



فرآیند جامع آنالیز تاخیرات در پروژه

بخش نهم:
آنالیز زمانی تاخیرات

آنالیز زمانی تاخیرات بعد از وقوع تاخیر و اختلاف
(After-the-Fact Schedule Analysis)

ارائه دهنده:

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What we will learn?

- ❑ After-the-Fact schedule analysis
 - ❖ Concepts
 - ❖ Retrospective IAP and TIA
 - ❖ Time slice windows analysis (TSWA)
 - ❖ As-planned vs. as-built windows analysis (APAB)
 - ❖ Retrospective longest path analysis (RLPA)
 - ❖ Collapsed as-built analysis (CAB)
- ❑ How to choose the methods?
- ❑ The most three types of logic
- ❑ Effects of three logic types on delay analysis

After-the-Fact Schedule Analysis

(Concepts)

Why after-the-Fact schedule analysis needed?

- ❑ Contractors frequently **assert** that they have been **delayed** for reasons **beyond** their control.
- ❑ Owners often remain **unconvinced** that the Contractor is legitimately entitled to a **time extension or delay, acceleration** and **loss of productivity damages**.
- ❑ **Large dollar amounts** may **hinge** upon the **outcome of a dispute** over project delay.

Consequently, a **thorough** retrospective schedule analysis of all project delays is essential for the **equitable resolution** of delay and impact-related **construction disputes**.

Why after-the-Fact schedule analysis needed?

❑ **Owner** may be **contractually** entitled to **recover either**:

1. **Liquidated damages** for delay caused by the contractor
2. **Actual damages** for delay caused by the contractor



Observational vs. Modeled

❑ Forensic schedule analyses generally can be **classified** into two types of methodologies:

1) Observational

❖ Observational techniques typically **consist** of using

(1) contemporaneous schedules + (2) **only modifications** for obvious and significant errors.

2) Modeled

❖ Modeled techniques **include**

(1) addition or subtraction of **activities** and or (2) logic to **model impact events**.

Do we need to change and correct the schedule even **after-the-fact**?

Why after-the-Fact schedule analysis needed?

❑ The **Prospective methods** of delay analysis may **no longer** be **appropriate** if the **delay** already **occurred**.

❖ **CP 4** should **not be used** in this case

✓ Then, there should be a **provision** that **addresses** the consideration of EOT applications:

1. **After completion of works**
2. **After the occurrence of delay events or its impact**

Contracts should include provisions as to what procedure should be used when delays already occurred.



Changing schedules after-the-fact

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

❑ Courts and boards typically attach a presumption that **contemporaneous CPM** schedules are **correct** and

schedules should be **presumed correct** unless otherwise shown to be

inaccurate. See, e.g., *Appeal of Santa Fe, Inc.*, VABCA No. 2168, 87-3 B.C.A. (CCH) ¶ 20104 (Aug. 25, 1987) “We do not find that the November revisions were necessary to “correct” the October CPM. Rather, the November CPM merely reflected a different plan for further prosecution of the work which differed from the previous plan. However, the adoption of an alternate method of performance in the later CPM does not, of itself, contradict the existence of a delay as shown in the preceding CPM. There is a rebuttable presumption of correctness attached to CPM’s upon which the parties have previously mutually agreed. In the absence of probative evidence, not present in this appeal, that the delay shown was not in fact sustained we will rely on the October CPM for the period it was in effect, i.e., through the end of November 1981. For the subsequent period, we will rely on the November CPM. To put it another way, in the absence of compelling evidence of actual errors in the CPM’s, we will let the parties ‘live or die’ by the CPM applicable to the relevant time frames.”





Changing schedules after-the-fact

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

❑ Changes to schedules made after the fact, such as **after project completion**, should be **limited to special circumstances**.

❖ Changes to the schedules may include changing

1. Activity durations,
2. Logic,
3. As-built dates,
4. Constraints, or
5. Other schedule information often kept in the schedule software.

When **changes** may be appropriate?



Changing schedules after-the-fact

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

- ❑ When **significant errors** are found in the schedule, **after-the-fact schedule** adjustment to fix the errors **may be allowable**.

See, e.g., *Neal & Company, Inc. v. U.S.*, 36 Fed. Cl. 600 (1996) analysis accepted where government's expert prepared a new baseline schedule after the project to add in logic ties for labor that were missing, then re-updated the schedule.



Changing schedules after-the-fact

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

- ❖ For example, logic errors, missing scope, or palpable incorrect durations may have to be **adjusted** before utilizing the schedule for **delay analysis purposes**.

See, e.g., *Appeals of States Roofing Corp.*, ASBCA No. 54860, 10-1 B.C.A. (CCH) ¶ 34356 (Jan. 12, 2010) “In any event, the credible evidence supports the finding that the adjustments [contractor’s expert] made were exactly as he described them: minor corrections to logic errors relating to submittals. The Navy did not dispute that there were such logic errors in the schedule and, to the extent there were, we consider correction of them to be in keeping with good scheduling practices.”);

Which logic should be corrected?
Should we also change **discretionary constraints?**



Changing schedules after-the-fact

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

10.5 Changes to schedules generally may be made to correct necessary physical or contractual constraints

but typically **not** the contractor's preferential sequencing

*CPM schedules generally should be **modified** only after the fact to correct errors in physical constraints or contractual constraints*

The burden of proof of changing lies with whom?



Changing schedules after-the-fact

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

- ❑ Burden of proof of changing the schedules after they are prepared and used during the project

lies with the **party making the changes**.

As a result, any changes made after the fact should be made with good justification and be carefully documented and explained.

See, e.g., *J. A. Jones Construction Co.*, ENGBCA No. 6252, 97-1 B.C.A. ¶ 28,918 (1997) “The more a contractor departs in litigation from its contemporaneously-prepared schedules, the greater the need to explain and justify the reasons and assumptions underlying such departures.”

So, let's look at the FSA methods?





FSA methods

- ❑ There are several industry accepted methodologies for **forensic schedule analysis**.
- ❑ **SCL** says **four forensic** methods
- ❑ **AACE** says **nine forensic** methodologies
- ❑ **Others** say **seventeen or more**
- ❑ **An argument** could be made for a **near infinite number**
- ❑ We will discuss **major types**

In order to **avoid** or at least **minimize disputes** over methodology, it is recommended that the **parties** try to **agree** an appropriate method of **delay analysis** for both contemporaneous and after-the-fact.

FSA methods – SCL Protocol

Method of Analysis	Analysis Type	Critical Path Determined	Delay Impact Determined	Requires
Time Slice Windows Analysis	Effect & Cause	Contemporaneously	Retrospectively	- Logic linked baseline programme. - Update programmes or progress information with which to update the baseline programme.
As-Planned versus As-Built Windows Analysis	Effect & Cause	Contemporaneously	Retrospectively	- Baseline programme. - As-built data.
Retrospective Longest Path Analysis	Effect & Cause	Retrospectively	Retrospectively	- Baseline Programme. - As-built programme.
Collapsed As-Built Analysis	Cause & Effect	Retrospectively	Retrospectively	- Logic linked as-built programme. - A selection of delay events to be modelled.

FSA methods - AACE RP29R-03

Observational	As-Planned As-Built	Gross	As-Planned vs. As-Built (MIP 3.1)
		Periodic	As-Planned vs. As-Built (MIP 3.2)
	Contemporaneous Period Analysis (Windows)	Contemporaneous As-Is	Contemporaneous Period Analysis (MIP 3.3)
		Bifurcated Contemporaneous	Bifurcated CPA (MIP 3.4)
		Recreated / Modified	Recreated CPA (MIP 3.5)
Modeled	Time Impact Analysis	Single Base	Impacted As-Planned (MIP 3.6)
		Multiple Base	Retrospective TIA (MIP 3.7)
	Collapsed As-Built	Single Simulation	Collapsed As-Built (Single) (MIP 3.8)
		Multiple Simulation	Collapsed As-Built (Multiple) (MIP 3.9)

FSA methods – Comparison

The Information Required					
	Baseline programme	Logic linked baseline programme	As-built data	Delay events to model	Up to date programmes/ process information
Time Slice Windows					
As-Planned v As-Built Windows					
Longest Path					
Collapsed As-Built					
The table above shows the evidence required for each delay analysis method. The table has been simplified.					

After-the-Fact Schedule Analysis

(Retrospective IAP and TIA)

Retrospective time impact analysis – Definition

- ❑ AACE Talks about this **method**
- ❑ Very **similar** to **prospective time impact analysis**
- 1. **Baseline** can be **used** for this analysis (**Impacted as-planned**)
- 2. **Contemporaneous update** can be **used** for this analysis (**Retrospective time impact analysis**)
- ❖ AACE **method implementation protocol (MIP) 3.7 and 3.8** say:
 - ✓ **Impacted as-planned** is less accurate than **retrospective time impact analysis**.

Retrospective time impact analysis – How to use?

1. Take a **contemporaneous schedule** and **revise** it based on **actual** situation = **As-built**
2. Take a **delay event**
3. Use its **actual duration** (**start** and **finish** times)
4. Insert **actual duration** and a **delay event** into the **contemporaneous schedules** that is **revised to date = As-built**
5. Show that event's alleged **impact** on the **contractor's update**.

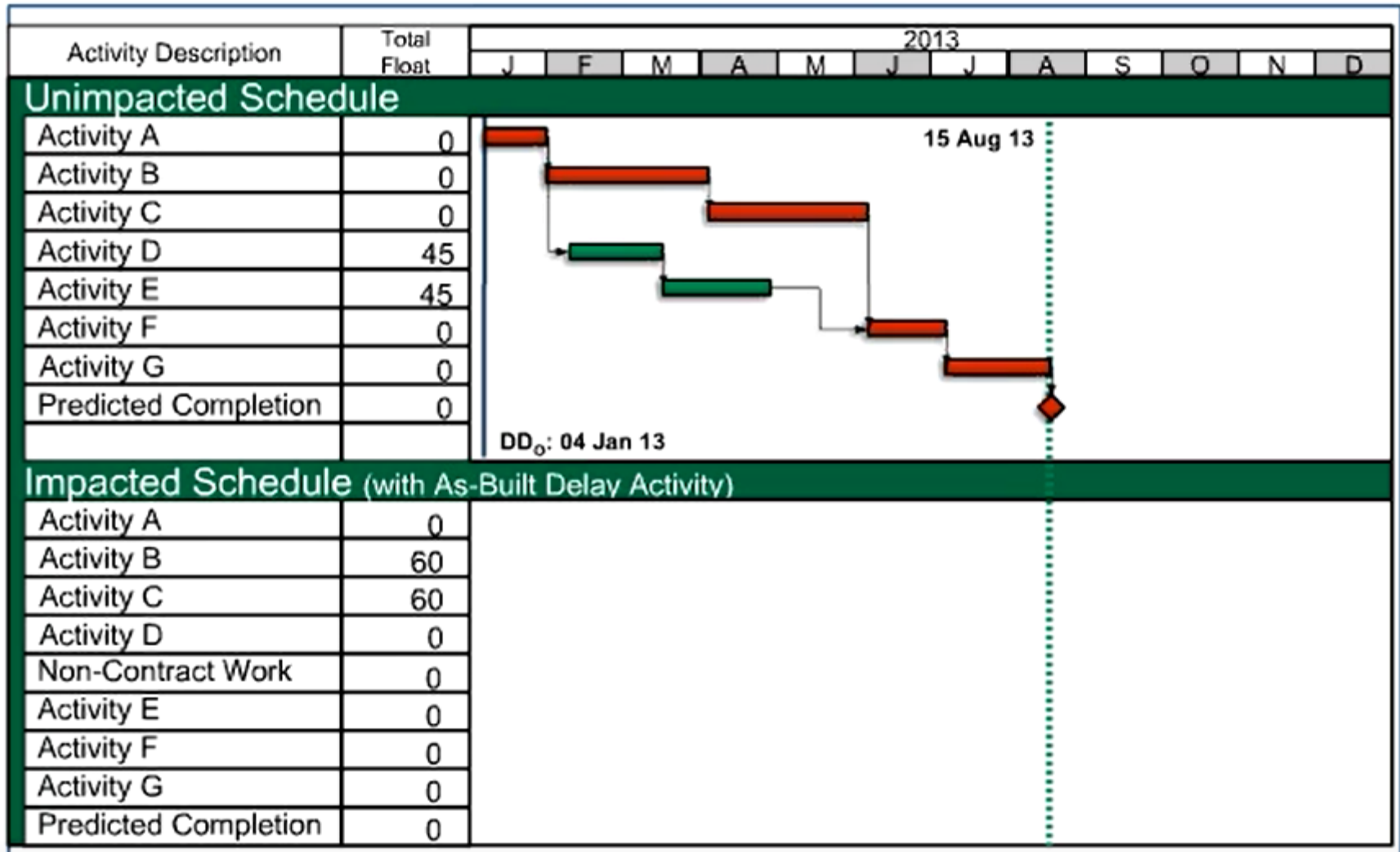
Unimpacted Schedule

- Impacted As-Planned uses the original baseline schedule as the unimpacted schedule.
- TIA typically uses one of the updated schedules, though implementations vary..

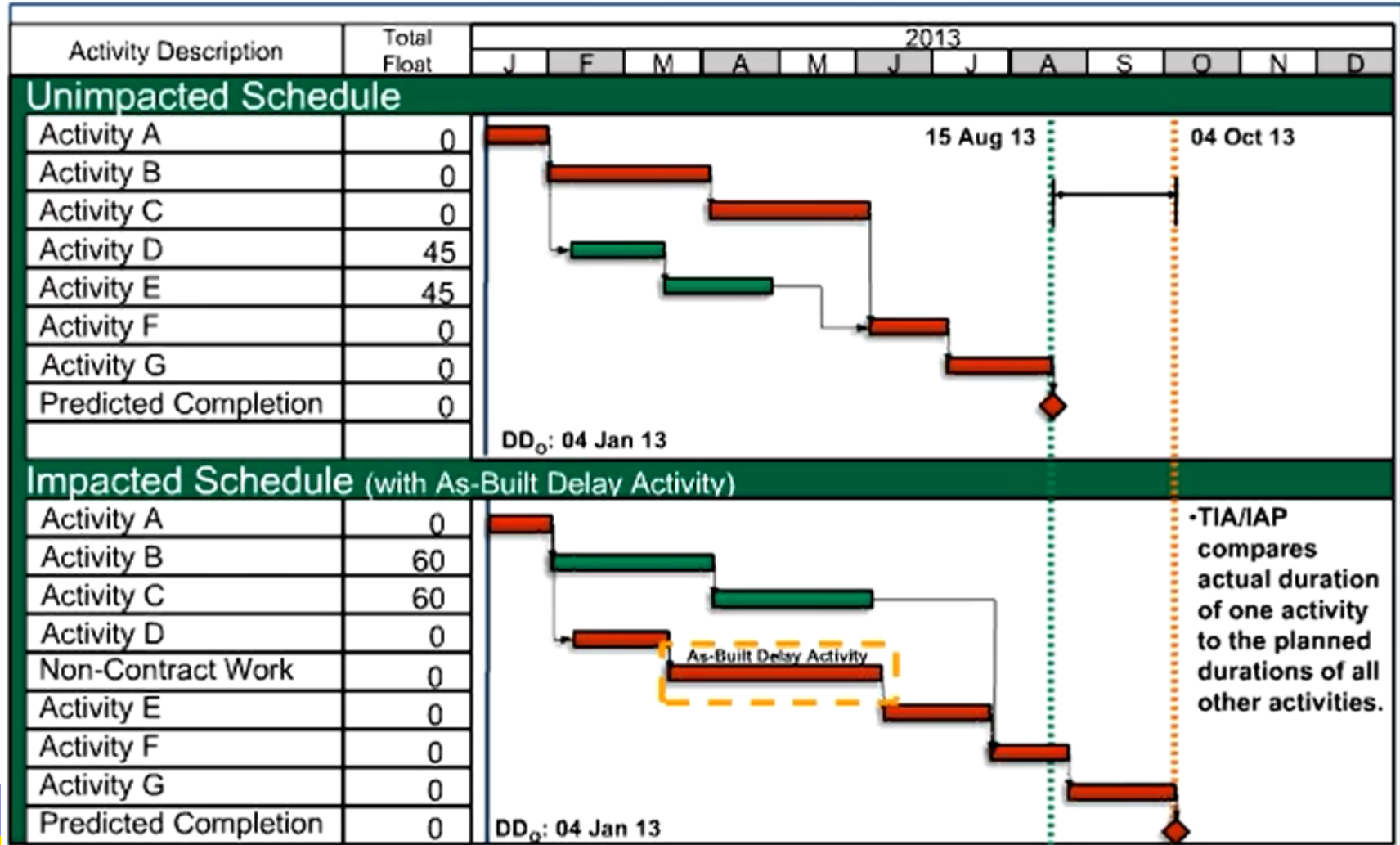
Impacted Schedule

- Schedule with an identical data date, and which is logically identical to the Unimpacted Schedule, except for the As-Built Activity.
- As-Built Activity is inserted into the network, logically tied into the impacted activity.

