



فرآیند جامع آنالیز تاخیرات در پروژه

بخش هفتم:
آنالیز زمانی تاخیرات

آنالیز زمانی تاخیرات قبل از وقوع تاخیر
(Contemporaneous Schedule Analysis)

ارائه دهنده:

سید محمدرضا علوی پور

CMAA Authorized Trainer

(PhD, PMP, CMIT)

دانشگاه Illinois Tech آمریکا

What we will learn?

- ❑ Critical path techniques
 - ❖ Delay analysis key terms – Review
 - ❖ Delay analysis using prospective methods
 - ✓ Impacted as planned analysis (IAP)
 - ✓ Time impact analysis (TIA)
- ❑ Non-critical path techniques
- ❑ Delays by subcontractors

Critical Path Techniques

(Delay analysis key terms – Review)

Cause and effect vs. effect and cause

1. Cause and effect type analysis

- ❖ Start with the **identification** and **description** of a **cause** and then its **impact**

2. Effect and cause type analysis

- ❖ **Identifying** critical delay (an effect) and then what might **have caused** that **delay**



Cause			Effect	
Delay Event	Risk Owner	Delay	Activity Impacted	Delay
Late completion of sample	Contractor	5 days	Façade construction	5 days
Late inspection	Owner	5 days	Façade construction	5 days

Contemporaneous vs. after-the-fact

1. For Contemporaneous analysis

❖ Cause and effect methods are recommended

✓ Time impact analysis

1. For After-the-fact analysis

❖ Effect and cause methods are **generally** more reliable

Because consider **all causes** of the **delay incurred**.

Prospective vs. retrospective

❑ **Delay impact** is determined in **one** of **two** different ways:

1. **Prospective** delay analysis

- ❖ It identifies the **likely impact** of **historical progress** or **delay events** on a **completion date**.
- ❖ The **conclusion** of this analysis **may not match** the **as-built schedule** because *the contractor's actual performance may well have been influenced by the effects of attempted acceleration, re-sequencing or redeployment of resources in order to **try to avoid liability** for liquidated damages or due to other Employer and Contractor Risk Events.*

2. **Retrospective** delay analysis

- ❖ It identifies the **actual impact** of the **delay events** on the **identified actual** or **as-built critical path**

Prospective vs. retrospective

1. The delay events are **happening or going to happen**, and your **objective** is to **ESTIMATE** the impacts from the delays so that the contractor and owner can make **new agreement**.
 - ❖ This analysis is often performed while the project is **in progress**.
 - ✓ “Contemporaneous Delay Analysis” or “Prospective Delay Analysis”
2. The delay events **have happened already**, and your **objective** is to **QUANTIFY** the delays and **IDENTIFY** the Responsibility by using **actual data**.
 - ❖ This analysis is usually performed **after** the events **happened** or after the project is **completed**.
 - ✓ “Forensic Delay Analysis” or “Retrospective Delay Analysis”



Criticality

❑ **Criticality** is determined in **one** of **three different ways**:

1. Purely prospective critical path assessments

- ❖ It adopts the perspective evident at the outset of the project only and **take no account** of **progress achieved**.

2. Contemporaneous critical path assessments

- ❖ It adopts an evolving perspective over the **course of the works** and **take account** of the **effect** that **both** historical progress and changes in the strategy for the **future prosecution** of the works have on **predicted criticality**.

3. Retrospective critical path assessments

- ❖ It adopts the perspective evident at the end of the project.



Importance of critical path

- ❑ CPM schedules can benefit **Owners** and **Contractors**
 - ❖ But **Contractors**, **Owners**, and **schedule analysts** must all become proficient in the **application** of these scheduling tools.
- ❑ The longest path may have zero float along its (1) entire path, (2) a portion of its path, or (3) nowhere on the path.
 - ❖ This means that it is possible, even likely, that **certain** activities on the **critical path** will **actually** have float.
 - ✓ A **close look** at the schedule logic will reveal **why the float** on these activities **makes sense**.

Often, this **float** is a **function** of a constraint that is modeling a Contract requirement or other known construction restriction

Importance of critical path

Understanding **how to identify shifts** in the **critical path** is essential to properly allocate **critical Project delays**.

- ❑ The **analysis techniques** employed by the **analyst** should be such that the **critical path** of the Project is **known for every day of the Project**.
- ❖ The **advanced features** of current CPM software have given us **powerful tools** that provide a **high level of precision** in the **analysis process**.

While the activities along the **critical path** may have **varying float values**, many schedules **still have critical paths** with zero float.

For simplicity purposes, *most of the examples used in this course will refer to zero float critical paths.*

Critical Path Techniques

(Delay Analysis Using Prospective Methods)

☐ Event Analysis Sheet

☐ CVIs (confirmation of verbal instructions)

☐ PCEs (potential compensation events)

☐ A list of potential delay events should then be created.

☐ For each potential delay event, an “**event analysis sheet**” should be prepared.

EVENT ANALYSIS SHEET

EAS REFERENCE: 001

REFERENCE DOCUMENTS

Location: _____
CVI: _____
RFI: _____
PCE.CE: _____

JOB REF: 1009.004

Hotel and Casino Projects
Client: Steel Company Inc.

EVENT DESCRIPTION:

EAS 001 [EVENT DESCRIPTION HERE]
CPM Activity: [Activity ID & Description here]

	Plan* (a)	Actual (b)	Variance (b) - (a)
Start			
Finish			
Duration			
Total float			

*planned dates in current "windows" schedule

WINDOWS REF: _____

ERECTION SEQUENCE: _____

PAY APP LINE ITEM REF: _____

TOTAL FLOAT LOSS IN WINDOW: _____

Time Analysis:

Relevant Facts:

Measurement of Delay:

Key Dates: - - -

SCHEDULE IMPACT : (ACTIVITIES ADDED/DELETED/REVISED)

ACTIVITY DESCRIPTION	ACTIVITY ID	DURATION	PRED	SUCC	LOGIC	CONSTR

COMMENTS / ASSUMPTIONS / ACTIONS :

STEP 7: Performing delay analysis procedure (CPs 4 and 11)

- ☐ **Details of all the delay issues** identified should be recorded in a **delay register** (below table).
- ☐ This table should capture **all delays**.
- ☐ This table could be more complex.

Ref no.	Cause and effect of delay or disruption	Delay to section or part of works	Delay to competition date	Contract clause relevant to delay	Date of delay notice and particulars
1.	Under-slab drainage Additional works arising out of discovery of ground beam clash	16 days	4 days	25 Relevant event 25.4.5.1	Contractor's letters: November 23 2005

STEP 7: Performing delay analysis procedure (CPs 4 and 11)**❑ CP 4 in SCL Protocol:****4. Do not 'wait and see' regarding impact of delay events (contemporaneous analysis)**

The parties should attempt so far as possible to deal with the time impact of Employer Risk Events as the work proceeds (both in terms of EOT and compensation). Applications for an EOT should be made and dealt with as close in time as possible to the delay event that gives rise to the application. A 'wait and see' approach to assessing EOT is discouraged. Where the Contractor has complied with its contractual obligations regarding delay events and EOT applications, the Contractor should not be prejudiced in any dispute with the Employer as a result of the CA failing to assess EOT applications. EOT entitlement should be assessed by the CA within a reasonable time after submission of an EOT application by the Contractor. The Contractor potentially will be entitled to an EOT only for those events or causes of delay in respect of which the Employer has assumed risk and responsibility (called in the Protocol Employer Risk Events) that impact the critical path.

STEP 7: Performing delay analysis procedure (CPs 4 and 11)

□ Contemporaneous analysis procedure

- ❖ Step 7 sets out a **recommended procedure** to be **followed in order** to deal **efficiently and accurately** with EOT applications during the **course of the project**.
- ❖ This procedure assumes Steps 1 to 6 have been **followed**.
- ❖ Step 7 does **not intend** to be **incorporated into a contract**.

Contemporaneous analysis – Why preferred?

- ❑ The contemporaneous project schedules are the **preferred tool** to measure Project delay because they were used by the **project participants** to **manage** and **construct** the project at a **moment in time** based on the **known Project conditions**.
1. By using the **contemporaneous schedules** and **updates**, and
 2. By **tracking delays** as they **occur throughout the project**,
there is **no need** to attempt to **inject information** that is **known at a later date**.

Contemporaneous analysis – Why preferred?

ASCE Standard ANSI/ASCE/CI 67-17 (Schedule Delay Analysis)

7.3 CONSIDERATION SHOULD BE INCLUDED AS TO **HOW DELAYS WERE EVALUATED** BY THE PARTICIPANTS DURING THE PROJECT

- ❑ Although delay events should be **recognized and measured** during the project as the project progresses,

in practice they are **not always identified** contemporaneously.

- ❑ During expert analysis, the more common industry practice is to measure the delays in an **after-the-fact analysis**,

which more accurately defines the delay events that **occurred** on a project.

- ❑ Although this process may reveal what may be considered **bad decisions with hindsight**,

contemporaneous decisions affecting project delay still may be justifiable.

Contemporaneous analysis – What schedule to measure delay?

Do not create schedules after-the-fact to measure delays

❑ Using a **schedule** created **after the fact** to measure and identify project delay, however, has **two weaknesses**:

1. The schedule does **not depict** the **original construction plan**
2. The schedule may include **predetermined conclusions** concerning delays

When possible, it is **always best** to use the **contemporaneous Project schedules** to measure Project delay **while** the analyst may **make very minor modifications** to the **contemporaneous schedule** to account for **obvious errors**.

Delay analysis using prospective methods – Introducing methods

Method of Analysis	Analysis Type	Critical Path Determined	Delay Impact Determined	Requires
Impacted As-Planned Analysis	Cause & Effect	Prospectively	Prospectively	- Logic linked baseline programme. - A selection of delay events to be modelled.
Time Impact Analysis	Cause & Effect	Contemporaneously	Prospectively	- Logic linked baseline programme. - Update programmes or progress information with which to update the baseline programme. - A selection of delay events to be modelled.

Delay analysis using prospective methods – Comparing methods

The Information Required					
	Baseline programme	Logic linked baseline programme	As-built data	Delay events to model	Up to date programmes/ process information
Impacted As-Planned					
Time Impact					

Delay analysis using prospective methods – References

Delay analysis using prospective methods

The following procedure proposed in this course provided by combining

1. *AACE 52R-06*
2. *AACE 29R-03*
3. *SCL Protocol*
4. *Construction Delays Book (Third Edition)*
5. *Delay Analysis in Construction Contracts Book (Second Edition)*
6. *My experience*

Impacted As-Planned (IAP)

Delay analysis using prospective methods – Introducing methods

Method of Analysis	Analysis Type	Critical Path Determined	Delay Impact Determined	Requires
Impacted As-Planned Analysis	Cause & Effect	Prospectively	Prospectively	- Logic linked baseline programme. - A selection of delay events to be modelled.
Time Impact Analysis	Cause & Effect	Contemporaneously	Prospectively	- Logic linked baseline programme. - Update programmes or progress information with which to update the baseline programme. - A selection of delay events to be modelled.

Delay analysis using prospective methods – Impacted as planned analysis

❑ Definition

- ❖ In this approach, the **analyst** identifies the as-planned schedule and then **inserts** into this schedule the **changes** that it believes

1. Will cause project delays
2. May have caused project delays

**Why should not be used as forensic analysis?
Think about it!**

- ✓ The source for **these changes** is **only** the perceived delays noted during **construction**.
- ✓ **This type** of analysis considers **only** the project team's original plan and the delay being analyzed.

This is done on “As-planned schedule”

Impacted As-Planned (IAP)
(Contemporaneous or Prospective)

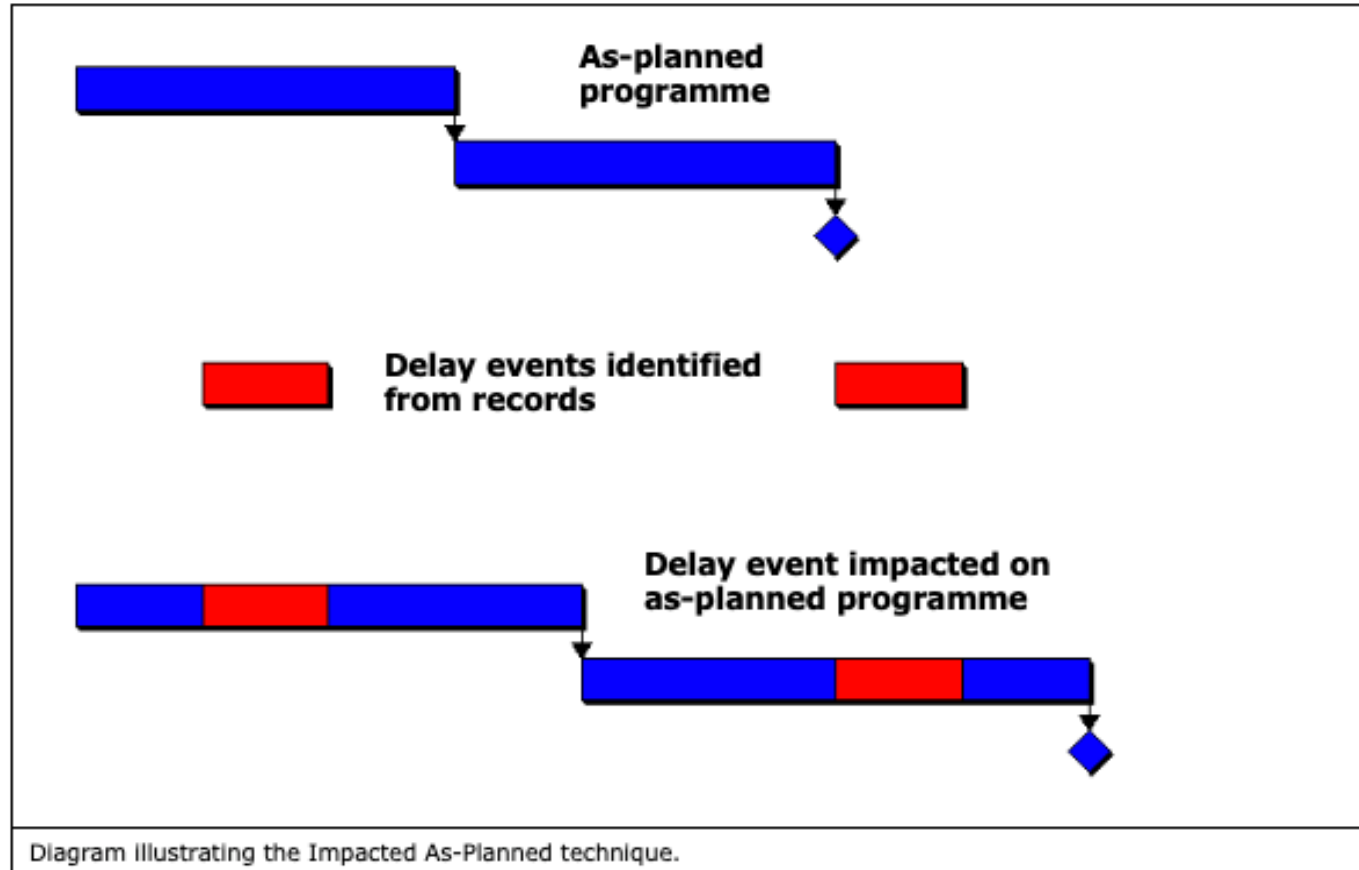
Impacted as planned analysis – Contemporaneous or prospective

□ How to use?

1. Use the **initial as-planned (baseline)** schedule for the project.
2. Incorporate the **delay event** as activity in the as-planned schedule and **link it to all activities** that it will impact.
3. Recalculate the **completion date**.
4. The difference between
 1. **Initial completion date** in the as-planned (baseline) schedule and
 2. **Completion date** on the recalculated schedulewill constitute the effect of the delay.

Impacted as planned analysis – Contemporaneous or prospective

□ Example

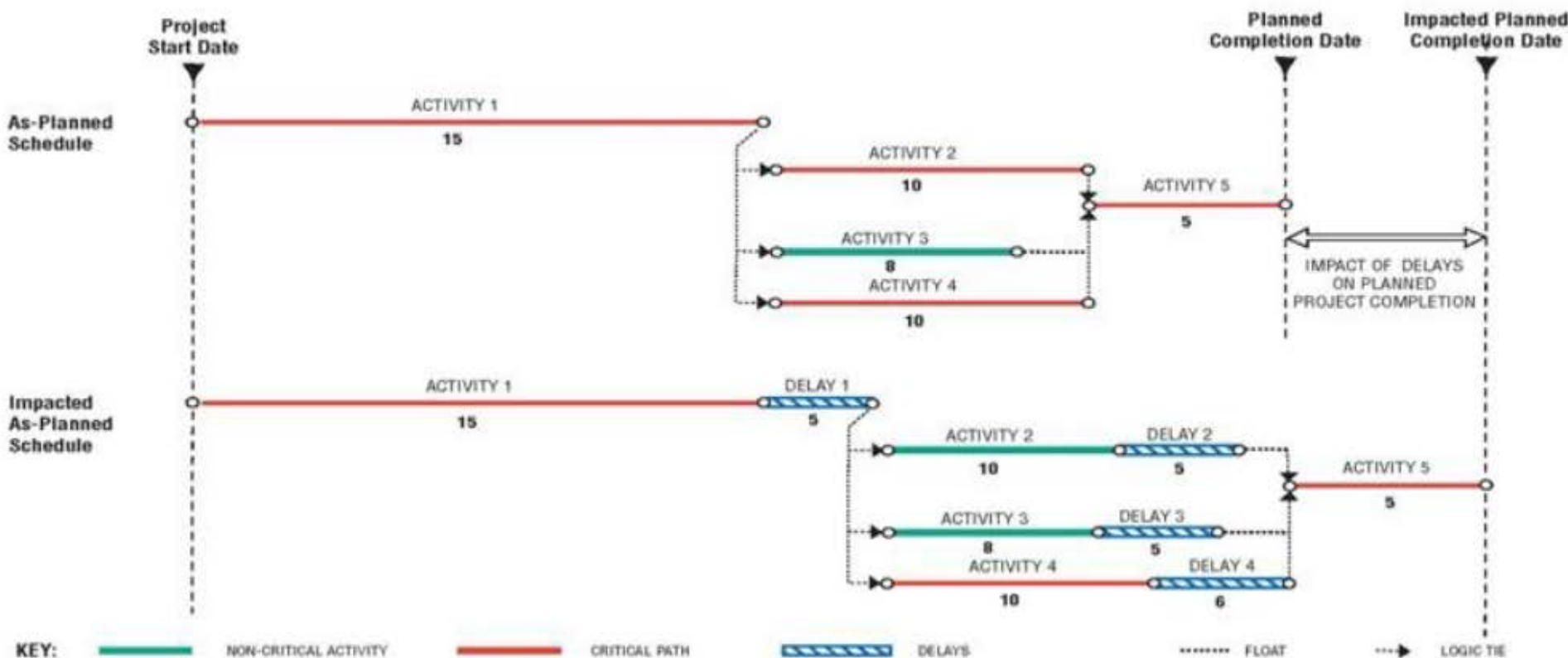


Could it be performed using windows?

Impacted as planned analysis – Contemporaneous or prospective

□ Example:

As-Planned Impacted Schedule Analysis with Delays



Do the courts accept it as a forensic analysis?

DCC

28

Impacted as planned analysis – Contemporaneous or prospective

❑ Example: Court decision

“We have found that [his] analysis systematically excluded all delays and disruptions except those allegedly caused by the Government ... We conclude that his analysis was inherently biased, and could lead to but one predictable outcome ... To be credible, a contractor’s CPM analysis ought to take into account, and give appropriate credit for all of the delays which were alleged to have occurred.”

Haney v. United States 30 CCF ¶ 70, 1891], 676 F.2d 584 (Ct. Cl. 1982); Pathman Construction Co. , ASBCA No. 23392, 85-2 BCA ¶ 18,906

Could it be used for compensation calculation?

Impacted as planned analysis – Contemporaneous or prospective

❑ SCL view

❖ The **SCL Protocol** envisaged the IAP technique as one which would **assist** in demonstrating extension of time entitlement only, and not prolongation costs.

❖ While **IAP models** can only estimate the impact of events prospectively,

It is foreseeable that the IAP model could be used as the basis for estimating prolongation on the basis of **pre-agreed rates**

if parties are inclined to **accept** the results of such an analysis.

How about concurrency?

Impacted as planned analysis – Contemporaneous or prospective

❑ SCL view

❖ It was **not concerned** with using the IAP technique for identifying **concurrent delays** if used as a **retrospective**.

○ Because SCL believes in **true concurrency**!

✓ This can only be done with **as-built records** and approaches which rely on **as-built programmes**.

Cannot calculate **true concurrency**!

So, if used prospective,
what to do to **resolve** this problem?

Impacted as planned analysis – Contemporaneous or prospective

❑ However, the **AACEI** recognizes that the approach is able to identify 'approximate concurrency' for the purposes of estimating

1. Concurrent delay and
2. Extension of time entitlement

Because AACE believes in functional theory as well!

Now, you know why I recommended using functional theory if you consider to use **prospective methods**!

What are the requirements of using IAP?

Impacted as planned analysis – Contemporaneous or prospective

The only schedule required to carry out an IAP is a baseline schedule that

1. Contractually compliant
2. Represents a contractor's true intention prior to commencing any works

What if the available baseline contains identifiable logical or duration **errors**?

Impacted as planned analysis – Contemporaneous or prospective

What if the available baseline contains identifiable logical or duration errors?

Don't use this method,

unless

there is an agreement to use it as a negotiating tool between contractor and employer!

Impacted as planned analysis – Contemporaneous or prospective

Could it be used as a retrospective method?

Yes, but not recommended at all!

This is the reason that SCL Protocol considers this as
Prospective approach!

But it have been using in Iran and it is so **prevalent**?

Ok, I will teach you how to improve the accuracy of this approach
when using as Retrospective!

Impacted As-Planned (IAP) **(Forensic or Retrospective)**

Impacted as planned analysis – Forensic or retrospective

□ How to use?

1. Once a **baseline** for analysis is **identified**, then either, or both, **employer delay event (EDE)** and **contractor delay event (CDE)** are added to the baseline programme.
 - a) If they are added **independently**, this is known as a **'non-integrated IAP'** (with either CDE or EDE, but not both).
 - b) If both are added **jointly**, then this is a **'combined IAP'**.
 - ❖ Combined IAP models require the impacts to be inserted in the **chronological order** in which they **first arose**.

Impacted as planned analysis – Forensic or retrospective**❑ How to use?**

1. Once a **baseline** for analysis is **identified**, then either, or both, **employer delay event (EDE)** and **contractor delay event (CDE)** are added to the baseline programme.

❑ The insertion can take many forms, including:

- Delaying the start of an existing, or inserted, activity with a constrained start date.
- Delaying the finish of an existing, or inserted, activity with a constrained finish date.
- Increasing the duration of an existing activity.
- Increasing or decreasing the hours available during a working week.
- Inserting a new fragnet or activity, logically linked to existing activities in the programme.
- Adding or deleting existing logical links to reflect the impact of changed conditions and dependencies.

Which method is recommended?

Impacted as planned analysis – Forensic or retrospective

❑ How to use?

1. Once a **baseline** for analysis is **identified**, then either, or both, **employer delay event (EDE)** and **contractor delay event (CDE)** are added to the baseline programme.
- ❑ The insertion can take many forms, including:
- Delaying the start of an existing, or inserted, activity with a constrained start date.

Some analysts **insert activities with start constraints**, thus avoiding the need to provide a **predecessor** in the existing baseline programme.

This is appropriate in certain circumstances but **should be avoided** when natural construction **predecessors** **can be identified** in the baseline programme.

- Delaying the finish of an existing, or inserted, activity with a constrained finish date.
Same thing...

Impacted as planned analysis – Forensic or retrospective

❑ How to use?

1. Once a **baseline** for analysis is **identified**, then either, or both, **employer delay event (EDE)** and **contractor delay event (CDE)** are added to the baseline programme.
- ❑ The insertion can take many forms, including:
- Increasing the duration of an existing activity.
 - Increasing or decreasing the hours available during a working week.
 - Adding or deleting existing logical links to reflect the impact of changed conditions and dependencies.

So, which one?

Impacted as planned analysis – Forensic or retrospective

□ How to use?

1. Once a **baseline** for analysis is **identified**, then either, or both, **employer delay event (EDE)** and **contractor delay event (CDE)** are added to the baseline programme.

This is performed by inserting **additional tasks** as discrete activities, complete with **logical relationships** and **durations** to the **original contract baseline schedule**.

Each CDE or EDE activity requires the following:

1. Estimated duration
2. List of logical predecessors
3. List of logical successor

Impacted as planned analysis – Forensic or retrospective

❑ How to use?

Any method of insertion **must be recorded as part of a transparent and auditable process.**

Impacted as planned analysis – Forensic or retrospective

□ How to use?

CDE and EDE can be inserted:

1. **One at a time**
2. **All at once**

2. The resulting delay impact on the completion date, is then measured and recorded.
 - a) **One at a time:** then the impacted completion date is recorded **event by event**.
 - ✓ Both CDE and EDE can be inserted in this way.
 - ✓ Concurrent effect is better calculated in this method.
 - b) **All at once:** then impacted completion date is recorded **once at a time**.

Impacted as planned analysis – Forensic or retrospective

❑ Practical procedure for CC-IAP:

What should be done for combined chronological impacted as planned (CC-IAP)?

1. Both CDE and EDE delays are identified and listed chronologically.
2. Each delay is inserted individually and cumulatively until all delays have been inserted into the program (*CC-IAP developed*).
3. Depending on whether the impact was caused by either a CDE or an EDE, the critical delay to completion is “**banked**” into a respective category and **tabulated**.
 - ✓ *Sum of CDEs = Non-excusable, non-compensable delays, and LDs*
 - ✓ *Sum of EDEs = Excusable and Compensable delays*

So, what to do for concurrent delays?

Impacted as planned analysis – Forensic or retrospective

□ Practical procedure for CC-IAP:

What should be done for combined chronological impacted as planned (CC-IAP)?

4. Prepare and insert only EDE in IAP to find concurrent delays (*EDE-IAP developed*)
 - ✓ *Sum of EDE-IAP – EDEs-CC-IAP = Concurrent delays (excusable but non-compensable)*
 - o While this is **not true concurrent delay**, because it is based on a theoretical prospective model, it provides a measure of **approximate concurrency**.

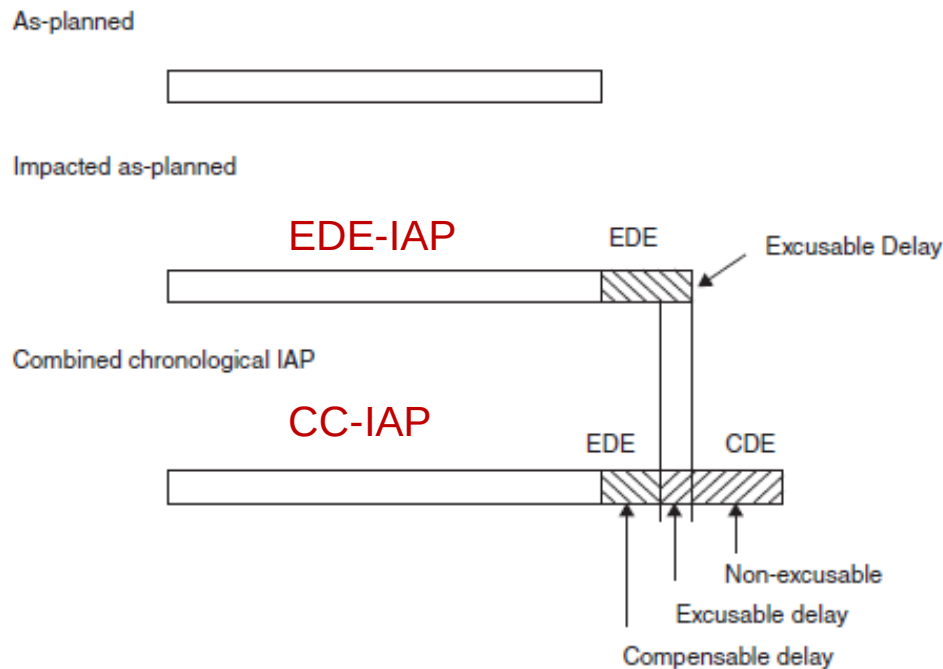
This is again the reason I told you to use “Functional Theory”

What should be done for Excusable but non-compensable?

Impacted as planned analysis – Forensic or retrospective

❑ Practical procedure for CC-IAP:

Combined



This could calculate the approximate concurrency

Impacted as planned analysis – Forensic or retrospective

However, payment for time-related costs during this approximate period can **only** be **estimated** by way of average daily rates, or some other pre-agreed daily rate which is **acceptable to both parties**.

The **resulting compensable delay** period will not identify

1. Actual period in which the **delay** was being **experienced**, or
2. Actual delay which was experienced to the **completion date**

Impacted as planned analysis – Forensic or retrospective

□ Practical procedure for NI-IAP:

What should be done for Non-integrated impacted as planned (NI-IAP)?

1. Impact of CDE separately from the EDE in two isolated models.
2. Compare two models:

I. *Sum of CDEs > Sum of EDEs*

- ✓ *CEDs = Non-excusable and LDs*
- ✓ *EDs = Excusable*
- ✓ *No compensation*

II. *Sum of CDEs < Sum of EDEs = Difference is compensable delay*

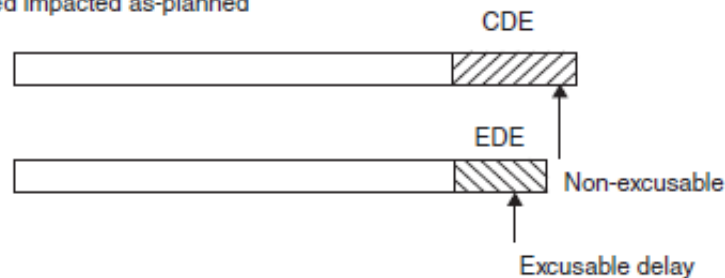
- ✓ *CEDs = Non-excusable and LDs*
- ✓ *EDs = Excusable*
- ✓ *Difference is compensable delay*

Impacted as planned analysis – Forensic or retrospective

❑ Practical procedure for NI-IAP:

Non-integrated

Non-integrated impacted as-planned



So, what to do for concurrent delays?

