1-Feb-07	13-Oct-07	–73	8	
0307	1-Mar-07	25-Oct-07	–85	12	
0407	1-Apr-07	12-Sep-07	–42	–43	C
0507	1-May-07	20-Sep-07	–50	8	
0607	1-Jun-07	10-Oct-07	–70	20	
0707	1-Jul-07	14-Oct-07	–74	4	D, E
0807	1-Aug-07	25-Oct-07	–85	11	F, G, H
0907	1-Sep-07	4-Nov-07	–95	10	I, J
1007	1-Oct-07	24-Dec-07	–145	50	
1107	1-Nov-07	15-Jan-08	–167	22	
1207	1-Dec-07	30-Nov-07	–121	–46	
0108	1-Jan-08	2-Dec-07	–123	2	K, L
As-Built	15-Jan-08	15-Jan-08	–167	44	M

STEP 5: Employer risk event – Table 6

- Each of the **employer risk events** can be allocated to either the **Terminal Building** or the **Control Tower**
- The **duration of each event** can now be **set against the amount of float lost** in each respective window, to
  1. **Determine whether** the **employer risk events** affected the critical path
  2. **How much delay** actually **resulted** when the impact of each employer risk event was being experienced

Employer risk event table.

Prog-ramme File Name	Data Date	Projected Completion Date	Total Float	Float Loss/Gain In Window	Delays Pleaded In Window
1006	1-Oct-06	29-Aug-07	−28		
1106	1-Nov-06	24-Aug-07	−23	−5	
1206	1-Dec-06	30-Sep-07	−60	37	A
0107	1-Jan-07	5-Oct-07	−65	5	B
0207	1-Feb-07	13-Oct-07	−73	8	
0307	1-Mar-07	25-Oct-07	−85	12	
0407	1-Apr-07	12-Sep-07	−42	−43	C
0507	1-May-07	20-Sep-07	−50	8	
0607	1-Jun-07	10-Oct-07	−70	20	
0707	1-Jul-07	14-Oct-07	−74	4	D, E
0807	1-Aug-07	25-Oct-07	−85	11	F, G, H
0907	1-Sep-07	4-Nov-07	−95	10	I, J
1007	1-Oct-07	24-Dec-07	−145	50	
1107	1-Nov-07	15-Jan-08	−167	22	
1207	1-Dec-07	30-Nov-07	−121	−46	
0108	1-Jan-08	2-Dec-07	−123	2	K, L
As-Built	15-Jan-08	15-Jan-08	−167	44	M

Let's see how these delays can be mapped against the as-built critical path

STEP 6: Delays mapped against the as-built critical path

- The **amount of delay** **attributable** to an **event** can in **some cases** **exceed** the amount of **delay actually measured** by **float loss** in each period.
  - This is **due to the fact** that progressed programmes contain **sequencing**, **duration** and **logic alterations** from month to month.