Retrospective time impact analysis – Example



Retrospective time impact analysis – Example



Retrospective time impact analysis – Example

General Information

Project Planned Start Date : 12, March, 2012.

Project Planned Finish Date : 22, April, 2013.

Available Updates Programme : 4 Programme



Retrospective time impact analysis – Example

- ❑ This has not been performed event by event because we don't know whether EDE or CDE occurred first in many places! **NON-INTEGRATED**

How to handle **concurrent delays**?

Window Technique – Case study- Window 0

Window	Window Start (1)	Window Finish (2)	Window Duration (3) = 2-1	Prog.	Source Programme	Project Finish date	Delay		Total Entitlement
							Contractor	Employer	
W0	10-Mar,2012	10-Apr,2012	31	P0	Appr. Baseline A.01	22, April, 2013	0	0	
				P1	P0+Delay Events	13, May, 2013		21	
				P2	P1+Progress update on DD	14, May, 2013	1	+	
Total Window Entitlement									22

Retrospective time impact analysis – Example

Window Technique – Case study- Window 1

Window	Window Start (1)	Window Finish (2)	Window Duration (3) = 2-1	Prog.	Source Programme	Project Finish date	Delay		Total Entitlement
							Contractor	Employer	
W1	11-Apr,2012	31-Dec,2012	264	P3	Approved P2	14,May, 2013	0	0	
				P4	P3+Delay Events	25,May, 2013		11	
				P5	P4+Progress update on DD	3,Jun , 2013	9	+	
Total Window Entitlement									20

Retrospective time impact analysis – Example

Window Technique – Case study- Window 2

Window	Window Start (1)	Window Finish (2)	Window Duration (3) = 2-1	Prog.	Source Programme	Project Finish date	Delay		Total Entitlement
							Contractor	Employer	
W2	1,Jan,2013	1,Feb,2013	264	P6	Approved P5	3,Jun , 2013	0	0	
				P7	P6+Delay Events	9,July, 2013		36	
				P8	P7+Progress update on DD	21,July, 2013	12	+	
Total Window Entitlement									48

Retrospective time impact analysis – Example

Window Technique – Case study- Window 3

Window	Window Start (1)	Window Finish (2)	Window Duration (3) = 2-1	Prog.	Source Programme	Project Finish date	Delay		Total Entitlement
							Contractor	Employer	
W3	2, Feb, 2013	22, Apr, 2013	79	P9	Approved P8	21, July, 2013	0	0	
				P10	P9+Delay Events	15, Aug, 2013		25	
				P11	P10+Progress update on DD	15, Sep., 2013	31	+	
Total Window Entitlement									56

Retrospective time impact analysis – Example

Window Technique – Case study- Summary

Window	Window Start	Window Finish	window Duration	Programme	Programme	Project Finish Date	Delay		Total Entitlement
							Contractor Delay	Employer Delay	
Window 0	10-Mar-12	10-Apr-12	31	P0	Approved BaseLine	22-Apr-13	0	0	
				P1	P0+Delay Events	13-May-13		21	
				P2	P1+Progress update on DD	14-May-13	1		22
window 1	11-Apr-12	31-Dec-12	264	P3	Approved P2	14-May-13			
				P4	P3+Delay Events	25-May-13		11	
				P5	P4+Progress update on DD	3-Jun-13	9		20
Window 2	1-Jan-13	1-Feb-13	31	P6	Approved P5	3-Jun-13			
				P7	P6+Delay Events	9-Jul-13		36	
				P8	P7+Progress update on DD	21-Jul-13	12		48
Window 3	2-Feb-13	22-Apr-13	79	P9	Approved P8	21-Jul-13			
				P10	P9+Delay Events	15-Aug-13		25	
				P11	P10+Progress update on DD	15-Sep-13	31		56
Total Entitlement							53	93	146

Retrospective time impact analysis – Pros and cons

- ✓ **Specifically designed** to measure project delay caused by **added or changed** work that was **not included in the project schedule**.
- ✓ **Sisters** to prospective time impact analysis
- ✓ Recognized by **Federal boards** in USA
- ✓ Can be **acceptable** analysis solution for **complicated networks**

Retrospective time impact analysis – Pros and cons

- × Can be **extremely complicated**
- × Subject to excessive **expert decision making**
- × Susceptible to **unintended or intended manipulation**
- × **Extremely sensitive** to the order of **fragnet insertion**
- × **True concurrency** and **primacy of delays** may be **ignored**
- × **Nature or cause** of the delay.
 - × Some delays may be caused by the **addition of work**
 - × **Suspension delays** occur because work cannot occur.
 - × **Despite this difference**, the Retrospective TIA treats these causes of delay the same.

Retrospective time impact analysis – When to use?

☐ When there are

1. Logic linked baseline schedule
2. Delay events to model
3. Contemporaneous schedules with process information

*In summary, the Retrospective TIA, though widely used, is problematic on many levels. If used, it should be used with **great caution**.*

After-the-Fact Schedule Analysis

(Time Slice Windows Analysis (TSWA))

FSA methods

Method of Analysis	Analysis Type	Critical Path Determined	Delay Impact Determined	Requires
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FSA methods

The Information Required					
	Baseline programme	Logic linked baseline programme	As-built data	Delay events to model	Up to date programmes/ process information
Time Slice Windows					
As-Planned v As-Built Windows					
Longest Path					
Collapsed As-Built					
The table above shows the evidence required for each delay analysis method. The table has been simplified.					

Time slice windows analysis – Definition

- ❑ Also referred to “snapshot”, “windows” and “contemporaneous period” analysis
- ❑ Commonly used observational method
- ❑ It requires a **reliable series** of contemporaneously updated baseline (TIME SLICES) schedules reflecting an accurate status of the works at various snapshots (**being the time slices**).
- ❑ **Most experts** say that this is the most accurate method.

Why?

Time slice windows analysis – Definition

❑ SCL Protocol:

❖ The series of time slice programmes reveals

1. Contemporaneous or actual critical path in each time slice period as the works progressed and
2. Critical delay status at the end of each time slice, thus allowing the analyst to conclude the extent of actual critical delay incurred within each window.

Thereafter, the analyst investigates the project records to determine what events might have caused the identified critical delay in each time slice period.

Time slice windows analysis – Definition

- ❑ AACE method implementation protocol (MIP) 3.3, 3.4 and 3.5 say:
 - ❖ **Most often** performed **after project completion (retrospective)**, but **can** be done while project is **ongoing** as well.
 - ❖ **Compares two schedules** with **successive data dates** in order to determine the **driving critical activities**.
 - ❖ **Relies heavily** on the **contemporaneous** understanding of **criticality**
 - ✓ Because **every time** the **critical path** may **change**

Time slice windows analysis – How to use?

Pre-impact Schedule

- Most recently accepted schedule with a data date prior to the event.
- Schedule may also be updated to the day prior to the event.
- Does not contain the fragnet.

Post-impact Schedule

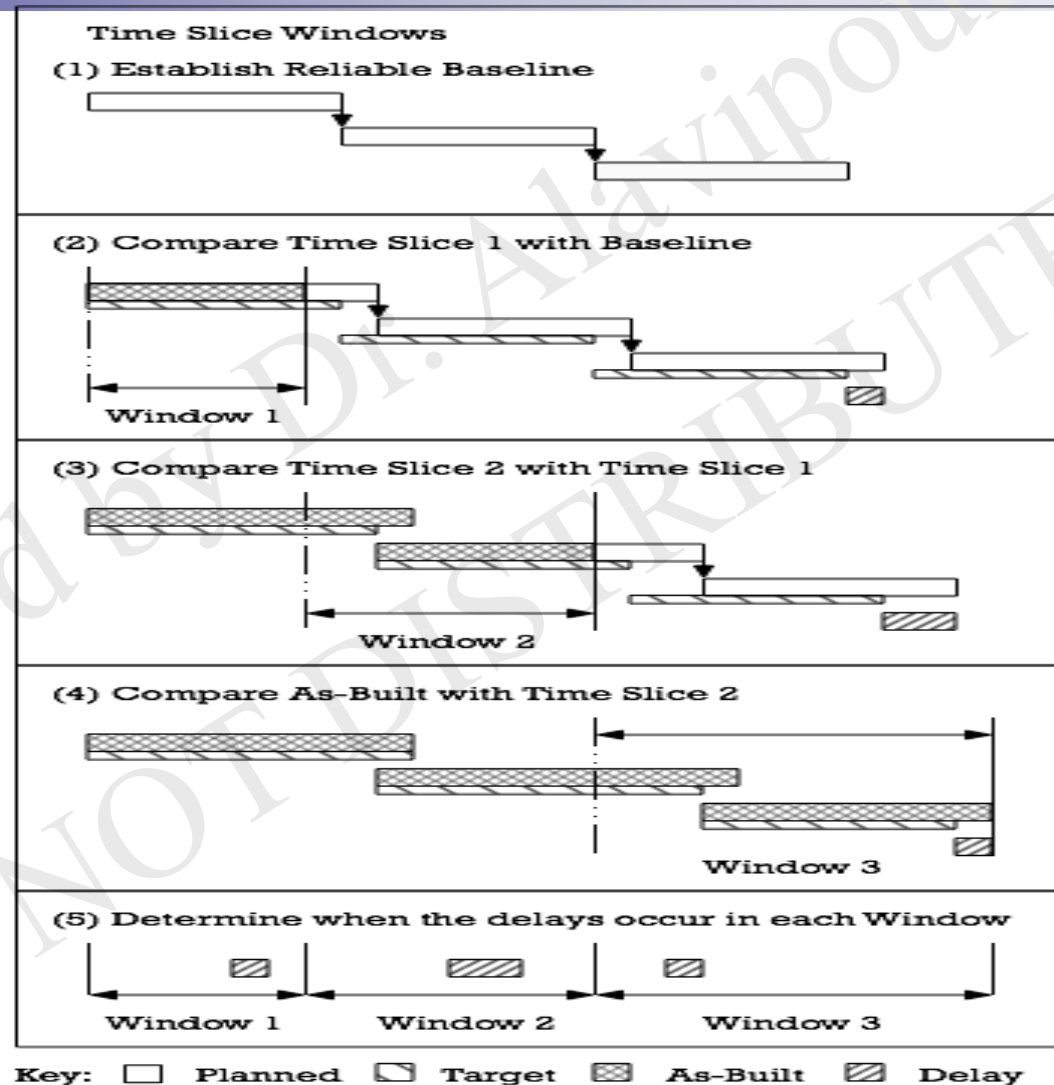
- Schedule which is logically identical to the Pre-Impact Schedule, except for progress.
- Does not need the fragnet (though it may be inserted with actual dates for record keeping).
- Recalculated as of the next appropriate data date.

Time slice windows analysis – How to use?

1. Logic linked baseline schedule is updated at **regular intervals**, usually monthly.
2. **Each update** provides a “snapshot” status or “time slice” at the **point in time**.
3. The **analysis** at the **start** and **end** of **each window** are compared to assess
 1. **How much delay** occurred
 2. Identify **which activities** were **delayed**
within each window.
4. Thereafter, the analyst **investigates** the **project records** to **determine** what **events** might have **caused** the **identified critical delay** in each window.

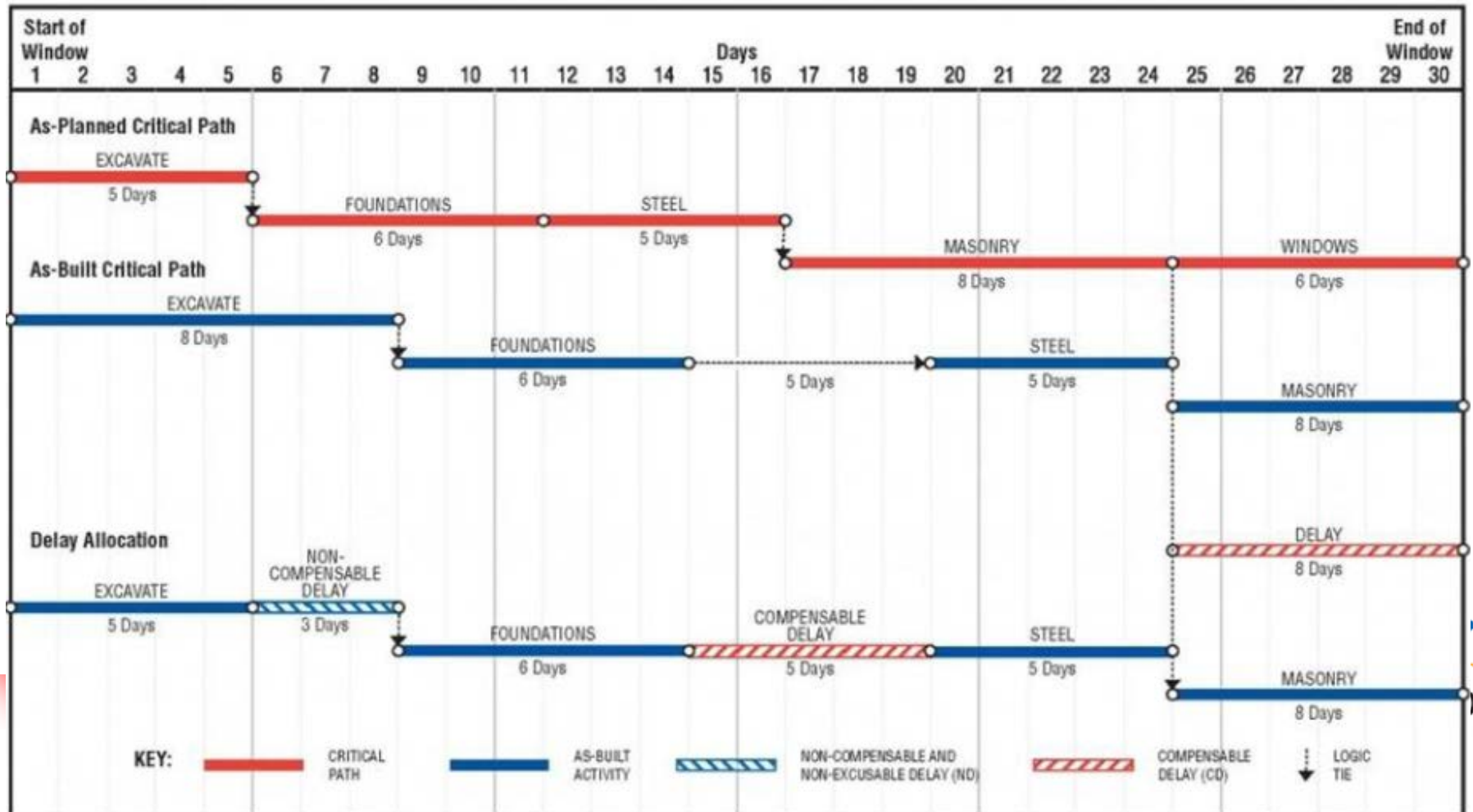
➡ For **each time slice schedule** the analyst **needs** to **verify** that the **historical components** reflect the **actual progress of the works**.