Impacted as planned analysis – Forensic or retrospective

❑ Practical procedure for NI-IAP:

What should be done for Non-integrated impacted as planned (NI-IAP)?

3. Estimate **CC-IAP** (again we need CC-IAP)
4. Compare **non-integrated CDE** with **CC-IAP**
 - ✓ *CC-IAP – Non-integrated CDE*
5. Compare the duration achieved from Step 4 with Non-integrated EDE
 - ✓ *Number achieved in Step 4 > Non-integrated EDE = No concurrency*
 - ✓ *Number achieved in Step 4 < Non-integrated EDE = Difference is concurrency*

Impacted as planned analysis – Forensic or retrospective

□ Example

Combined

Combined IAP model results.

Combined impacted liability table			Cumulative delay	
Event	Event type	Impacted completion date	EDE	CDE
Baseline		1-Jan-09		
001	EDE	2-Jan-09	1	
002	EDE	5-Jan-09	3	
003	CDE	8-Jan-09		3
004	EDE	10-Jan-09	2	
005	CDE	15-Jan-09		5
006	CDE	15-Jan-09		0
007	EDE	18-Jan-09	3	

Don't forget to use negative sign for acceleration

Impacted as planned analysis – Forensic or retrospective

- ☐ It must be remembered that **these assessments** are **only estimates** of **approximate liability**.
- ☐ The **actual delay** experienced in total may **not be equal to the 17 days** of total delay determined by the **IAP model**.

Why?

Impacted As-Planned (IAP) **(Weaknesses)**

Impacted as planned analysis – Weaknesses

❑ Major weaknesses of this approach

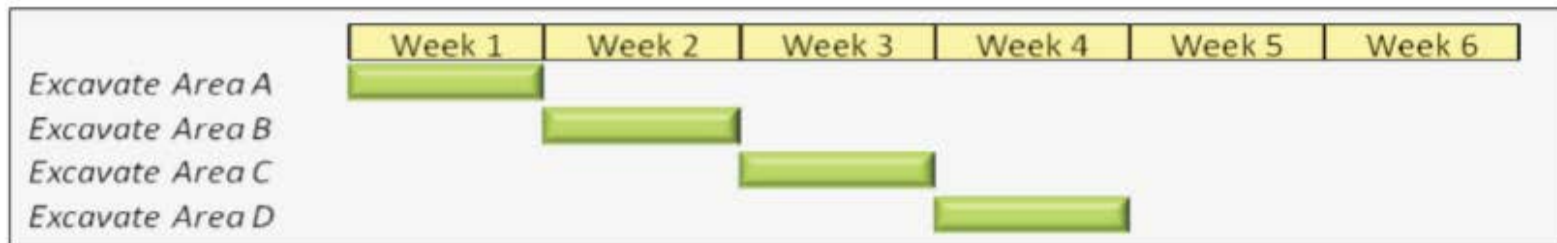
- ❖ The difference between the **IAP impacted contract completion date** and the **actual contract duration** achieved can be explained by several factors:
 - ✓ **Deviations** from the as-planned sequence,
 - Out-of-sequence
 - ✓ **Deviations** from the as-planned durations,
 - Documentation problem and contemporaneous records
 - ✓ **Additional delays** not considered in the IAP model
 - Often **subjective** and **one-sided**
 - ✓ **Mitigation** achieved along the critical path
 - ✓ Changes in critical path
 - **Most significantly**, it **does not consider** the **dynamic nature** of a **project** and the **critical path**.

Impacted as planned analysis – Weaknesses

❑ Major weaknesses of this approach

Labour

As-Planned Schedule



Impacted Schedule

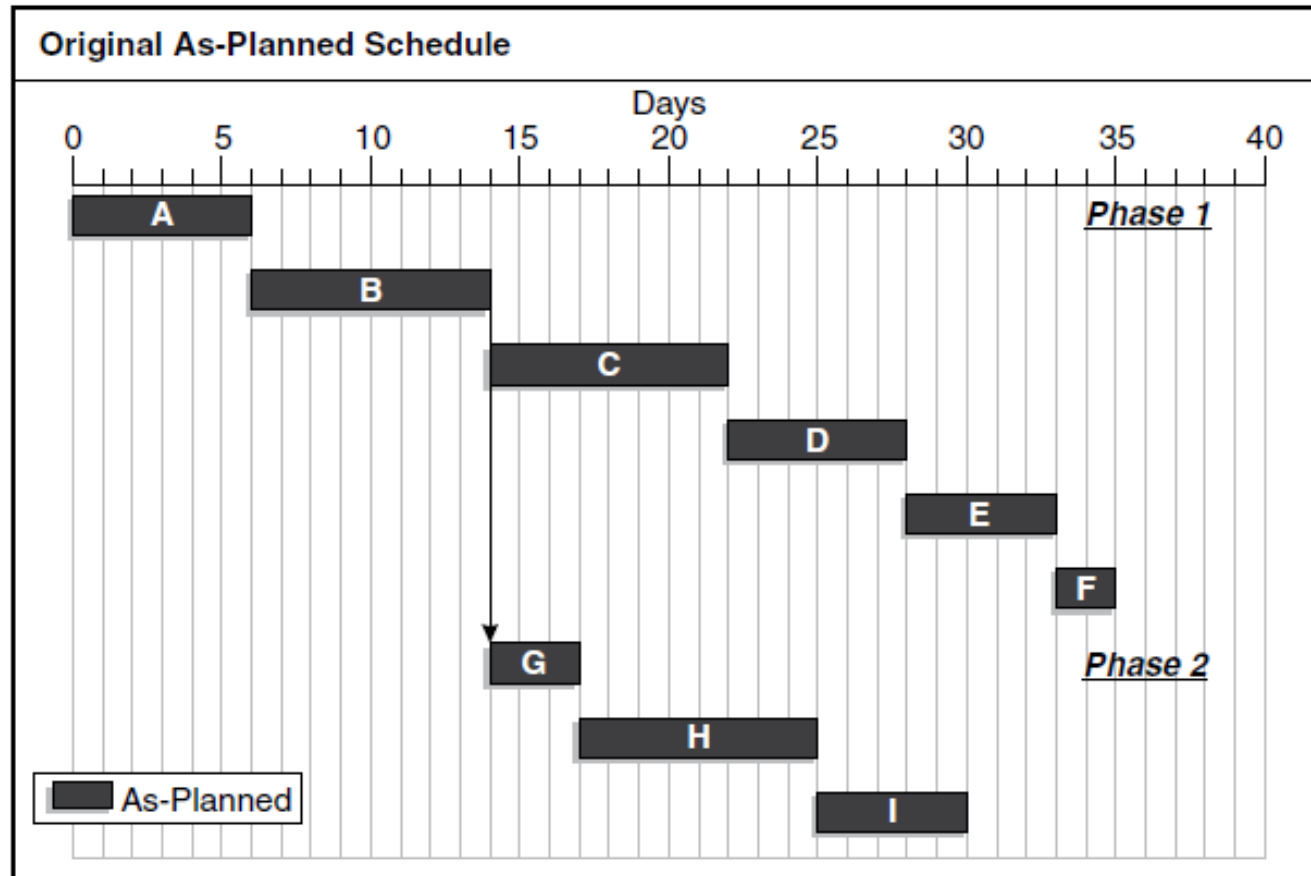


What Actually Happened



Impacted as planned analysis – Weaknesses

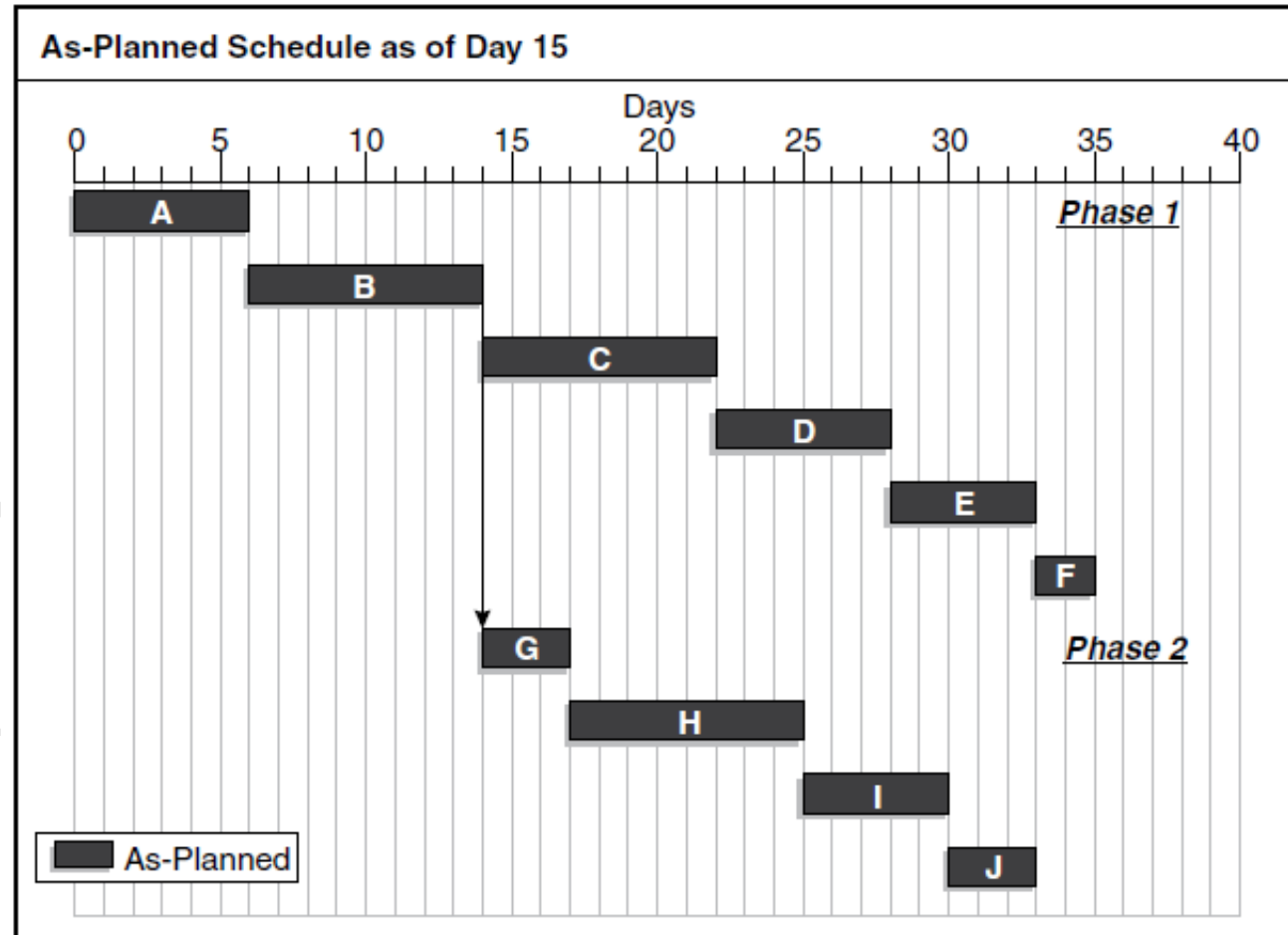
❑ **Example:** A through F must be performed in sequence.



Impacted as planned analysis – Weaknesses

❑ **Example:** On day 15, the contractor modifies its work and adds J with a duration of three days.

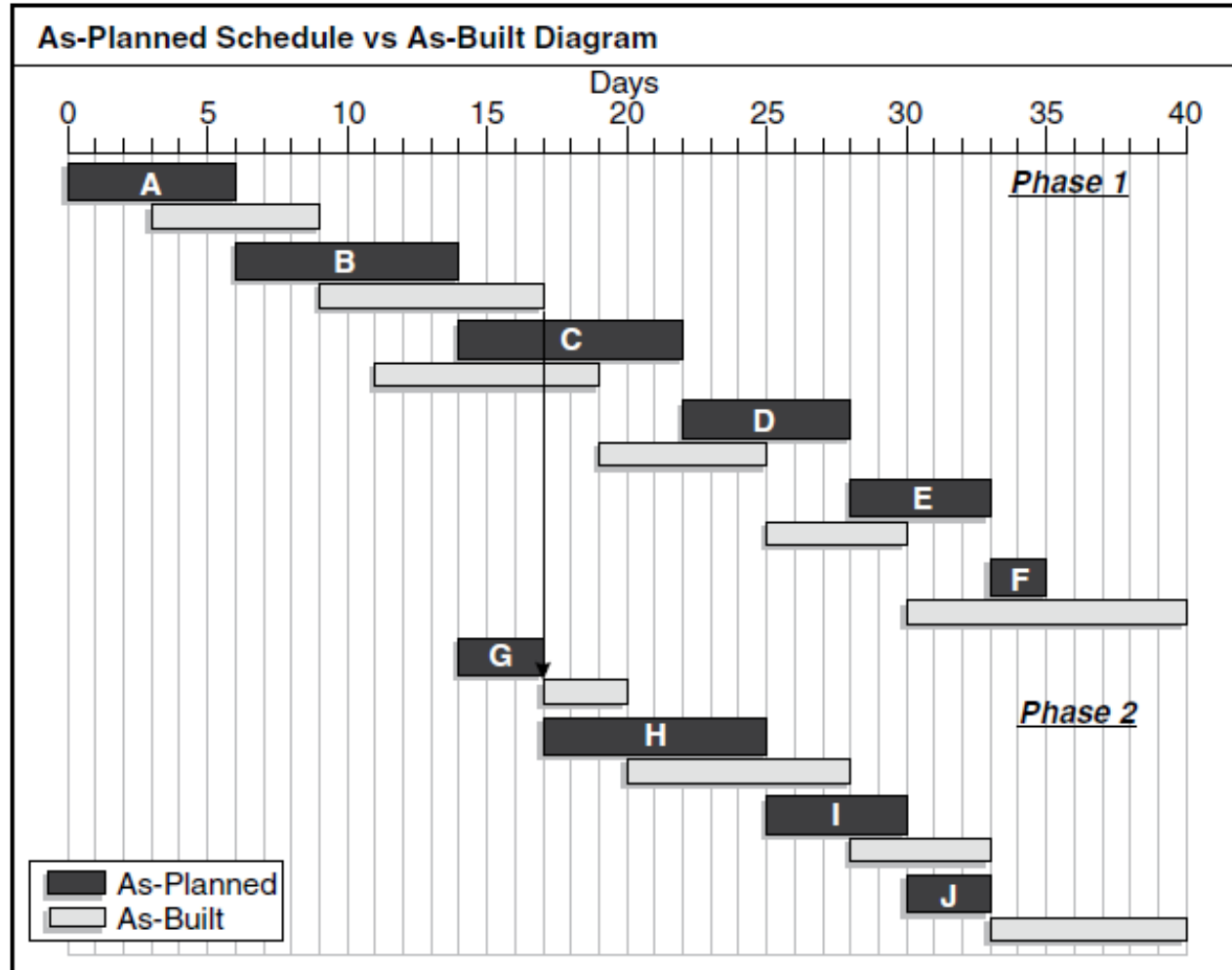
❖ So, nothing should be changed so far.



Impacted as planned analysis – Weaknesses

❑ Example: As-planned vs. as-built

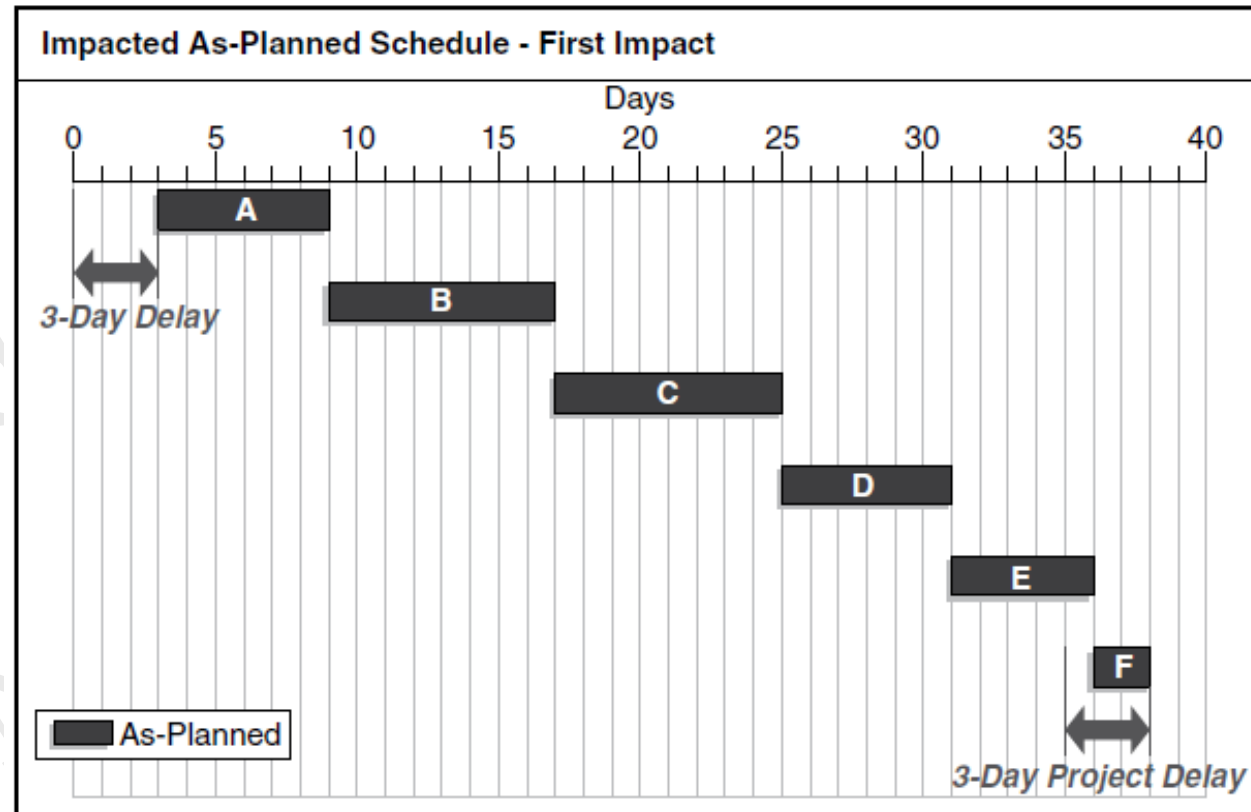
- ❖ The project is actually completed in 40 days (5 days delay)
- ❖ Activity A started three days late.
- ❖ Activity C started six days early and out of sequence.
- ❖ Activity F took eight days longer.
- ❖ Activity J took four days longer.



Impacted as planned analysis – Weaknesses

❑ **Example:** Impacted as-planned – First impact

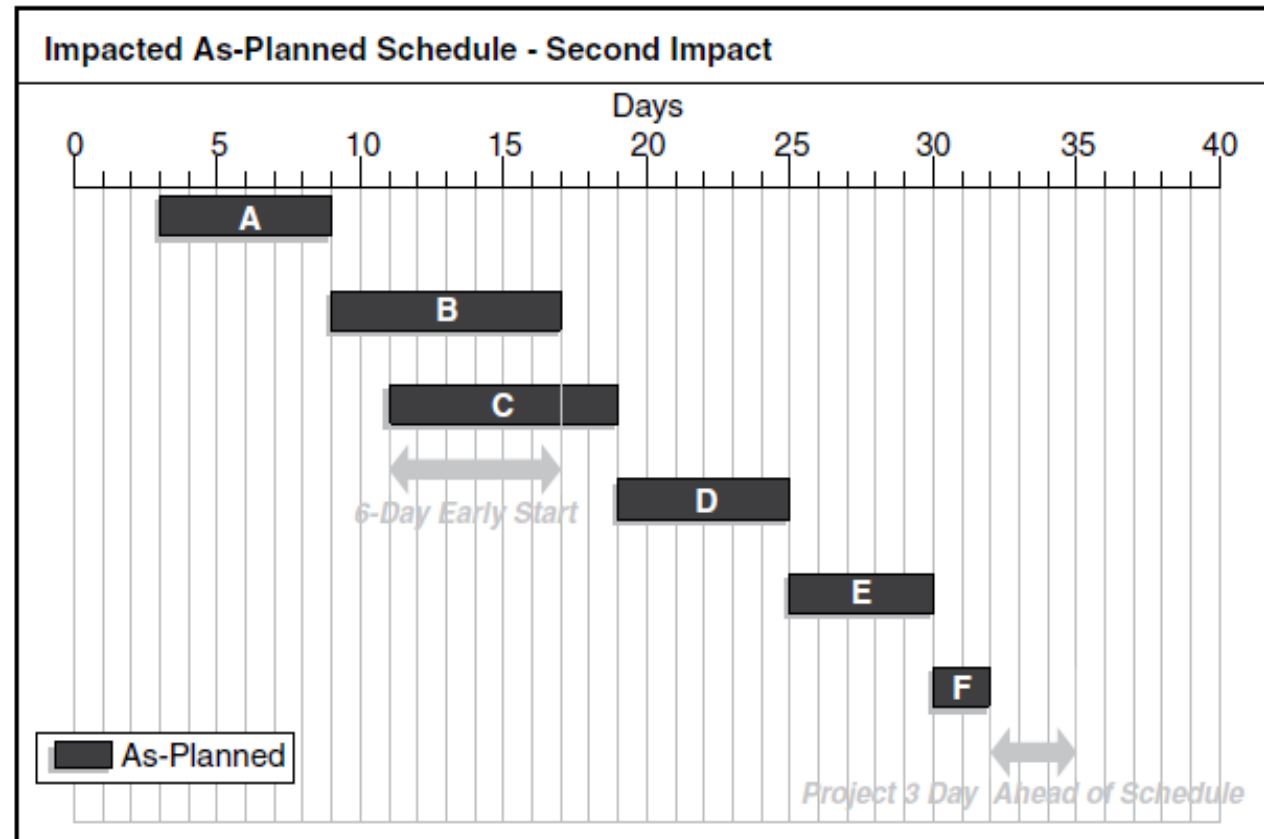
❖ Project delayed by three days because of the late start of Activity A.



Impacted as planned analysis – Weaknesses

❑ **Example:** Impacted as-planned – Second impact

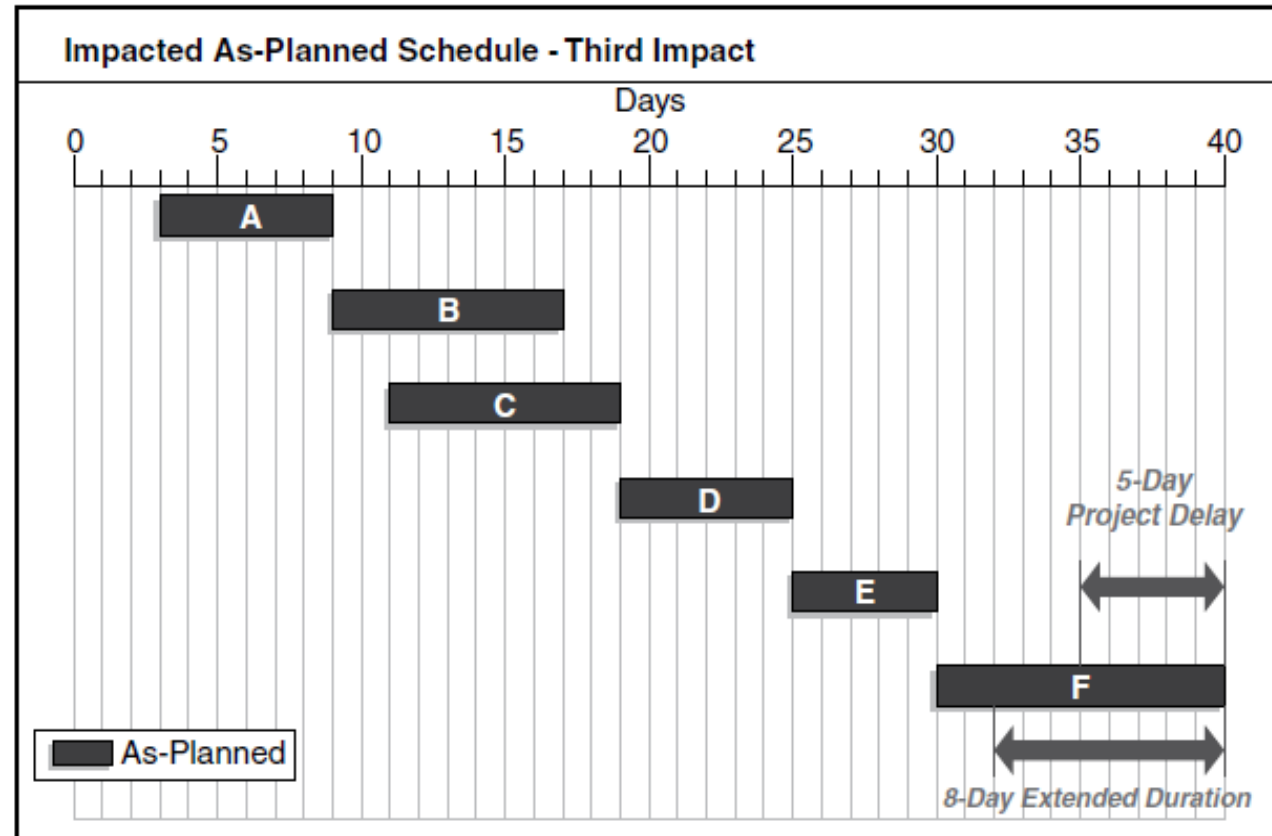
❖ Project ahead of schedule by three days because of the early start of Activity C.



Impacted as planned analysis – Weaknesses

❑ Example: Impacted as-planned – Third impact

- ❖ Project delayed a total of five days due to the extended duration of Activity F.



Impacted as planned analysis – Weaknesses

❑ **Example:** Impacted as-planned – Final conclusion

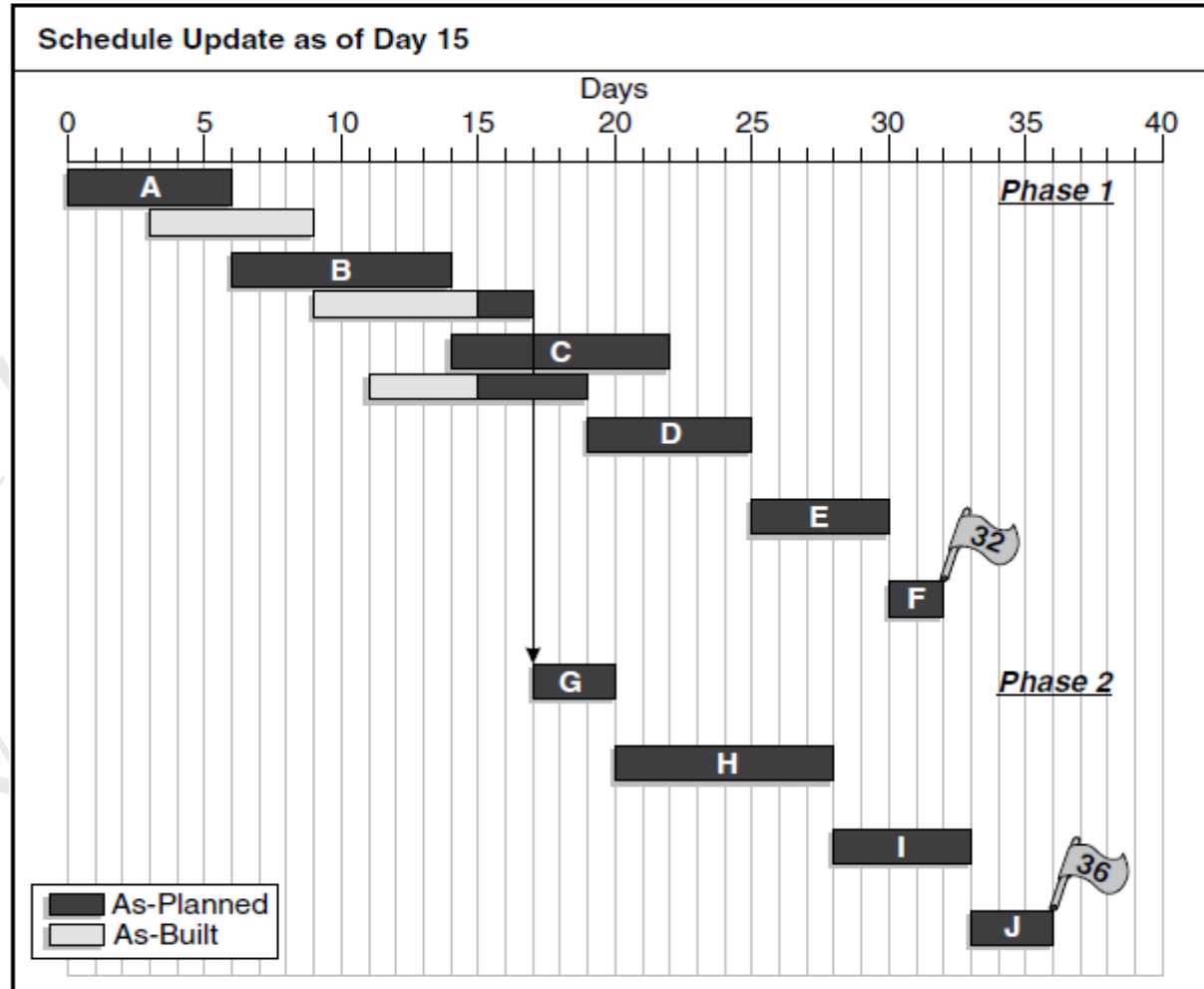
*The **overall conclusion** is that the Project was delayed **by five days**, primarily because of the **late finish of activity F**.*

This conclusion is erroneous.

Impacted as planned analysis – Weaknesses

❑ **Example:** What if the CPM approach is used?

- ❖ Schedule is updated as of **day 15**, the day the Contractor added activity J.
- ❖ The critical path has shifted to the **Phase 2 path** of activities, G through J due to the delay to **activity A**.
- ❖ The original critical path never becomes critical again and the project is delayed by **1 day** due to **activity J**.