Act	Title	2006			2007												08
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
	CPM programme file name	1006	1106	1206	0107	0207	0307	0407	0507	0607	0707	0807	0907	1007	1107	1207	0108
	Maximum delay (total float)	-28	-23	-64	-65	-73	-85	-81	-81	-86	-74	-105	-95	-145	-167	-121	-123
Concurrent critical path 1 - terminal building																	
C1B115030	Protection works to ex fuel line grid 42-46/A-B	-15	-		-	-	-	-	-	-	-	-	-	-	-	-	-
C1B215310	Construct strip found grid 42-46/A	-13	-	Event A 15 CD	-	-	-	-	-	-	-	-	-	-	-	-	-
C1B215570	Construct 1st lift wall grid 41-43/A-B	-15	-6		-	-	-	-	-	-	-	-	-	-	-	-	-
C1B215610	Backfill/blind lwr lvl slab grid 43-46/A-E	-27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C1B216060	Install services below grade slab grid 43-46/E-J	-28	-	-	Event B 20 CD	-	-	-	-	-	-	-	-	-	-	-	-
C1B115040	Protection works to ex fuel line grid 35-42/A	-15	-23	-60	-	-	-	-	-	-	-	-	-	-	-	-	-
C1B215450	Construct 1st lift columns grid 35-41/A	-15	-23	-60	-	-	-	-	-	-	-	-	-	-	-	-	-
C1B328220	Construct grnd beams grade lvl grid 35-43/A-D	-15	-23	-60	-53	-	-	-	-	-	-	-	-	-	-	-	-
C1B328230	Construct columns grade 1st lvl grid 37-43/-D,E	5	-23	-60	-53	-	-	-	-	-	-	-	-	-	-	-	-
C1C3A0210	Construct 2 lifts columns 4th-5th lvl cont tower	0	-7	-11	-16	-33	-85	-	-	-	-	-	-	-	-	-	-
C1B544210	E-M 1st fix conduit/cabling 2nd lvl 35-43/E-J	-8	-18	-40	-33	37	23	-42	-40	-46	-38	-	-	-	-	-	-
C1B545210	E-M 1st fix conduit/cabling 2nd lvl 43-46/E-J	24	24	28	13	4	-2	-42	-47	-67	-	-	-	-	-	-	-
C1B545310	E-M 1st fix duct/pipework 2nd lvl 43-46/E-J	8	9	3	-13	-1	-17	-42	-41	-61	-	-	-	-	-	-	-
C1B644010	Blockwork to 2nd lvl walls grid 35-43/E-J	-8	-18	-40	-33	37	23	-42	-41	-	Event E 12 CD	-	-	-	-	-	-
C1B645010	Blockwork to 2nd lvl walls grid 43-46/E-J	24	24	28	13	-1	-17	-42	-41	-61	-	-	-	-	-	-	-
C1B644210	Plaster walls/ceilings 2nd lvl grid 35-43/E-J	-8	-18	-40	-33	-14	-42	-42	-42	-	-	-	-	-	-	-	-
C1B544310	E-M 1st fix duct/pipework 2nd lvl 35-43/E-J	-8	-18	-34	-27	45	23	-40	-43	-52	-42	-16	-	-	-	-	-
C1B534210	E-M 1st fix conduit/cabling 1st lvl 35-43/E-J	-27	-21	-32	-36	-49	-57	-57	-50	-70	Event G 46 CD	-	-	-	-	-	-
C1B534310	E-M 1st fix duct/pipework 1st lvl 35-43/E-J	-14	-21	-32	-36	-49	-50	-51	-50	-70	-	-	Event J 20 CD	-	-	-	-
C1B634210	Plaster walls/ceilings 1st lvl grid 35-43/E-J	-27	-21	-32	-33	-14	-57	-57	-56	-70	-	-	-	-	-	-	-
C1B730090	Final decoration to 1st lvl	-27	-23	-40	-33	-14	-62	-57	-56	-70	-74	-85	-90	-90	-108	-120	-
C1B731040	Terrazzo floor tiling 1st lvl grid 25-35/J-RA														-108		
C1B733056	Lath & plaster ceiling 1st lvl grid 35-46/J-RA	*	*	*	*	*	-37	-4	Event H 20 CD	-68	-55	-105	Event I 15 CD		-108	-	-
C1B710090	Final decoration to lower lvl grids 35-46/A-J	-28	-9	-15	8	-8	-24	-2	-22	-31	-81	-	-	-106	-121	-	
C1B715059	Fix acoustic ceiling lwr lvl	*	*	*	*	*	*	*	*	*	*	*	*	-97	-121	-	
Concurrent critical path 2 - control tower																	
C11400017	Submit & obtain approval 1st shop drawings	17	2	-64	-65	-73	-74	-	-	-	-	-	-	-	-	-	-
C11400018	Manufacture & deliver 1st shipment to site	17	2	-64	-65	-73	-74	-81	-81	-86	-50	-49	-75	Event K 14 CD	-	-	-
C1C4F0045	Fix curtain wall to control tower vcr lvl	*	*	Event C 4 CD	*	-19	-31	-31	-31	-41	-49	-63	-74	-145	-167	-	-
C1C560010	E-M 1st fix services installation to control	10	3		-19	-27	-27	-23	-30	-54	-51	-71	-95	-144	-167	-120	-
C1C660020	Plaster control tower walls internally	6	-1		-27	-26	Event D 33 CD		-25	-45	-69	-71	-134	-167	-	-	
C1C860010	1st fix installation/cabling for tower equipment	10	3	-1	-6	-19	-27	-6	-54	-51	-71	-95	-144	-167	-	-	
C1C860050	Install/test & commission tower equipment	0	-7	-11	-16	-27	-31	-31	-31	-59	-61	-71	-81		-118	-109	
C1C320200	Duct bank/cabling to temp control rm in w jetty	*	*	*	*	*	*	*	*	*	*	-71	-73	Event L 7 CD	-118	-123	
C1C900099	New control tower operational	0	-7	-11	-16	-27	-31	-31	-31	-59	-61	-71	-81		-118	-123	
C1B729010	Reinstatement & Marking E Terminal Apron Area														-97	-121	
C1C900100	Decommission existing conrol tower by others	*	*	*	*	*	*	*	*	*	*	-71	-81	-103	-119	-118	-123

Do you know what does that mean? You will see later!

STEP 6: Delays mapped against the as-built critical path

So, what was next?

STEP 6: Delays mapped against the as-built critical path

- By **linking** the **events identified** to the **actual delay experienced**,

  as measured by the **float deterioration** from month to month,

  the **tribunal expert** was able to summarize the results and compare the discrete as-built critical path delays to the results pleaded in the TIA conclusions.

What happened to concurrency?

STEP 7: Concurrent critical path employer risk event

- The **employer risk events** which were deemed to be relevant could then be reviewed for **concurrency** and **dominance** with other delays, in windows in which **more than one employer risk event** was experienced.

Was that concurrent?

STEP 7: Concurrent critical path employer risk event

- The **duration of the employer risk events** are tabulated below, along with the **Critical Path (CP 1 or CP 2)** which they potentially affected.
  - Where there were **two delays in the same window**, the **larger of the two** was considered relevant for calculating the **contractor's entitlement in each window**.

*In **August 2007**, there were **two delay events** that impacted on CP 1, the Terminal Building. **Both** of these events are **excusable** (See Page 74).*

Event Rev	Description		2006			2007												08
		CP	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
A	Additional services below slab	1		15														
B	Additional protection works to underground utilities	1			20													
C	Shop drawing approval	2						4										
D	Revised columns to control tower	2									33							
E	Revised blockwork to terminal building	1									12							
F	Revised curtain walling to term building	n/a										10						
G	M&E revisions - 1st fix 2nd level term bldg	1										46						
H	M&E revisions - 1st fix 1st level term bldg	1										20						
I	M&E revisions - 1st fix grnd level term bldg	1											15					
J	Terrazzo floor changes - term bldg	1											20					
K	Revised curtain walling to control tower	1															14	
L	Accoustic celing revision - control tower	2															7	
M	Revised retail layout - term bldg	n/a																24
	Maximum delay calculated in TIA	**152**	0	15	20	0	0	4	0	0	33	46	20	0	0	0	14	24
	Terminal building critical delays	113		15	20						12	46	20					
	Control tower critical delays	51						4			33						14	

STEP 7: Concurrent critical path employer risk event

Keep it in your mind

Illustration of critical paths.