Time slice windows analysis – Example

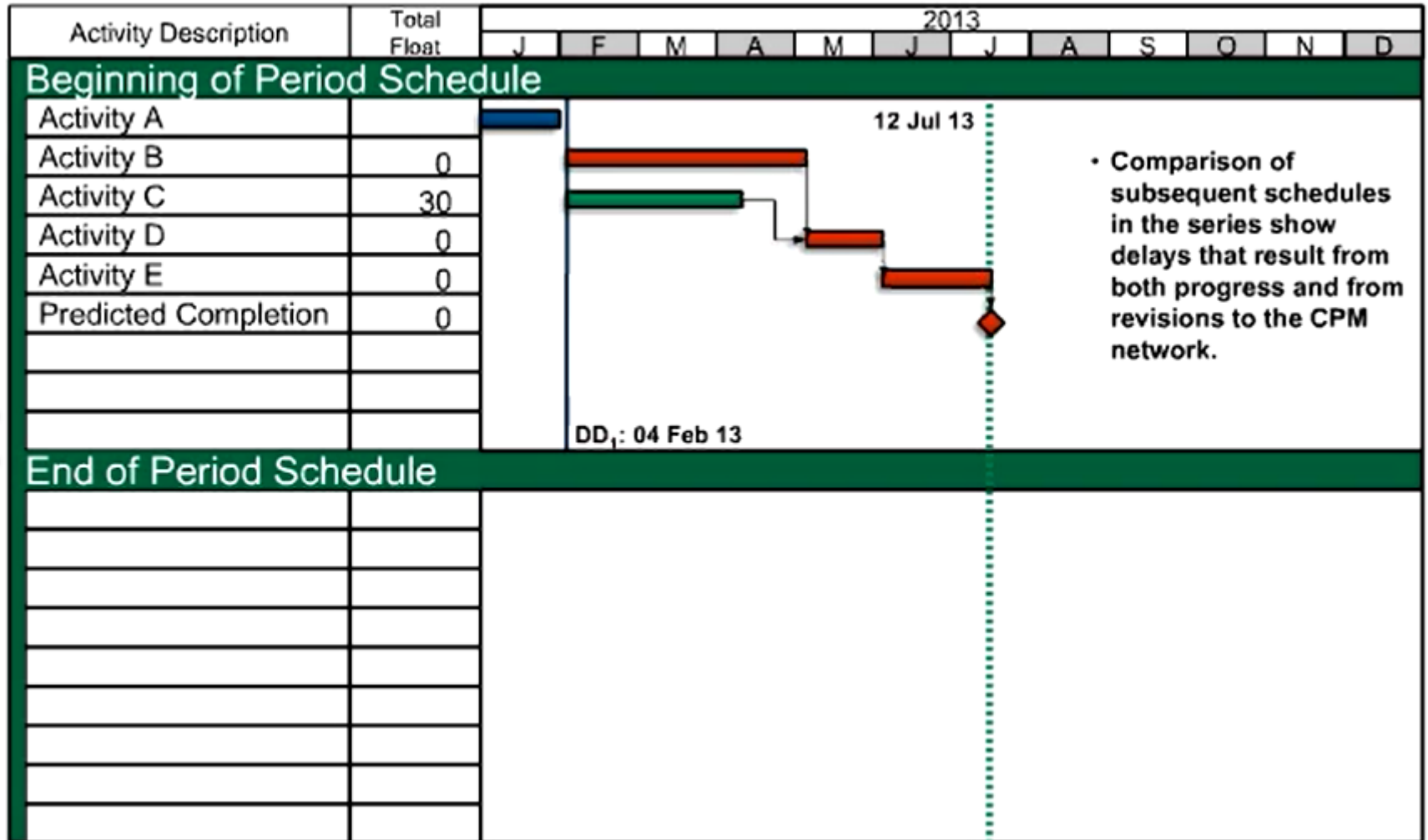


Time slice windows analysis – Example

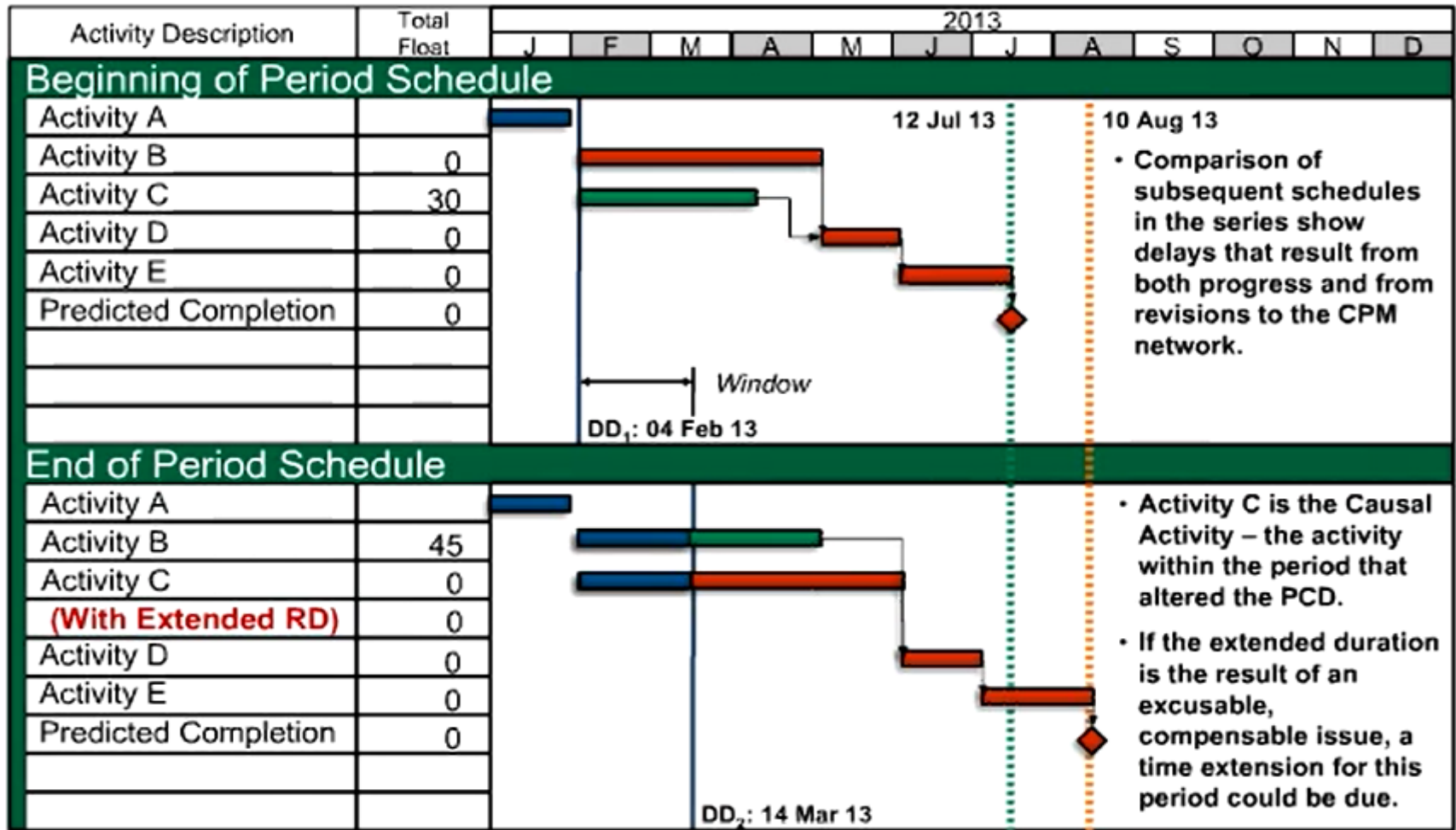
- ❑ Prepare the table of CDE, EDE, and concurrent from the as-built data.
 - ❖ For this purpose we need to adopt window-based approach on the occurrence of a delay



Time slice windows analysis – Example

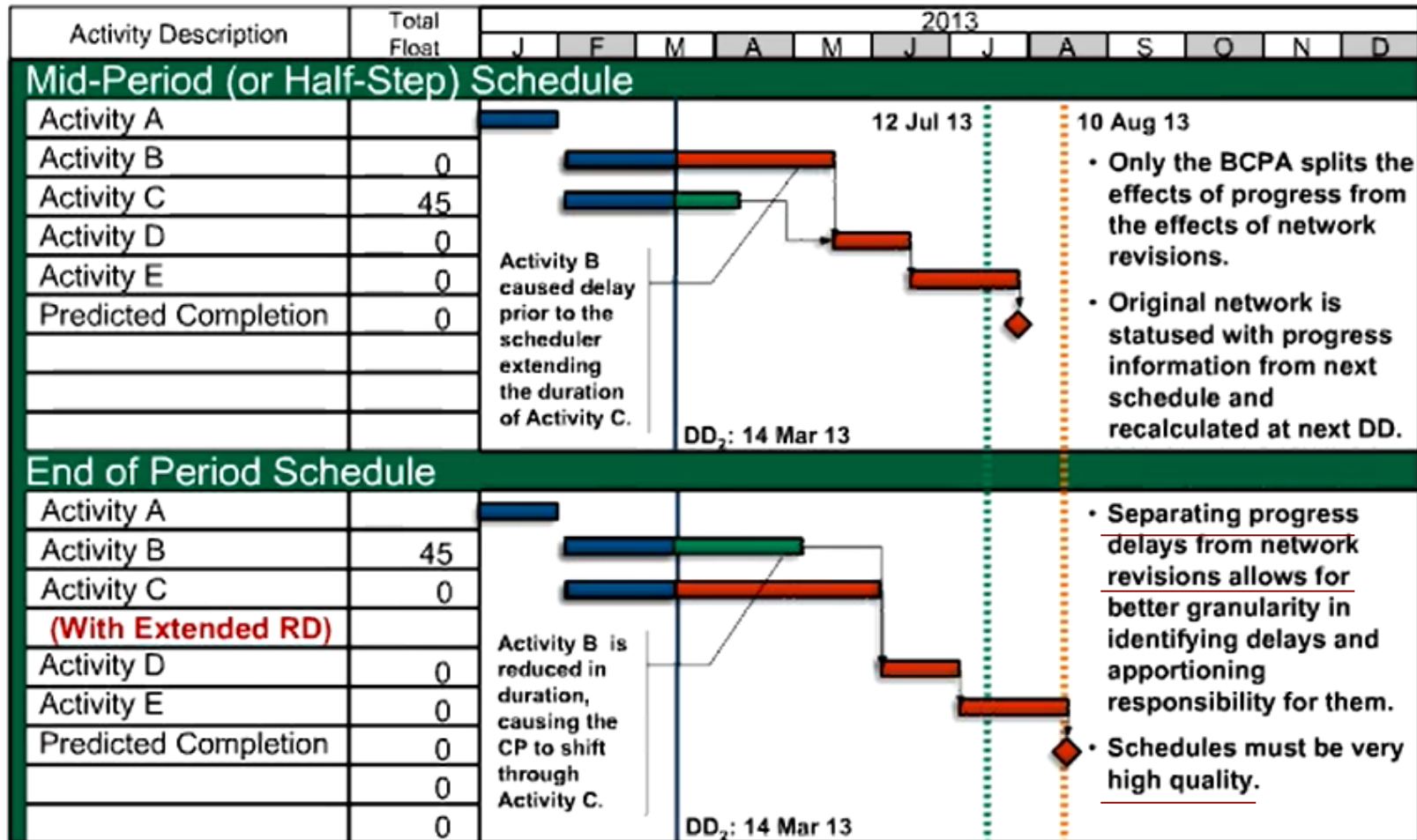


Time slice windows analysis – Example



Time slice windows analysis – Example

BCPA = BIFRUCATED CONTEMPORANEOUS PERIOD ANALYSIS



Time slice windows analysis – Example of court decision

Contractors need to anticipate that a court or board may express a preference for contemporaneously updated schedules over after-the-fact as-built schedules when assessing delay claims. The decision of the Armed Services Board of Contract Appeals, *Hedgecock Elec., Inc.*, ASBCA No. 56307, 12-2 BCA ¶ 35,086, illustrates this point.

Time slice windows analysis – Pros and cons

- ✓ Divides the project into manageable time periods, and therefore reflects the impacts on periodic basis.
- ✓ Extremely accurate if: (1) **accurate updates (contemporaneous schedule)** and (2) **bifurcated methodology**
 - ✓ But **not always** all of them
- ✓ Probably the most widely used by experts
- ✓ Commonly accepted retrospective analysis technique by almost all courts
- ✓ Dynamic analysis (**contemporaneous critical path**)
- ✓ Can be used for after-the-fact schedule (**retrospective delay impact**)
- ✓ It **considers** actual progress and changes (**not hypothetical**)
- ✓ Concurrent delays can be considered
 - × If windows are large, it could also cause a problem

Time slice windows analysis – Pros and cons

- × **Contemporaneous** schedule updates must be **validated** as **accurate**
 - × **Systematic** schedule updates are required.
- × **High** in terms of **cost** and **time** (more than other methods)
- × **Subjective** in that choice of **window** affects **outcome**
 - × If **one window** (update) is **not accurate**, the **result** will be **subjective**
- × It **requires** a **detailed data** to analyze

Time slice windows analysis – When to use?