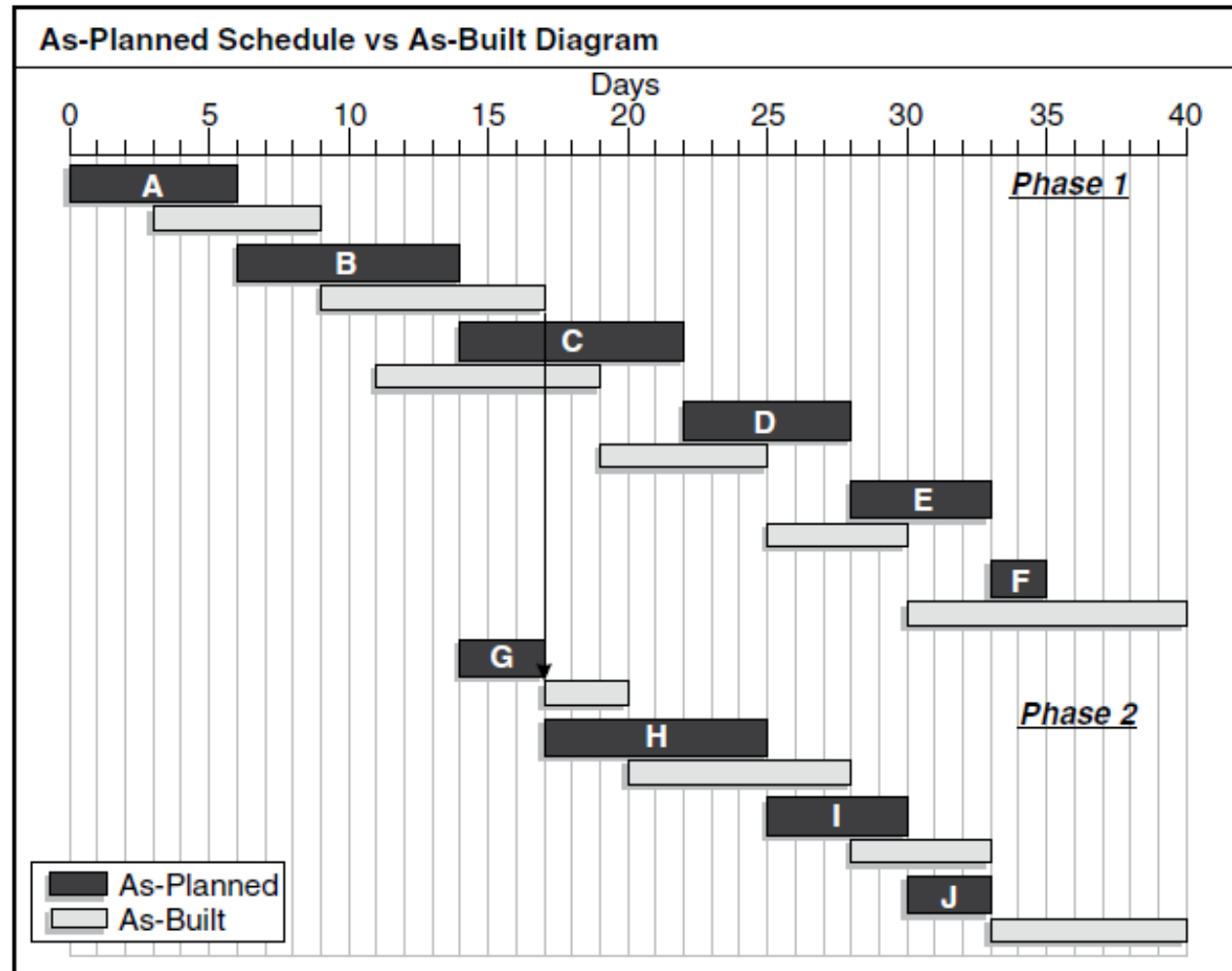
Impacted as planned analysis – Weaknesses

❑ **Example:** What if the CPM approach is used?

❖ Although

- ✓ Activity F took eight days longer.
- ✓ Activity J took four days longer.

Is it concurrent?



Impacted as planned analysis – Weaknesses

❑ **Example:** What if the CPM approach is used?

❖ Impacted as-planned

✓ Project was delayed **by five days**, primarily because of the **late finish of activity F**.

❖ CPM approach using contemporaneous update:

✓ **1 day** of delay due to **activity J**

✓ **4 days** of delay due to **concurrency**

Impacted as planned analysis – Weaknesses

❑ Example: Court decision

Mr. Maurer, appellant's expert, testified about the critical delays to the Project.... The analysis about the critical delays was based on appellant's original schedule, the schedule updates, the daily reports, Project correspondence, and the contract documents. Mr. Maurer described his analysis as a step-by-step process, beginning with the original schedule and proceeding chronologically through the Project, updating the sequence at intervals to see what happens as the Project progressed [(tr. 262) ASBCA No. 34, 645, 90–3 BCA ¶ 12, 173 (1990)].

Impacted as planned analysis – Weaknesses

❑ Example: Court decision

- ❖ The judge's criticism was that the outcome of an impacted as-planned analysis, because it ignores everything other than the as-planned schedule.
- ❖ It would overstate the delay, if any, associated with the **inserted delay**.
 - ✓ Years of experience **analyzing impacted as-planned analyses** have confirmed this judgment.
- ❖ **Employing** an impacted as-planned analytical technique is **flawed** and to be avoided.

Impacted as planned analysis – Weaknesses

❑ Example: Court decision

- ❖ Taken together, **these decisions** have an **important message**:

When analyzing delays, it is important to **evaluate Project events relying on the documents in use on the Project at the time the delay occurred.**

- ❖ In summary, the **only valid perspective** for the analyst is to adopt a **view of the Project contemporaneous** to the delay itself—**not from the beginning** of the Project or the **end of the Project**.

Impacted As-Planned (IAP)

(Conclusion)

Impacted as planned analysis – Conclusion

❑ Pros and Cons:

- ✓ **Simplest** and **low** in terms of **time** and **cost**
- ✓ **Only** requires **as-planned schedule** or original plan
- ✓ **Could be used for contemporaneous schedule** (**prospective delay impact**)
- × **Static analysis** (**prospective critical path**)
 - ❖ Assumes that **critical path** never shifted
- × It does **not consider** actual progress and changes (**hypothetical**)
- × **Subjective** because it is **one-sided**: typically **only** considers **owner delays** and does not consider contractor delays
- × **No consideration** of **true concurrent delays**
- × **Typically rejected** by the **courts**, **panels**, and **boards**

Impacted as planned analysis – Conclusion

❑ When to use?

1. Useful as **negotiation tools** when,
for whatever reason, more in-depth and detailed methods of analysis are ruled out or **not available** to the parties.
2. If a **pre-agreed daily rate** for prolongation is available, accounting for **compensable delay** in a cumulative,
combined and **forward-looking manner** is also **possible** using the **IAP modelling approach**.

Impacted as planned analysis – Conclusion

□ When to use?

- ✓ The as-planned **logic** was accurate
- ✓ The as-planned **durations** were accurate
- ✓ The **delay events** were recorded

1. As prospective analysis when:

- ✓ I usually **do not recommend** to use it, however
 - If time and budget for the analysis is **very limited** and the **accuracy** of the outcome is **not that important**

2. As a retrospective analysis

- ✓ I **do not recommend** to use it, unless
 - **Contractor followed** the as-planned logic or there is **no as-built data**
 - Both the owner and contractor **agree to use** this procedure

Time Impact Analysis (TIA)

Time impact analysis

□ Definition

- ❖ Invented immediately after CPM scheduling method (maybe 1950) and developed in the early 1980s.
- ❖ Two forms:
 1. Contemporaneous analysis = **prospective** method
 - ✓ Originally developed for prospective analysis
 2. After-the-fact analysis = **retrospective** method
- ❖ They are very similar – SCL prospective and AACE retrospective
 - ✓ The **application** of this method in **post-contract dispute resolution** is deeply questionable.
 - **Proponents** of SCL Protocol does not appreciate this view.

Time impact analysis

□ Definition

- ❖ TIA is more effective as a **forward-looking tool** than as a **backward-looking** (or forensic) tool.
 - ✓ This is partially **due to** the ability of the **Owner** to
 1. Forecast and respond to the **results** of the analysis and
 2. Minimize the **cost impacts** of a delay.
 - However, **TIA** is an acceptable and useable tool for the **determination** of the **effects** of a **past delay** when employed for **forensic analysis**.

*The **longer the period** between the **delay** and the **approval of the TIA**, the **less useful** and **valid** the TIA becomes.*

Time impact analysis

□ Definition

- ❖ This **TIA prospective practice** concerns itself with **time aspects**,
not cost aspects of projects.
- ❖ The **time impact must** be **quantified prior** to **determining any cost** implications.
- ❖ **Linking time** and **cost** into **one analysis** implies that **time impacts** are a **function of costs**,
which for the purposes of a prospective TIA is **not true**.
- ❖ **Separating time analysis** from **cost analysis** makes TIA inherently **easier** to accomplish and accept contractually.

*Maintaining a set of **timely, accepted, schedule updates** is very important to the TIA success.*

Time impact analysis

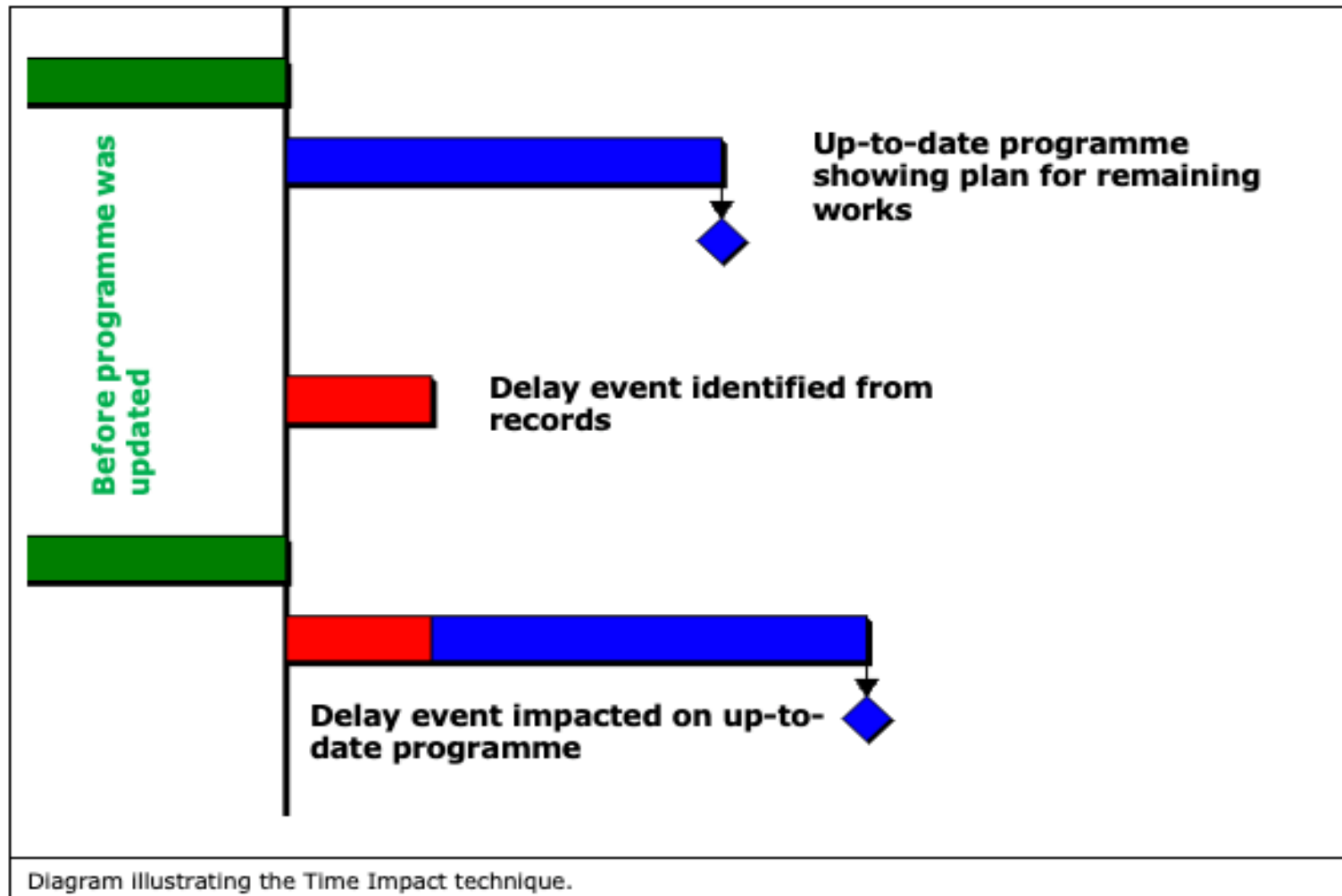
❑ How to use (general steps)?

1. Identify **contemporaneous schedule** (**contemporaneously updated baseline schedule**)
2. Update the schedule, if necessary, to date of the change
 - ❖ If an **updated schedule** is not available,
update the baseline schedule with **current progress information**.
3. Insert **delay event sub-networks (fragnet)** into a **update schedule**
4. **Recalculate CPM** using CPM programming software
5. **Determine** the **impact** of sub-networks (fragnet) have on the **predicted contract completion dates** shown **within** the **update schedule**

This is done on “Updated Schedule”

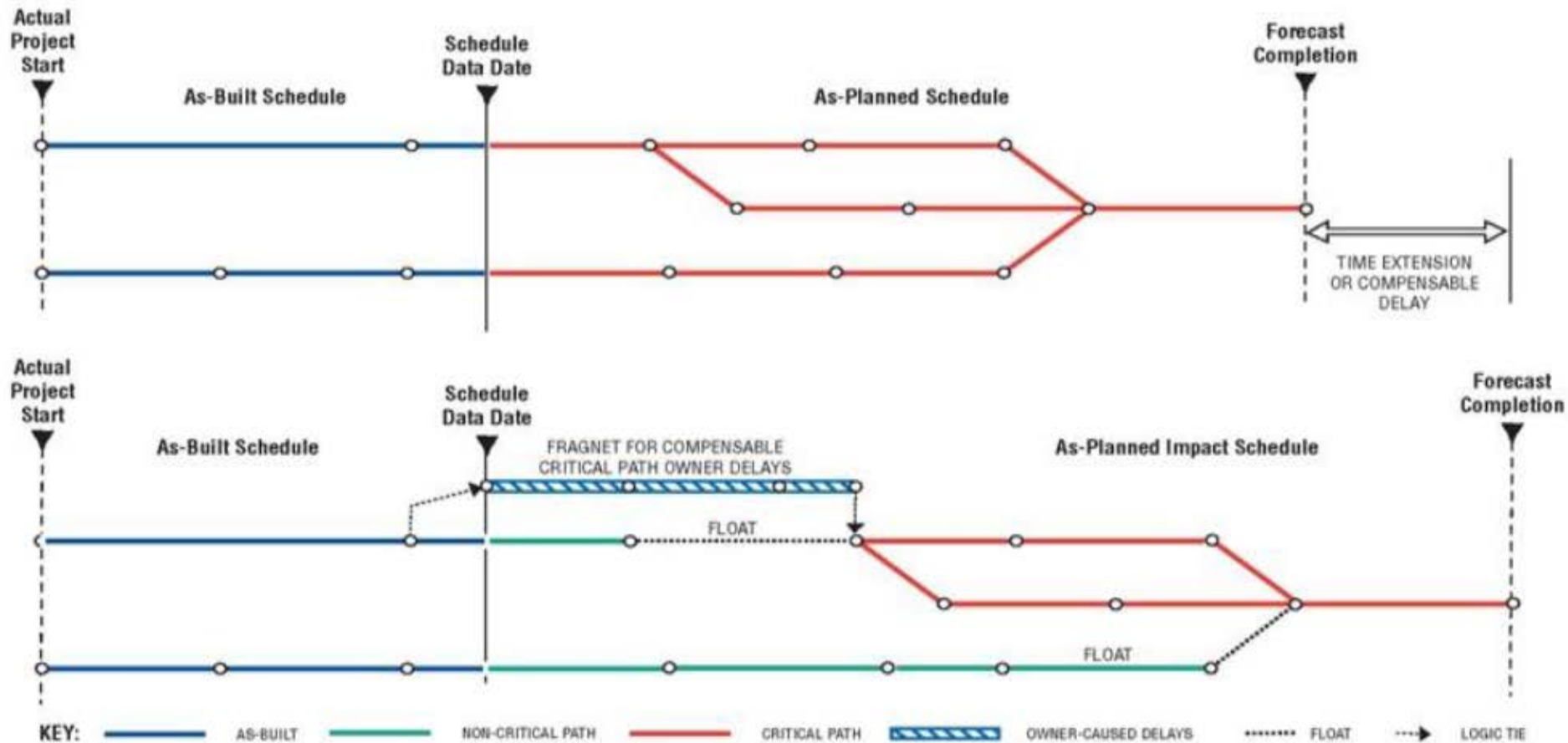
Time impact analysis

□ Example



Time impact analysis

□ Example



Time impact analysis

❑ Pros and cons

- ✓ It is **recommended** by SCL CP 4.
- ✓ **Dynamic analysis** (**contemporaneous critical path**)
- ✓ **Can** be used for both **contemporaneous** and **after-the-fact** schedule (**prospective and retrospective delay impact**)
 - × It is the most **time-consuming** and **costly** method when performed **forensically**
- ✓ It **considers** actual progress and changes (**not hypothetical**)
- ✓ Subjectivity is **eliminated** or **reduced** (**because of day to day analysis**)

Time impact analysis

❑ Pros and cons

- × It **requires** a **detailed data** to analyze
- × **High** in terms of **time** and **cost**
- × **Requires** reliable periodic **schedule updates**
- × **Typically** does **not consider** concurrency unless **functional theory** is considered
- × **Subjective**, **when** only the delays of **one party are considered**, because the method cannot account for delays that are **not inserted**.
 1. If **updated up** to the fragnet and
 2. If **functional theory** is considered,

subjectivity **reduced**.
- × **Susceptible to manipulation** when actual or as-built durations are compared to estimated durations
- × **Extremely sensitive** to
 1. Order of fragnet
 2. Logic insertion

Time impact analysis

❑ When to use?

- ❖ When **project** is **ongoing** (prospective analysis)
- ❖ When **time** is really important for the project
- ❖ When there are
 1. **Logic linked baseline** schedule
 2. **Delay events** to model
 3. **Contemporaneous schedules** with process information

TIA is more or less acceptable and useable for the determination of delay impacts under some circumstances.

Let's see!

Time impact analysis

□ When to use?

1. More useable

a) **Frozen work plan**

- ❖ If the **contractor** has **not** been **given** the **right** and is **not able** to redeploy his **work force** in order to **resume the work**, then the work plan is said to be **“frozen”** and TIA can be very **useable**.

b) **Forward looking**

- ❖ The **tendency** for parties to **wait and observe** the **actual durations** is in conflict with the **primary purpose** of **timely resolution in TIAs**.

c) **Short duration of delay**

- ❖ TIAs are **intended** to model delays of **less than** one reporting period.
- ❖ If **longer periods** are **considered**, then an **additional step** (**detailed later**) must be considered to **address** the legal requirement and natural tendency of the Contractor to **mitigate** any delays where the mitigation **does not** involve **additional costs**.

Time impact analysis

❑ When to use?

2. Less useable

a) **The more your schedule update does not reflect actual conditions at the time of the delay**

❖ The **longer time period** between the updated schedule and when the delay started.

✓ It is because **more conditions** will have **changed** between times.

b) **The less linear of the work plan**

❖ Work plans with **more physical constraints** are **harder** than work plans with resource constraints that can be **allocated** to **mitigate**.

c) **If more mitigation was accomplished during the delay**

❖ This is **opposite** of a “frozen” work plan.

❖ The more work performed “out-of-sequence,”

the more effort performed by either owner or contractor to **reduce** the **effects of a delay**, and

the less effective a TIA due to many changes.

Time impact analysis

□ When to use?

- ❖ The product of this method of analysis is a conclusion as to the **likely delay** of the **modelled delay events**
on the programme/critical path that is **most reflective of the contemporaneous position** when the delay events arose.
- ❖ This method usually **does not capture the eventual actual delay** caused by the delay events as **subsequent project progress** is **not considered**.

Time impact analysis

□ Guide to the TIA

1. List all identified delay events in a table:

- ❖ Duration
- ❖ predecessors
- ❖ successors
- ❖ commencement date (when the event was first identified or first had an effect on the work).

Time impact analysis – Practical procedure: Stage 2

2. Assess the **liability** for **each delay event** based on circumstances, risks and **contractual obligations**.

❖ Who is responsible (EDE, CDE, or concurrent)

✓ EAS and delay register sheets

Why CDE is also considered?

Time impact analysis – Practical procedure: Stage 3

3. **Obtain progress data** for **all activities** in the programme at the **point** **immediately prior to (or as close as reasonably possible to)** each **subsequent delay commencement date**.

Why prior to or as close as possible?

Time impact analysis – Practical procedure: Stage 4

4. Create a **series of TIA** base programmes by either:

a) **Based on the time of schedule update:**

- ❖ Relying on updated contemporaneous progress programmes closest to **each commencement date**

- ❖ *This is a 'contemporaneous update TIA'*

b) **Based on the time of each delay occurs:**

- ❖ Identifying the contemporaneous **progress** programmes closest to the **date of each delay event** and

- ❖ Updating each of those programmes with **progress data** up to the **point immediately prior** to the commencement date of **each delay event**.

- ❖ *This is a 'chronological event analysis'*

In which one concurrent delays cause problem?

Time impact analysis – Practical procedure: Stage 4

4. Create a **series of TIA** base programmes

Note:

Prior to determining the **effect** of an employer risk event on the updated schedule:

1. Any unreasonable penalty
2. Unrealistic logic
3. Unrealistic constraints
4. Unrealistic durations

Should be **corrected** by **agreement**

Time impact analysis – Practical procedure: Stage 4

4. Create a **series of TIA** base programmes

☐ Constraints:

- ❖ Constraints **not required** by contract and **not included** in the Accepted Baseline Schedule should **not** be included in the analysis.
- ❖ Non-contractual constraints should be **removed**.
- ❖ Contractual constraints should be **reduced** to the least restrictive, before proceeding to the **next step**
- ❖ **Other constraints** may be considered on a case-by-case basis, but this should be **fully documented**.

Time impact analysis – Practical procedure: Stage 4

4. Create a **series of TIA** base programmes

*All contemporary evidence should be submitted to ensure that any resulting EOT is both **reasonable** and **consistent** with the factual circumstances.*

Remember the records and documents mentioned in previous section?

What if CA and contractor disagree?

Time impact analysis – Practical procedure: Stage 4

4. Create a **series of TIA** base programmes

- ❖ CA's view should **prevail** unless and until overturned under the contract dispute resolution Provisions (SCL).

Time impact analysis – Practical procedure: Stage 5

5. Tabulate

a) Data dates

b) Projected completion date

of each of the base programmes prior to inserting any of the delay events

- i. Copy
- ii. Rename
- iii. Save each of the base programmes for impacting

Time impact analysis – Practical procedure: Stage 6

6. Convert each delay event to a new subset of activities (Fragnet)

- a) **Estimated durations**
- b) **Identified predecessor activities**
- c) **Identified successor activities**
- d) **Commencement date** (when the event was first identified or first had an effect on the work).

When using retrospectively, the analyst has the option of using **as-built durations** for the “fragnets.”

How to continue from this step?

Time impact analysis – Practical procedure: Stage 7

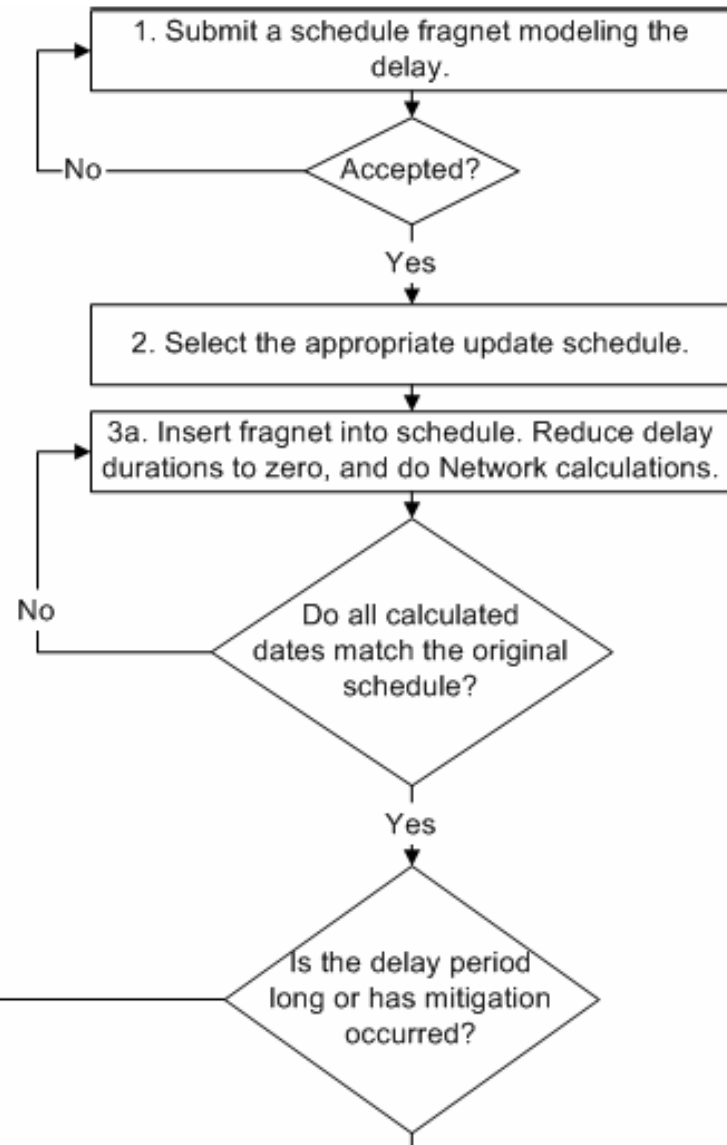
❑ TIA Flowchart

❖ Recommended by AACE 52R-06

❑ My experience

❑ Book written by Caletka

❑ Book written by Trauner



Time impact analysis – Practical procedure: Stage 7

❑ TIA Flowchart

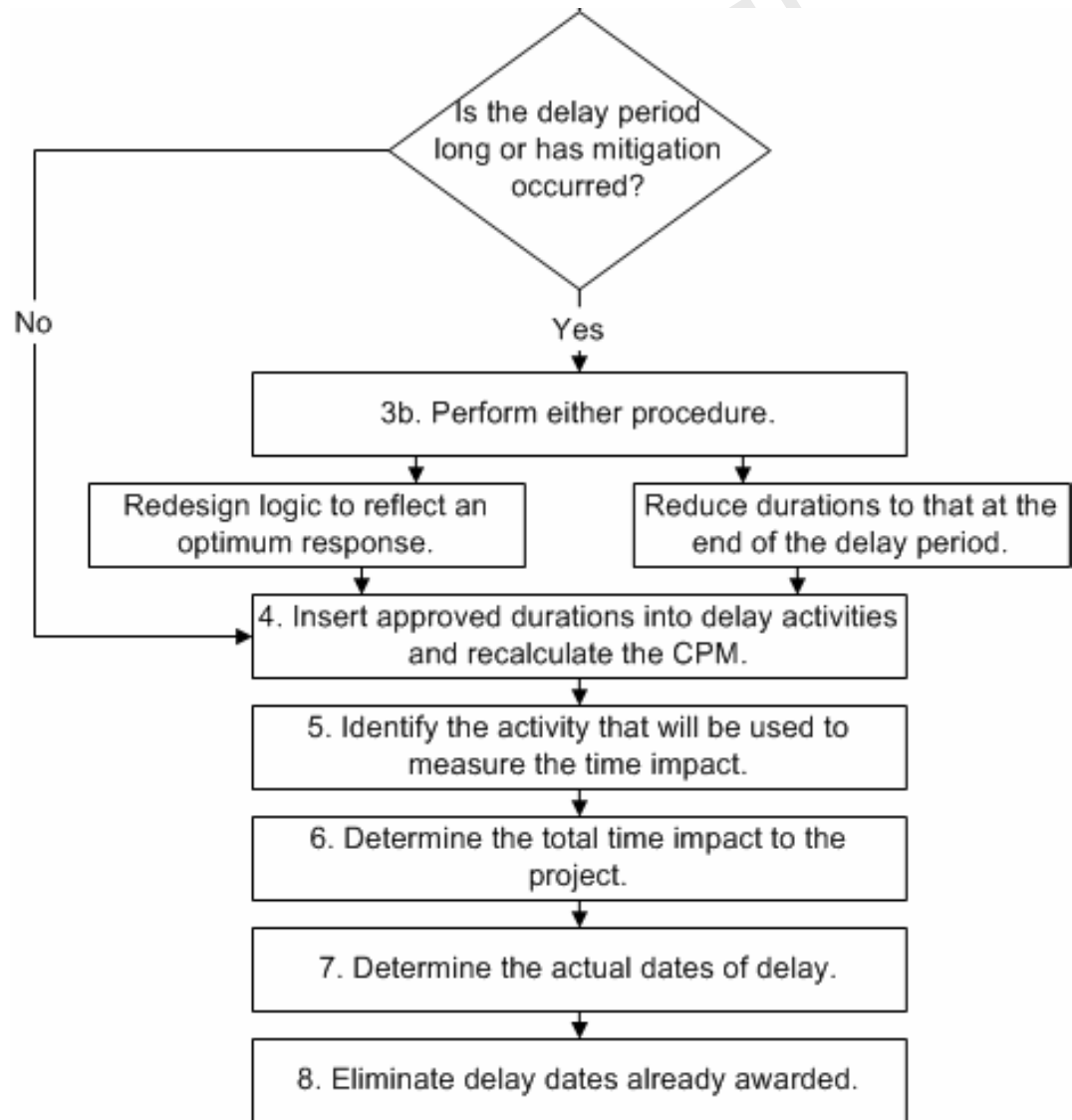
❖ Recommended by AACE

52R-06

❑ My experience

❑ Book written by Caletka

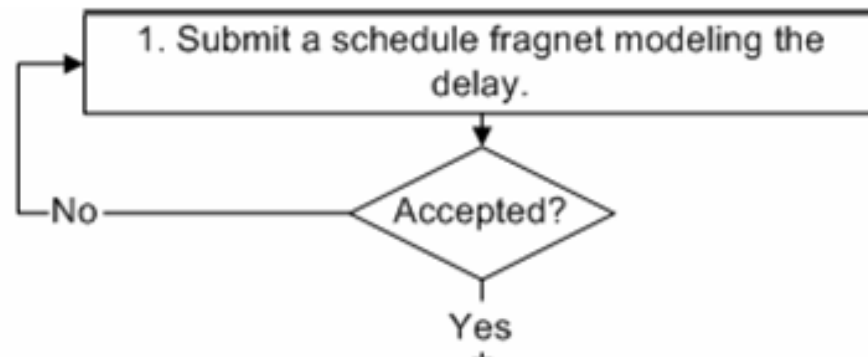
❑ Book written by Trauner



Time impact analysis – Practical procedure: Stage 7

❑ STEP 1: Submit a schedule fragnet modeling the delay

Let's first look at fragnet!