Act	Title	2006			2007												08
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
	CPM programme file name	1006	1106	1206	0107	0207	0307	0407	0507	0607	0707	0807	0907	1007	1107	1207	0108
	Maximum delay (total float)	-28	-23	-64	-65	-73	-85	-81	-81	-86	-74	-105	-95	-145	-167	-121	-123
Concurrent critical path 1 - terminal building																	
C1B115030	Protection works to ex fuel line grid 42-46/A-B	-15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C1B215310	Construct strip found grid 42-46/A	-13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C1B215570	Construct 1st lift wall grid 41-43/A-B	-15	-6	-42	-	-	-	-	-	-	-	-	-	-	-	-	-
C1B215610	Backfill/blind lwr lvl slab grid 43-46/A-E	-27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C1B216060	Install services below grade slab grid 43-46/E-J	-28															
C1B115040	Protection works to ex fuel line grid 35-42/A	-15	-23	-60	-	-	-	-	-	-	-	-	-	-	-	-	-
C1B215450	Construct 1st lift columns grid 35-41/A	-15	-23	-60	-	-	-	-	-	-	-	-	-	-	-	-	-
C1B328220	Construct gmd beams grade lvl grid 35-43/A-D	-15	-23	-60	-53	-	-	-	-	-	-	-		-	-	-	-
C1B328230	Construct columns grade 1st lvl grid 37-43/-D,E	5	-23	-60	-53	-	-	-	-	-	-	-	-	-	-	-	-
C1C3A0210	Construct 2 lifts columns 4th-5th lvl cont tower	0	-7	-11	-16	-33	-85	-	-	-	-	-	-	-	-	-	-
C1B544210	E-M 1st fix conduit/cabling 2nd lvl 35-43/E-J	-8	-18	-40	-33	37	23	-42	-40	-46	-38	-	-	-	-	-	-
C1B545210	E-M 1st fix conduit/cabling 2nd lvl 43-46/E-J	24	24	28	13	4	-2	-42	-47	-67	-	-	-	-	-	-	-
C1B545310	E-M 1st fix duct/pipework 2nd lvl 43-46/E-J	8	9	3	-13	-1	-17	-42	-41	-61	-	-	-	-	-	-	-
C1B644010	Blockwork to 2nd lvl walls grid 35-43/E-J	-8	-18	-40	-33	37	23	-42	-41	-	-	-	-	-	-	-	-
C1B645010	Blockwork to 2nd lvl walls grid 43-46/E-J	24	24	28	13	-1	-17	-42	-41	-61	-	-	-	-	-	-	-
C1B644210	Plaster walls/ceilings 2nd lvl grid 35-43/E-J	-8	-18	-40	-33	-14	-42	-42	-42	-	-	-	-	-	-	-	-
C1B544310	E-M 1st fix duct/pipework 2nd lvl 35-43/E-J	-8	-18	-34	-27	45	23	-40	-43	-52	-42	-16	-	-	-	-	-
C1B534210	E-M 1st fix conduit/cabling 1st lvl 35-43/E-J	-27	-21	-32	-36	-49	-57	-57	-50	-70	-	-	-	-	-	-	-
C1B534310	E-M 1st fix duct/pipework 1st lvl 35-43/E-J	-14	-21	-32	-36	-49	-50	-51	-50	-70	-	-	-	-	-	-	-
C1B634210	Plaster walls/ceilings 1st lvl grid 35-43/E-J	-27	-21	-32	-33	-14	-57	-57	-56	-70	-	-	-	-	-	-	-
C1B730090	Final decoration to 1st lvl	-27	-23	-40	-33	-14	-62	-57	-56	-70	-74	-85	-90	-90	-108	-120	-
C1B731040	Terrazzo floor tiling 1st lvl grid 25-35/J-RA														-108		
C1B733056	Lath & plaster ceiling 1st lvl grid 35-46/J-RA	*	*	*	*	*	-37	-43	-35	-48	-55	-105	710	-69	-108	-	-
C1B710090	Final decoration to lower lvl grids 35-46/A-J	-28	-9	-15	8	-8	-24	-24	-4	-22	-31	-81	-81	-90	-106	-121	-
C1B715059	Fix acoustic ceiling lwr lvl	*	*	*	*	*	*	*	*	*	*	*	-81	-74	-97	-121	-
Concurrent critical path 2 - control tower																	
C11400017	Submit & obtain approval 1st shop drawings	17	2	-64	-65	-73	-74	-	-	-	-	-	-	-	-	-	-
C11400018	Manufacture & deliver 1st shipment to site	17	2	-64	-65	-73	-74	-81	-81	-86	-50	-49	-75	-	-	-	-
C1C4F0045	Fix curtain wall to control tower vcr lvl	*	*	*	*	*	-31	-31	-31	-47	-49	-63	-74	-145	-167	-	-
C1C560010	E-M 1st fix services installation to control	10	3	-1	-6	-19	-27	-23	-30	-54	-51	-71	-95	-144	-167	-120	-
C1C660020	Plaster control tower walls internally	6	-1	-5	-10	-27	-26	-22	-14	-25	-45	-69	-71	-134	-167	-	-
C1C860010	1st fix installation/cabling for tower equipment	10	3	-1	-6	-19	-27	-23	-30	-54	-51	-71	-95	-144	-167	-	-
C1C860050	Install/test & commission tower equipment	0	-7	-11	-16	-27	-31	-31	-31	-59	-61	-71	-81	-145	-167	-118	-109
C1C320200	Duct bank/cabling to temp control rm in w jetty	*	*	*	*	*	*	*	*	*	*	-71	-73	-73	-144	-118	-123
C1C900099	New control tower operational	0	-7	-11	-16	-27	-31	-31	-31	-59	-61	-71	-81	-103	-119	-118	-123
C1B729010	Reinstatement & Marking E Terminal Apron Area															-97	-121
C1C900100	Decommission existing conrol tower by others	*	*	*	*	*	*	*	*	*	*	-71	-81	-103	-119	-118	-123

STEP 7: Concurrent critical path employer risk event

- Had one event been **excusable**, and the other **non-excusable**, arguments regarding **concurrent delay** would have been relevant.
- In our case study, the **'Maximum Delay Calculated in TIA'**, as summarized at the **bottom of the table**