- ❑ When we have a **reliable series** of **contemporaneously updated baseline** schedules reflecting an **accurate status** of the works at **various snapshots** (being the **time slices**).

It has **three criteria**:

1. The **logic linked baseline** must be **detailed** and **no flaws** be in the schedule
2. The **historic element** of each **snapshot schedule** must be developed from **accurate** and **detailed as-built data**
 - ❖ If **regular detailed progress data** is **not available**, then it is **highly unlikely** that this method can be **used**
3. The **future element** of **each snapshot schedule** should **accurately** and reasonably represent the **status** of the **works** on the **analysis date**.

Time slice windows analysis – Practical procedure

❑ The **steps** for performing a **contemporaneous period analysis** are summarized below:

1. Become familiar with the project and relevant documents
2. Perform a high level review of the available project schedules
3. Select schedule windows
4. Identify the critical and near-critical paths
5. Perform a detailed review of the schedules selected for the analysis
6. Determine the changes made between the schedules selected for the schedule windows
7. Make copies of the analysis schedules and implement necessary corrections
8. Develop variance tables to calculate date and duration variances
9. Research activity impacts and allocate responsibility for delays
10. Sum and document the results

Time slice windows analysis – Practical procedure

1. Become familiar with the project and relevant documents

- ☐ Review the **contract** and understand the **contract documents**
- ☐ Note any **contract provisions** pertaining to a **claim situation**
- ☐ Understand the **contract completion dates**
 - ❖ Specify if the **contract** requires **any interim completion milestones** prior to overall project completion.
- ☐ Evaluate **change orders** to understand how the **contract** has been **modified** and if any time extensions have been **executed** as part of any **change orders**.
- ☐ Review **contract scope of work** and know the **parties** to the **contract**.

Time slice windows analysis – Practical procedure

2. Perform a high level review of the available project schedules

☐ **Electronic schedules** should be provided.

☐ **Analyst** should **review** the following:

1. **Available schedules**

2. **Number of activities** and **relationships** in each available schedule file

3. **Changes** that **occur between** each of the **contractor's schedule updates**

Time slice windows analysis – Practical procedure

2. Perform a high level review of the available project schedules

❑ **Contractors** are required to provide **monthly schedule updates**, **but additional updates** may be **available** that model **certain impacts** or **“what-if” scenarios** completed by the contractor.

❖ Additionally, a **prudent contractor** on a **large** and or **difficult project** may elect to:

1. **Update** the schedules **more than once a month**
2. **Update** a schedule in **conjunction** with a **large impact or change order**

Time slice windows analysis – Practical procedure

2. Perform a high level review of the available project schedules

❑ After initial review, **several schedule** should be selected for a **more thorough review**.

Items to review and note include:

1. Activity ID structure
2. Level of detail in activity names
3. Existence and quality of a work breakdown structure and/or activity coding
4. Open-ended activities
5. Number and types of activity constraints
6. Calendars used and the types of activities assigned to each calendar
7. Cost and resource loading assignments

Determine which **activity** will be used to **track** the completion of the project.

It can be **final** or **substantial completion**.

This activity will be **used** in the delay analysis to **quantify delay** in **each schedule window**.

Time slice windows analysis – Practical procedure

3. Select schedule windows

- ❑ Now, the analyst has an understanding of contract requirements and project schedules.
- ❑ The **analyst now** should select the **schedules** that will be used as the beginning and end of the **schedule windows**.
 - ❖ These windows become the **periods of time** that will be **studied** in the analysis.

Time slice windows analysis – Practical procedure

3. Select schedule windows

Timing of significant milestones, impacts, and delay events are important factors to select the **beginning and **end** of the **schedule windows**.**

The entire project may not need to be part of the analysis

❑ AACE says:

Every update may **not be used. However, **every update** should be considered.**

Accuracy is reduced if **updates are not evaluated for multiple-month periods **when** schedule revisions or changes in sequence **occurred** to the project plan.**

Time slice windows analysis – Practical procedure

3. Select schedule windows

- ☐ Identify the contractor's as-planned CPM programme and contemporaneous progress updates through to completion.
- ☐ Once the schedules are selected, the schedule **data dates** establish the beginning and/or ending dates of the **schedule windows**.

Table 1
Sample Schedule Windows

Window No.	Schedule Window Dates	Schedule Data Date (Beginning of Window)	Schedule Data Date (End of Window)	Length of Window (Cal. Days)
1	21 October 2013 – 28 January 2014	21-Oct-2013	29-Jan-2014	101
2	29 January 2014 – 20 March 2014	29-Jan-2014	21-Mar-2014	52
3	21 March 2014 – 27 July 2014	21-Mar-2014	28-Jul-2014	130
4	28 July 2014 – 25 October 2014	28-Jul-2014	26-Oct-2014	91
5	26 October 2014 – 5 December 2014	26-Oct-2014	06-Dec-2014	42

Time slice windows analysis – Practical procedure

4. Identify the critical and near critical paths

a) Based on total float:

- ❖ Determine the **most critical activities** in each window by identifying the activities with the **least amount of positive total float** (*near critical path*)
- ❖ Determine the **most critical activities** in each window by identifying the activities with the **greatest amount of negative total float**

b) Based on longest path:

- ❖ Tasks which were **predecessors to “driving” critical activities** along each path

c) Concurrent as-built critical paths

Time slice windows analysis – Practical procedure

4. Identify the critical and near critical paths

- ☐ **Review** and **document** the **critical** and **near-critical paths** for selected **schedule windows**.
- ☐ The **paths** then must be **checked** for **reasonableness** (**THIS WILL BE TALKED IN NEXT STEP**).
 - ❖ **Constraints, lags and logics** should be **checked before** the **analysis**
 - ❖ **Analyst** should **document** these **issues** and **identify** if **corrections** to any activities are necessary.

The coding of the critical and near-critical paths is an important step!

This step is often omitted due to time and budget constraints because it is time consuming to document and determine the actual dates and as-built schedules.

Time slice windows analysis – Practical procedure

5. Perform a detailed review of the schedules selected for the analysis

- ☐ Upon reviewing and coding the **critical** and **near-critical paths**, each schedule should be **reviewed** in detail to determine if **any schedule corrections** are necessary.
- ☐ It is **important** to:
 1. Evaluate the **quality** and **reasonableness** of the **schedules**
 2. Identify **items** that may be **necessary** to **correct** to ensure **schedule accuracy**

Time slice windows analysis – Practical procedure

5. Perform a detailed review of the schedules selected for the analysis

❑ **Typical items** that can **affect** the analysis include:

1. Excessive number of open-ended activities
2. Overuse of constraints
3. Activity and logic changes
4. Duration changes
5. Calendar changes
6. Activities with unreasonably large total float values
7. Inconsistent use of schedule calculation methods
8. Incorrect as-built dates
9. Excessive positive or negative relationship lags

Any deficiencies in any above items should be **corrected before critical and near-critical paths are found.**

Let's talk about some of them!

Time slice windows analysis – Practical procedure

5. Perform a detailed review of the schedules selected for the analysis

❑ Open-ended activities

- ❖ One of the **most fundamental quality checks**
- ❖ **Activities** that **lack** a **predecessor**, **successor**, or **both**
- ❖ **Exception** to this is the **project start** and **completion activities**
- ❖ A large number of **open-ended activities** will create **float values** and **forecasted completion dates** that may be **incorrect** and they **MUST BE CORRECTED**.

Time slice windows analysis – Practical procedure

5. Perform a detailed review of the schedules selected for the analysis

❑ Overuse of constraints

- ❖ Use of a constraint **restricts** the **start or finish of an activity**.
- ❖ The **use of a few soft constraints** is **not bad practice**, however **a large number** of constraints should be **avoided**.
 - ❖ This **restricts** the **normal forward and backward path** scheduling calculations.
 - ❖ The **misuse** of constraints may generate **artificial activity dates** and **float values**.

The analyst must **evaluate** the **relevance** of the constraint to determine

(1) **Reason** for its use

(2) **If the constraint should be removed** from the schedule

Time slice windows analysis – Practical procedure

5. Perform a detailed review of the schedules selected for the analysis

□ Use of calendars

❖ **Several aspects** of the project calendars **must be considered**.

1. Calendars themselves should be considered.

✓ **Note** if the **specific calendars** were **changed** **during the evolution** of the schedules.

- A five-day, eight-hour per day calendar may have been changed to a five-day, ten-hour per day calendar.

2. Note if the calendars include planning for adverse weather.

✓ A **properly developed schedule** will include **anticipated lost time** due to **inclement weather**.

- This should be based on **contractual requirements** and **historic weather data** specific to the geographical area of the project

3. Determine if activities had a calendar change during the selected schedule window

Changes between schedule updates are discussed in next step



Time slice windows analysis – Practical procedure

5. Perform a detailed review of the schedules selected for the analysis

☐ Other common schedule deficiencies include the following:

- ❖ Incorrect and inconsistent use of as-built dates;
- ❖ Activity planned durations that are inconsistent with the Contractor's bid estimate calculations;
- ❖ Missing contractual scope of work;
- ❖ Lack of contractually required completion activities;
- ❖ Overuse of constraint dates;
- ❖ Missing predecessor or successor logic ties creating open-end activities;
- ❖ Inadequate depiction of equipment and materials procurement and delivery activities;
- ❖ Inaccurate predecessor logic for Owner approval activities;
- ❖ Lack of a contractual Owner approval period for submittal and turnover packages;
- ❖ Lack of reasonable project punch list and demobilization periods;
- ❖ Inconsistent use of Calendars, Progress Override and Retained Logic schedule calculation options; and
- ❖ Unrealistic as-built logic relationships indicating out-of-sequence progress.

Time slice windows analysis – Practical procedure

6. Determine changes made between the schedules selected for the schedule windows

❑ In **addition** to deficiencies, changes made between **schedule updates** should be identified.

❖ Any delays or acceleration efforts that **added** or **removed** should be identified.

❑ **Three common changes:**

- ❖ Logic changes
- ❖ Activity changes
- ❖ Duration changes

Time slice windows analysis – Practical procedure

6. Determine changes made between the schedules selected for the schedule windows

❑ Logic changes

❖ Analyst **must** document:

1. Any **activity additions** to schedule **logic**
2. Any **activity subtractions** from schedule **logic**
3. Any **modifications** to schedule **logic**

Time slice windows analysis – Practical procedure

6. Determine changes made between the schedules selected for the schedule windows

□ Activity changes

❖ Check the consistency of activity IDs and names

*If activities are **continually changing** IDs and names, the analyst may conclude that the contractor's scheduling was **not** in accordance with industry **accepted** and **standard** practices.*

In this case, it is very difficult to perform the analysis

Time slice windows analysis – Practical procedure

6. Determine changes made between the schedules selected for the schedule windows

❑ Duration changes

- ❖ Contractors may **modify** the **scope** of an activity by adjusting the **original** or **remaining duration**

*Although this is **not the good practice**, if the analyst **notes** a **delay** to an activity that was caused by increased original or remaining duration of an activity, the **changed duration** will need to be researched to determine if the **increase** was **justified**.*

When faced with delays in the schedules, **many contractors** will simply reduce activity durations to **mitigate delay**.

*This is **often done** without any **basis**. These instances must be **noted** for the **analysis**.*

Time slice windows analysis – Practical procedure

7. Make copies of the analysis schedules and implement necessary corrections

- ❑ Each of the corrections identified in prior analysis steps is implemented in this step and each change must be made in **all of the analysis schedules**.

- ❑ Analyst should make **copies** of the **original schedule files**, prior to making **changes**.

❖ Any **changes** to the schedule should be made in copies of the original files.

- ❑ The corrections to the schedules are an acceptable part of AACE 29R-03:

*The **issue of correcting** the schedule is one of balance and reasonableness and, for this reason corrections should **not be made across the board** or automatically!*

Time slice windows analysis – Practical procedure

7. Make copies of the analysis schedules and implement necessary corrections

□ Review critical and near-critical paths

❖ The **critical** and **near-critical paths** must be **re-evaluated** to **determine whether if** the **corrections** or **modifications** to schedule cause any **changes** to **critical or near-critical paths**.

1. If no changes, analyst can proceed to next step
2. If changed, additional research is required
 - ❖ The change should be identified.
 - ❖ The validity of the change must be reevaluated.
 - ❖ The nature of the change should be discussed and identified.

*In some cases, if the **owner** is **uncertain** and the **project team** is **unavailable** (as is sometimes the case in forensic analysis), the **analyst** must **make a decision** on the **best option** and which **critical path** reflects the work as of the **data date**.*

This decision **must not be made in the **best interests** of the **owner**,
but must reflect the **most accurate portrayal** of the project record.**

Time slice windows analysis – Practical procedure

8. Develop variance tables to calculate date and duration variances

- ❑ **After** identification and confirmation of the **critical and near-critical paths**, analyst should develop **variance tables** for **each window** which calculate
 1. **Date variances** for **each activity** within the **schedule windows**
 2. **Duration variances** for **each activity** within the **schedule windows**

Why we need the variance calculations?

*Because **delays** can be the **result** of*

1. An activity **not starting on time** and/or
2. An activity **taking longer than planned**,

it is **necessary** to perform **variance calculations** for the **date** and **duration** of the activities.

Time slice windows analysis – Practical procedure

8. Develop variance tables to calculate date and duration variances

- ❑ For this step, analyst typically **exports** the activities and associated data to a spreadsheet.

Keep a record of the float values for all of the driving activities in a “**float map**” which tracks the **gain and loss of float** against each driving activity through all of the **available contemporaneous progress records**.

Time slice windows analysis – Practical procedure

8. Develop variance tables to calculate date and duration variances

❑ Variance tables should be developed using the **spreadsheets** for the **two** schedules which correspond to the **beginning** and **end** of a **schedule window**.

1. Each spreadsheet will be the **summary** of the window
2. Each spreadsheet documents the variance (**gain** or **delay**) for each activity's
 - ❖ Original duration
 - ❖ Remaining duration
 - ❖ Start date
 - ❖ Finish date

Time slice windows analysis – Practical procedure

8. Develop variance tables to calculate date and duration variances

Table 2
Sample Variance Table

Activity ID	TF (Days)	Activity Status	LI CP	05-Sep-13 OD (Days)	05-Oct-13 OD (Days)	OD Var. (Days)	05-Sep-13 Start Date	A	05-Oct-13 Start Date	A	Start Var.
D1590	-51	Not Started	CP1	8	8	0	07-Oct-2013		14-Nov-2013		38
M1500	-45	Not Started		1	1	0	13-Sep-2013		22-Oct-2013		39
M2010	-43	Not Started		6	4	-2	11-Sep-2013		11-Oct-2013		30
S1480	-51	In Progress	CP1	10	13	3	24-Jun-2013	A	24-Jun-2013	A	0
S1620	-45	Not Started		5	12	7	07-Sep-2013		17-Oct-2013		40
S1760	-38	In Progress		9	9	0	03-Sep-2013		05-Sep-2013	A	2
S1835	-51	In Progress	CP1	6	6	0	28-Jun-2013	A	28-Jun-2013	A	0

TF – Total Float CP – Critical Path OD – Original Duration A – Actual Var. – Variance

- ☐ Finish variance and remaining duration variance not shown.
- ☐ Activity name has been omitted , but should be included.
- ☐ This should be prepared for each window.