Time impact analysis – Practical procedure: Stage 7

❑ STEP 1: Submit a schedule fragnet modeling the delay

❖ Fragnet can be the **result of**:

1. Change order
2. Specific portion of the existing CPM

Many **private** and **public Owners** require **Contractors** to use **fragnets** to express, in a **CPM format**, the activities associated with **change orders** and use this to **request time extensions**.

The **U.S. Army Corps of Engineers**, the **Department of Veterans Affairs**, and the **Florida Department of Transportation** are just a few of the **public owners** that require **contractors** to use **fragnets**.

Time impact analysis – Practical procedure: Stage 7

❑ STEP 1: Submit a schedule fragnet modeling the delay

❖ Fragnet disadvantages:

✓ The **two biggest disadvantages** are:

1. The **time** it takes to **develop** and **negotiate** a fragnet
2. **Determining** into **which CPM update** the fragnet should be **inserted**

You should establish the date on which the **change directive** was issued or **delay** initiated.

Why?

Because the **deadline** would be **set** from the time that

1. Change directive issued or
2. Delay initiated

Time impact analysis – Practical procedure: Stage 7

❑ STEP 1: Submit a schedule fragnet modeling the delay

❖ Fragnet disadvantages:

1. The time it takes to develop and negotiate a fragnet

- ✓ Many contracts allow the Contractor 30 calendar days to provide its change order proposal.
- ✓ Once the **proposal** has been received and reviewed, it may take an **Owner** several weeks before it is prepared to negotiate the **costs** and the **time**.
- ✓ The **negotiations** themselves may take several weeks depending on the amount in question and the support provided by the **Contractor**.
- ✓ Therefore, it could be more than two months **after** the **Contractor** was directed to perform the work that the parties **agree** upon the fragnet.

In many instances the parties do not agree, and time is not discussed until the end of the Project.

Time impact analysis – Practical procedure: Stage 7

❑ STEP 1: Submit a schedule fragnet modeling the delay

❖ Fragnet disadvantages:

2. Determining into which CPM update the fragnet should be inserted

- ✓ The **fragnet** should be **inserted** into the **CPM update** that was in **effect at the time:**

1. **Change** was issued
2. **Both parties** understood that there was a change
3. **Contractor** began its work related to the change

Whichever was the earliest!

In addition to **using** a fragnet to **analyze change orders**,

CPM fragnets are also used to **evaluate** delays to:

1. Specific features of work
2. Specific subcontractor's work

Time impact analysis – Practical procedure: Stage 7

❑ STEP 1: Submit a schedule fragnet modeling the delay

What is the recommended procedure to submit a schedule fragnet?

Time impact analysis – Practical procedure: Stage 7

❑ STEP 1: Submit a schedule fragnet modeling the delay

1. The **contractor** should **submit** a **sub-network** (also called a “**fragnet**”) showing:

❖ **Actual** or **anticipated** effect of the **employer risk event**

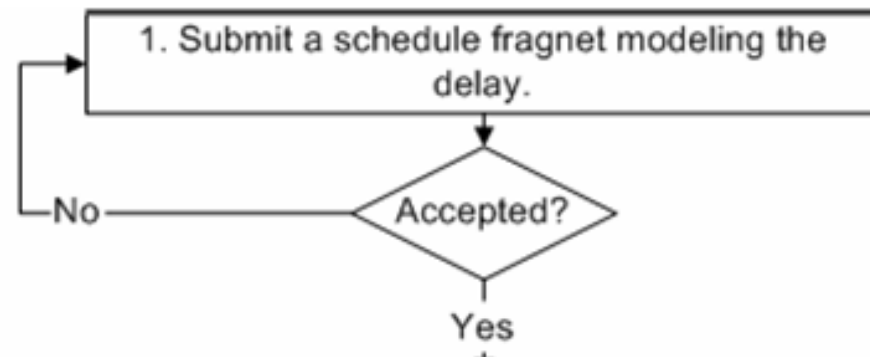
❖ **Employer risk event linkage** into the **updated schedule**

to the **CA** for agreement.

❖ The **sub-network** should be **prepared** by the **contractor**:

a) In the **same manner** as the **accepted schedule**

b) Using the **same software** as the **accepted schedule**



Time impact analysis – Practical procedure: Stage 7

❑ STEP 1: Submit a schedule fragnet modeling the delay

1. The **contractor** should **submit** a **sub-network** (also called a “**fragnet**”)

❖ It should **consist of**:

a) Activities resulting employer risk event

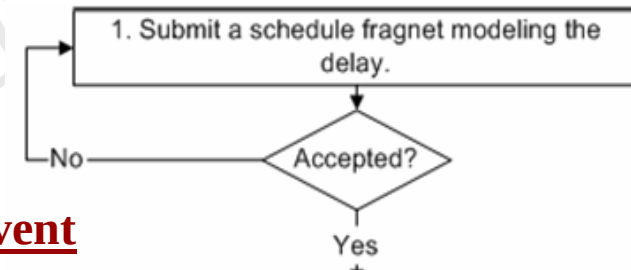
b) Durations resulting from the employer risk event

✓ For example, the sub-network for a **variation** (change order from owner) should consist of:

I. Instruction for the **variation**

II. Activities required to **carry out** that variation

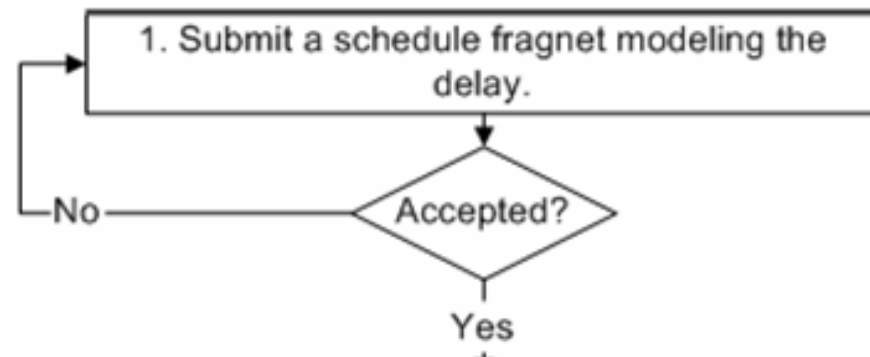
III. Variation linkage to the **activities** in the updated schedule



Time impact analysis – Practical procedure: Stage 7

❑ STEP 1: Submit a schedule fragnet modeling the delay

1. The **contractor** should **submit** a **sub-network** (also called a “**fragnet**”)
 - ❖ Use the **fewest number** of activities and **relationships**
 - ❖ **Added activities** should be **numbered** in a **logical manner** to make it **easy** to **distinguish** them as **new activities** associated with the **delay**



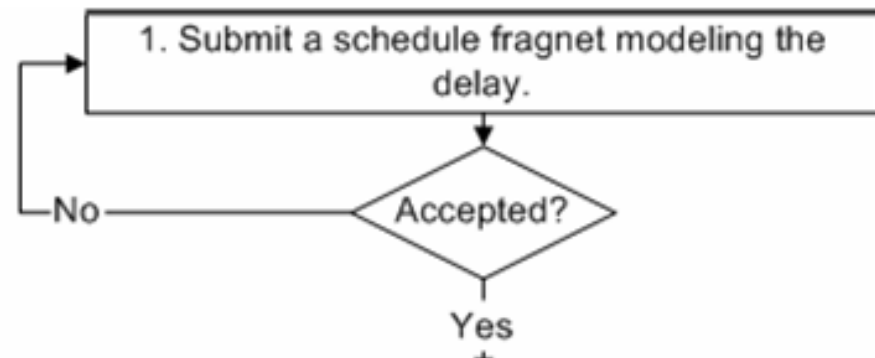
Time impact analysis – Practical procedure: Stage 7

❑ STEP 1: Submit a schedule fragnet modeling the delay

1. The **contractor** should **submit** a **sub-network** (also called a “**fragnet**”)

❖ Newly created activities should be **consistent** with the **original baseline programme requirements**.

✓ For instance, the **contract specification** may have required the **duration of each programme activity** to be **less than 15 days**.



What should be done if delay event exceeds the **duration of several windows**?

Time impact analysis – Practical procedure: Stage 7

❑ STEP 1: Submit a schedule fragnet modeling the delay

1. The **contractor** should **submit** a **sub-network** (also called a “**fragnet**”)
 - ❖ If the duration of a delay event **exceeds** the **duration of several windows**, the analyst should attempt to **break** the impact down to **several events**

Why this may cause a problem?

Time impact analysis – Practical procedure: Stage 7

❑ STEP 1: Submit a schedule fragnet modeling the delay

1. The **contractor** should **submit** a **sub-network** (also called a “**fragnet**”)
 - ❖ Inserting **fragnets** with **excessive durations** (spanning **several updating cycles**)
 1. Will effectively **override** progress achieved during that **entire period**
 2. Will **not allow** to account for any **delays** due to
 - ✓ Concurrent events,
 - ✓ Lack of progress or
 - ✓ Logic changes

Implemented in the relevant monthly updates.

Now you may know why this analysis is **time-consuming**?

Time impact analysis – Practical procedure: Stage 7

❑ STEP 1: Submit a schedule fragnet modeling the delay

1. The **contractor** should **submit** a **sub-network** (also called a “**fragnet**”)

❖ **Breaking events** into **bite-sized chunks** for analysis is one of the reasons the TIA approach is known as being **labor intensive and technically complex**.

✓ *The longer the fragnet, and*

✓ *The longer the duration between each base programme,*

*the **more prospective and theoretical** the results will be.*

Let's see an example!

Time impact analysis – Practical procedure: Stage 7

❑ STEP 1: Submit a schedule fragnet modeling the delay

1. The **contractor** should **submit** a **sub-network** (also called a “**fragnet**”)
 - ❖ If the duration of a delay event **exceeds** the **duration of several windows**, the analyst should attempt to **break** the impact down to **several events**
 - a) For example, the fragnet (access manhole to a pipeline issued in May) is **68 working days** or 95 calendar days.
 - b) The impact represented over a period of **three updating cycles** (May, June, and July) assuming **monthly updating cycles**.

Time impact analysis – Practical procedure: Stage 7

❑ STEP 1: Submit a schedule fragnet modeling the delay

1. The **contractor** should **submit** a **sub-network** (also called a “**fragnet**”)
 - ❖ It may be appropriate to break the fragnet into three discrete base programmes:
 - ❖ X100 and X200 in May
 - ❖ X300 and X400 in June
 - ❖ X500 and X600 in July

Activity ID	Description	Original duration	2008				
			Apr	May	Jun	Jul	Aug
x100	Engineer issues revised design requirements	10					
x200	Prepare and submit shop drwgs for approval	14					
x300	Engineer - Review and Approve Drawings	14					
x400	Formwork, embedment and reinforcing steel	16					
x500	Place concrete and curing period	9					
x600	Strip formwork	1					
x700	Remove seal and re-test pipeline	4					
			Apr	May	Jun	Jul	Aug
			2008				

Time impact analysis – Practical procedure: Stage 7

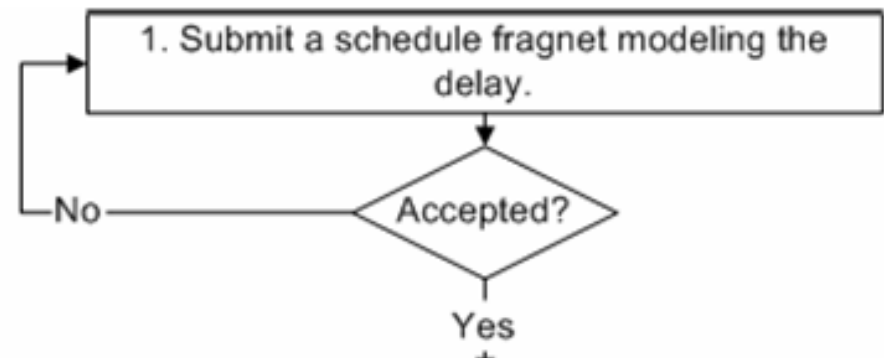
❑ STEP 1: Submit a schedule fragnet modeling the delay

2. The CA should **consider** the **sub-network** and, **if agreed**, the **sub-network** should be **inserted** into the contractor's updated schedule.

❖ CA should **consider whether** the claimed event or cause of delay is an **Employer risk event** or not.

a) Should be on critical path

b) Can be considered as Excusable or owner/designer delays



What if the CA concludes that the event or cause of delay is **not an Employer Risk Event**?

Time impact analysis – Practical procedure: Stage 7

❑ STEP 1: Submit a schedule fragnet modeling the delay

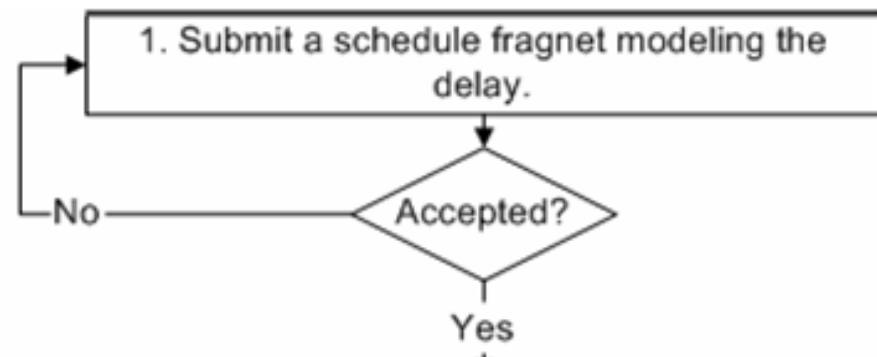
2. The CA should **consider** the **sub-network** and, **if agreed**, the **sub-network** should be **inserted** into the contractor's updated schedule.

❖ If the CA **concludes** that the event or cause of delay is **not an Employer Risk Event**,

the CA should so **notify the Contractor**.

❖ **Any disagreement** about the **sub-network** should be **resolved quickly** and (like all delay issue) **not left** until after completion.

❖ **Without prejudice** to that, the CA may wish to comment on **other aspects** of the Contractor's submission.



Time impact analysis – Practical procedure: Stage 7

❑ STEP 1: Submit a schedule fragnet modeling the delay

❖ Cost Considerations:

- ❖ Costs should be **separated** and **impacted fragnet** should **first** be **isolated** from the schedule to be **analyzed**
- ❖ Owners who **claim** that they **cannot approve** a fragnet **until** they know the extent of the **impact on project completion** are **trying** to make time a **function of costs**.
 - ✓ This is **not true** and the **time impact** is a function of **impacting activity**.
 - ✓ The **time impact** is a **function** of the **impacting activity**.

The **owner** should **review** and **approve** the **step considerations** in order to **approve the TIA**

Time impact analysis – Practical procedure: Stage 7

❑ STEP 2: Select the appropriate update schedule

- ❖ The **appropriate accepted schedule** should be the **last owner-accepted schedule** and **updated prior** to the time of the **change** or **delay**.
- ❖ The **schedule** to be **impacted** is called, the “**original schedule update**.”
- ❖ This **sub-network** is **inserted** into that **updated schedule** which was **submitted** by the **contractor** as close as possible to the **date of the Employer risk event**
 - ✓ **Most recent updated schedule**, if **none**, **accepted schedule**.
- ❖ The **baseline schedule** should be used if the **delay began** **prior** to the **first schedule update**.

2. Select the appropriate update schedule.

Time impact analysis – Practical procedure: Stage 7

❑ STEP 2: Select the appropriate update schedule

❖ Steps provided by SCL Protocol

- a) Programme should be brought **fully up to date** (as to **progress** and the **effect of all delays** that have **occurred up to that date**,
whether Employer Delays or Contractor Delays to the **point immediately before the occurrence** of the **Employer Risk Event**;
- b) Programme should **then be modified** to reflect the Contractor's reasonable, realistic and achievable plans to **recover any delays** that **have occurred**,
including any **changes in the logic of the Updated Programme** proposed for that purpose (subject to CA review and acceptance);

2. Select the appropriate update schedule.

Time impact analysis – Practical procedure: Stage 7

❑ STEP 2: Select the appropriate update schedule

1. What if the **time interval** between the start of the delay and the last accepted schedule update is **too great**?
2. What if **significant deviation** to the schedule was experienced between the last update and the start of the delay?

❖ The Contractor may elect to first provide a **new schedule status** and **update with a status date** immediately prior to the **start of the delay**.

❖ Before this **new update schedule** is to be **used**, it should first be submitted to the Owner for **review** and **acceptance**, just like any other schedule update (AACE 52R-06).

2. Select the appropriate update schedule.

Time impact analysis – Practical procedure: Stage 7

❑ STEP 2: Select the appropriate update schedule

From this point, you will see two types of analysis

Example 1 and Example 2

Time impact analysis – Practical procedure: Stage 7

❑ STEP 2: Select the appropriate update schedule

- ❖ The delays should be analyzed **before** fragnet inserted into the **current schedule**. This could be carried out:
 - a) Once for EDE and separately for CDE, or
 - b) Same series of TIA base calculations in a combined model

What if two or more events commence on the same day?

Time impact analysis – Practical procedure: Stage 7

❑ STEP 2: Select the appropriate update schedule

❖ The delays should be analyzed **before** fragnet inserted into the **current schedule**. This could be carried out:

- a) One to demonstrate the impact of the EDE
- b) One to demonstrate the impact of the CDE
- c) One to demonstrate the combined impact of both in the same base programme
 - ✓ The TIA model can also incorporate ‘**neutral**’ events such as force majeure and weather impacts.
 - o These are treated the same as **concurrent delays** in the TIA model.

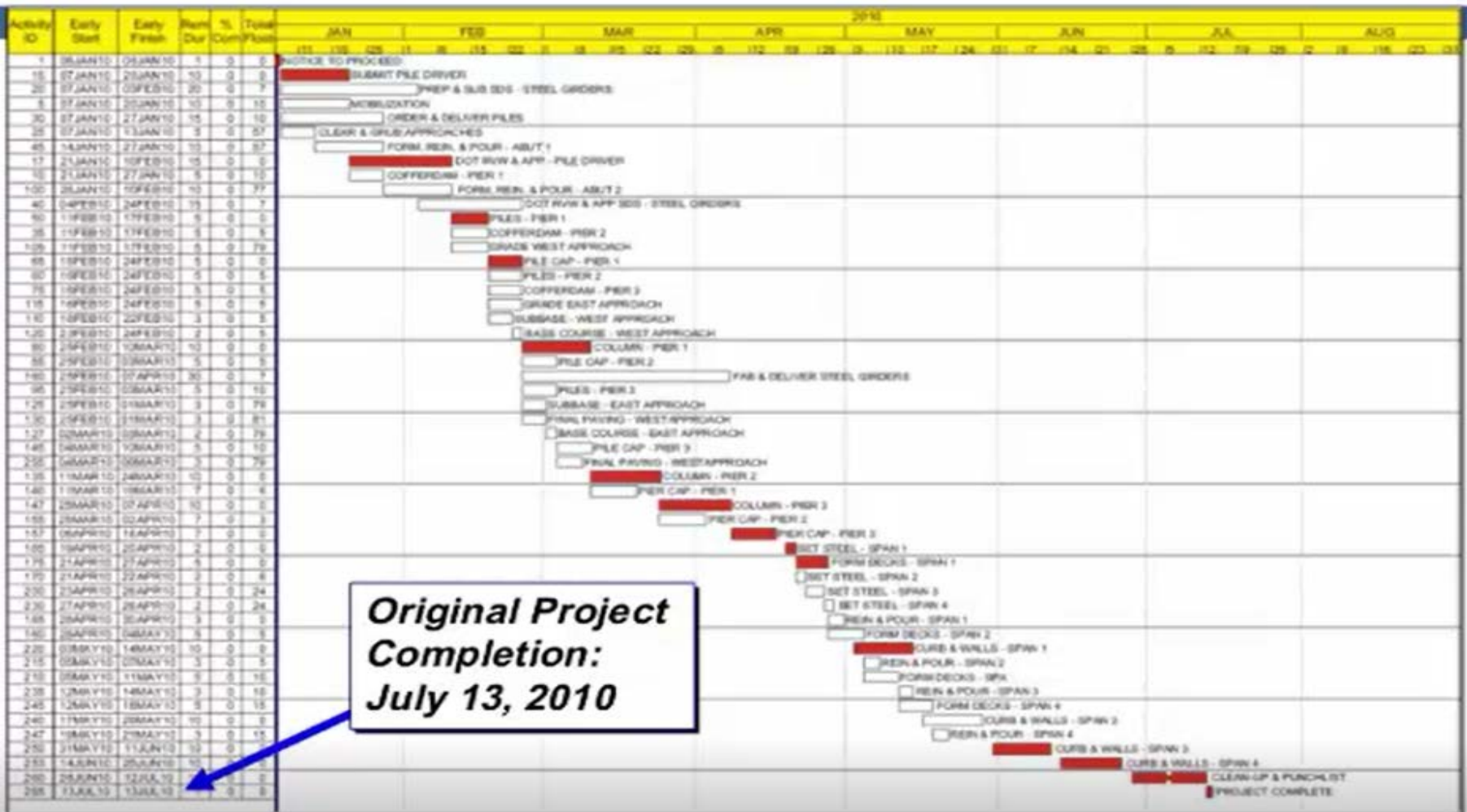
Same as what we did for IAP!

You can also perform step-basis analysis in one model!

Time impact analysis – Practical procedure: Stage 7

❑ STEP 2: Select the appropriate update schedule

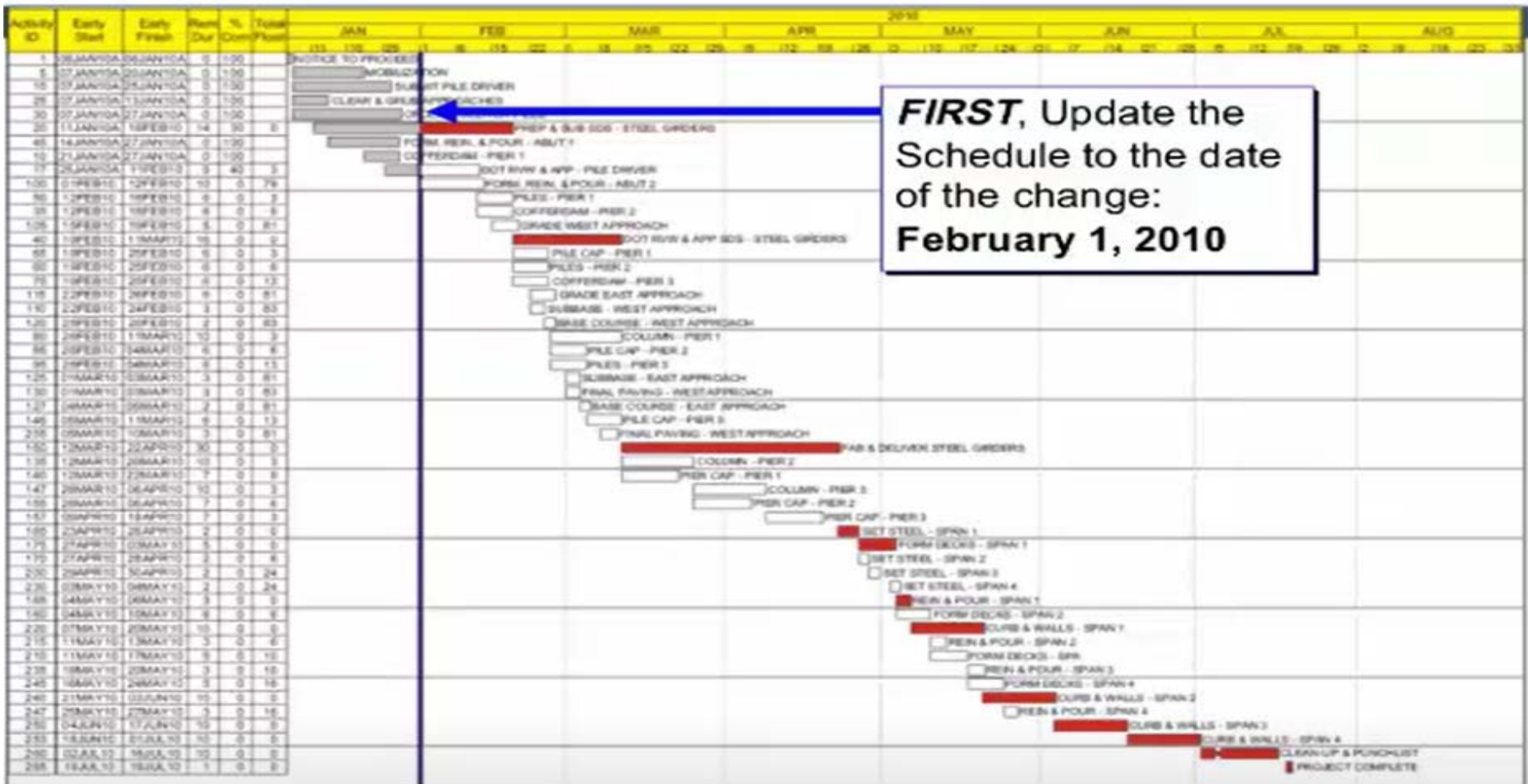
❖ Example 1: Baseline schedule



Time impact analysis – Practical procedure: Stage 7

❑ STEP 2: Select the appropriate update schedule

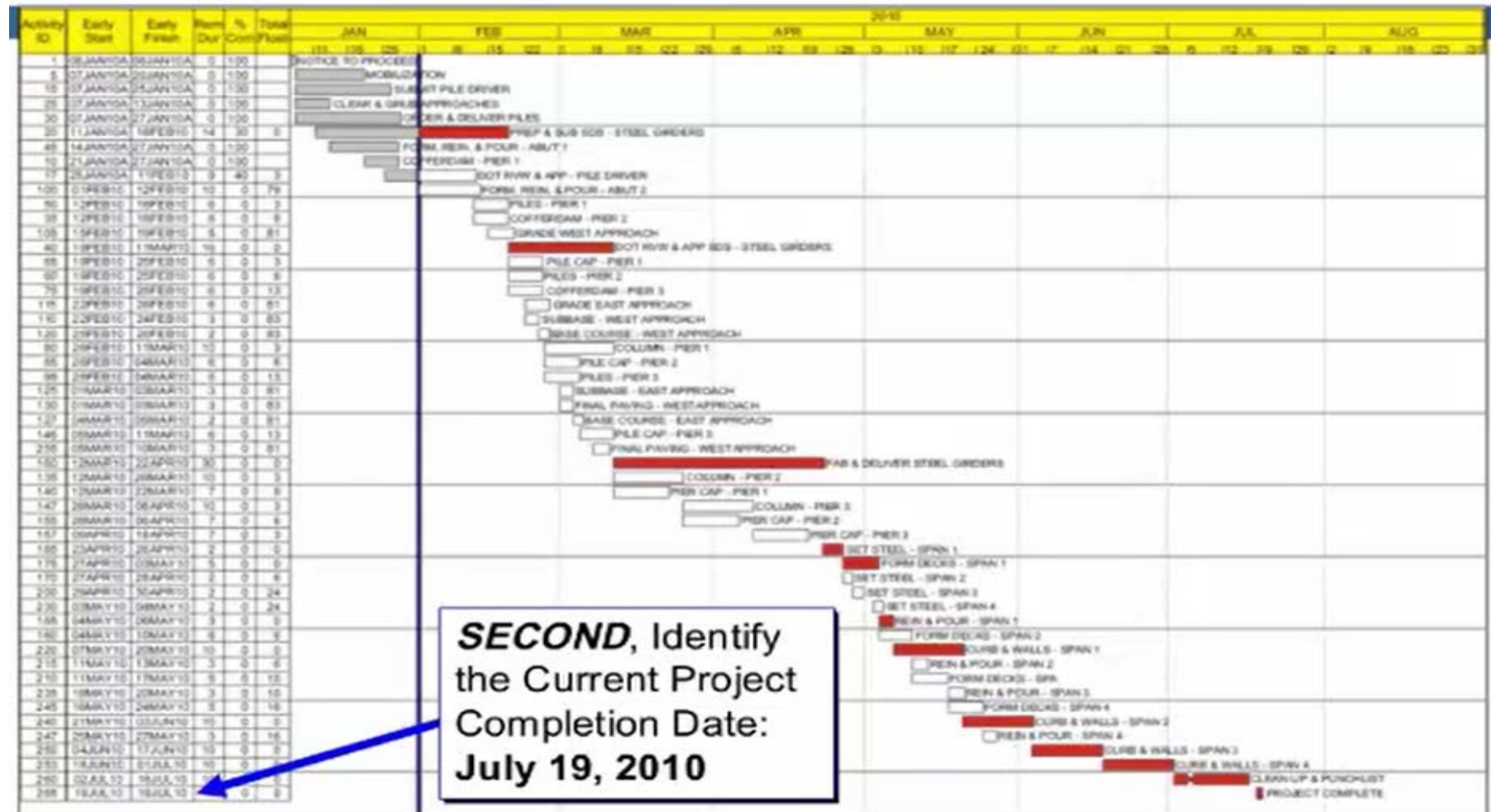
- ❖ Example 1: **Update for change** (update to date of Feb 1 by putting all actual starts, actual finishes, changes, and durations)



Time impact analysis – Practical procedure: Stage 7

❑ STEP 2: Select the appropriate update schedule

❖ Example 1: Update for change (new completion date - we lost 6 calendar dates)



Time impact analysis – Practical procedure: Stage 7

❑ STEP 2: Select the appropriate update schedule

❖ Example 2:

- ❖ In this model, there were **five base programmes** relied on.
- ❖ In this model, there are **both EDE and CDE events** analyzed in a **cumulative**, transparent and **forward-looking fashion**, while the 'events' could be **discrete single activities** or **fragnets of several related activities**.