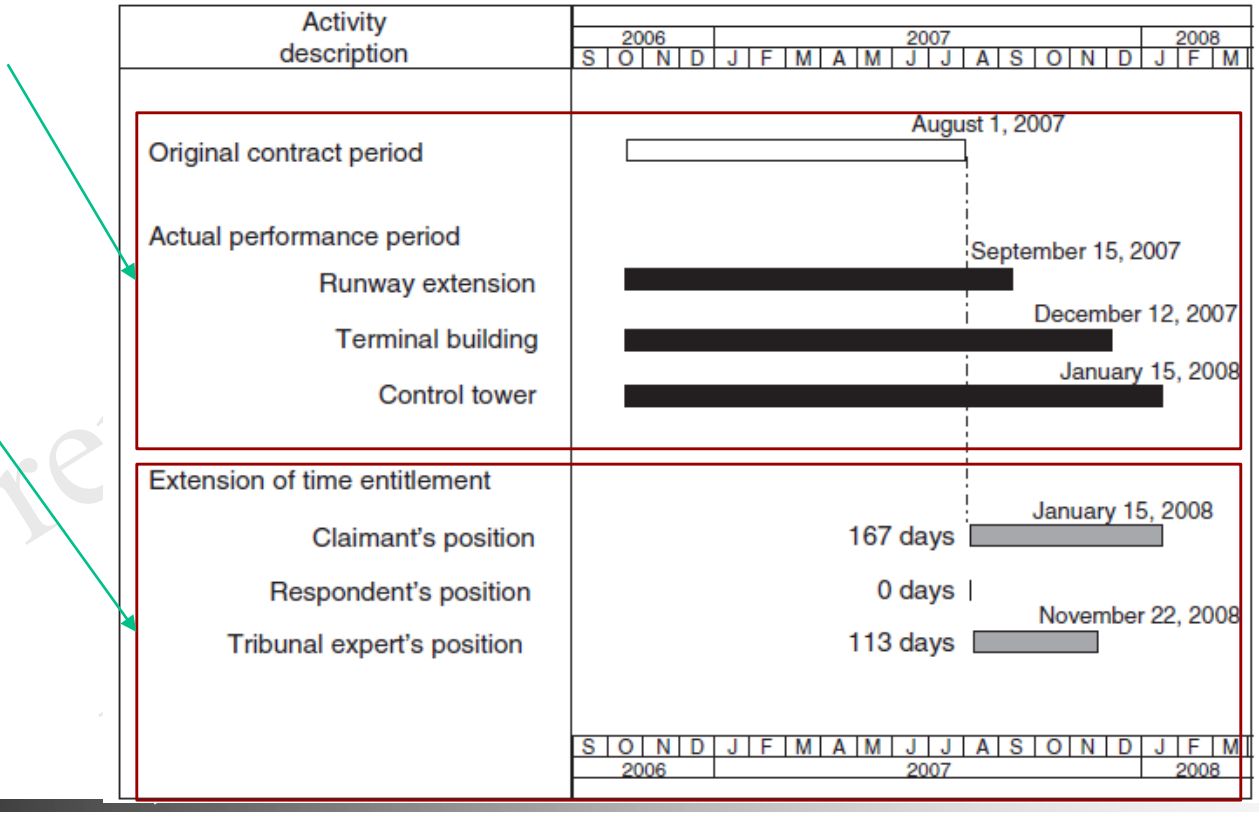
Control Tower was completed on **January 15, 2008 (167 days late)**

Event Rev	Description		2006			2007												08
		CP	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
A	Additional services below slab	1		15														
B	Additional protection works to underground utilities	1			20													
C	Shop drawing approval	2						4										
D	Revised columns to control tower	2									33							
E	Revised blockwork to terminal building	1									12							
F	Revised curtain walling to term building	n/a	←									10						
G	M&E revisions - 1st fix 2nd level term bldg	1										46						
H	M&E revisions - 1st fix 1st level term bldg	1										20						
I	M&E revisions - 1st fix grnd level term bldg	1											15					
J	Terrazzo floor changes - term bldg	1											20					
K	Revised curtain walling to control tower	1															14	
L	Accoustic celing revision - control tower	2															7	
M	Revised retail layout - term bldg	n/a	←															24
	Maximum delay calculated in TIA	**152**	0	15	20	0	0	4	0	0	33	46	20	0	0	0	14	24
	Terminal building critical delays	113		15	20						12	46	20					
	Control tower critical delays	51						4			33						14	

What tribunal expert concluded?

STEP 8: Tribunal expert analysis result

- The **tribunal expert concluded** that the contractor was entitled to either
  1. **113 days** of excusable, compensable delay due to delays experienced along the **Terminal Building Critical Path** or
  2. **51 days** of excusable, compensable delay along the **Control Tower Critical Path**



Control Tower was completed on **January 15, 2008** **(167 days late)**

STEP 8: Tribunal expert analysis result

- By keeping the impact of **unrelated events separate**, and **quantifying their impact** along discrete **parallel critical paths**,

  it was possible to

  arrive at an assessment that was **both fair and reasonable**

  which was also based solely on **contemporaneous evidence** and

  analyses **relied** on by the **party-appointed experts**.

- This **contemporaneous update windows analysis hybrid with TIA,** provided the **arbitration tribunal** with the key needed to **link liability and causation** and was relied on in their award.

But the owner also claimed for acceleration…

Case Study: Airport Terminal Expansion

Demonstrating Acceleration

Acceleration claim definition

- In the same case, there was **both a claim** for
  1. Acceleration, and
  2. Allegation that the claimant **failed to act on instructions to accelerate** the work.
     - The float maps were based on the contemporaneous programmes, which were themselves **argued by the JV** to have been **accelerated from February 2007 onwards**,

       with acceleration through **additional resources** and **resequencing** implemented **each month.**

How the expert analyzed?