Time slice windows analysis – Practical procedure

8. Develop variance tables to calculate date and duration variances

- ☐ After the table is developed, the spreadsheet should be **filtered** for the **critical and near-critical activities** to determine which activities are the **causes of delays** in the **window**.
- ☐ The **activities** that are **found** to be the **causes of delay** in **each window** may be referred as **critical path originating activities**.
- ☐ These **activities** must be researched to **determine** the **allocation of delay**

Time slice windows analysis – Practical procedure

9. Research activity impacts and allocated responsibility for delays

Investigate the **cause of delay** to the driving activities in each period where a **measurable loss or gain** is identified

- ❑ For each critical path **identified** in the **prior step**, the **schedules** and **contemporaneous project documentation** must be researched to:

determine the **factor or factors** that may have caused the **start delay** and/or **extended activity duration**.

- ❑ **Activities** and **logic** may have been modified as **acceleration measures**, or **delay** may have been added via **duration adjustments**.

- ❖ **If** these instances are **noted**, the **project record** must be **analyzed** to determine if these **changes** were **supported**.

Time slice windows analysis – Practical procedure

9. Research activity impacts and allocated responsibility for delays

- ☐ **Determine** the **factor or factors** that **may have caused** the start delay and/or extended activity duration
- ☐ A **sample** of **documented critical paths**, **originating activities**, and **delay summary** are included in the table below:

Table 3
Critical Paths and Originating Activities

Critical Path	Activity ID	Activity Description	Delay Summary
1st Critical Path	A1800	Excavate for Sump A19	22 day finish delay
	A1790	Install Sump A19	15 day start delay due to excavation – OD/RD decreased from 12 to 4 days
	A1810	Excavate for Underground Sump Tank	5 day OD/RD decrease
2nd Critical Path	P1825	Complete Pipe delivery for 30" Raw Water Line	36 day finish delay
	P1775	Install Raw Water Piping	15 day finish delay
	P1750	Backfill Raw Water Piping	8 day start delay and 25 day finish delay

OD – Original Duration RD – Remaining Duration

Time slice windows analysis – Practical procedure

9. Research activity impacts and allocated responsibility for delays

1. If there is one type of delay in each window (EDE, CDE, or concurrent)

- a) If Delays to the originating activities > total delay recognized in the window
the **contractor most likely** implemented acceleration measures in the schedules for the **window**.

❖ Although the maximum delay is 36 days,
if the **total delay** was **ten days during the window**,
the analyst would allocate the ten days of delay, not 36 days.

- b) If Delays to the originating activities = total delay recognized in the window

You can easily allocate all delays

- c) If Delays to the originating activities < total delay recognized in the window

There should be a problem and you should review the result

What if there are two or more types of delays in a window?

Time slice windows analysis – Practical procedure

9. Research activity impacts and allocate responsibility for delays

2. If there two or more types of delays in each window (EDE, CDE, or concurrent)

- a) If you have updates immediately **before and after** the time when each different type of delay occurs (*bifurcated updates*)

There would be no difficulty to calculate (similar to Case 1)!

Time slice windows analysis – Practical procedure**9. Research activity impacts and allocate responsibility for delays****2. If there two or more types of delays in each window (EDE, CDE, or concurrent)**b) If you do not have bifurcated updates and other delays also exist in a windowi. **If $EDE (10) + CDE (5) = \text{total delay recognized in the window (15)}$** ***No concurrent delays*** = Allocate based on each delayii. **If $EDE (10) + CDE (5) > \text{total delay recognized in the window (12)}$** ***a) Primacy of delays*** = One that occurred first may have created float for others❖ You may perform ***collapsed as-built analysis******b) Concurrent delays*** = May concurrent delay exists in the window (3).❖ If you don't know the time of occurrence, you need to accept functional theory and overlook primacy of delays

$$EDE = 10 - 3 = 7 \ \& \ CDE = 5 - 3 = 2, \text{ Concurrent} = 3$$

iii. **If $EDE (10) + CDE (5) < \text{total delay recognized in the window (17)}$** *There should be a problem and you should review the result*

Time slice windows analysis – Practical procedure

9. Research activity impacts and allocate responsibility for delays

Apportion responsibility for the **loss or gain measured** in each window by reference to the **driving activity** and **causative events** documented in the contemporaneous records.

Time slice windows analysis – Practical procedure

9. Research activity impacts and allocate responsibility for delays

- ☐ It is also **necessary** to research any **potential weather impacts** during the **window** to **determine** if **part**, or **all**, of the delay is **due to adverse weather**.
- ☐ **Lost time** due to **inclement weather** may change the **apportionment of delay** **if** the weather delay is **concurrent** with a **contractor delay**.
- ☐ Weather delays that are **excusable**, may **not be compensable**, however the contract terms should be reviewed **prior** to **allocating delay** due to weather.

Time slice windows analysis – Practical procedure

10. Sum and document the results

- ☐ The **analyst** must perform these steps and allocation for **each of the schedule windows**.
- ☐ **Upon completion** of the exercise, the **total delay allocation** should be **summed** and **documented**.

After-the-Fact Schedule Analysis

(As-Planned vs. As-Built Analysis (APAB))

FSA methods

Method of Analysis	Analysis Type	Critical Path Determined	Delay Impact Determined	Requires
Time Slice Windows Analysis	Effect & Cause	Contemporaneously	Retrospectively	- Logic linked baseline programme. - Update programmes or progress information with which to update the baseline programme.
As-Planned versus As-Built Windows Analysis	Effect & Cause	Contemporaneously	Retrospectively	- Baseline programme. - As-built data.
Retrospective Longest Path Analysis	Effect & Cause	Retrospectively	Retrospectively	- Baseline Programme. - As-built programme.
Collapsed As-Built Analysis	Cause & Effect	Retrospectively	Retrospectively	- Logic linked as-built programme. - A selection of delay events to be modelled.

FSA methods

The Information Required					
	Baseline programme	Logic linked baseline programme	As-built data	Delay events to model	Up to date programmes/ process information
Time Slice Windows					
As-Planned v As-Built Windows					
Longest Path					
Collapsed As-Built					
The table above shows the evidence required for each delay analysis method. The table has been simplified.					

As-planned vs. as-built windows analysis – Definition

- ❑ This is the **second** of the “**windows**” analysis methods.
- ❑ It is **less reliant** on **programming software**
- ❑ The **prerequisite** for this type of analysis is:

1. **A baseline schedule**

2. **An as-built schedule**

❖ As-built schedule can **either** be:

1. An **existing** as-built schedule or
2. An as-built schedule **constructed** from **scratch**

In either case the **as-built schedule** needs to be **verified** using the **as-built data** however **no specific guide** is given in the **Protocols**.

As-planned vs. as-built windows analysis – Definition

❑ AACE method implementation protocol (MIP) 3.1 and 3.2 say:

❖ **Compares** the **as-planned schedule** to the **as-built**,

establishes an **as-built critical path**, and

determines what **events** actually **drove project completion**

- ✓ If windows analysis performed (periodic) = contemporaneous critical path
- ✓ If total time analysis performed (gross) = as-built critical path

As-planned vs. as-built windows analysis – How to use?

As-Planned Schedule

- Accepted/approved baseline schedule from the project.
- Unaltered CPM network.

As-Built Schedule

- Either the fully statused schedule from the project, or a schedule recreated from project records (Daily Specific As-Built).
- Contains both parties' delays.
- Often associated with "total time" delay claims, which are rejected by the courts.
- Sophisticated implementations are not total time.

As-planned vs. as-built windows analysis – How to use?

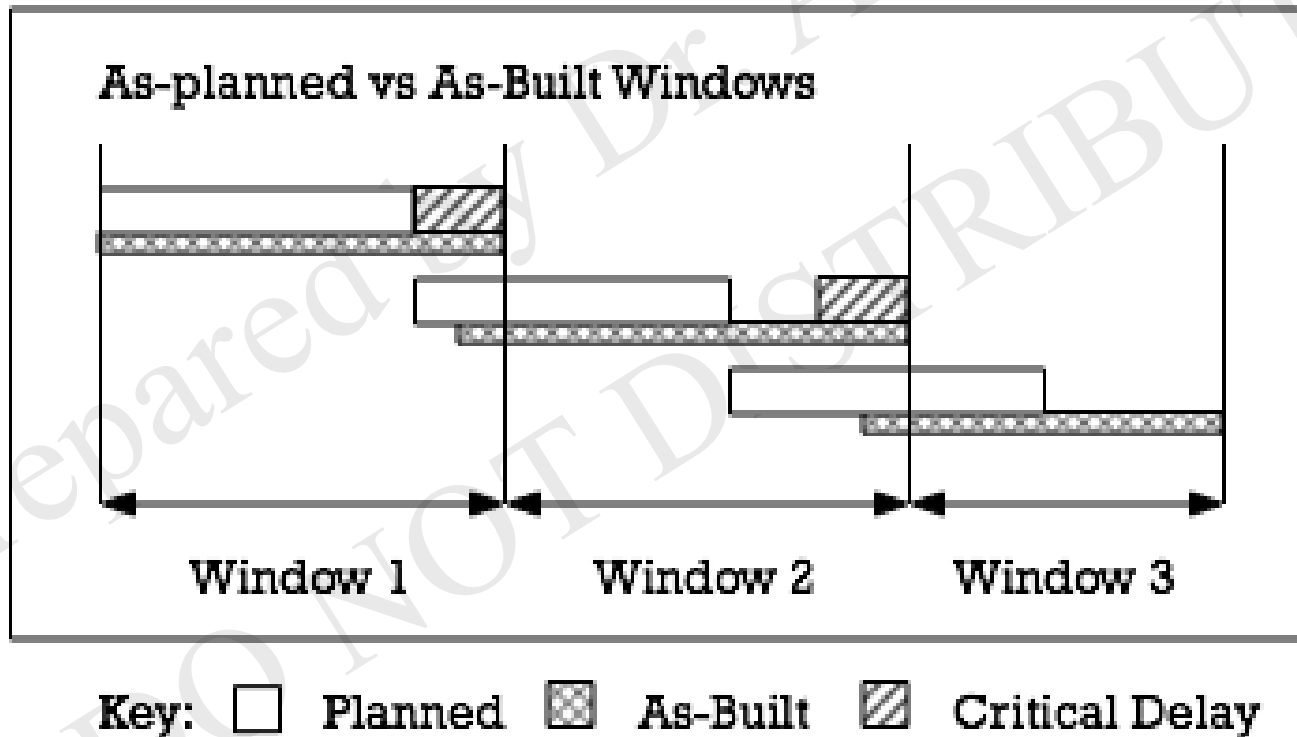
1. The **duration** of the **work** is **broken** down into **windows**.
 - ❖ **Time slices** are **not necessarily used**.
 - ✓ Regular intervals **not** needed.
 - ❖ Instead, **windows** are defined as **periods** between the dates when **key items** were **actually started** or **achieved**.
 - ✓ Sometimes we don't have update at the time of key items, sometimes have
2. **Windows** are **framed** by **revised contemporaneous schedules**, **contemporaneous update schedules**, **milestones**, **delays** or **significant events**.
 - ❖ Analyst determines the **contemporaneous** or **retrospective (as-built)** **critical path** in **each window** by a **common-sense** and **practical analysis** of the **available facts**.
 - As this task does **not substantially rely** on **programming software**, it is important that the **analyst** sets out the **rationale and reasoning** by which **criticality has been determined**.

As-planned vs. as-built windows analysis – How to use?

3. Find the **contemporaneous** or **retrospective (as-built)** critical path
4. Each window is then determined by comparing key dates along
 - ❖ The **contemporaneous** or **retrospective (as-built)** critical path **against**
 - ❖ Corresponding **planned dates** in the **baseline schedule**.
5. Thereafter, the analyst investigates the **project records** to determine what delay events **might have caused** the identified critical delay
6. The **critical delay** incurred and the **mitigation** or **acceleration** achieved in each window is accumulated to identify **critical delay** over the **duration of the works**.

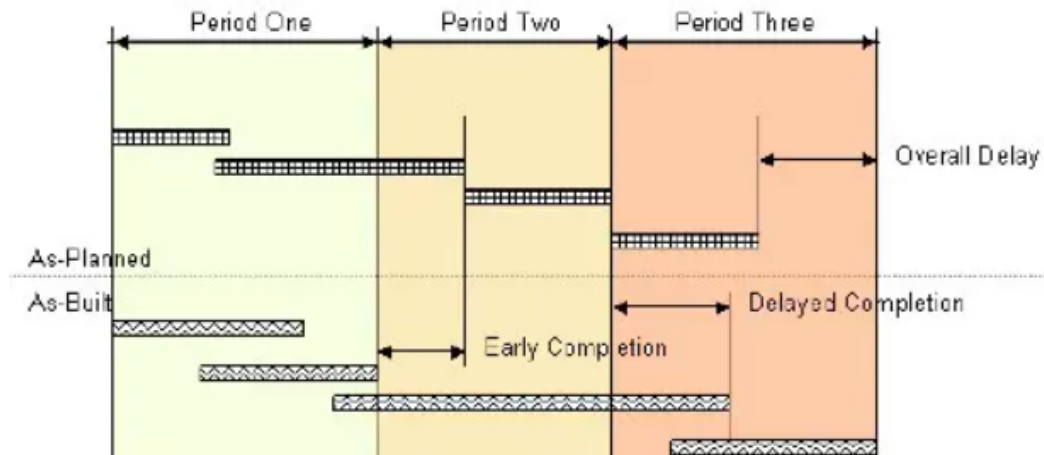
As-planned vs. as-built windows analysis – windows analysis

- ❑ When you have adequate project record documentation
 - ❖ Here you can realize if **critical paths shifted** at least at **key dates!**
 - ✓ **Contemporaneous critical path**



As-planned vs. as-built windows analysis – windows analysis

- ❑ When you have **adequate project record documentation**
 - ❖ Here you can realize if **critical paths shifted** at least at **key dates**
 - ✓ **Contemporaneous critical path**



Source: AACE International Recommended Practice No 29R-03 – Forensic Schedule Analysis, AACE International, Morgantown, WV, 2011