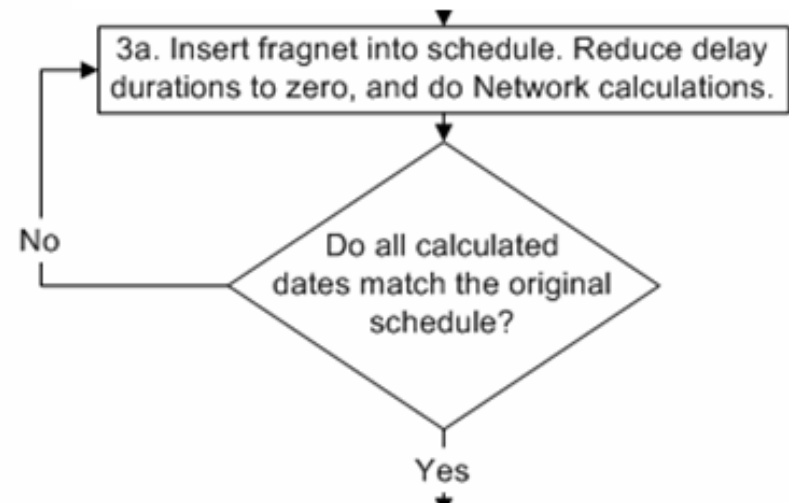
Window 1	is the Baseline to the first update, UD01
Window 2	is from UD01 to UD02
Window 3	is from UD02 to an updated version of UD02 through August 14, 2008 – UD02A
Window 4	is from UD02A to UD03
Window 5	is UD03 to completion

Time impact analysis – Practical procedure: Stage 7

❑ **STEP 3a: Insert fragnet into schedule. Reduce delay durations to zero, and do network calculations.**

1. Insert the **fragnet** into a **copy** of the current schedule update prepared as described.
2. Using the **accepted fragnet** as a **template**, add the impact activities and logic.
3. Set the **duration** of the **delay activities** to zero and recalculate the CPM.
4. All computed and actual dates in the **original schedule update** should **match**.

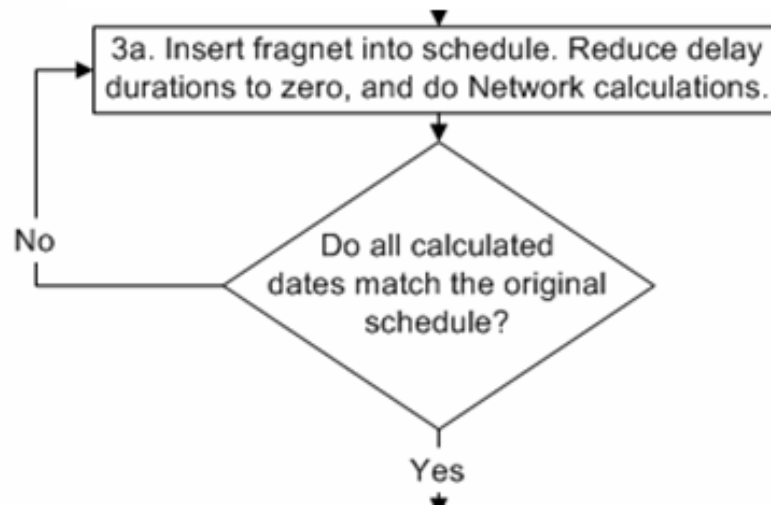
How to insert?



Time impact analysis – Practical procedure: Stage 7

❑ **STEP 3a: Insert fragnet into schedule. Reduce delay durations to zero, and do network calculations.**

1. It is **acceptable** to add a delay as a **successor to an activity** when in fact, that delay occurred **during the activity** and delayed **its completion**.
2. It is **acceptable** to **split** existing **delayed activity** into **two activities**:
 1. One representing the **portion of the planned work** to be performed **before** delay
 2. Other portion of the **planned work** **after** the delay



Time impact analysis – Practical procedure: Stage 7

- ❑ **STEP 3a: Insert fragnet into schedule. Reduce delay durations to zero, and do network calculations.**

❖ **Example 1:** The change

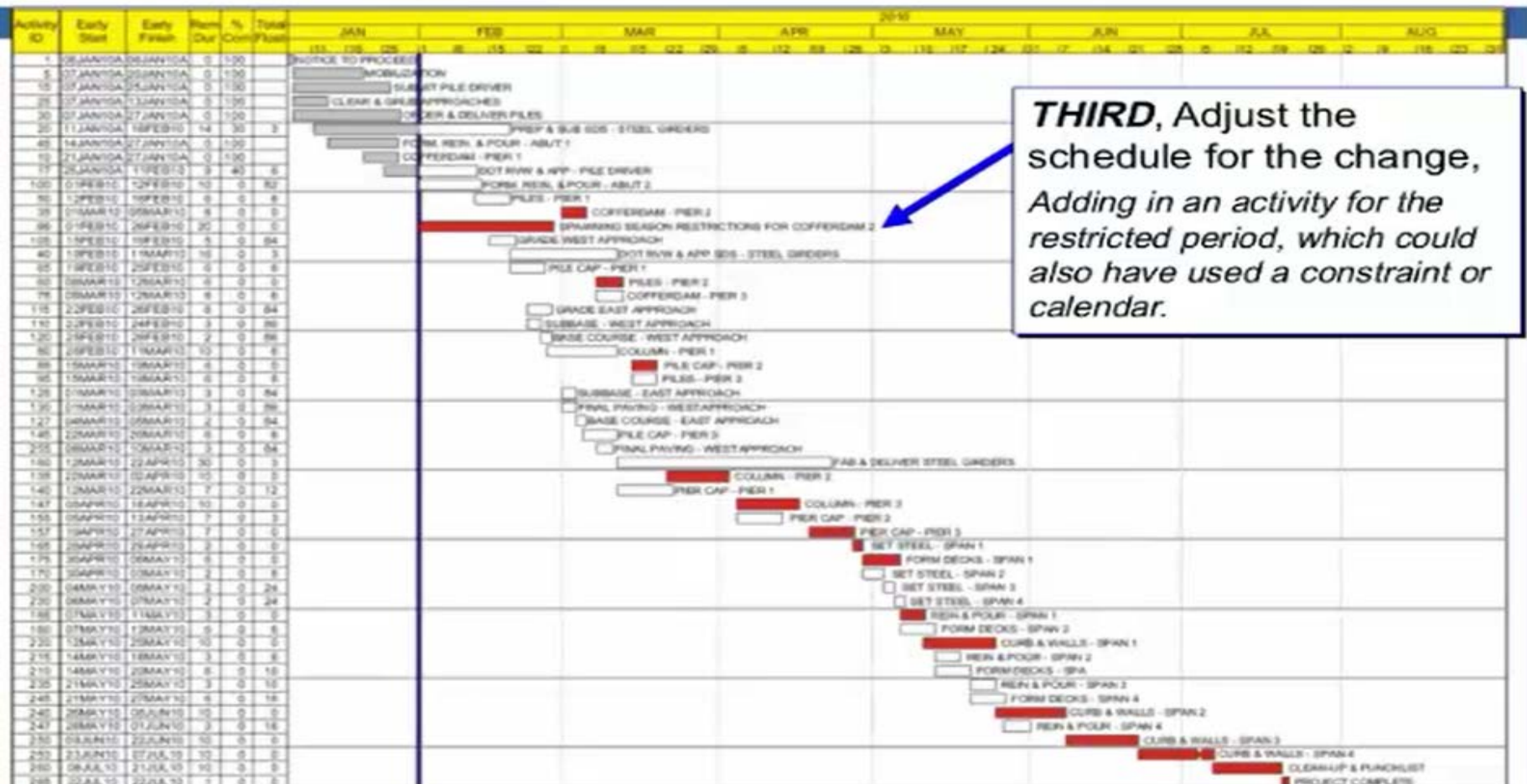
On February 1, the owner informed the contractor that to accommodate the spawning season this year, the project's environmental permit had been modified. The second cofferdam, located in a flowing portion of the river, could not be installed until March.

We know this ahead of time and want to see how it changes the schedule

Time impact analysis – Practical procedure: Stage 7

❑ **STEP 3a: Insert fragnet into schedule. Reduce delay durations to zero, and do network calculations.**

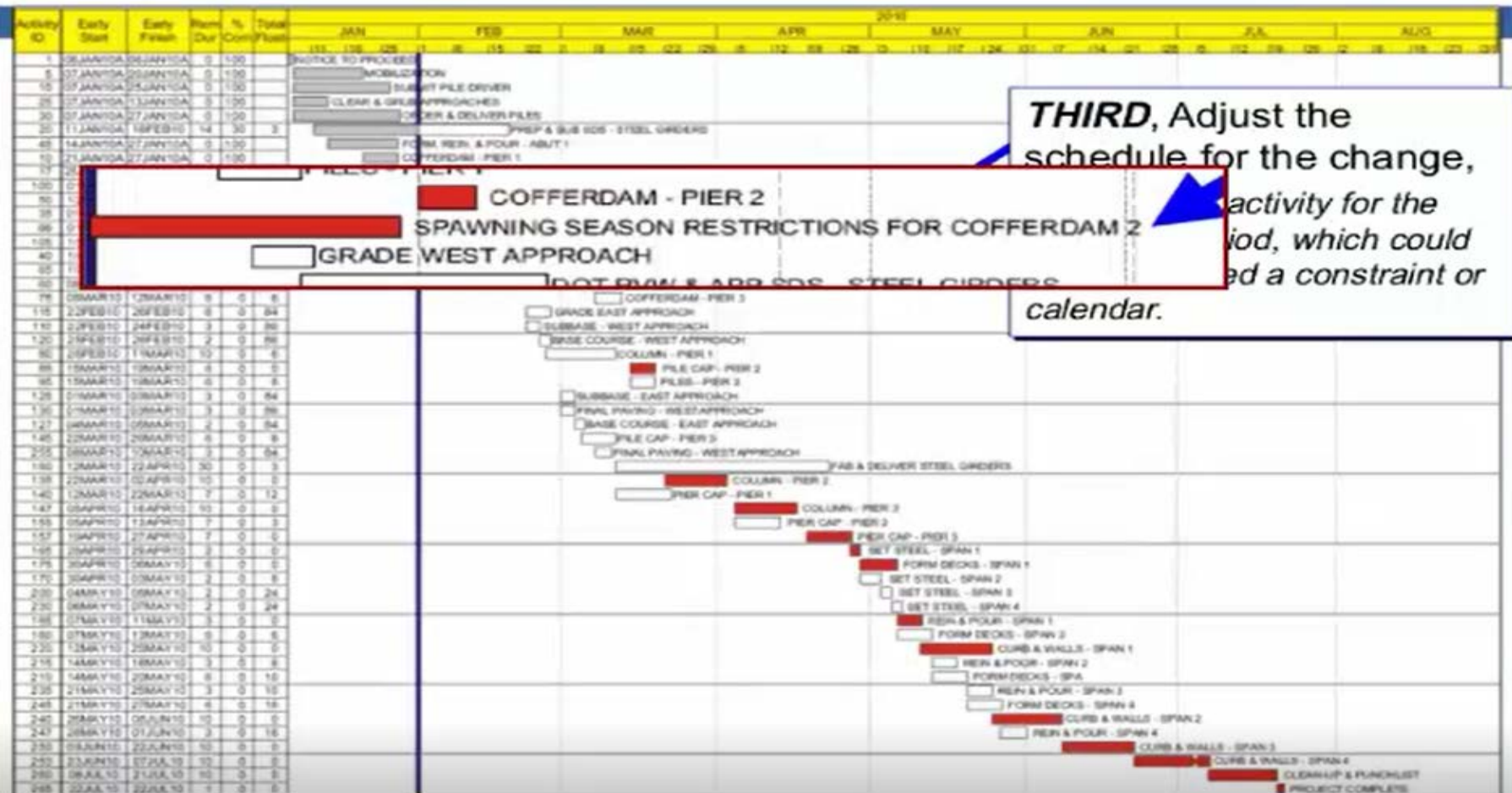
❖ **Example 1: Adjust for change (create **fragnet**, what activities do we need, duration and logic)**



Time impact analysis – Practical procedure: Stage 7

❑ STEP 3a: Insert fragnet into schedule. Reduce delay durations to zero, and do network calculations.

❖ Example 1: Adjust for change (create **fragnet**, what activities do we need, duration and logic)



Time impact analysis – Practical procedure: Stage 7

❑ **STEP 3a: Insert fragnet into schedule. Reduce delay durations to zero, and do network calculations.**

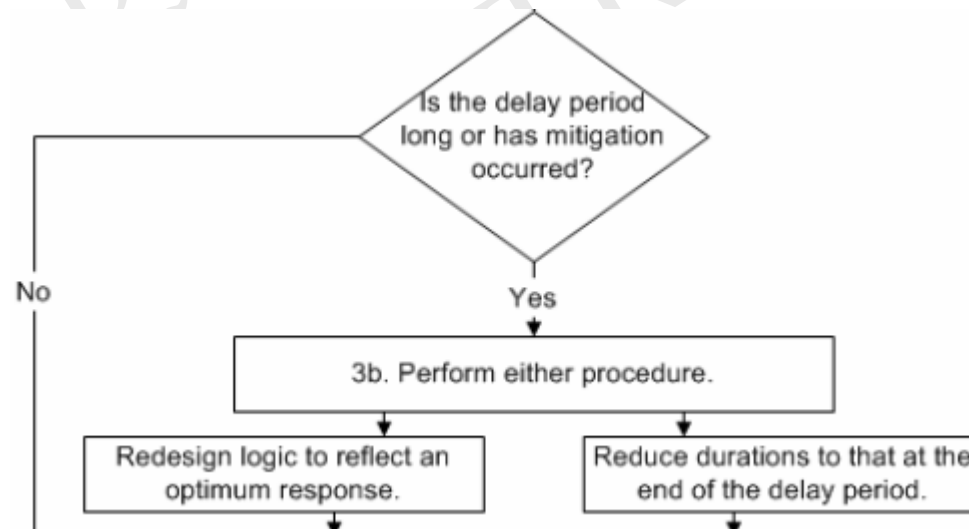
❖ **Example 2:**

Event (fragnet)	Event type	Event actual start date	Base schedule	Base schedule data date
001	EDE	3-Jun-08	Baseline	1-Jun-08
002	EDE	5-Jun-08		1-Jun-08
003	CDE	2-Jul-08	UD01	30-Jun-08
004	EDE	2-Jul-08		30-Jun-08
			UD02	31-Jul-08
			UD02A	14-Aug-08
005	CDE	15-Aug-08		31-Jul-08
006	CDE	4-Sep-08	UD03	31-Aug-08
007	EDE	7-Sep-08		31-Aug-08

Time impact analysis – Practical procedure: Stage 7

❑ OPTIONAL STEP 3b: Consider the effects of mitigation

- ❖ This step is **necessary** if **mitigation** efforts by either the **owner** or **contractor** have **modified** the **actual impact** of a delay on **project completion**.
- ❖ **Skipping this step** in this circumstance may result in a calculated time impact that **does not closely relate** to the **actual impact**.

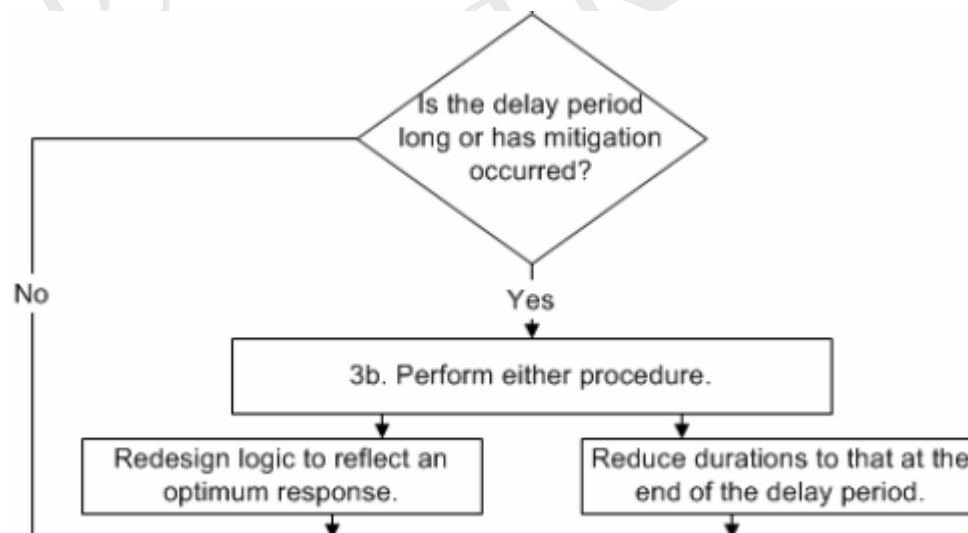


Time impact analysis – Practical procedure: Stage 7

❑ OPTIONAL STEP 3b: Consider the effects of mitigation

- ❖ If it is used **after the delay occurred**,
- ❖ contractor may elect to **revise the remaining duration status** of **every activity** in the schedule to

remaining duration status evidenced at the time of the **actual end of the delay**.

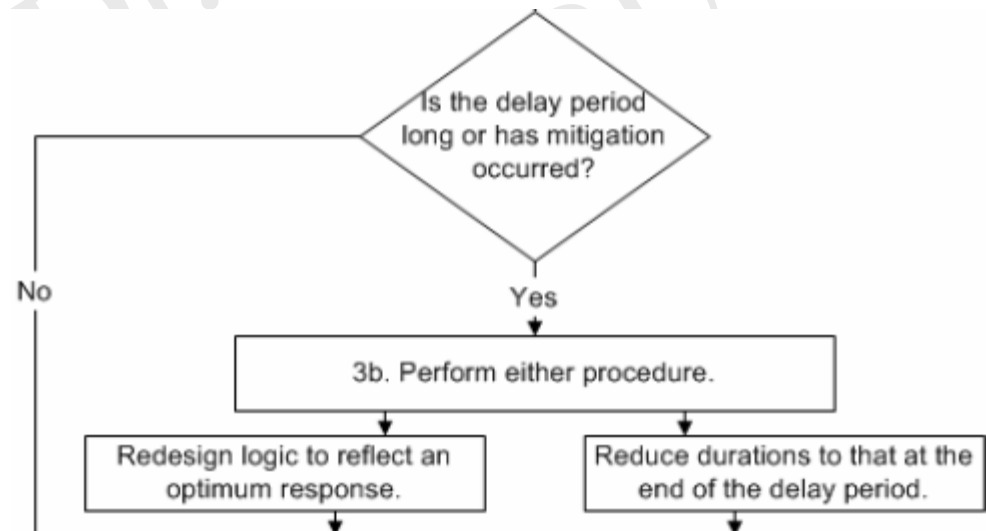


Time impact analysis – Practical procedure: Stage 7

❑ OPTIONAL STEP 3b: Consider the effects of mitigation

❖ If this step is **not implemented**, a **statement** should be provided with the **TIA** to explain **why** this step was unnecessary. Some of the **reasons** may be:

- ✓ A frozen work plan
- ✓ Forward-looking impact analysis
- ✓ Shortness of duration of the delay

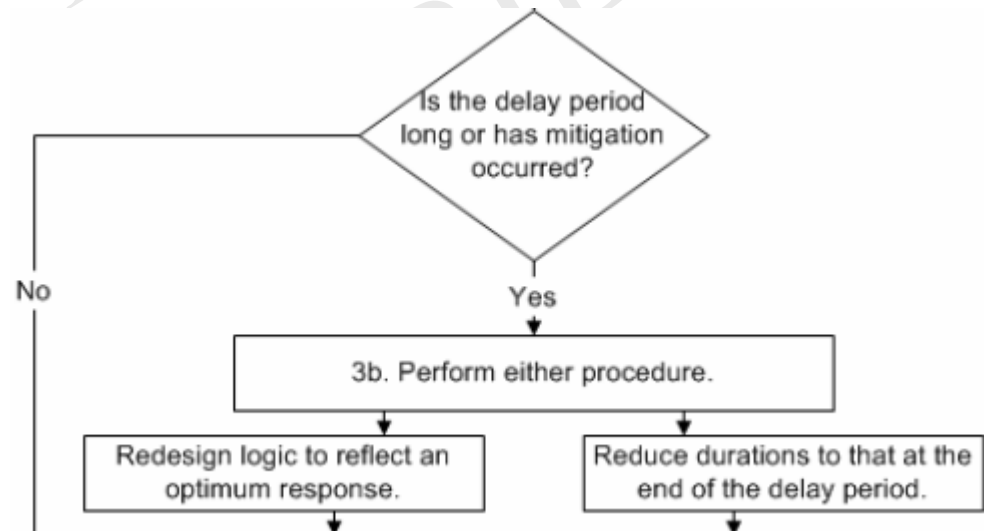


Time impact analysis – Practical procedure: Stage 7

❑ OPTIONAL STEP 3b: Consider the effects of mitigation

❖ Whatever changes made to the schedule to satisfy the Step 3b requirements, should be **fully documented** and included as **part** of the **TIA submittal**.

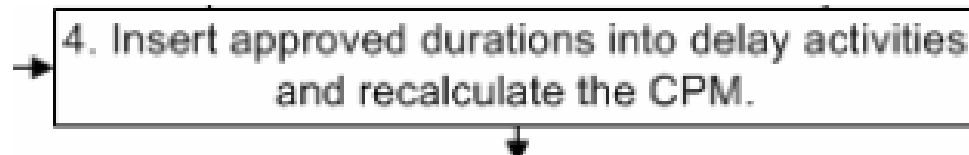
- ✓ These **changes** are subject to review, negotiation, and acceptance by the **owner**.



Time impact analysis – Practical procedure: Stage 7

❑ STEP 4: Insert approved durations into delay activities and recalculate the CPM

1. Insert the **durations** used in the **fragnet** into the **added delay activities** and **re-compute the CPM**.
2. The calculated change to the **completion date** (loss or gain) for each successive delay event is tabulated and inserted chronologically into the table.



Time impact analysis – Practical procedure: Stage 7

❑ **STEP 5: Identify the activity that will be used to measure the time impact.**

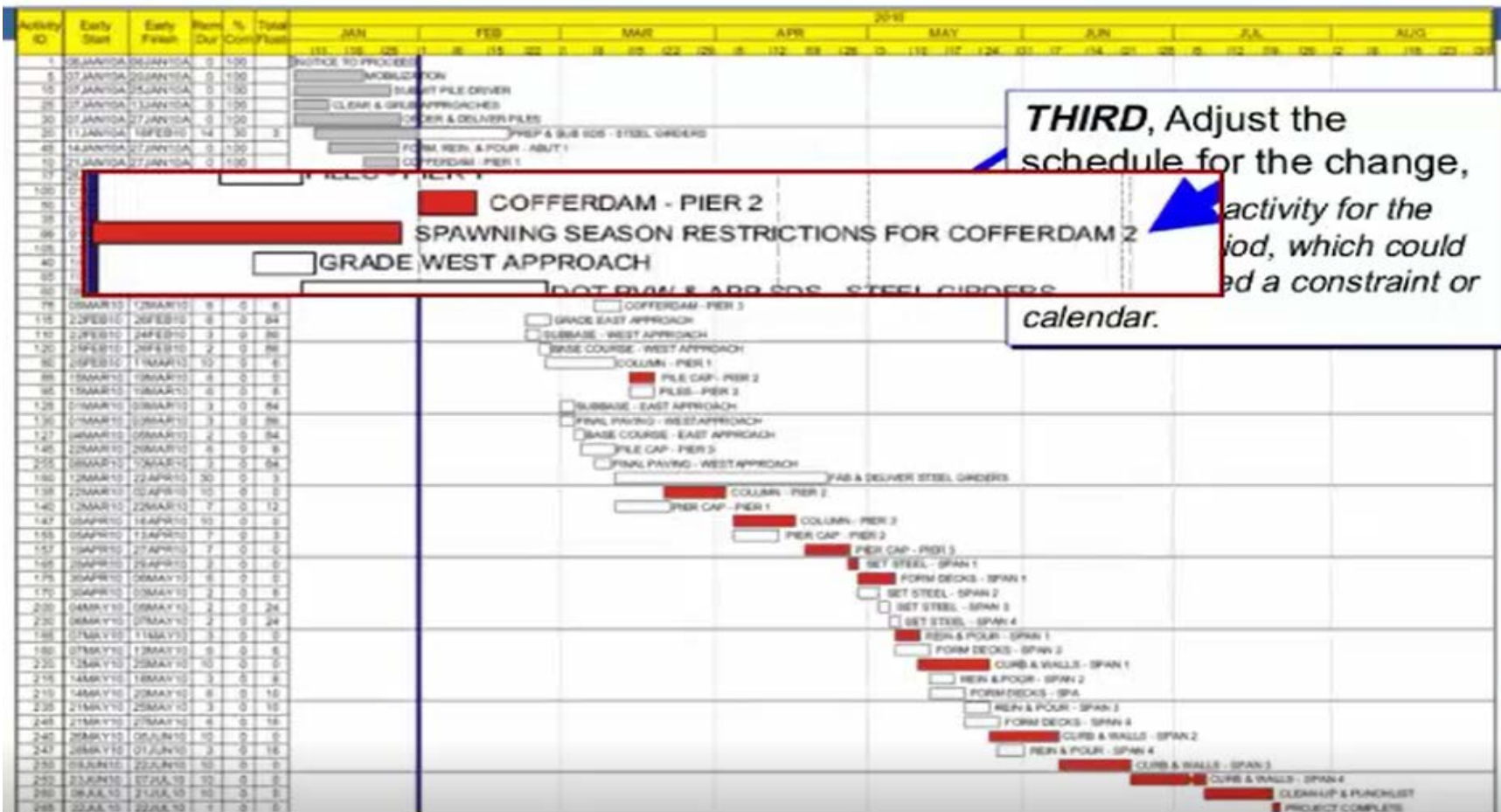
- ❖ **Identify** the **activity** indicating **project completion**
- ❖ **Note** any **change** in the **project completion date**.
- ❖ The **delay** or **acceleration effect** to **all contractual milestones not completed** should be **noted** and **documented**.

5. Identify the activity that will be used to measure the time impact.

Time impact analysis – Practical procedure: Stage 7

❑ STEP 5: Identify the activity that will be used to measure the time impact.

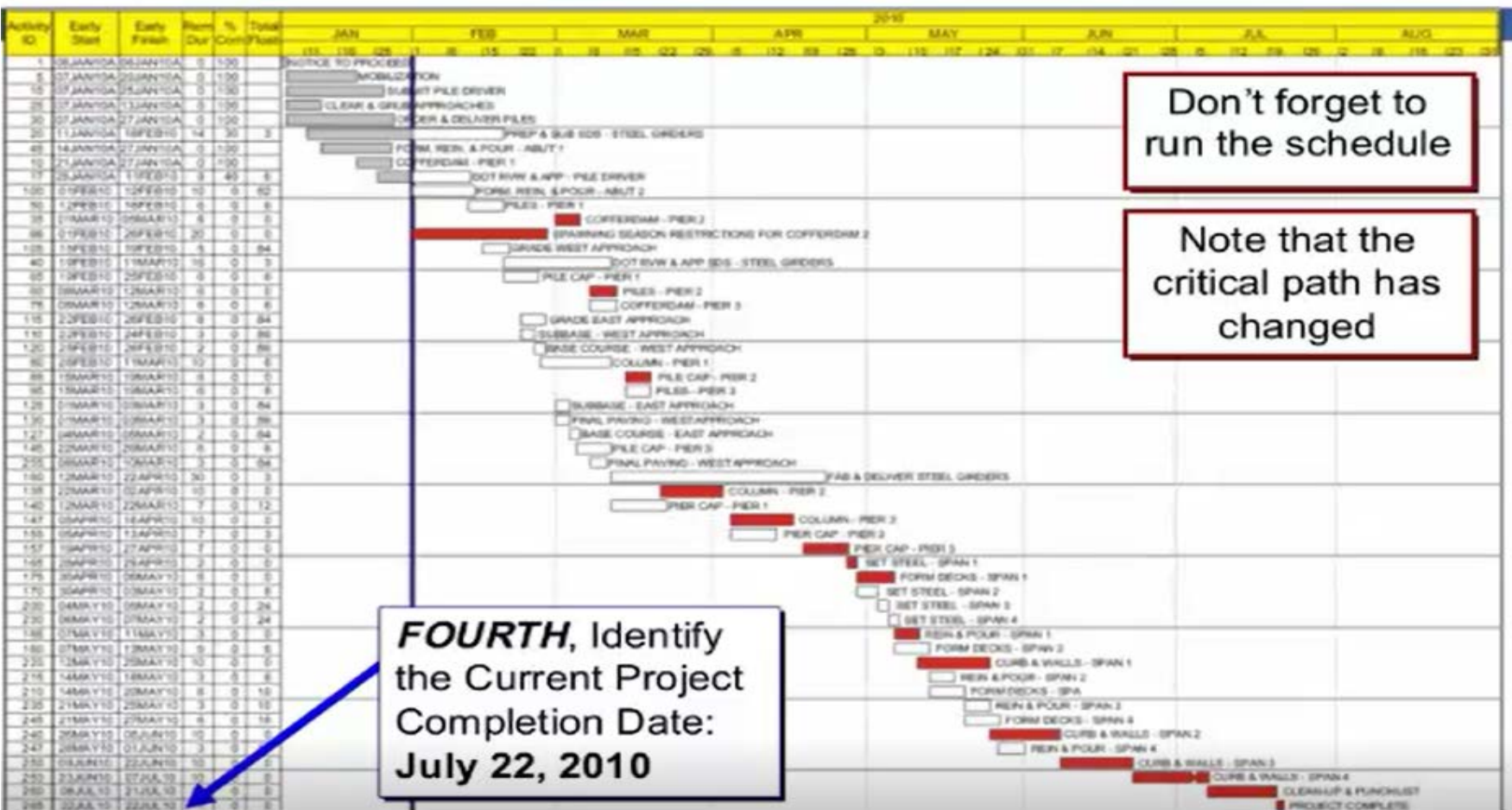
- ❖ Example 1: Adjust for change (create **fragnet**, what activities do we need, duration and logic)



Time impact analysis – Practical procedure: Stage 7

❑ STEP 5: Identify the activity that will be used to measure the time impact.