Acceleration claim analysis

- To assist in **quantifying how much**, if any, acceleration was actually achieved, the expert simply
  1. Analyzed the **actual progress achieved** in **each window**, against **each activity (actual start, actual finish, % complete and so on)** and
  2. **Updated the non-accelerated logic** in the **January 2007 programme**.
     - ❖ This was the programme in place and **being used to manage** the works **before attempting acceleration**.
       - ✓ The JV argued acceleration from **February**.

Is it that easy?

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Acceleration claim analysis

- This **technique is actually straightforward** to carry out, owing to the functionality of most of today's high-end CPM network analysis **software** which allows for the transfer of progress data to and from various assigned **'target'** and **'baseline'** files.
  - However, the process requires **much skill and care**, and the **conclusions must be checked** and confirmed **manually**.

How the analysis performed?

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Acceleration claim analysis

- By **importing progress** into the **January 2007 programme**, and **recalculating a projected completion date** for each month in which the **JV argued it had implemented acceleration**, the amount of **delay that would have been projected**, **absent** of any **attempted acceleration**, is apparent.

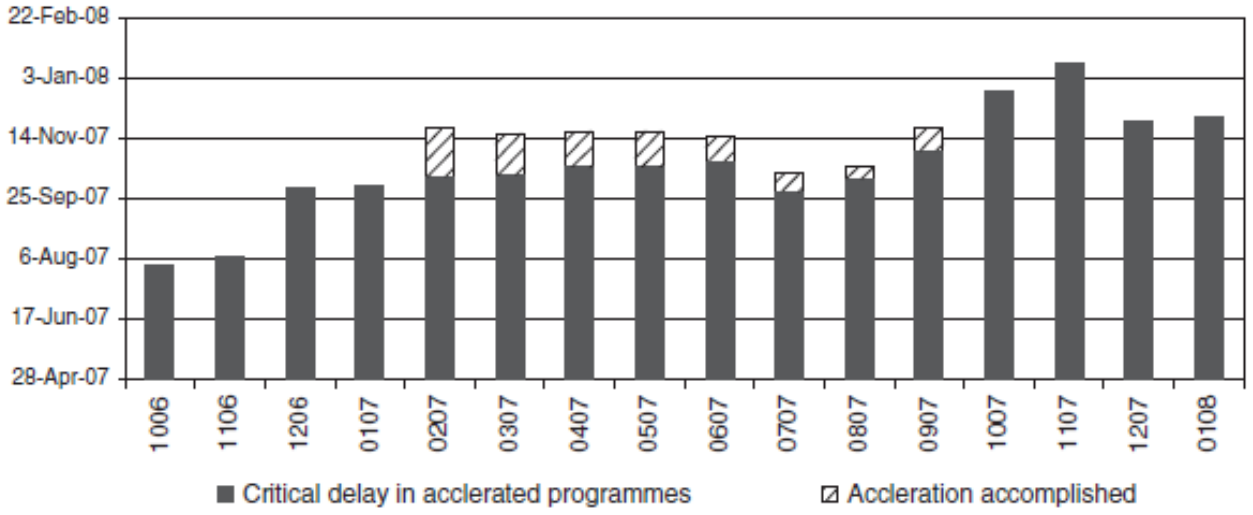
Let's see the result!

Acceleration claim analysis

- The **resulting completion date** calculated from the **progressed programmes** with the **original logic**,

  as compared to the **accelerated programmes** with the **same logic**, is illustrated in the Figure.

  *This analysis determined that the **JV had achieved acceleration** in **eight consecutive months** (February 2007 to September 2007).*



What further analysis performed?

Acceleration claim analysis

- When the **actual progress** and **sequence** was **compared with the planned sequence** of works,

  it was **apparent that the JV attempted** acceleration by working **out of sequence**, **advancing certain works** in advance of their **natural sequence as originally planned.**

  - This is demonstrated by 'out-of-sequence' progress reports, such as the one listed in Figure.

Progress reports output.

Activity	Predecessor	Rel	Lag	Description of out of sequence progress
C1B357077	C1B357067	FS	0	Started before its predecessor finished
C1B451020	C1B403140	FS	12	Started before its predecessor's lag would allow
C1B512210	C1B516210	FF	0	Started too early to allow it to finish on or after its predecessor's finish
C1B513210	C1B516210	FF	0	Started too early to allow it to finish on or after its predecessor's finish
C1B513211	C1B516210	FF	0	Started too early to allow it to finish on or after its predecessor's finish
C1B516210	C1B516310	FF	0	Started too early to allow it to finish on or after its predecessor's finish
C1B536210	C1B636010	FF	12	Started too early to allow it to finish after the expiration of its predecessor's lag
C1B536310	C1B636010	FF	12	Started too early to allow it to finish after the expiration of its predecessor's lag
C1B544210	C1B644010	FF	6	Started too early to allow it to finish after the expiration of its predecessor's lag
C1B544310	C1B644010	FF	10	Started too early to allow it to finish after the expiration of its predecessor's lag

Let's see the conclusion!

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Acceleration case – Conclusion

- In addition to **supporting cost data** that indicated an **increase** in supervision, labor, plant and temporary work costs,

  this analysis indicated that the **claimant was attempting to accelerate**, by

  1. Working out-of-sequence
  2. Increasing outputs and reducing activity durations

  - While there are **many forms of acceleration**

    this analysis demonstrated that acceleration was in fact being attempted, and in some cases achieved.

What happened to the cost?