**What is the difference between
as-planned vs. as-built windows analysis
And
impacted as-planned analysis?**

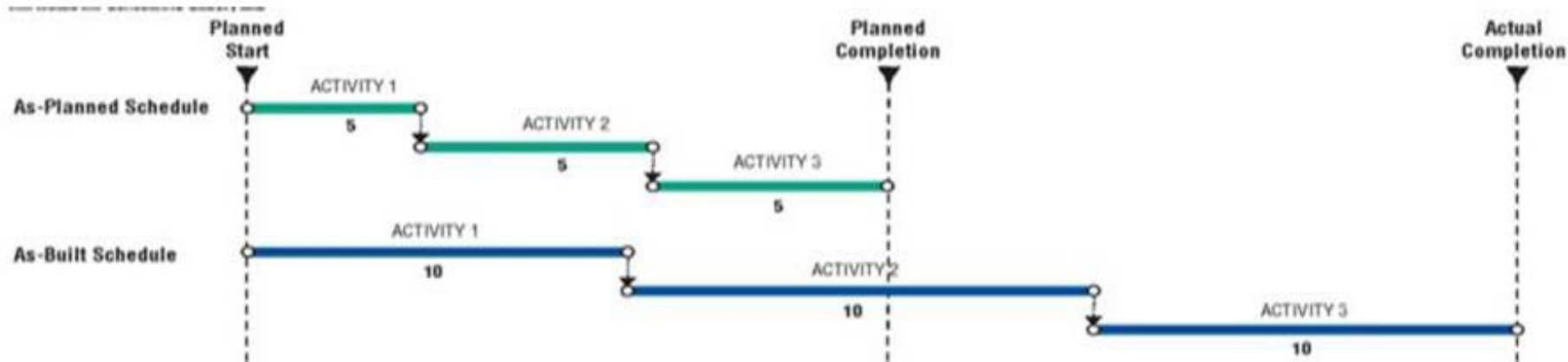
**What is the difference between
as-planned vs. as-built windows analysis
And
time slice windows analysis?**

As-planned vs. as-built windows analysis – Total time analysis

❑ When you have **inadequate** project record documentation

❖ Here you **cannot** realize if **critical paths shifted**

✓ **Retrospective (As-built) critical path**

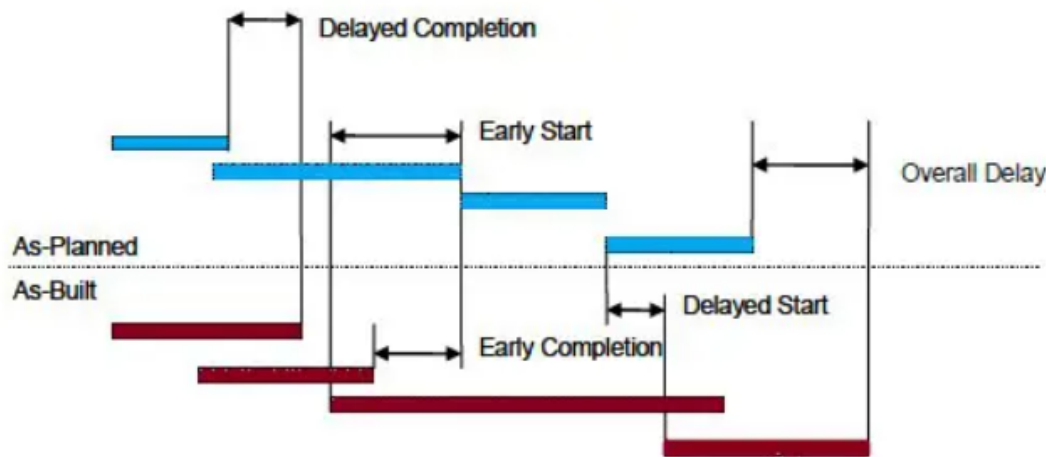


As-planned vs. as-built windows analysis – Total time analysis

❑ When you have **inadequate** project record documentation

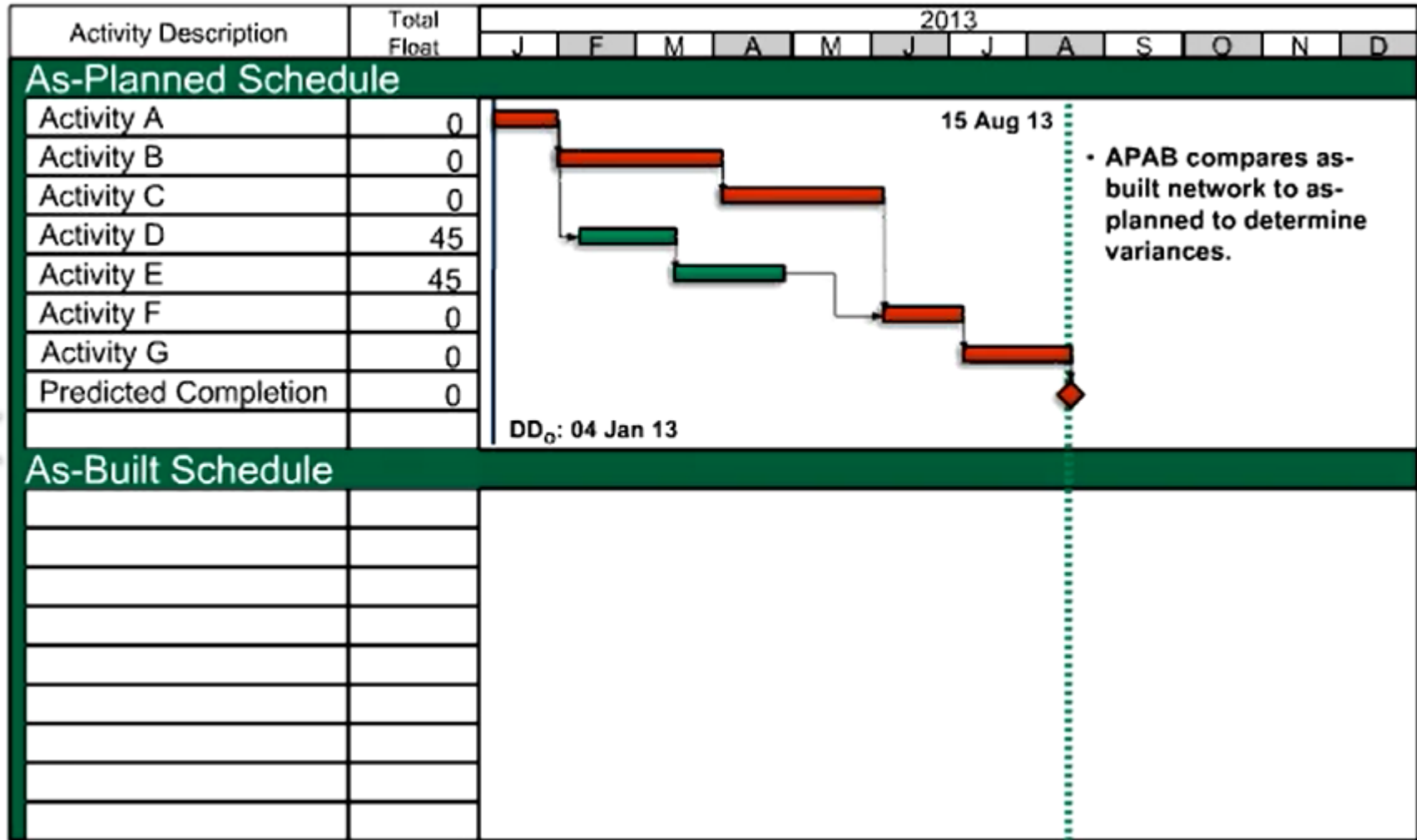
❖ Here you **cannot** realize if **critical paths shifted**

✓ **Retrospective (As-built) critical path**

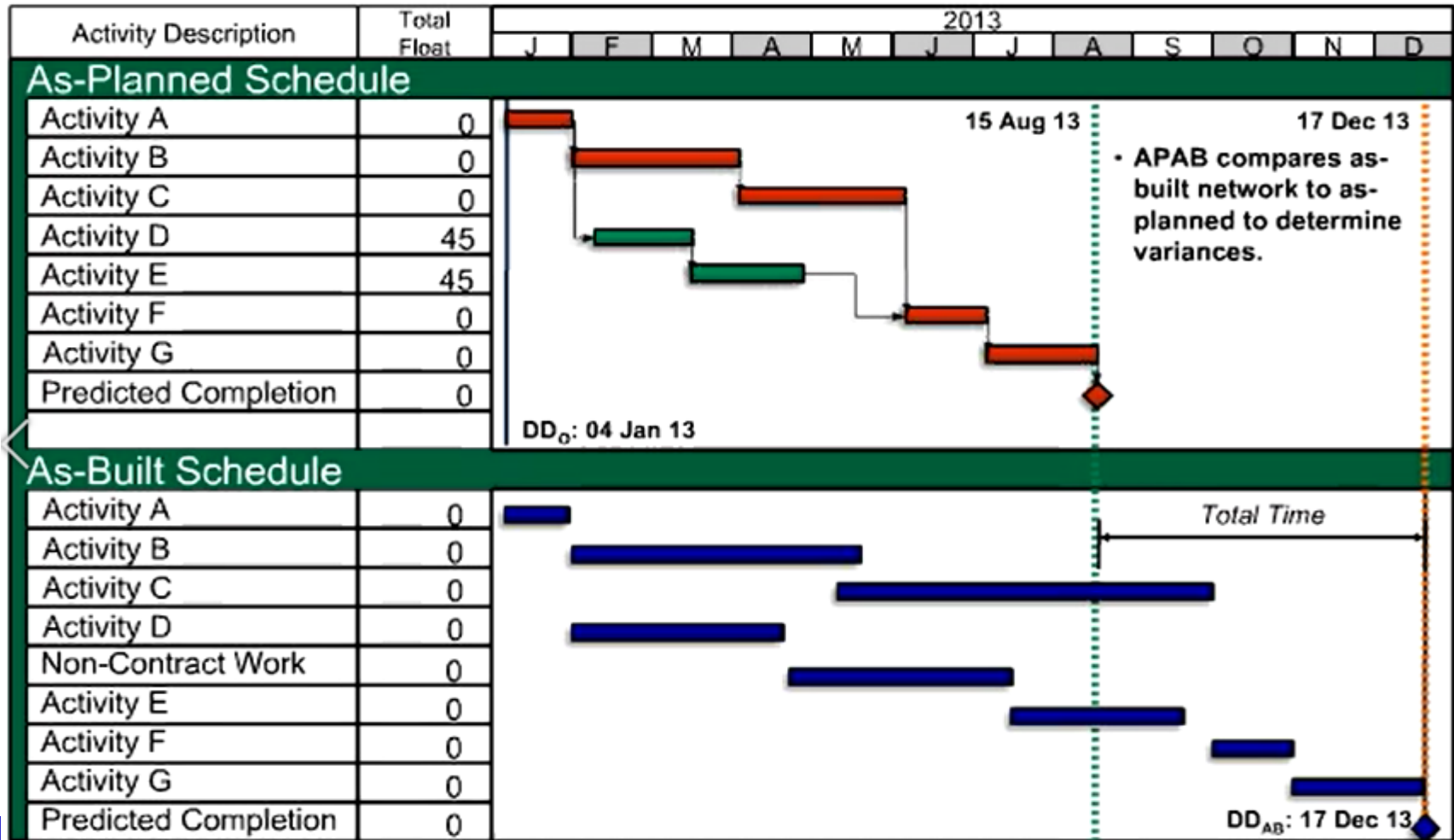


Source: AACE International Recommended Practice No 29R-03 – Forensic Schedule Analysis, AACE International, Morgantown, WV, 2011

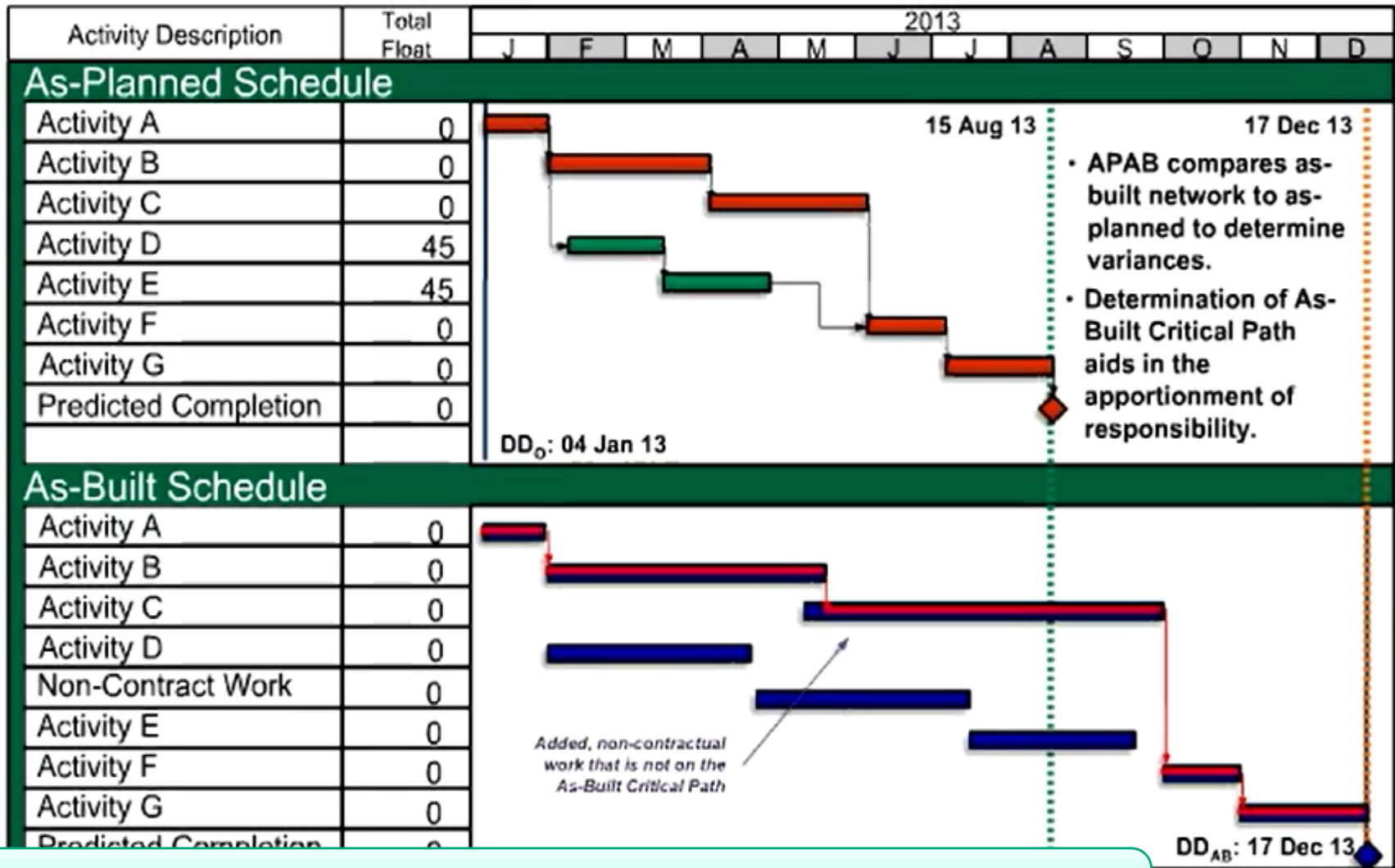
As-planned vs. as-built windows analysis – Total time analysis Example