❖ Example 1: Adjust for change (new update – we have lost 3 additional days)



Time impact analysis – Practical procedure: Stage 7

❑ STEP 5: Identify the activity that will be used to measure the time impact.

❖ Example 2:

Event (fragnet)	Event type	Event actual start date	Base schedule	Base schedule data date
			Baseline	1-Jun-08
001	EDE	3-Jun-08		1-Jun-08
002	EDE	5-Jun-08		1-Jun-08
			UD01	30-Jun-08
003	CDE	2-Jul-08		30-Jun-08
004	EDE	2-Jul-08		30-Jun-08
			UD02	31-Jul-08
			UD02A	14-Aug-08
005	CDE	15-Aug-08		31-Jul-08
			UD03	31-Aug-08
006	CDE	4-Sep-08		31-Aug-08
007	EDE	7-Sep-08		31-Aug-08

Window 1 is the Baseline to the first update, UD01
 Window 2 is from UD01 to UD02
 Window 3 is from UD02 to an updated version of UD02 through August 14, 2008 – UD02A
 Window 4 is from UD02A to UD03
 Window 5 is UD03 to completion

Time impact analysis – Practical procedure: Stage 7

❑ STEP 5: Identify the activity that will be used to measure the time impact.

❖ Example 2:

Window 1	is the Baseline to the first update, UD01
Window 2	is from UD01 to UD02
Window 3	is from UD02 to an updated version of UD02 through August 14, 2008 – UD02A
Window 4	is from UD02A to UD03
Window 5	is UD03 to completion

- In Window 1, there were two events. These were both EDE and both occurred within a week of the baseline data date, June 1, 2008. It was decided that the baseline was an appropriate base to impact for these purposes.
- In Window 2, there were two events, a CDE and EDE. These were impacted both individually and in tandem. When impacted individually, the CDE had a delay impact of three calendar days and the EDE had a delay impact of five calendar days (3 days concurrent with the CDE and 2 days in excess of the CDE). Therefore, it was determined that 3 days were concurrent and not solely due to the contractor.

Time impact analysis – Practical procedure: Stage 7**❑ STEP 5: Identify the activity that will be used to measure the time impact.****❖ Example 2:**

Window 1	is the Baseline to the first update, UD01
Window 2	is from UD01 to UD02
Window 3	is from UD02 to an updated version of UD02 through August 14, 2008 – UD02A
Window 4	is from UD02A to UD03
Window 5	is UD03 to completion

- In Window 3, UD02 to UD02A, there were no events.
- In Window 4, there was one CDE delay event. This event commenced 15 days after the most recent contemporaneous update, and it was deemed necessary to create an intermediate (or bifurcated) schedule on August 14, 2008, immediately before the CDE commencement, which is between update UD02 and UD03. This update was referred to as UD02A.
- In Window 5, there were two delay events, a CDE and an EDE. In this window, the results concluded that the contractor delay of 1 day was concurrent with the EDE, and that the EDE caused a delay of 3 days in excess of the CDE. Therefore, 1 day of delay was considered neutral or concurrent.

Time impact analysis – Practical procedure: Stage 7

❑ STEP 5: Identify the activity that will be used to measure the time impact.

❖ Example 2:

WHY?

Event (fragnet)	Event type	Event actual start date	Base schedule	Base schedule data date	Projected completion date	Net loss/gain	Cumulative delay		
							EDE	CDE	Concurrent
001	EDE	3-Jun-08	Baseline	1-Jun-08	1-Jan-09				
002	EDE	5-Jun-08		1-Jun-08	2-Jan-09	1	1		
003	EDE		UD01	1-Jun-08	5-Jan-09	3	3		
004	EDE			30-Jun-08	5-Jan-09	0			
003	CDE	2-Jul-08		30-Jun-08	8-Jan-09	3			3
004	EDE	2-Jul-08		30-Jun-08	10-Jan-09	2	2		
			UD02	31-Jul-08	6-Jan-09	-4		-4	
			UD02A	14-Aug-08	8-Jan-09	2		2	
005	CDE	15-Aug-08		31-Jul-08	15-Jan-09	7		7	
			UD03	31-Aug-08	14-Jan-09	-1		-1	
006	CDE	4-Sep-08		31-Aug-08	15-Jan-09	1			1
007	EDE	7-Sep-08		31-Aug-08	18-Jan-09	3	3		
Totals:						17	9	4	4

Why 3 days of CDE have no impact?

Time impact analysis – Practical procedure: Stage 7

❑ **STEP 5: Identify the activity that will be used to measure the time impact.**

❖ **Acceleration** and **disruption** accompanying the delay may be considered to be **incorporated in a TIA**, and

may account for the **apparent difference** between predicted and actual effects of a delay.

❖ The **projected completion date** is also **adjusted** according to the **actual progress** achieved in each 'window.'

any resulting gain, or loss, **calculated in each subsequent** base programme is allocated to the **benefit of the contractor**.

✓ This occurred in the above analysis when **UD02** was updated,

Time impact analysis – Practical procedure: Stage 7

❑ STEP 5: Identify the activity that will be used to measure the time impact.

- ❖ Losses and gains achieved due to the **natural progress of the work** are **not EDE**, and any delay which is **unexplained** is by definition a **CDE**.
- ✓ This occurred in the above analysis when **UD02A** was updated,

Is it always perfect and possible to do so?

Time impact analysis – Practical procedure: Stage 7

❑ **STEP 5: Identify the activity that will be used to measure the time impact.**

❖ A **predictive modelling** technique cannot, by itself, identify actual results.

*While imperfect, the **ease and quickness** of preparing and reviewing a TIA should compensate for the **lack of exactness** in modeling the exact features of the impacts to a project due to delay (AACE 52R-06).*

Is it always easy to use TIA after delay already occurred?

Time impact analysis – Practical procedure: Stage 7

❑ **STEP 5: Identify the activity that will be used to measure the time impact.**

❖ When **many small delay events** are being evaluated, the **process of calculating and rationalizing the impact of each event**, using a **new base programme** for each event,

becomes a project in and of itself, **requiring many assessments** regarding the status (%complete, remaining duration) of each activity in the programme.

This approach should only be adopted if

1. Appropriately **detailed data** exists, and
2. Resulting impacts can be **reconciled with as-built data** and grounded in fact

Time impact analysis – Practical procedure: Stage 7

❑ STEP 6: Determine the total time impact to the project

❖ Determine the **correct time impact** for the **project delay**.

1. Cumulative loss or gains are determined for **EDE**, **CDE**, and **concurrent** periods.
 - ✓ Neutral events (excusable but non-compensable) such as **force majeure** are treated the same as **concurrent delays**.
 - ✓ If the contract **specifies work days**, then this unit of measurement should be made in work days.
 - ✓ If the contract **specifies calendar days** or specifies an absolute date for **completion**, then the unit of measure should be made in calendar days.
2. Any anomalous results are **reviewed** and where **corrections** are necessary, the process is repeated as required.

6. Determine the total time impact to the project.

Time impact analysis – Practical procedure: Stage 7

❑ STEP 6: Determine the total time impact to the project

Example 1

❑ If you put the change in the **baseline** instead of schedule update or

❑ If you put the change in **schedule revision** back on **January**,
what would happen?

All you know is that we went from July 13 to July 21===9 days



❑ But if you put the change on **schedule update**:

❖ **Split it up into two delays:**

❖ 6 days of delays because of project progress (**non-excusable delays**)

❖ 3 days for the actual change from owners (**excusable delays + may compensable**)

1. What was the completion date?

a. Before the change: July 19

b. After the change: July 22

2. The change order issued for the permit revision should include a 3-day time extension.

3. Alternately, the work could be accelerated to mitigate the delay and achieve timely completion.



Time impact analysis – Practical procedure: Stage 7**❑ STEP 6: Determine the total time impact to the project****Example 2**

Total delay experienced	17
Total pure EDE delay experienced	9
Total pure CDE delay experienced	4
Concurrent delay experienced	4

- ❖ 9 days of excusable–compensable extension of time,
- ❖ 4 days excusable-non-compensable extension of time.
 - ✓ In total, 13 days of additional extension of time and relief from liquidated damages should be recognized.
- ❖ 4 days of liquidated damages (assuming the project actually completes on January 18, 2009) and no further critical EDE events are identified.

Time impact analysis – Practical procedure: Stage 7

❑ STEP 7: Determine the actual dates of delay

- ❖ Using the original schedule update, determine when the **successor activity** to the **delay impact** actually became a project critical activity.

7. Determine the actual dates of delay.

1. The **procedure** mentioned before assumes (either by contract or standard default) that project float belongs to the party who uses it first.
2. It also **assumes** that the **project** does not meet all legal requirements for a **declared early project completion**.

*If **either** of these **assumptions** is **incorrect**, then the **appropriate adjustment** should be made in **counting the delay days**.*

What should be done when **granting** or **refusing** an EOT?

Time impact analysis – Practical procedure: Stage 7

❑ STEP 7: Determine the actual dates of delay

- ❖ The CA makes **decision**. When granting or refusing an EOT:
 - ✓ The CA should so **notify** the **contractor**
 - ✓ **Sufficient information** should be **provided** by CA as the **reasons** for decision

What should be done in the **absence of a submission** that complies with TIA **instructions**?

Time impact analysis – Practical procedure: Stage 7

❑ **STEP 7: Determine the actual dates of delay**

- ❖ CA (unless the contract otherwise provides) should make its **own determination** of the EOT (if any) that is due, based on such **information as is available** to it.

What if **no sufficient** information exists?

Time impact analysis – Practical procedure: Stage 7

❑ **STEP 7: Determine the actual dates of delay**

- ❖ Given that it is **difficult if not impossible** to withdraw an **EOT once granted**, it is **reasonably to be expected** that, where the CA has **not been presented with the information** on which to base its decision,
the CA will award only the minimum EOT that can be justified at the time.

What should be done if the **Contractor** does **not agree** with the CA's decision?

Time impact analysis – Practical procedure: Stage 7

❑ STEP 7: Determine the actual dates of delay

If the **contractor** does **not agree** with the **CA's decision**, it should so **inform** the **CA** immediately.

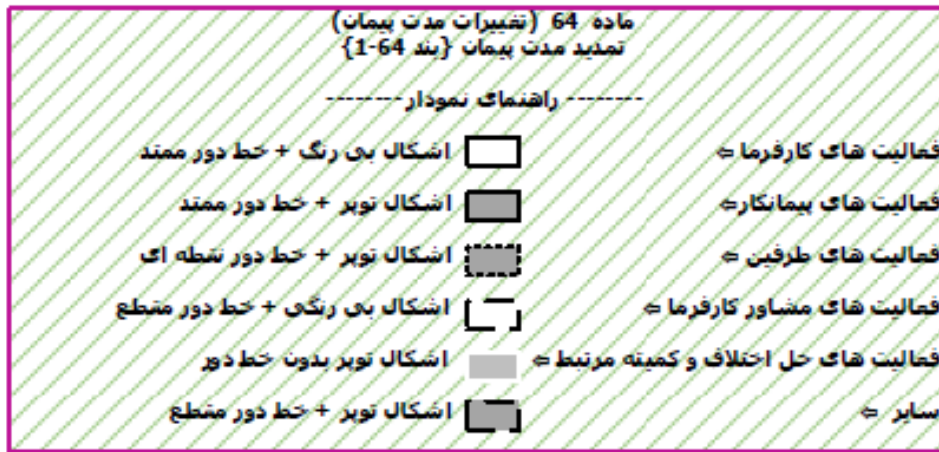
- ❖ Disagreements on EOT should **not be left** to be **resolved** at the **end of** the project.

What if no agreement can be reached quickly?

Steps should be taken by either party to have the dispute resolved in accordance with the contract dispute resolution provisions

Time impact analysis – Practical procedure: Stage 7

❑ STEP 7: Determine the actual dates of delay



کارفرما باید مدت تمدید پیمان و برنامه زمانی جدید که مورد تاییدش می باشد را تصویب و به پیمانکار ابلاغ نماید.

در صورتی که کارفرما ظرف مهلت های مقرر بررسی و ابلاغ تمدید مدت پیمان را انجام ندهد و یا پیمانکار با مدت تمدید پیمان که توسط کارفرما ابلاغ شده است موافق نباشد، پیمانکار می تواند موضوع اختلاف را به کمیته دائمی پیشگیری و رسیدگی به اختلاف موضوع بند 1-75 ارجاع نماید.

Time impact analysis – Practical procedure: Stage 7

❑ STEP 8: Eliminate delay dates already awarded

- ❖ Eliminate **delay dates** from the TIA request that have previously been **awarded**.
- ❖ Delays that are excusable but non-compensable should be considered as a **concurrent delay**.
- ❖ No more than one day of **excusable delay** should be assigned to a **single date**.

8. Eliminate delay dates already awarded.

Could it be a time limit to submit the analysis?

Time Impact Analysis (TIA)

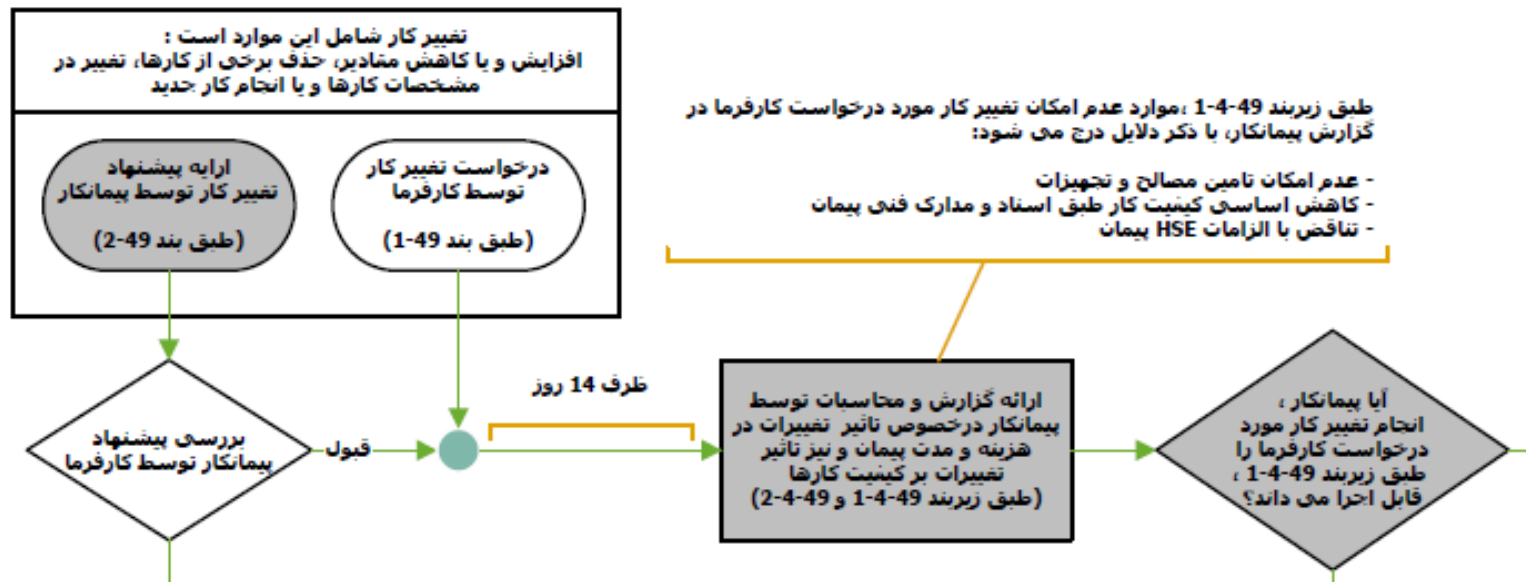
(Important notes and Conclusion)

Time impact analysis – Important notes

Could it be a time limit to submit the analysis?

1. For change orders and delays **before occurrence**, the analysis discussed for **TIA** shall be submitted within **14 calendar days** following
 - i. Owner's issuance of the change order or
 - ii. Initiation of the delay
as a part of
 - i. **Contractor's proposal** for the work or
 - ii. Delay contemplated by the **proposed change order**

Time impact analysis – Important notes



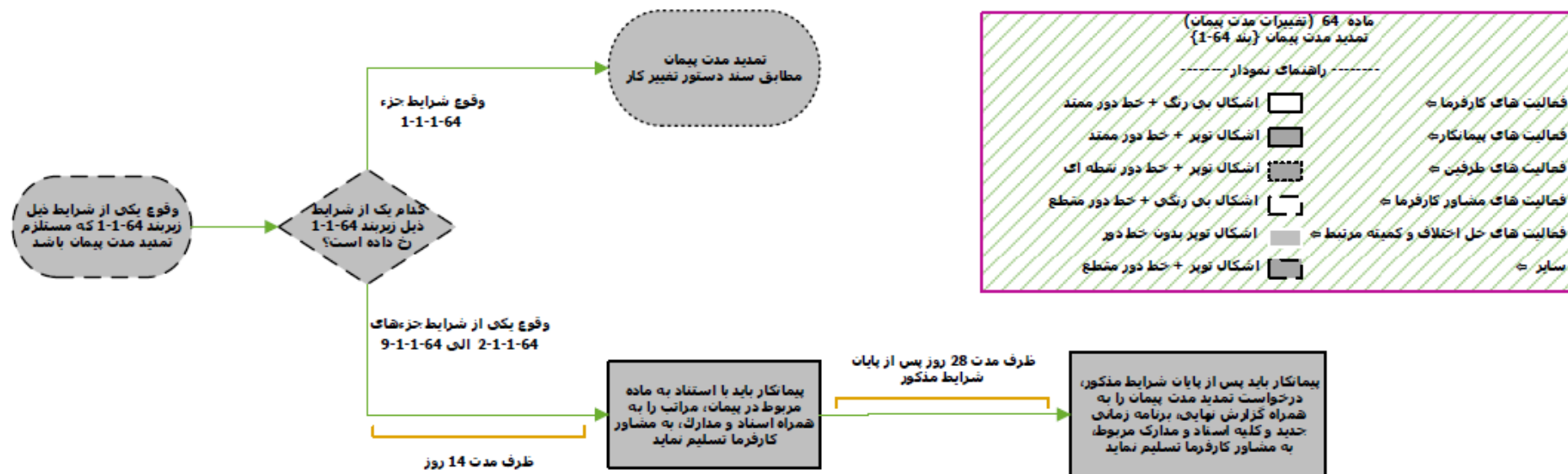
You will see how this could greatly work in claim management course!

Time impact analysis – Important notes

Could it be a time limit to submit the analysis?

2. For change orders or delays after delay already occurred, the analysis discussed for TIA shall be submitted within **14 calendar days** following
- ii. Completion of the work related to the change order or
 - iii. Conclusion of the delay

Time impact analysis – Important notes



You will see how this could greatly work in claim management course!

What software should be used?

Time impact analysis – Important notes

What software should be used?

- ☐ No matter how powerful the software becomes, the **capabilities** of the **user** are still the **most important** ingredient in using scheduling software as an effective management tool.
- ☐ No matter what software was used to manage the project schedule, the basic principles of analyzing a project for delays and improvements **remain the same**.
- ☐ Primavera software is the **most widely used** software in the **industry**, terminology from Primavera scheduling software is used.

Time impact analysis – Important notes

- ❑ Analyst should use **electronic copies** of all project schedules.
 1. **Hard copy** printouts can be **easily manipulated** to show **only the information** the hard copy provider **wants** the analyst to see.
 2. **Hard copy** often **lack information** (logic ties, relationship lags, scheduling options) that is **vital to determine** what the **contractor's contemporaneous plan** was for completing the Project.

Time impact analysis – Conclusion

TIA is **not an attempt** to simulate reality, only to **approximate it**.

It is a recognized **analytical technique** intended to facilitate a **reasonable estimate** of the time delay to the project caused by a single delay or a discrete series of delays.

TIA is not completely accurate, instead it is approximate

It is **not reasonable** to require that a **delay modeled in a TIA** manifest itself in that **exact number of days** that a project **actually** ends up being late.

Time impact analysis – Conclusion

- 4.12 The methodology described in this section is known as ‘time impact analysis’. This methodology requires a logic linked baseline programme (which ordinarily would be the Accepted Programme), updated programmes (which ordinarily would be the Updated Programmes) or progress information with which to update the baseline programme and the selection of delay events to be modelled. If the parties have not followed the guidance to Core Principle 1 in Part B, such that there is no Accepted Programme and/or Updated Programmes, this is likely to lead to more disputes regarding the contemporaneous assessment of EOT applications.

Time Impact Analysis (TIA)

(TIA vs. IAP)

Time impact analysis vs. impacted as planned

Factor	TIA	Impacted Baseline
Time Required	Moderate to High depends on data	Lesser Time required compared to TIA
Level of Effort	High	Moderate

Time impact analysis vs. impacted as planned

Comparing Factor	TIA	Impacted Baseline
Expertise Level Required	High	Moderate
Complexity	High	Low
Data Requirement	High	Moderate

Time impact analysis vs. impacted as planned

Comparing Factor	TIA	Impacted Baseline
Accuracy of Result	More accurate with Perspective Analysis	Moderate
Prospective or Retrospective Application	Both, Prospective and Retrospective	Both, Prospective and Retrospective

Time impact analysis vs. impacted as planned

- ✓ Many Methods available for Delay Analysis
- ✓ Each method could give different results
- ✓ Many factors to be considered while selecting one
- ✓ Most Important – contractual requirement
- ✓ Owners should give more options
- ✓ Contractors should not always go for simplest one

Non-Critical Path Techniques

Techniques

- ❑ Under some circumstances, a critical path project schedule is **not available for a project**.
- ❑ It is more prevalent in **smaller projects**.
- ❑ When faced with this **challenging set of circumstances** one of the following methods can be **considered** to determine the impact of a delay, however not recommended.

1. S-Curve

2. Global impact
3. Net impact



S-Curve

- ❑ The **S-curve method** makes use of a **time-cost chart** where the **cumulative expenditure** during the construction period is expressed.
- ❑ The one **axis** of the chart depicts project expenditure and the other project duration.
- ❑ To apply this method a **baseline S-curve** and an **as-built S-curve** without any additional cost are required.
- ❑ This method is based on the **assumption** that **slow progress** would result in a **lower than planned expenditure**.
- ❑ By **comparing** the baseline S-curve with the as-built S-curve the **impact of the delay** can be determined.

Is it correct?



S-Curve

There is a **widely held**
but mistaken belief
that the **dollar value of the work performed** is directly related to the
time progress of the job.

Let's see some of the arguments!

Delay analysis based on dollars

❑ Example

- ❖ **Contractor**: I was able to complete **90 percent of the work** in **ten months** on the job. Then, **because** of the **Owner delays** in **inspection** and **punch list**, it took **four months to complete** the last 10 percent of the work.
- ❖ **Owner**: During the **period** of the **claimed delay** to the Contractor, he was able to **perform 25 percent of the dollar value** of his work on the Project. The **dollar value** of work accomplished during that period **reflected** the **same rate of progress** as that **before and after the delay**. Therefore, we could **not possibly** have **delayed** the **Contractor**.

Which one is true?

Delay analysis based on dollars

❑ Example

❖ While **both** of these arguments may **appear plausible** and **logical**, there is **no quantifiable linear relationship** between **time progress** and **dollars** on any Project.

1. The **dollar value** at each stage of the Project **depends** on the **(1) nature** and **(2) cost assigned** to the specific activities completed.

❖ For instance, some **high-dollar-value** items of work may be performed in a **short period of time**, whereas some **low-dollar-value** items of work may **take more time**.

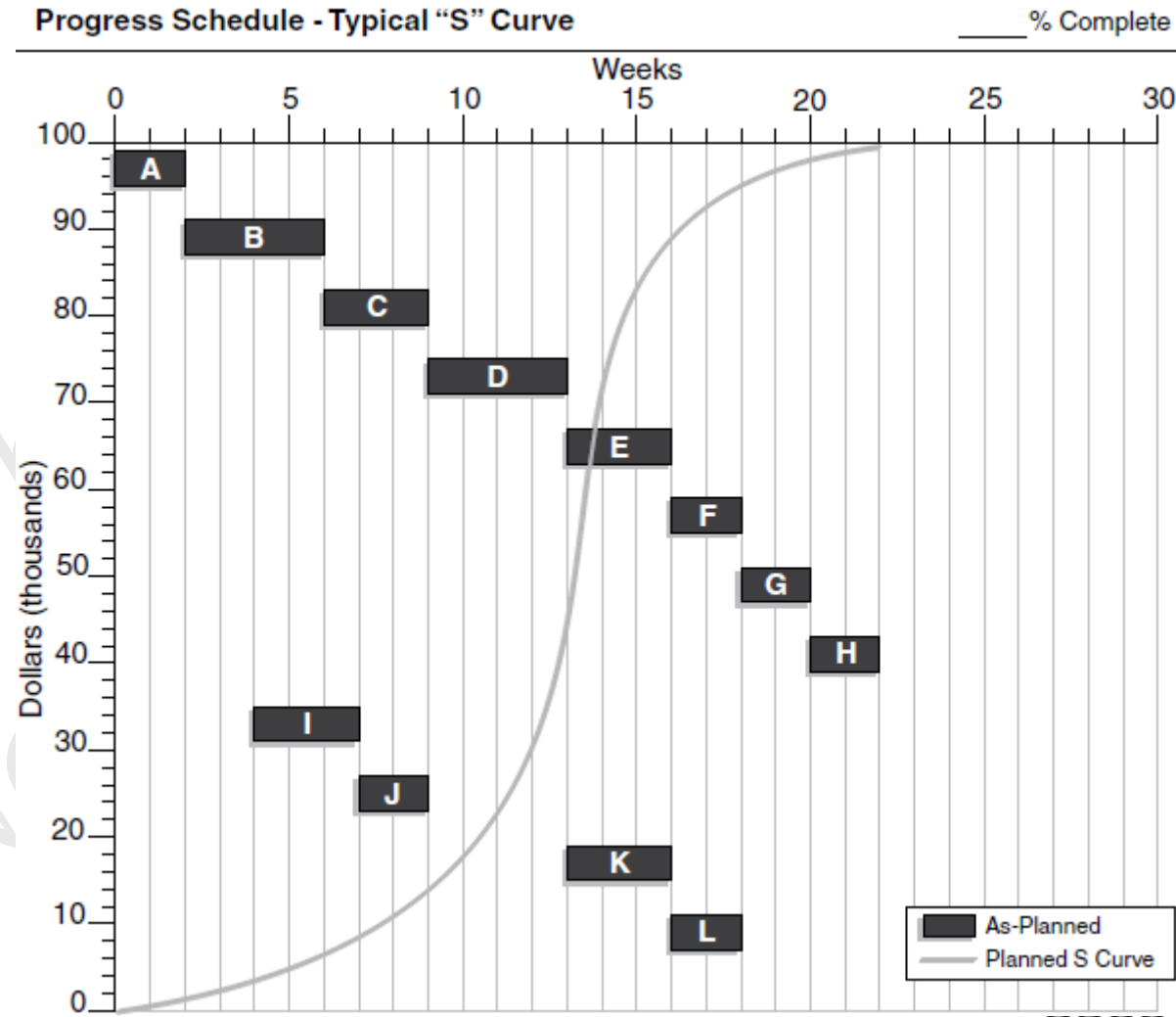
2. Dollar value method does **not identify** and **track** the activities on the **critical path** of the Project, as the **most reliable method** for determining delays.

Delay analysis based on dollars

❑ S-Curves

- ❖ In the **past**, the **Corps of Engineers** required **Contractors** to **provide** **“S” curves** to show **job progress**.