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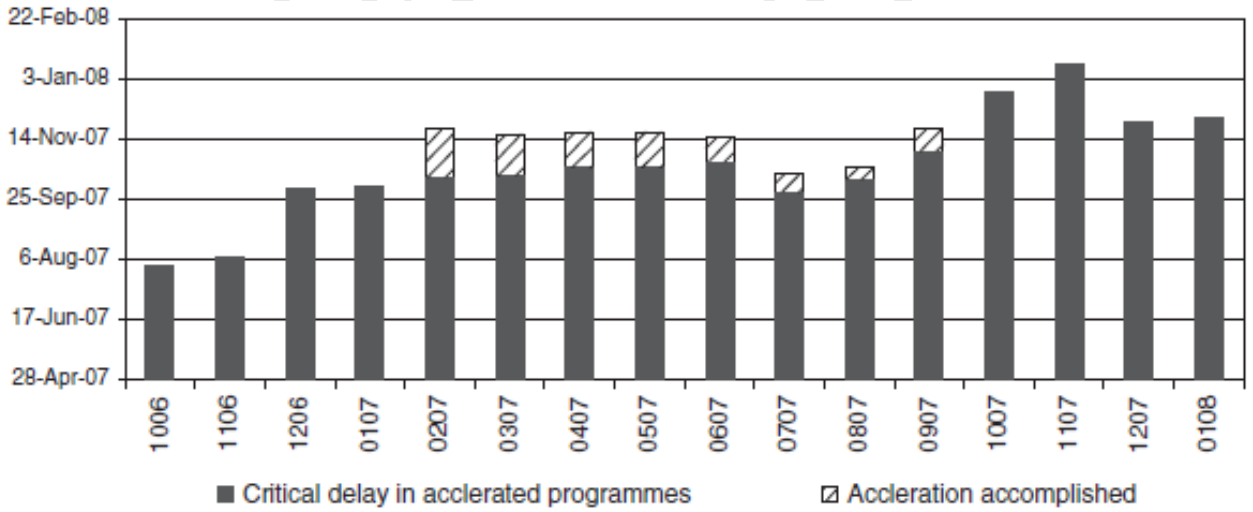
Acceleration case – Conclusion

- Due to the fact that the **claimant** was **awarded less than** a **full extension of time**, it was determined that the **costs of acceleration were to be apportioned**, in proportion with the **claimant's and respondent's respective liabilities** for time and prolongation costs, as determined from the **as-built critical path analysis**.



Case Study: Airport Terminal Expansion

Presentation Skills: Demonstrative Evidence

Introduction

- The **presentation of delay claims** is always **challenging**.
  - **Delay claims** often **rely on specialist terminology** and require the review and consideration of **multiple documents**.

Solution?

Demonstrative evidence

- The use of **demonstrative exhibits** and **graphics** during all forms of **dispute resolution** is **commonplace** to overcome some of these obstacles.

Why using graphics?

- It is **well established** that people are, largely, **visual learners**.
- They usually und**erstand and retain information** at a much **higher rate** when it is **presented to them visually**.
- A **pure oral presentation** of material would, to a large degree, be **lost on an audience (including tribunals and courts).**

Does it happen also to jurors?

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Demonstrative evidence

- In **support of this statement** are studies in the **United States** which have shown that jurors retains little as **10–20% of the material** presented to them **orally**.
- It has also been **found that jurors** retain as much as **65–80% of material presented** to them **visually or with visual supplements**.
  - ✓ *John S., 'The Prejudicial Effects of Computer-Generated Animation in the Courtroom', Berkeley Technology Law Journal 338, 352 (Fall 1994).*
  - ✓ *5Mary Q. C., 'Practitioner's Guide The Use of Demonstrative Exhibits at Trial', Tulsa Law Journal 567, 568 (1999).*

How to use it for delay claims and documentation?

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Documents

- It is possible to use a **'call-out box'** on **each document** (an enlargement of certain text on the document)

  which is **usually accentuated** with **highlighting** or **other graphics**.

  - This allows the **tribunal** to find important or relevant language **quickly**, while **evidence is being presented** during a **hearing**.

Documents can be **highlighted**, while the **'timeline'** should **not be**.

Why timeline should not be highlighted?

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Timeline

- **Timeline** and **chronology** exhibits must be
  1. Objective
  2. Factual
  3. Should **not be prejudicial** by underlining, highlighting or emphasizing dates or events.

So, what to do with timeline?

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Timeline

- It is necessary that the timeline be
  1. **Visually** appealing
  2. **Easy** to follow
  3. **Big** enough

     to include the **entire period of time** on one **board or sheet**.

     - ✓ An expert **must carefully plan** the **level of detail** included in a **timeline** or **chronology exhibit** to ensure that it does **not become cluttered** with technical detail, jargon, text boxes, arrows, bars or dates.
     - ✓ The expert should also make sure that these exhibits **do not overuse colors**, which could result in them becoming confusing, complex or unsighty in appearance.

Should I have the similar approach for all audience?

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Audience

- It is important to **consider your audience**.
  - For example, **how** a particular adjudicator, arbitrator or judge might **likely respond** to the introduction of demonstrative evidence.

There are **different reasons** to introduce or rely on **demonstrative evidence**.

Could you give us an example?

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Audience – Example

- On a **nuclear power plant project**, one of the key elements of the case was to demonstrate

  impact of installing large mechanical and electrical equipment in confined spaces

  at the same time **as large scale civil engineering work** was being carried out, the **latter out of sequence**

Power station project.

So, what was the problem?