As-planned vs. as-built windows analysis – Total time analysis Example



As-planned vs. as-built windows analysis – Total time analysis Example

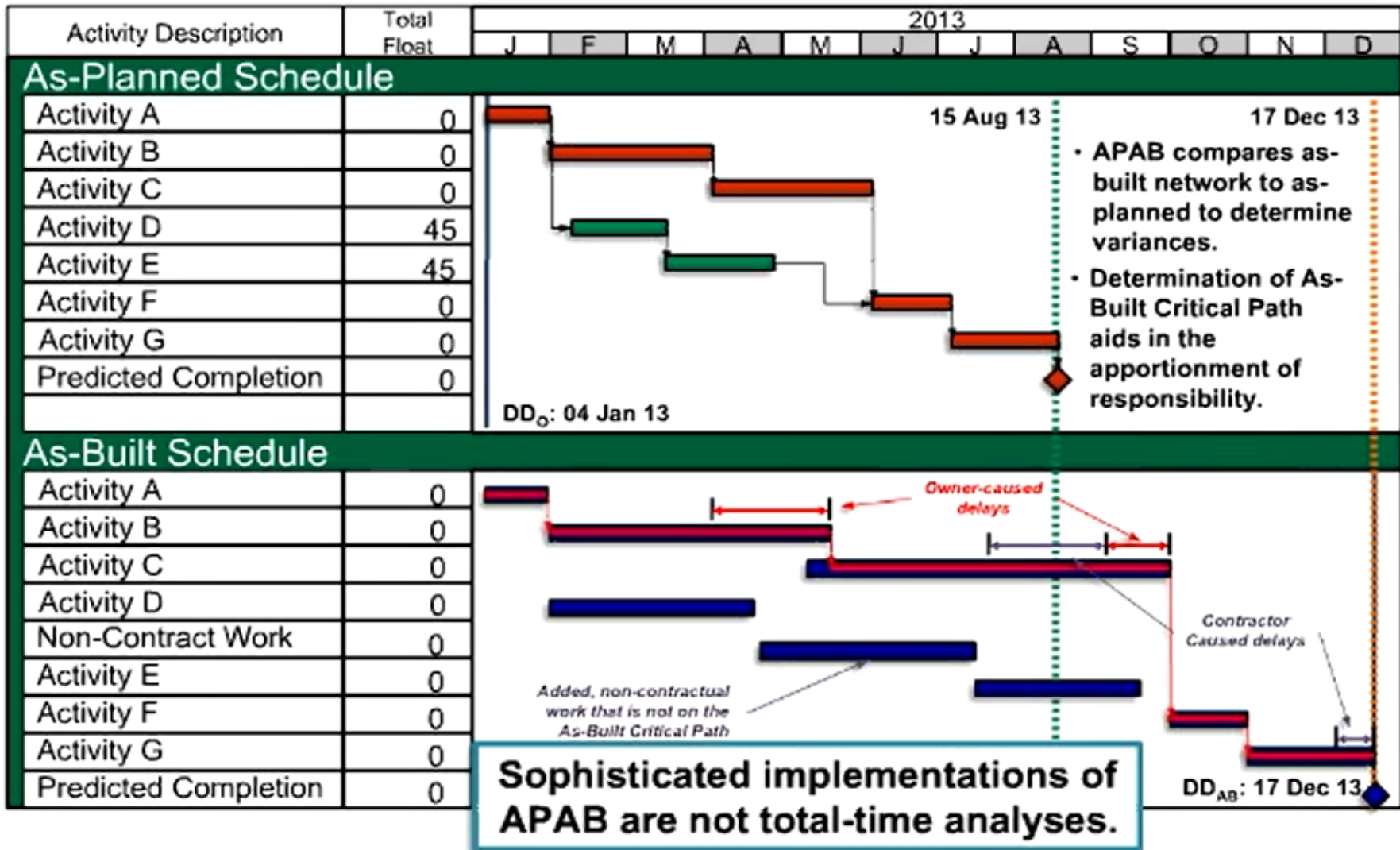


Caution:

Do not use total time analysis in this case == The court will reject

ذکر مطالب فوق تنها

As-planned vs. as-built windows analysis – Total time analysis Example



As-planned vs. as-built windows analysis – Pros and cons

If windows analysis is used:

- ✓ **Low to Moderate** in terms of **cost** and **time**
 - ✓ However, if the **as-built data** are **not accurate**, this can be **very expensive**
- ✓ **Contemporaneous critical path** if enough records are available.
- ✓ Used for **after-the-fact** schedule (**retrospective delay impact**)
- ✓ It **considers** actual progress and changes (**not hypothetical**)
- ✓ **Accepted** by **many courts** if performed as windows basis
 - × Rejected by many if total analysis used

As-planned vs. as-built windows analysis – Pros and cons

- × **As-built sequence** must relate to **as-planned sequence** for activity **level variance method**
 - × If the **sequences of activities** have a **great variance**, it will have **lower accuracy**
- × **Concurrent delays** may not be considered if don't have enough records
- × **May be Subjective**
 - × It **can** rely heavily on the **rationale** and **determination** of **analyst**
 - × **Susceptible** to **unintentional** or **intentional manipulation** by choice of as-built data that is **incorporated** into **schedule**
- × **Can be difficult** if the project is **complex** and **long**
 - × Since it does **not rely** on **programming software**

As-planned vs. as-built windows analysis – When to use?

❑ It is **usually** applied **when**:

1. There is **concern** over the **validity** or **reasonableness** of the **baseline schedule**
2. There is **concern** over the **validity** or **reasonableness** contemporaneously updated **schedules**
3. There are **too few** contemporaneously updated schedules.
4. There are **baseline schedule (only Gantt chart) + As-built data**

When the **benefits** of this approach decrease?

As-planned vs. as-built windows analysis – When to use?

Caution:

The **benefits** of this approach are decreased when:

1. **Regular updates** are available
2. Not well-suited to determining delay causation when a project is **complex** and **spans longer durations**
3. Not suitable for projects built in a manner **significantly different** than **planned**
 - ❖ This has lot to do with discretionary logic === we will talk later
4. Not typically appropriate for projects that include **near-critical paths** that experienced delay,
 - as the method cannot appropriately consider **shifts** in the critical path over time.
 - ✓ Before using this method, the **float analysis** should be performed

As-planned vs. as-built windows analysis – When to use?

The **main drawback** is that the costs associated with the delay in each window would require an **average prolongation rate** if the duration of each window increases

When the duration of each window increases == average rate is more applicable rather than calculating actual cost

As-planned vs. as-built windows analysis – Practical procedure

1. The windows should be selected first.

- ❑ The beginning and end of each “window” is usually defined by:
 - ❖ Key milestone events which occurred during the course of the works.
 - ❖ Periods when the contractor’s intentions, logic or methodology **changed** (e.g. **attempted acceleration or changed conditions**).
 - ❖ Periods when snapshots of progress were recorded contemporaneously, allowing earned value analysis calculations **within each window**.
 - ❖ Key changes, suspensions or delays having been experienced.

As-built critical path windows.

Window Ref.	Description	Actual Start	Actual Finish
CP-1.001	Install pipe	6-Jan-06	12-Feb-06
CP-1.002	Test pipe	13-Feb-06	30-May-06
CP-1.003	Handover	31-May-06	28-Jun-06

As-planned vs. as-built windows analysis – Practical procedure

2. Window level variances reconciliation table (WLVs) should be calculated

Window level variance reconciliation table.

Window Ref.	Planned Start	Planned Finish	Actual Start	Actual Finish	Start var. (less prev. WLV)	Finish var. (less prev. WLV)	WLV
CP1-001	1-Jan-06	7-Feb-06	6-Jan-06	12-Feb-06	5	–	5
CP1-002	8-Feb-06	12-Feb-06	13-Feb-06	30-May-06	–	102	102
CP1-003	13-Feb-06	28-Feb-06	31-May-06	28-June-06	–	13	13

As-planned vs. as-built windows analysis – Practical procedure**3. Liability assessment**

- ❑ To allow **apportionment** of the delay in each window, the WLV analysis requires one additional step of liability assessment.

Liability assessment.

Window Ref. CP	Description	WLV	CDE	EDE	Liability Assessment
CP1-001	Install pipe	5		5	Delayed site access (5 days)
CP1-002	Test pipe	102	82	20	Pipe repair (80 days), late instruction (20 d), plant breakdown (2 days)
CP1-003	Handover	13		13	Additional back-fill (10 days), additional manhole (3 days)

After-the-Fact Schedule Analysis

(Retrospective longest path analysis (RLPA))

FSA methods

Method of Analysis	Analysis Type	Critical Path Determined	Delay Impact Determined	Requires
Time Slice Windows Analysis	Effect & Cause	Contemporaneously	Retrospectively	- Logic linked baseline programme. - Update programmes or progress information with which to update the baseline programme.
As-Planned versus As-Built Windows Analysis	Effect & Cause	Contemporaneously	Retrospectively	- Baseline programme. - As-built data.
Retrospective Longest Path Analysis	Effect & Cause	Retrospectively	Retrospectively	- Baseline Programme. - As-built programme.
Collapsed As-Built Analysis	Cause & Effect	Retrospectively	Retrospectively	- Logic linked as-built programme. - A selection of delay events to be modelled.

FSA methods

The Information Required					
	Baseline programme	Logic linked baseline programme	As-built data	Delay events to model	Up to date programmes/ process information
Time Slice Windows					
As-Planned v As-Built Windows					
Longest Path					
Collapsed As-Built					
The table above shows the evidence required for each delay analysis method. The table has been simplified.					

Retrospective longest path analysis – Definition

- ☐ It involves the determination of the “**retrospective as-built critical path.**”
- ☐ It **adopts** “the perspective evident at the **end of the project.**”
- ☐ The **prerequisite** for this type of analysis is:
 1. A **baseline** schedule
 2. An **as-built schedule** and/or **records.**

Retrospective longest path analysis – Definition

- ❑ In this method the analyst **must first** either **verify an existing as-built schedule**

What if an as-built schedule is not available?

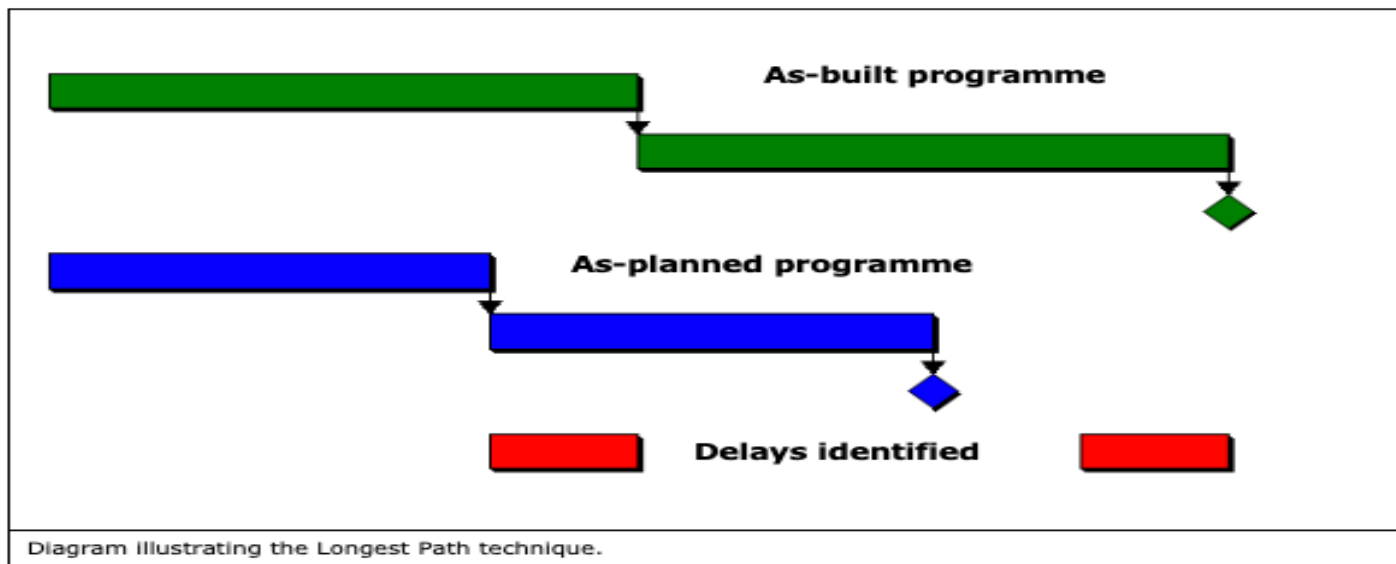
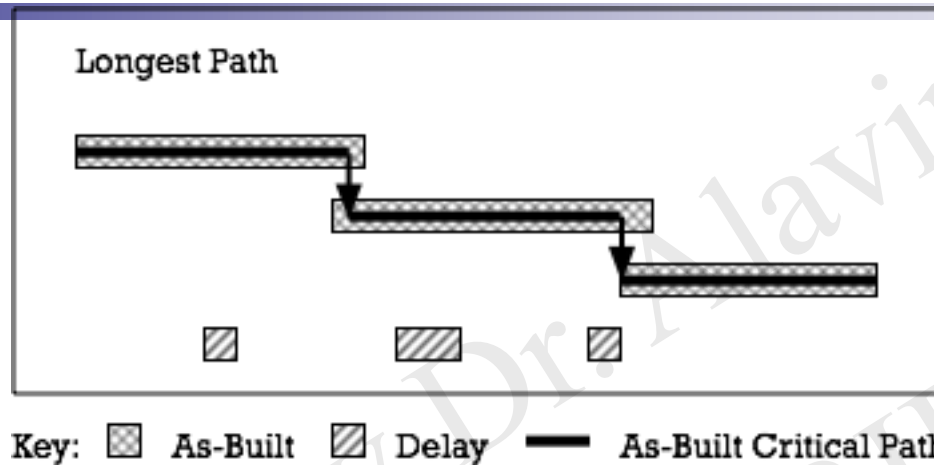
Develop a detailed one

The **as-built schedule** does **not need** to be at the **same level of detail** as the **baseline schedule**, **unlike** the **As-planned vs As-Built Windows Analysis**.

Retrospective longest path analysis – How to use?

1. Develop **as-built** schedule
2. **Analyst** traces the **longest continuous path** **backwards** from the **actual completion** date to determine the **as-built critical path**
3. **key dates compared** along
 - ❖ The **retrospective (as-built) critical path** **against**
 - ❖ Corresponding **planned dates** in the **baseline schedule**.
4. Thereafter, the **analyst investigates** the **project records** to **determine** what **delay events** **might have caused** the **identified critical delay**

Retrospective longest path analysis – Example



Have you realized something?

Retrospective longest path analysis – Pros and cons

- ✓ **Low** in terms of **cost** and **time**
- ✓ **Can** be used for **after-the-fact** schedule (**retrospective delay impact**)
- × **Static analysis** (**Retrospective critical path**)
 - × **Limited capacity** to recognize and allow for switches in the critical path
- × It may **not consider** actual progress and changes (**may be hypothetical**)
- × **Subjective**
 - × In terms of **actual progress** and **changes**
 - × In terms of **critical path**
- × **May not allow** analyst to **identify** and **quantify** every day of delay
- × Cannot consider concurrent delays

Retrospective longest path analysis – When to use?