Progress Schedule - Typical “S” Curve



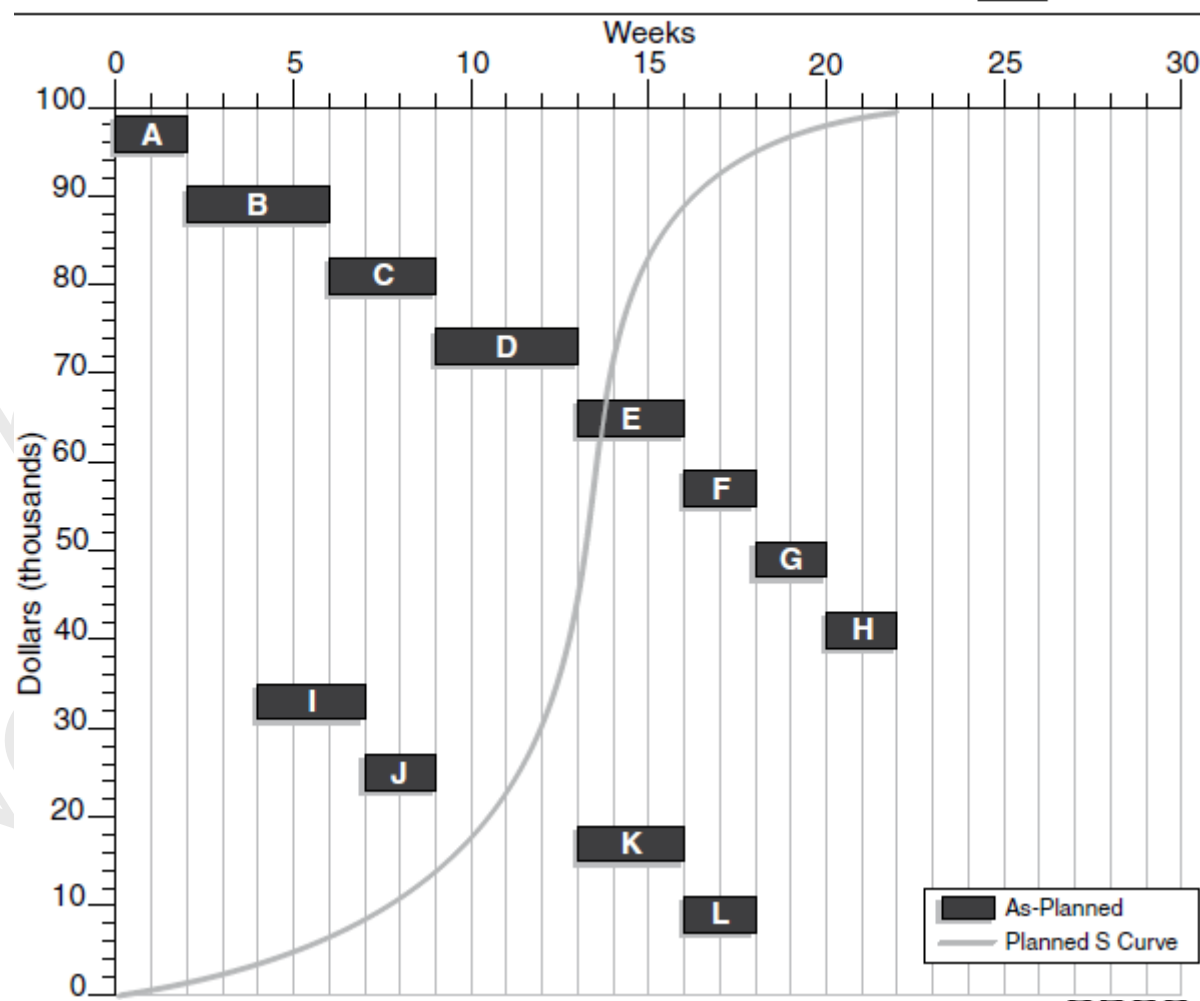
Delay analysis based on dollars

□ S-Curves

1. The **Contractor** provides a bar chart of the major activities on the job and applies the **dollar value** from the **schedule** of **values** to the bar chart.

- ❖ By summing the **dollars over time**, an “S” curve is **generated**.

Progress Schedule - Typical “S” Curve

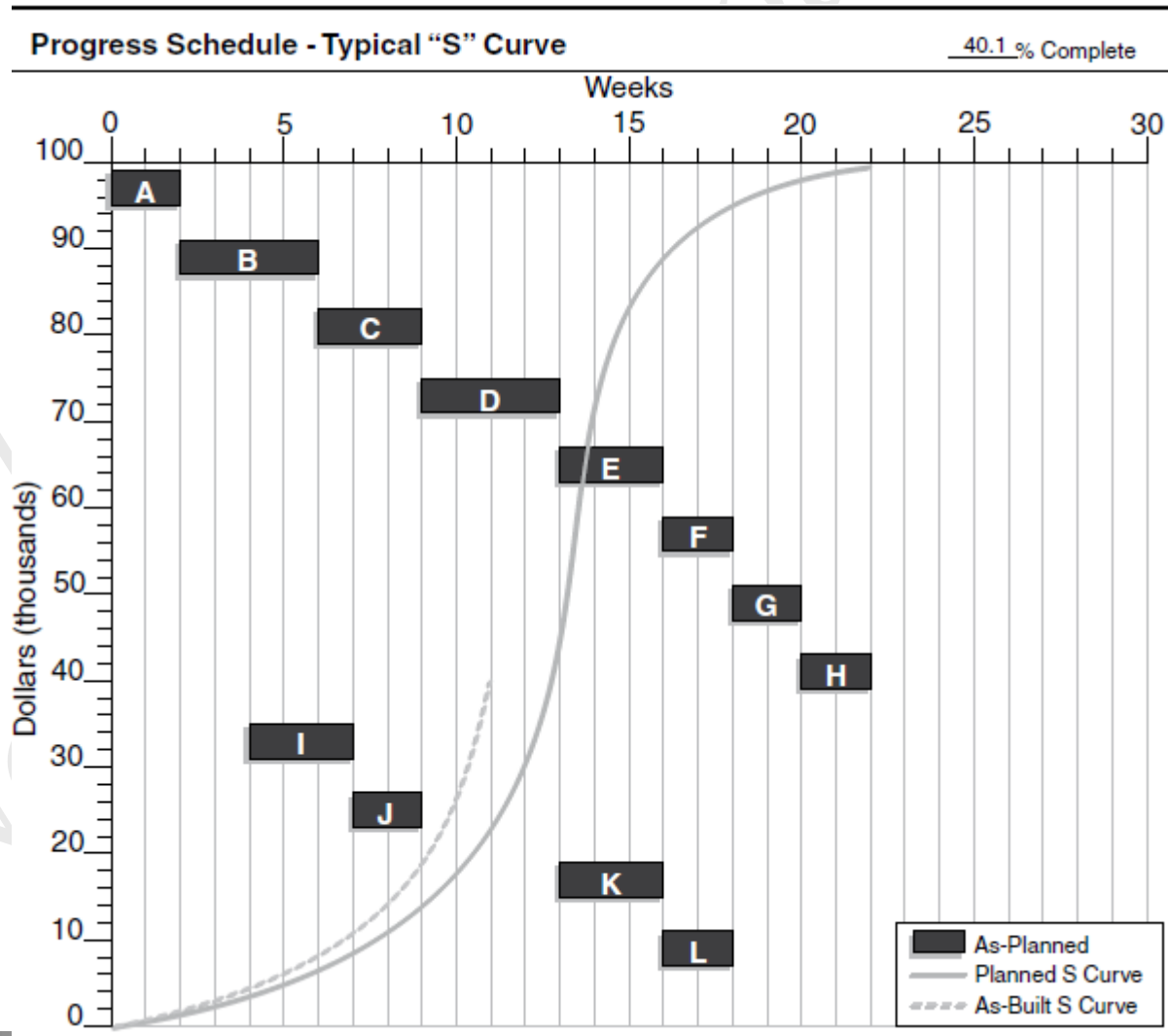


Delay analysis based on dollars

❑ S-Curves

2. The **Contractor** must then submit an **updated “S” curve** with each monthly pay request.

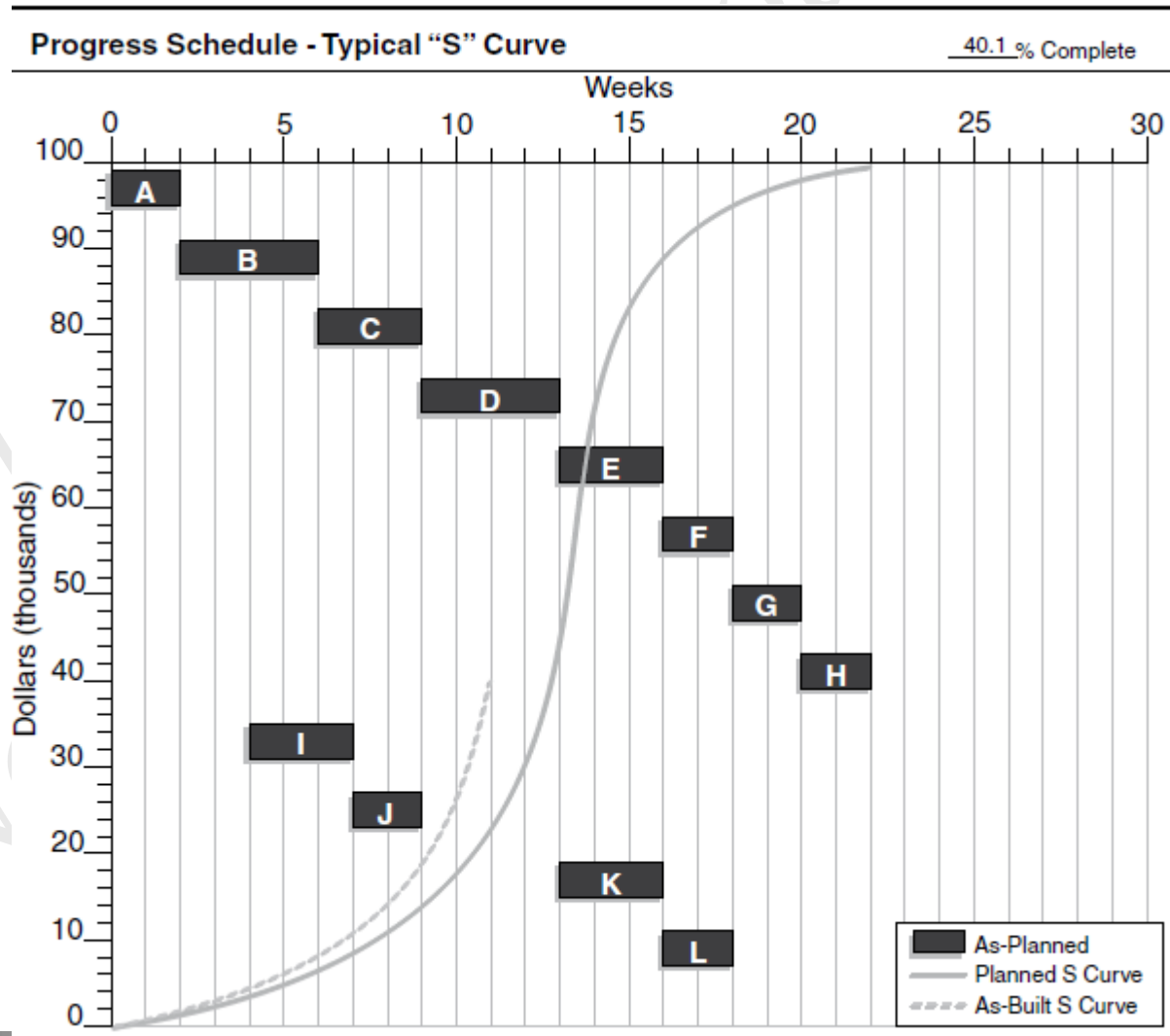
❖ Unfortunately, the monthly submission also has an entry for “progress to date,” **recorded** as a percentage.



Delay analysis based on dollars

❑ S-Curves

- ❖ This update has often been used to measure the Contractor's progress in time, which is **very often misleading**.
- ❖ "S" curves developed from a **Contractor's total billing dollars** do not measure the time progress of the Project but merely **show** the progress of billings over the course of time.



Delay analysis based on dollars

❑ S-Curves

❖ There are **several reasons** why the we **do not recommend** using an this kind of **“S” curve** for **determining job progress**.

1. The **original planned “S” curve** **might not** be accurate due to **“front end loading,”** or other factors.
2. The **updated “S” curve** information **might** be **misleading** because of **payments** for stored materials and equipment.

*The Contractor could **overbill** or **“front end load”** its **bid items** to **recover its costs** as **early as possible**, and, therefore, **reliance** on the **“S” curve** could **portray more “progress”** than had **actually occurred**.*

Because they are **unreliable**, **time-to-dollar relationships** should **not be used** to **establish delays** on a Project.

Delays By Subcontractors

Delays by subcontractors – State of the problem

When a Project is **managed** by a **well-thought-out** and **periodically updated CPM schedule**, the analyst has **many tools** at his disposal to **determine** the delays to the Prime Contractor's performance period.

However, in the **case of delays to the Subcontractor's performance period**, these tools are less effective.

As a result, we **must apply** a more in-depth knowledge of **both** the subcontracting process and of the Project management process in order to determine the **most appropriate way to resolve disputes** related to **Subcontractor delays**.

Delays by subcontractors – How to investigate and analyze delays?

1. When investigating potential delays to a Subcontractor's performance, we begin by evaluating the performance requirements of the subcontract (**contract with SC**).
 - ❖ The **objective** of this evaluation is to determine the period of performance for which the Subcontractor is obligated **under** the terms of the subcontract.
 - ✓ Often, a **Subcontractor** is required to perform its work according to the Project schedule.

Delays by subcontractors – How to investigate and analyze delays?

2. If required to perform according to the project schedule:

❑ **Typically**, the Prime Contractor reserves its right to **modify the schedule** as necessary to complete the work in a timely fashion.

❖ The subcontract will then **require** the **Subcontractor** to perform according to these **modifications** as well.

❖ Because these modifications are **not known** at the time of the subcontract agreement, there is a **certain expectation** that the parties have regarding the **Subcontractor's performance period** that results in **negotiation before** signing subcontracts.

While the **Subcontractor** typically **takes on some risk** regarding the Prime Contractor's right to modify the schedule, this risk is typically **not without limits** in subcontracts.

Delays by subcontractors – How to investigate and analyze delays?

2. If required to perform according to the project schedule:

❑ What limits in subcontracts?

- ❖ The Contract CPM schedule will **identify** early and late dates for **all of the Subcontractor's work activities**.
- ✓ The **Subcontractor** is obligated to be **on site** from the projected early start date of its **first activity** to the late finish of its **last work activity**.
 - The **work activities** do not need to be **performed** on the early dates for the Project to complete on time.
 - Thus, performance of the work **within** the **early and late date** ranges are foreseeable, **even if** such performance **affects** the **continuity** of the **trade Subcontractor's work activities**.

Delays by subcontractors – How to investigate and analyze delays?

Unlimited modifications to the sequence and duration of the work are generally **not anticipated** by the **parties**.

Modifications by **prime contractors** should be **limited** in subcontracts

Delays by subcontractors – How to investigate and analyze delays?

2. If required to perform according to the project schedule:

❑ Unlike the Prime Contractor's contract performance period, which is generally expressed in the **Contract**, the parties may be **unable to agree** on the **subcontract period of performance**.

❖ In such cases, the **parties** will **prepare** their respective arguments based on the **subcontract performance period** **they believe** to be **correct** and **every subcontract** has **its own condition**.

Delays by subcontractors – How to investigate and analyze delays?

3. Once the subcontract period of performance has been established

- ❑ A comparison to the **Subcontractor's actual performance period** provides a measure of the **total delay** experienced by the **Subcontractor**.

But this is only the beginning of the story

- ❑ Next, it is necessary to determine the causal link between the **actions of the parties** and the **delays incurred** in order to determine if the **Subcontractor's delays** were caused by others.

The **Subcontractors** may be able to **recover the delay costs** caused by others (usually overhead costs)

Delays by subcontractors – How to investigate and analyze delays?

3. Once the subcontract period of performance has been established

- ❑ It is **necessary** to determine the critical path of the Subcontractor's work.
- ❖ The **critical path** of the Subcontractor's work is the **longest path of activities** leading from the first work activity to be performed by the **Subcontractor to the last**.
 - ✓ This path may consist of **some** or **all** of the Subcontractor's work activities, as well as work activities performed by others.
 - Because **these activities** are integrated within the entire schedule network, the analyst **cannot simply isolate** the Subcontractor's work activities and evaluate the paths among these in a vacuum.

Delays by subcontractors – How to investigate and analyze delays?

3. Once the subcontract period of performance has been established

As a result of these **complexities**, it may **not be possible** to determine the **longest path** between the **Subcontractor's start** and **end points** through electronic analysis of the schedules.

- ❑ As an alternative, it may be necessary to determine the **Subcontractor's critical path** through a detailed evaluation of the Subcontractor's daily work progress.

This evaluation is similar to the As-Built Delay Analysis discussed later.

Delays by subcontractors – How to investigate and analyze delays?

4. Process of a detailed evaluation of the subcontractor's daily work progress begins

□ This **process begins** with the preparation of a **detailed as-built diagram** that **tracks all** of the Subcontractor's actual performance.

❖ This **performance** is then **compared** to **all of the available planned performance information**.

✓ To begin with, the analyst **determines** if the Subcontractor was able to meet **planned durations** for its work and, if not, **why not**.

○ Did the Subcontractor provide **sufficient resources** to accomplish the work?

○ Was the Subcontractor **in control of the pace** of the work, or was **something else controlling the pace**?

Delays by subcontractors – How to investigate and analyze delays?

4. Process of a detailed evaluation of the subcontractor's daily work progress begins

□ By evaluating the **Subcontractor's as-built work performance** moving forward through the Project and considering the work that remains, we can determine:

1. **Critical path** of the subcontractor's work
2. **Factors** that extended the work along this path



فرآیند جامع آنالیز تاخیرات در پروژه

بخش هشتم:
آنالیز زمانی تاخیرات

آنالیز تاخیرات در شرایطی که برنامه زمانبندی وجود ندارد!

ارائه دهنده:

سید محمدرضا علوی پور

CMAA Authorized Trainer

(PhD, PMP, CMIT)

دانشگاه Illinois Tech آمریکا

What we will learn?

- ❑ Introduction
- ❑ STEP 1: Use of contemporaneous documents for sequence and timing
 1. Contract documents
 2. Correspondence between the general contractor and the owner or owner's representative
 3. Subcontract agreements
 4. Correspondence with subcontractors
 5. Partial schedules produced during the project
 6. Meetings minutes
 7. Daily log or diary entries by either the general contractor's personnel or the owner's representative
 8. Purchase orders with suppliers
- ❑ STEP 2: Use of as-built analysis to quantify delays

Introduction

- ❑ The **preceding sections** discussed the performance of a delay analysis using a **detailed CPM schedule**.
- ❑ This section addresses the “**worst case**” situation: the Project with **no as-planned schedule**.
- ❑ This is the **most difficult situation** in which to perform a delay analysis.
- ❑ Again, as the **available information decreases**, the **analyst** must make **more assumptions**, and the analysis becomes **more subjective**.

*However, while this type of analysis is **difficult**, it is **not impossible**.*

IMPORTANT NOTE:

When no schedule exists or the schedule so flawed, the **analyst** may be tempted to create an **“after the fact” schedule**, reasoning that it will allow the **analysis** to be more precise.

*It is best not to create such a **schedule**, but sometimes it is unavoidable!*

*This practice may bias the analysis and not reflect the **Contractor’s original planned sequence** of the work.*

Introduction

❑ **Two steps** should be adopted in this case:

1. Use of **contemporaneous documents** for **sequence** and **timing** to

✓ **Define** some form of an **as-planned schedule**

or

✓ **Establish** a **general sequence**

2. Use of **as-built analysis** to **quantify delays**

STEP 1: Use Of Contemporaneous Documents For Sequence and Timing

STEP 1: Use of contemporaneous documents for sequence and timing

- ❑ When there is **no as-planned schedule**, it is usually because the **General Contractor** did **not prepare** a **schedule** for the Project.
- ❑ In this situation, the **analyst** should begin by **reviewing all available documentation** to determine **if** any **information exists** that may **provide**:
 1. Some idea of a **proposed sequence** of the work for specific activities
 2. Some idea of a **proposed timing** for specific activities

What documents should be investigated in this case?

STEP 1: Use of contemporaneous documents for sequence and timing

❑ **The analyst should investigate the following documents:**

1. Contract documents
2. Correspondence between the general contractor and the owner or owner's representative
3. Subcontract agreements
4. Correspondence with subcontractors
5. Partial schedules produced during the project
6. Meetings minutes
7. Daily log or diary entries by either the general contractor's personnel or the owner's representative
8. Purchase orders with suppliers

STEP 1: Use of contemporaneous documents for sequence and timing

1. Contract documents

- ❖ The **contract documents** for any specific sequence, phasing, or staging specified as a requirement on the project.
- ❖ The Contract required that **all abutment work** be completed before any paving was performed on the approaches.
- ❖ The Contract also required that **completion** of the Project occur by the middle of the 24th week.

Special Conditions of the Contract-West Street Bridge-Section 1.01,
paragraph 5.a:

In staging its work the contractor must complete all abutment construction activities prior to paving of the approaches on both the east and west sides of the bridge.

Special Conditions of the Contract-West Street Bridge-Section 0.01,
paragraph 3.b:

TIME FOR COMPLETION: All contract work must be completed by the middle of the 24th week after the Notice to Proceed.

STEP 1: Use of contemporaneous documents for sequence and timing

2. Correspondence between the general contractor and the owner or owner's representative

- ❖ The **correspondence** for **references** to **sequence** or **timing**, **even if** only for a **portion** of the project.
- ❖ *The Contractor planned to work from east to west, or from abutment #1 to abutment #2, and from pier #1 to pier #3.*

June 15, 2007

John Lewis
Owner's Representative
Job Trailer
West Street Bridge
Podunk, New York 00001

**June 15, 2007 contractor
correspondence**

Dear Mr. Lewis:

As we discussed yesterday during our meeting, we plan to work our construction operations on the West Street Bridge from an east to west direction. In other words, we will construct abutment #1 first and then abutment #2. Our paving of our approaches will follow the same sequence.

Similarly, our operations on the piers will progress from east to west direction, starting with pier #1 and progressing through pier #3.

I trust this answers the question you raised, and you can notify the Township authorities accordingly so they may effect the appropriate detours during the course of the project.

Sincerely,
Joe Super
Ace Construction



STEP 1: Use of contemporaneous documents for sequence and timing

فرآیند جامع آنالیز تاخیرات در پروژه

آنالیز زمانی تاخیرات: آنالیز تاخیرات در شرایطی که برنامه زمانبندی وجود ندارد!

August 20, 2007

Mr. Joe Super
Ace Construction
Job Trailer/West Street Bridge
Podunk, New York 00001

August 20, 2007 owner correspondence

Dear Mr. Super:

Returned herein are the shop drawings submitted by Ace Construction for the reinforcing steel for the pier caps. As you will note, the drawings are approved as noted. Fabrication of the reinforcing steel can begin in accordance with the corrections noted.

I must note these drawings are being returned to you five weeks later than you requested. There are two reasons why the return of the shop drawings is five weeks beyond your requested date. First, you did not allow the engineer adequate time to review the drawings. As a minimum, the engineer requires three weeks to review, but you allowed only one week if they were to be returned within the time frame requested.

Second, the drawings were not prepared in accordance with normal shop drawing practices and consequently required much more time to review. As submitted, the drawings were extremely difficult to understand. While the engineer could have returned them disapproved and required resubmission in the proper manner, it was decided to take the extra time to correct them on the first submission in order to expedite the process.

If you have any questions, please feel free to call.

Sincerely,
John Lewis
Owner's Representative

❖ The Owner's representative noted that the review and approval of the shop drawings for the reinforcing steel in the pier caps had taken longer than required and were not returned to the Contractor until five weeks later than requested.

STEP 1: Use of contemporaneous documents for sequence and timing

3. Subcontract agreements

- ❖ Subcontract agreements to look for **any sequence** or **timing** dictated to the subcontractors by the **general contractor** concerning specific **subcontract work**.

STEP 1: Use of contemporaneous documents for sequence and timing

4. Correspondence with subcontractors

- ❖ Correspondence with subcontractors for **any discussion** concerning schedules, sequence, or timing.

June 25, 2007

- ❖ *The Contractor planned on erecting the steel at the beginning of the 13th week of the Project*

Mr. Grey Ferrous
Ferrous Steel Erectors
Iron Street
Steeltown, New York 00002

June 25, 2007 correspondence to subcontractor

Dear Mr. Ferrous:

In accordance with our previous conversations, Ace Construction will require the delivery and erection of the steel for the West Street Bridge to begin by the beginning of the 13th week of the project. Based on your present fabrication schedule, it appears that this should not be a problem.

Please be advised that time is of the essence on this contract. In the past, we have had problems with steel suppliers promising delivery dates and not adhering to them. Action such as this will not be tolerated on this project. Your delivery and erection of steel is critical to our timely completion of the project.

Sincerely,
John Lewis
Owner's Representative

STEP 1: Use of contemporaneous documents for sequence and timing

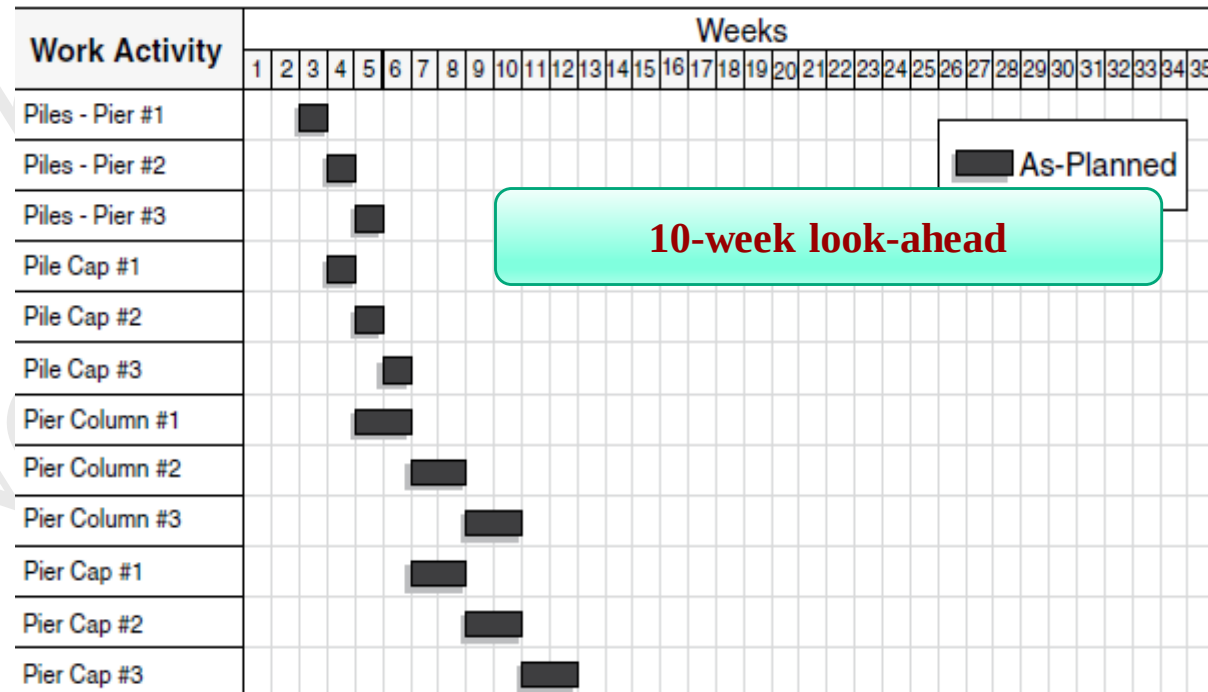
5. Partial schedules produced during the project

- ❖ Partial schedules produced during the project, which may describe any planned sequence or timing for **portions of the project**.

❖ The Contractor produced at least one ten-week “look-ahead” schedule that addressed the work on the piers and described the specific sequence for this work, including the piles, pile caps, pier columns, and pier caps

West Street Bridge

Partial Schedule - 10-Week Look-Ahead - Pile & Pier Work



STEP 1: Use of contemporaneous documents for sequence and timing

6. Meeting minutes

❖ Meeting minutes for **any discussions** concerning **scheduling**, particularly the **preconstruction meeting minutes**.

❖ The Contractor anticipated a two-week duration for the forming, **reinforcing**, and **placing of** each of the concrete deck spans

Pre-construction meeting minute

Contractor noted that the forming, reinforcing, and placing of the concrete deck spans will take two weeks per span. Contractor will proceed from east to west constructing span #1 through span #4.

STEP 1: Use of contemporaneous documents for sequence and timing

7. Daily log or diary entries by either the general contractor's personnel or the owner's representative

- ❖ *The Contractor expected four-week durations for each of the **abutments** and two-week durations for each of the **approaches**.*

Inspector's Daily Diary (Excerpt)

Daily diary

During discussion today with Joe Super (Ace Construction), he noted that the abutment work would take about four weeks to perform for each abutment, and the paving of the approaches would take about two weeks for each side of the bridge. Joe noted that the existing abutment sills are acceptable as shown on the contract drawings. Therefore, they can accept the steel as is. The remainder of the work on the abutments can be performed either before the steel is in place or after it is set. He is going to try to have the abutments completed before he sets any steel, since the work will be easier that way. However, he is concerned about the lead time allowed for obtaining the epoxy material called for in the contract. He said that, if necessary, he would set the steel so as not to delay the deck work that he feels controls his completion of the job.

STEP 1: Use of contemporaneous documents for sequence and timing

8. Purchase orders with suppliers

- ❖ **Purchase orders with suppliers** that show **planned dates for delivery** of materials or equipment.

STEP 1: Use of contemporaneous documents for sequence and timing

Conclusion based on the information reviewed

1. The contract required that all abutment work be completed before any paving was performed on the approaches. The contract also required that completion of the project occur by the middle of the 24th week *(from Fig. 1)*.
2. The contractor planned to work from east to west, or from Abutment #1 to Abutment #2, and from Pier #1 to Pier #3 *(from Fig. 2)*.
3. The owner's representative noted that the review and approval of the shop drawings for the reinforcing steel in the pier caps had taken longer than required and were not returned to the contractor until 5 weeks later than requested *(from Fig. 3)*.
4. The contractor planned on erecting the steel at the beginning of the 13th week of the project *(from Fig. 4)*.
5. The contractor produced at least one, 10-week "look-ahead" schedule that addressed the work on the piers and described the specific sequence for this work, including the piles, pile caps, pier columns, and pier caps *(from Fig. 5)*.
6. The contractor anticipated a 2-week duration for the forming, reinforcing, and placing of each of the concrete deck spans *(from Fig. 6)*.
7. The contractor expected 4-week durations for each of the abutments and 2-week durations for each of the approaches *(from Fig. 7)*.

STEP 1: Use of contemporaneous documents for sequence and timing

❑ The **analyst** should use **all the available information** to:

1. **Define** some form of an **as-planned schedule** or
2. **Establish** a **general sequence**

for the **work** on the Project for **different points** or **portions** of the Project.

*Based on **this information**, the analyst can proceed with the analysis, **despite the lack** of a complete **as-planned schedule**.*

STEP 1: Use of contemporaneous documents for sequence and timing

- ❑ Keep in mind that the **goal is not** to prepare an **“alternative” or “after-the-fact” baseline** or **new as-planned schedule** for the project.
 - ❖ Rather, the goal is to **mine the project information** in search of the **contractor’s original plan** for construction.
- ❑ To the extent a “planned” schedule is **drafted as the basis of the analysis**, it should be done so with
 1. Only the information that can be gleaned from **project documents**, such as the examples outlined in this course,
 2. **Mandatory sequencing** dictated by the physical construction attributes and conditions.
 3. **Understanding** that the as-planned is **incomplete and limited** in terms of its **precision**.