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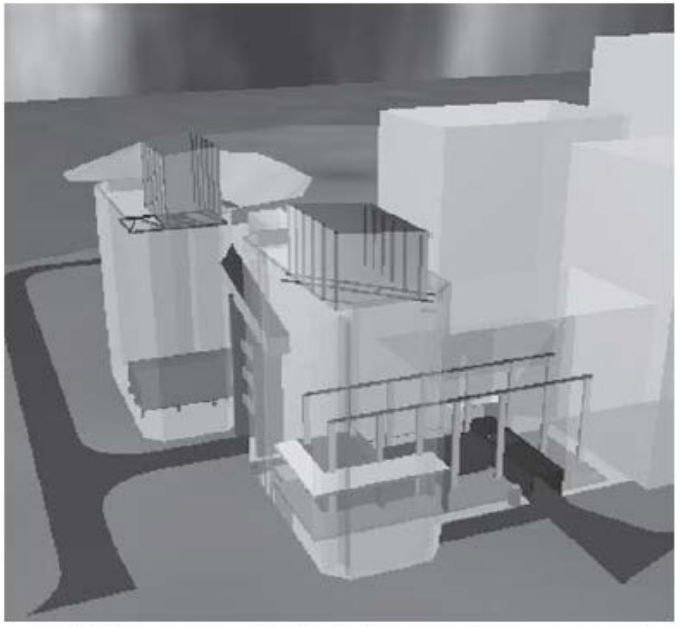
Audience – Example

- At one point in the proceedings, it was deemed that the **arbitrator's health** would **not allow him** to be exposed to the **low levels of radiation** that were likely during a **site tour of the operating plant**.

  - Therefore, a **3-D computer model** of the facility was created, and that model projected through time, to demonstrate, **side by side**,

    1. **Planned sequence** and **timing** of the works as **compared** to
    2. **Actual sequence** and **timing** of the work (a 'time-phased 3-D model')

What other common forms of presenting demonstrative evidence exist?



CAD (computer-aided design) model of the power station.

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Other common forms

- **4-D models** for both **pre-planning** and **forensic analysis**
  - Charts and graphs
  - CPM programmes and extracts
  - Document blow-ups/call-outs
  - Scale diagrams and models
  - Animations and BIM models
- A **computer animation** is produced by **linking a series** of images, each of which is technically accurate,

  to **show progress or events over time**.

  Animations fall into two categories, demonstration and reconstruction.

Let's look at demonstration and reconstruction!

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Demonstration

- **Demonstration** is usually designed to show **how** some physical principle or process **works**.
- A **'demonstration' animation** could be produced to show
  1. **Overview** of a **process** plant
  2. **Labelling** all components
  3. **Structures** for identification

- Next, the **animation** would **zoom in on each piece** of equipment, showing how it works by following the **animated flow** of the product through the **entire process**.

Why needed?

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Demonstration

- **This type of animation** does **not show or indicate** the **party's position in the case**.
  - This will assist them to **later understand the opinion or evidence** of an **expert**.

Let's see an example!

ODCC

Demonstration

- For example, the **Figure below** is an illustration that **demonstrates why a gas main** needed to be **diverted**

  when additional mini-bored piles were **added** to a **facility**.

- The **gas mains prior location** and new location can be seen in relation to the **existing foundations** and **proposed 'redesigned bored piles'.**
  - This image, and others like it, could save valuable time in a hearing.

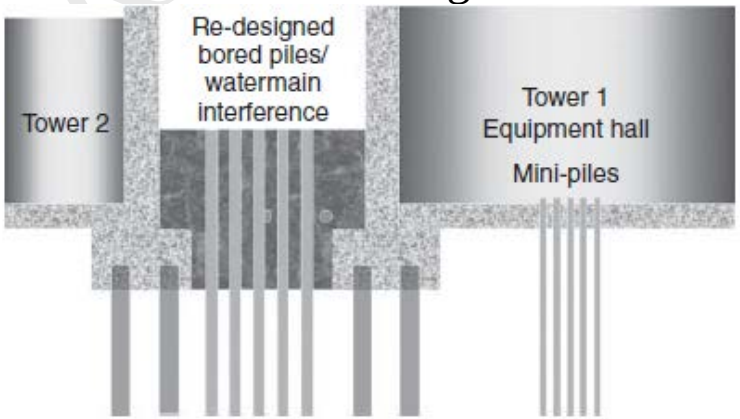


Illustration of relocated gas main.

Let's see reconstruction!

Reconstruction

- A **reconstruction** illustrates how **events actually occurred** **sequentially** and is possibly the **most complicated and controversial type** of animation.
  - While this type of evidence **may simply represent**, for example an **as-planned versus as-built sequence**, they are usually relied on to **depict one expert's theory** of **what happened** in a case.

- This type of animation could **permit experts** to give **their theory of what happened**, while a **tribunal watched the story** visually unfold **in front of them**.

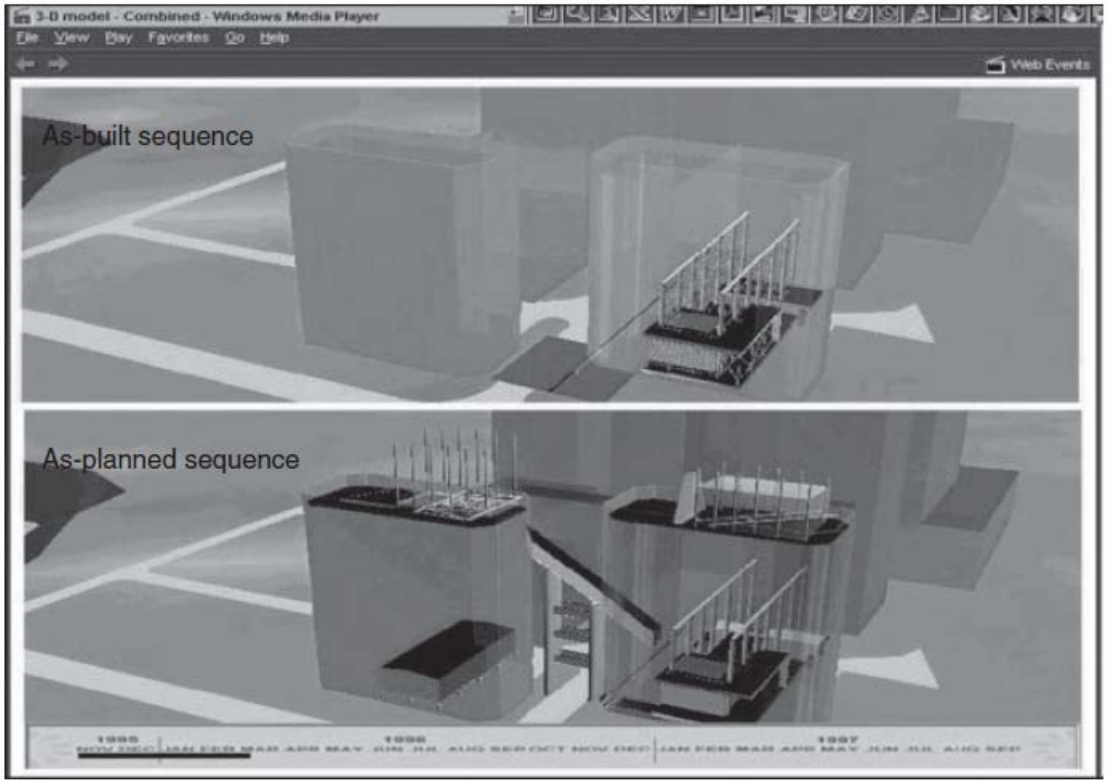
Let's see an example!