STEP 2: Use Of As-built Analysis To Quantify Delays

STEP 2: Use of as-built analysis to quantify delays

- ☐ Although no updated schedules exist for this Project, **detailed daily reports** do exist.
- ☐ Daily reports allow the analyst to prepare an as-built diagram for the job.



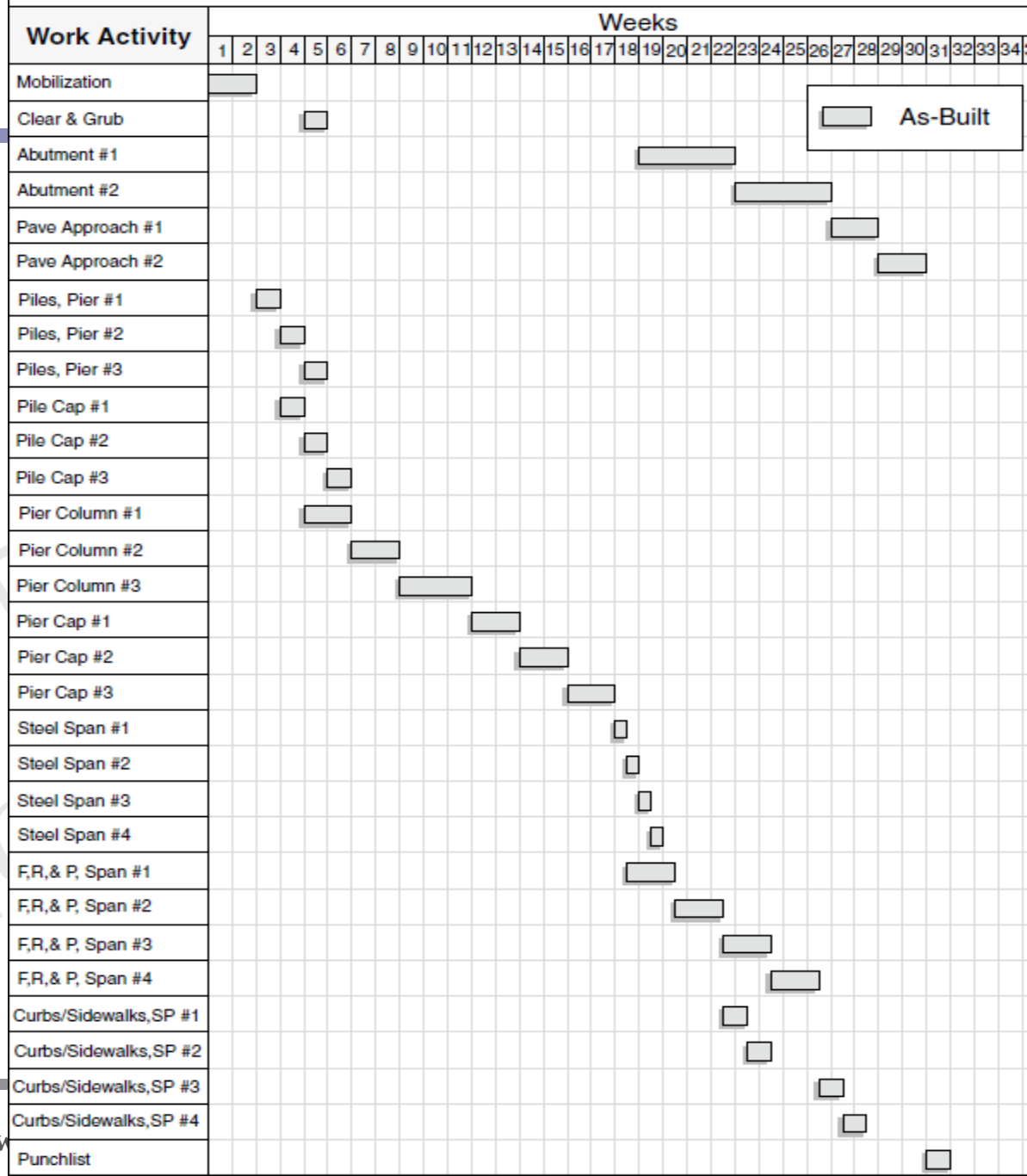
STEP 2

❑ In reviewing the as-built diagram, the first obvious conclusion is that the Project was **delayed seven and one-half weeks**.

❖ It was to be completed by the middle of the 24th week but was **not actually finished** until the end of the 31st week.

❖ *This is net delay*

West Street Bridge
As-Built Steel Diagram Based on Daily Reports



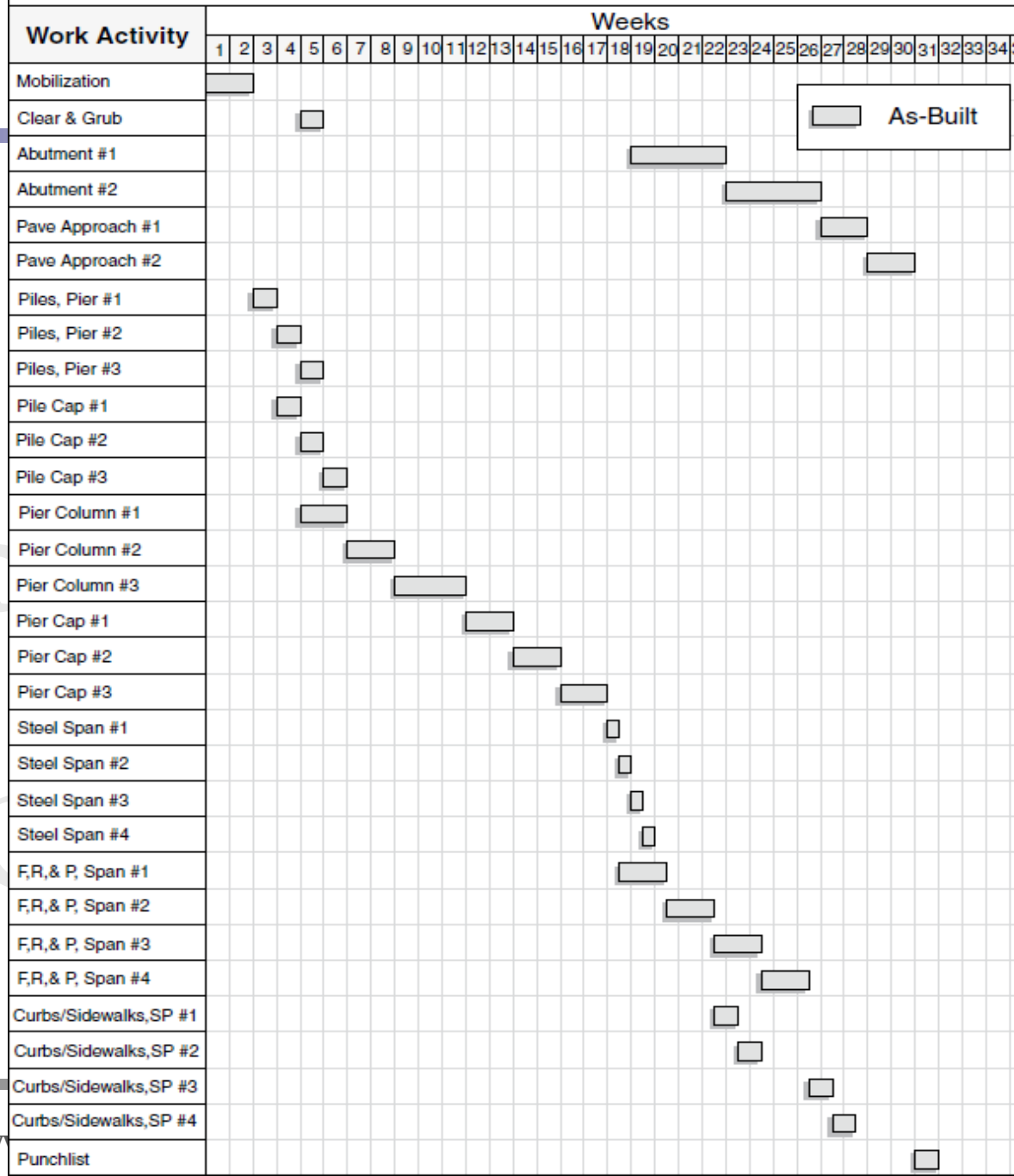


STEP 2

- ❑ Analyst must account for at least **seven and one-half weeks of net delay**.
- ❑ The delay **could**, in fact, be **greater if** the Contractor had planned to **finish** the Project **early**.
 - ❖ However, **no such plans** were indicated in the **Project correspondence**, so this **assumption** will **not be made**.
- ❑ The **as-built diagram** also shows that the **Contractor did work** from **east to west as planned**.

West Street Bridge

As-Built Steel Diagram Based on Daily Reports





STEP 2

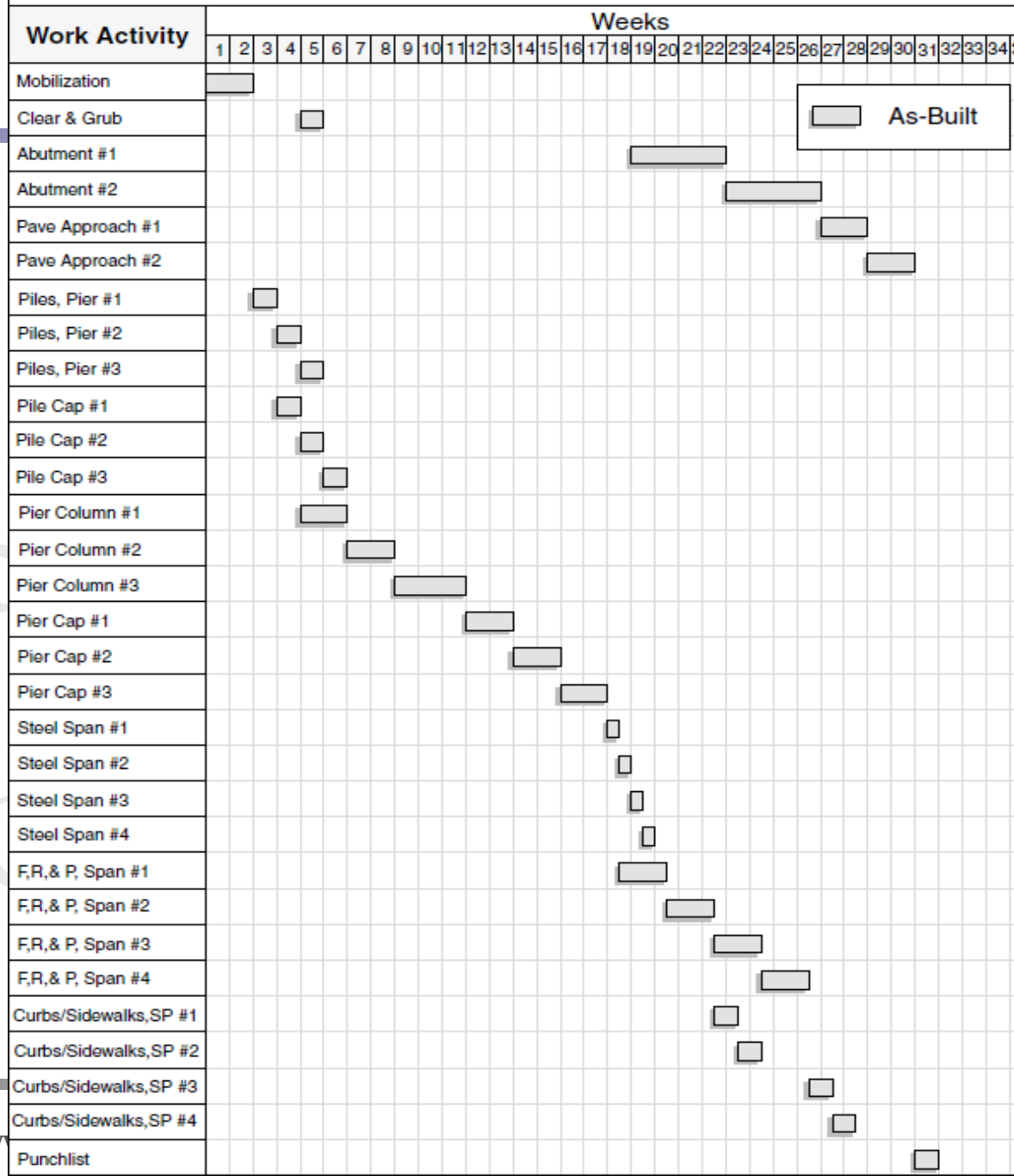
❑ Based on the **letter** to **Ferrous Steel Erectors**, the Contractor planned to **start steel erection** at the beginning of the **13th week**.

❑ The **as-built diagram** shows that **steel erection** began at the **beginning** of the **18th week**.

*A five-week delay can be identified for the **start of the steel erection**.*

West Street Bridge

As-Built Steel Diagram Based on Daily Reports

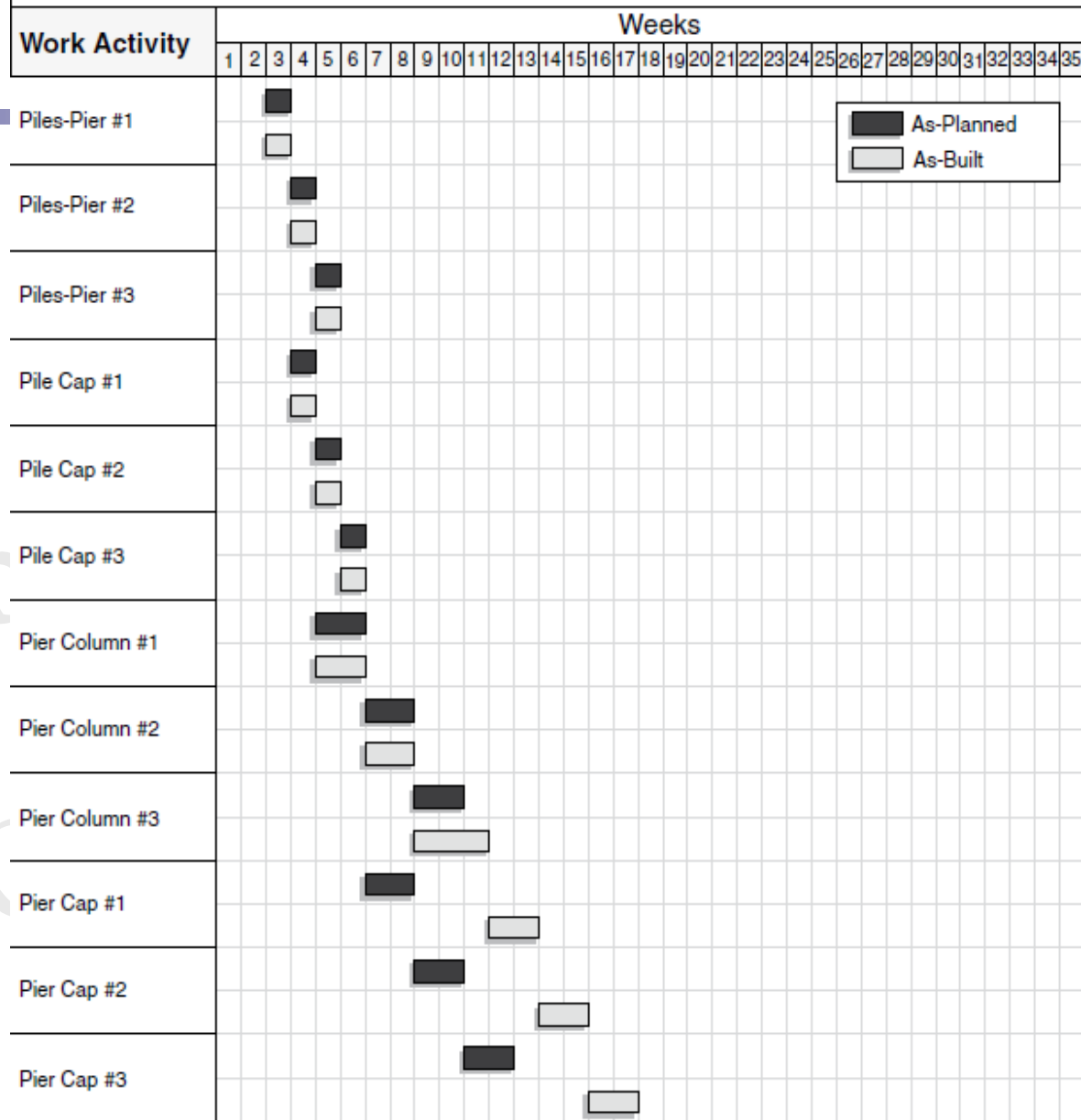


STEP 2

❑ **Analyst** breaks down the activities that **precede** the start of steel erection.

❑ **Analyst** uses the **ten-week** “look-ahead” schedule, which the **Contractor** produced at the **end of the second week** of the Project.

West Street Bridge Comparison of Partial Look-Ahead Schedule and As-Built Diagrams



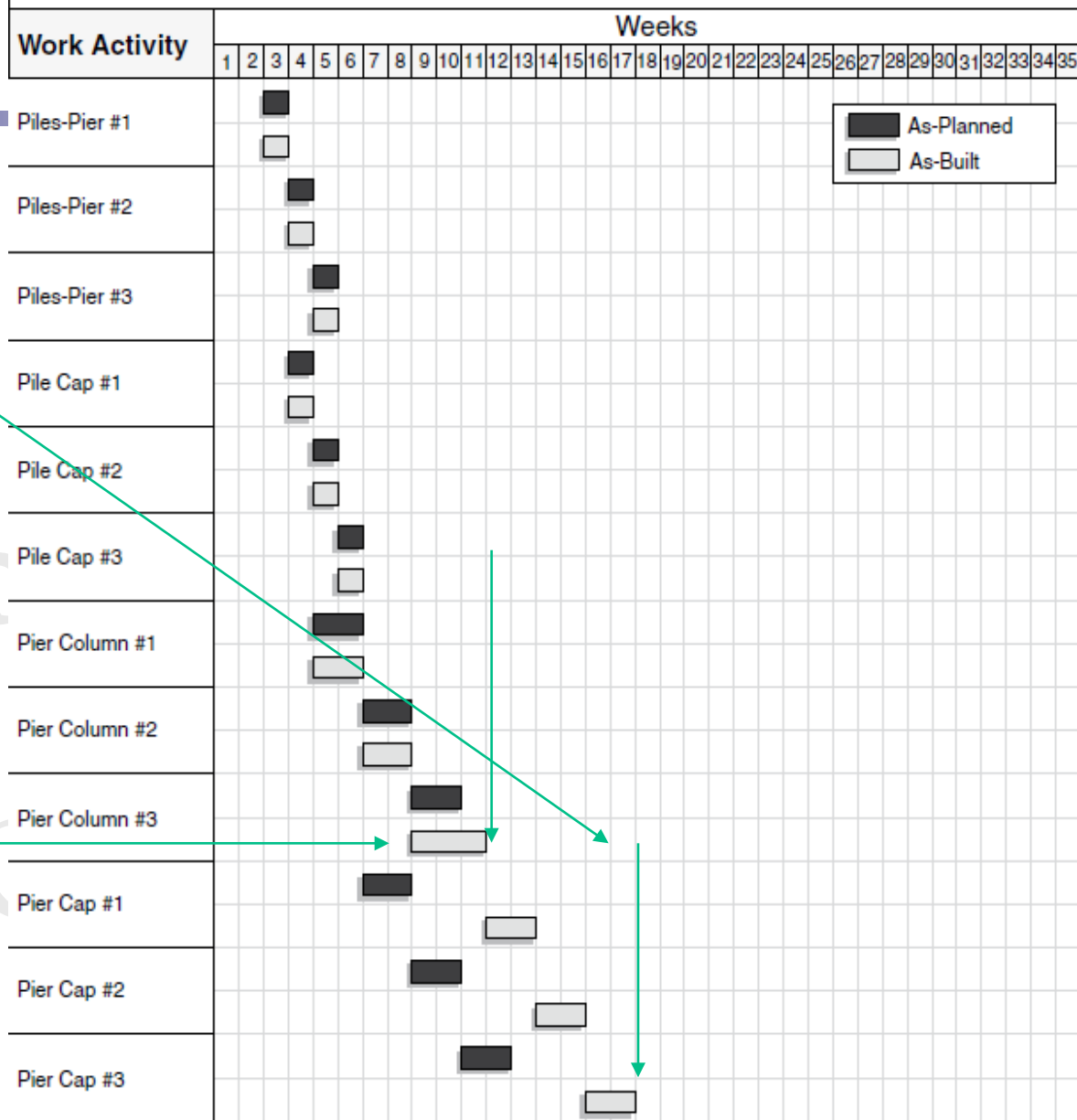
STEP 2

- ❑ A **comparison** shows that a **delay** occurred to the **construction of the pier caps**.

- ❑ A **delay** also appears in the **construction of pier column #3**, which took **three weeks instead of two weeks** to complete.

Is it the first critical delay?

West Street Bridge Comparison of Partial Look-Ahead Schedule and As-Built Diagrams

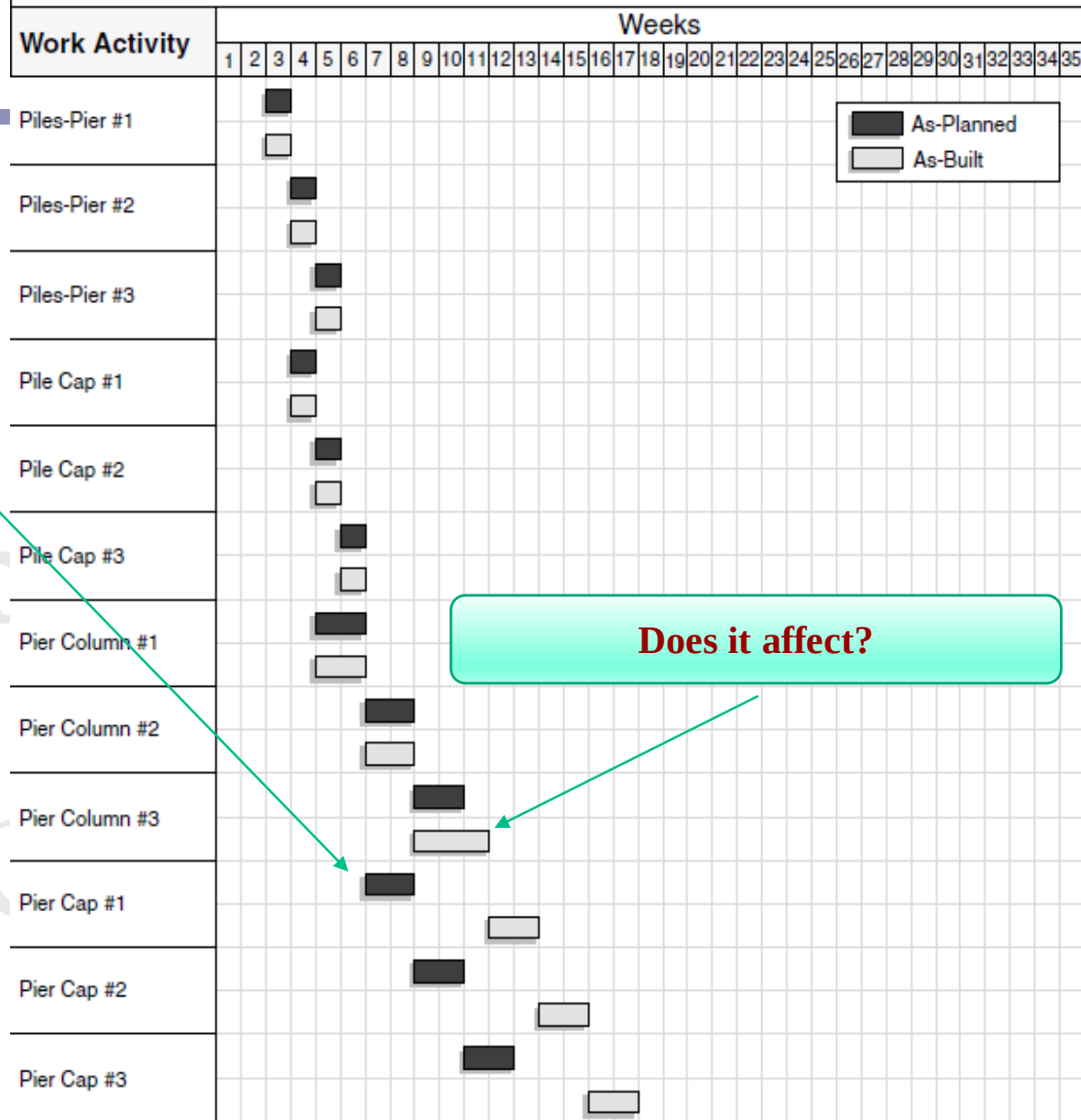


STEP 2

❑ A **comparison** shows that the **controlling delay** was the **delay to the Pier Cap #1.**

❑ This may have been the **result** of the **five-week delay** in approval of the **shop drawings** to which the **Owner's representative** had referred in **correspondence** **(Fig. 2).**

West Street Bridge Comparison of Partial Look-Ahead Schedule and As-Built Diagrams

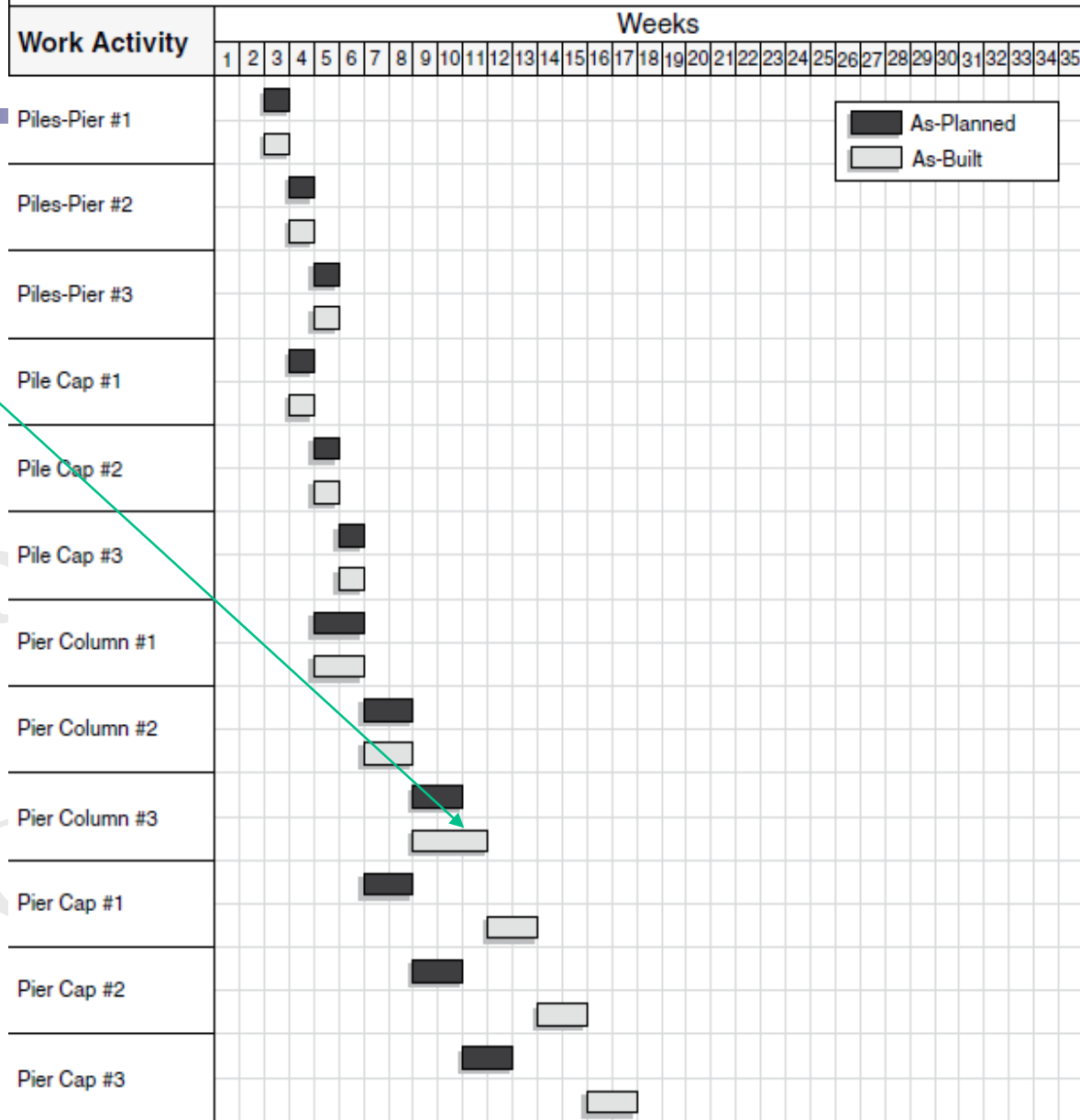


STEP 2

❑ It does **not** appear that the delay in the **completion of pier column #3** affected the **completion of the Project**.

❑ The **remainder of the work** along the **pier/deck path** appears to have been performed in a **logical, sequential fashion** and does **not** indicate **further delay**.

West Street Bridge Comparison of Partial Look-Ahead Schedule and As-Built Diagrams





- There is, **however**, a **gap** between the **completion** of the **curbs** and **sidewalks** and the **beginning** of the **punch list work**.

- ❑ The punch list work did **not start until** the **abutments** and **approaches** were completed.





- The delay of seven and one-half weeks is from:
- (1) Five weeks of delay to the start of the pier cap work.
 - (2) Two and one-half weeks of delay to the start of the abutment/approach work.



موسسه مهندسی و مدیریت ساخت علوی پور (ACEMI)

دفتر آموزش



تهران، بلوار فردوس شرق، مجتمع آبگینه، طبقه سوم اداری، واحد C42



+۹۸ ۲۱ ۴۶ ۱۰۰ ۴۴۵



+۹۸ ۲۱ ۴۶ ۱۰۰ ۴۵۰



info@dralavipour.com



www.dralavipour.com



@alavipour_pm



@acemi_social



@alavipour_pm



@IRANACEMI