ACEMI

Reconstruction

- Again in the **power project referred to previously**, it was considered **necessary to prepare a 4-D model (3-D time-scaled animation)**

  to demonstrate at various points in time **how far in advance** the **civil engineering works** should have been progressed in order to allow mechanical work to follow on.



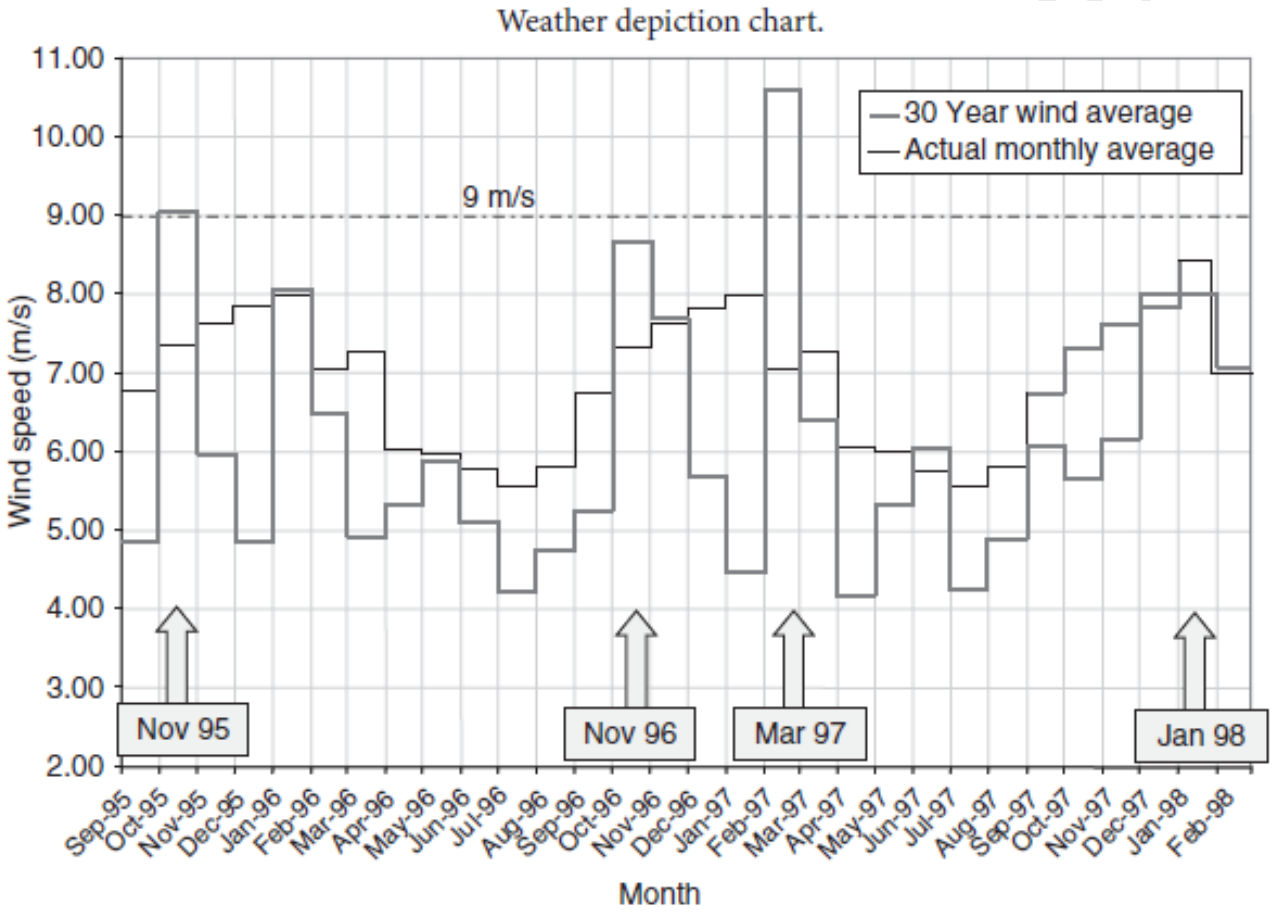
Animated model.

What requirements needed for courts?

Demonstration in court

- In order to use a **reconstructive animation** in court, **several pieces of information** must be **disclosed or exchanged** with the legal representatives of the opposing party and are as follows:
  - ✓ **Identity** of both the **expert who created** the animation and the **expert who will testify** as to the accuracy of the information depicted in the animation.
  - ✓ **Identity** of the **hardware** and **software** used to construct the animation.
  - ✓ **Documents** and other **sources of data** included in the animation.
  - ✓ **Computer data files** that make up the completed animation.

One last point!



موسسه مهندسی و مدیریت ساخت علوی پور (ACEMI)

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