- ☐ It is **usually** applied **when** there are **no** update schedules or **usable** update schedules
- ☐ There are **baseline schedule (only Gantt chart) + As-built data**

Caution:

It is **recommended** to use **other methods** to **support** this analysis

e.g., resource curve analysis or earned value analysis

After-the-Fact Schedule Analysis

(Collapsed As-Built Analysis (CAB))

FSA methods

Method of Analysis	Analysis Type	Critical Path Determined	Delay Impact Determined	Requires
Time Slice Windows Analysis	Effect & Cause	Contemporaneously	Retrospectively	- Logic linked baseline programme. - Update programmes or progress information with which to update the baseline programme.
As-Planned versus As-Built Windows Analysis	Effect & Cause	Contemporaneously	Retrospectively	- Baseline programme. - As-built data.
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FSA methods

The Information Required					
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Time Slice Windows					
As-Planned v As-Built Windows					
Longest Path					
Collapsed As-Built					
The table above shows the evidence required for each delay analysis method. The table has been simplified.					

Collapsed as-built analysis – Definition

❑ SCL Protocol:

- ❖ Very **similar** to **impacted as-planned** (**in reverse**)
- ❖ Also known as “**As-Built But for (ABBF)**” analysis
- ❖ This is a **what if scenario**
- ❖ It involves the **extraction of delay events** from the **as-built schedule** to provide a **hypothesis** of what **might have happened** had the **delay events not occurred**.
- ❖ It does **not require** a **baseline schedule**.
- ❖ It requires a **detailed logic-linked as-built schedule**.
 - ✓ It is **rare** that such a schedule would **exist** on the project
 - Therefore the analyst is usually required to **introduce logic** to a **verified as-built schedule**.
 - This can be **very time consuming** and **complex endeavor**.

Collapsed as-built analysis – Definition

❑ SCL Protocol:

❖ Once **completed (logic-linked as-built created)**,

sub-networks for the delay events within the as-built programme are identified

they are **‘collapsed’ or extracted** in order to determine the **net impact** of the delay events.

❖ This method is sometimes done in windows, using interim or **contemporaneous programmes** which contain detailed and comprehensive as-built data.

Collapsed as-built analysis – Definition

❑ SCL Protocol says:

‘4.7 Collapsed as-built is based on the effect of employer risk events on the programme of work as it was actually built. Similar to the as-planned versus as-built, the use of this technique is restricted by its inability to identify concurrency, resequencing, redistribution of resources or acceleration. This is particularly the case when the nature of the as-built logic is complex, requiring subjective reconstruction of as-built logic. Where acceleration, redistribution of resources or resequencing has taken place during the course of the works to overcome the effects of events, this form of analysis may produce unreliable results’.

❑ The SCL Protocol is justifiably cautious about recommending the **CAB approach**.

Collapsed as-built analysis – Definition

- ❑ AACE method implementation protocol (MIP) 3.8 and 3.9 say:
 - ❖ **Recreates a CPM model** starting with the **as-built schedule**,
then **deletes selected delay activities** in order to **show**
what **would have happened**, had that **event not taken place**

Collapsed as-built analysis – How to use?

NTP = NET TIME PRESENT

AS=ACTUAL START

ABCP=ACTUAL BASED CRITICAL PATH

Collapsible As-Built

- Schedule created with a Data Date equal to NTP, original durations equal to actual durations, and logic designed to make ES/EF equal to AS/AF.
- Also contains activities representing delays.
- ABCP is calculated.

Collapsed As-Built

- Delay activities are dissolved, in reverse order.
- Schedule is recalculated after each dissolution.
- Method purports to demonstrate what would have happened “but for” the dissolved events.

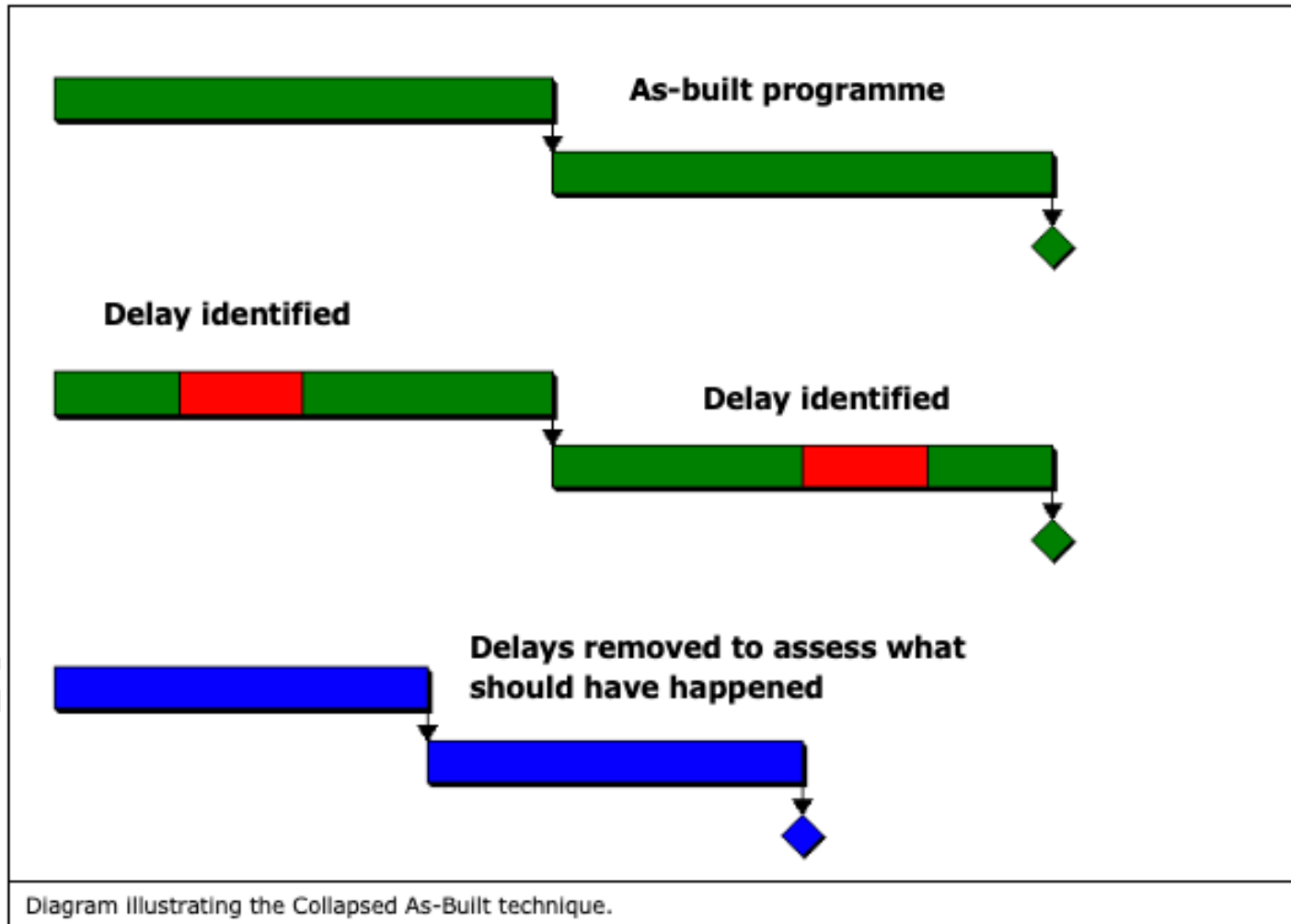
Collapsed as-built analysis – How to use?

1. Develop a **detailed logic-linked as-built schedule**.
 2. **Sub-networks** (fragnets) for the **delay events** are **identified** within **as-built schedule**
 3. **Collapse** and **extract Sub-networks** (fragnets) for the **delay events** in order to determine the **net impact** of the **delay events**
- ☐ This method is **sometimes** done in **windows**, using **interim** or **contemporaneous** schedules which contain **detailed** and **comprehensive as-built data**.

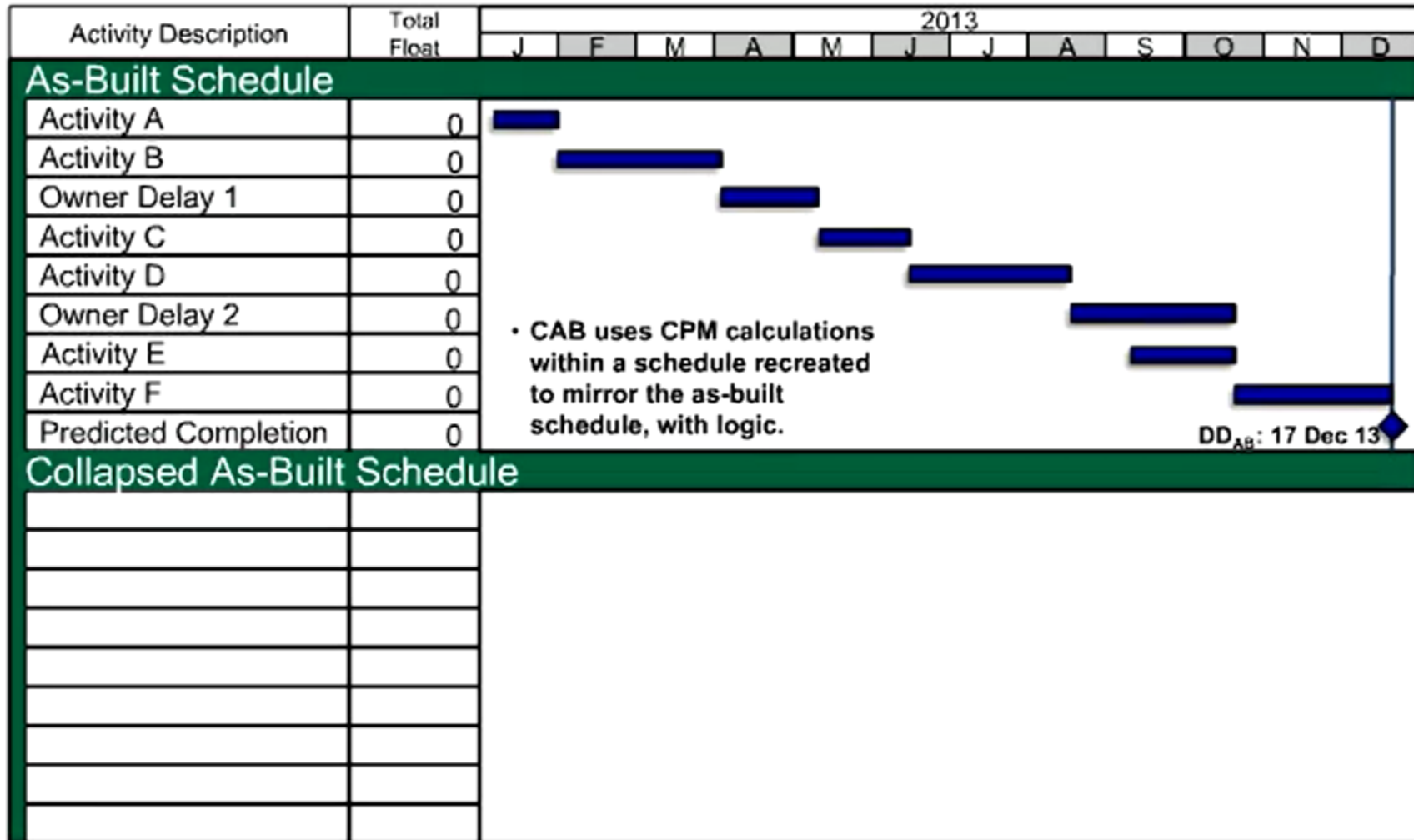
Before any collapsing can take place, the delay events relied on EDE, CDE, or both, must be discretely identified among the as-built activities.

These can be in the form of “fragnets.”

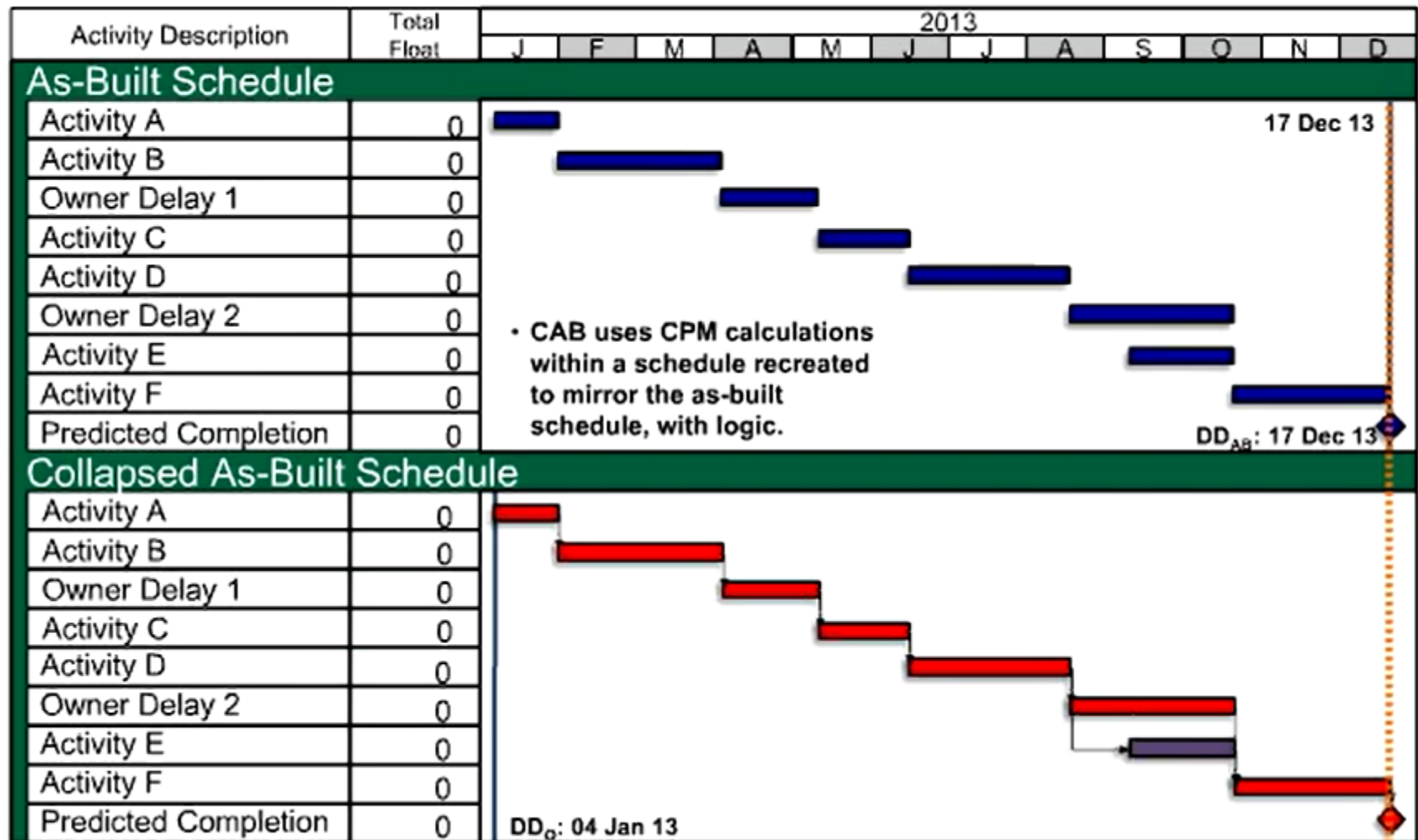
Collapsed as-built analysis – Example



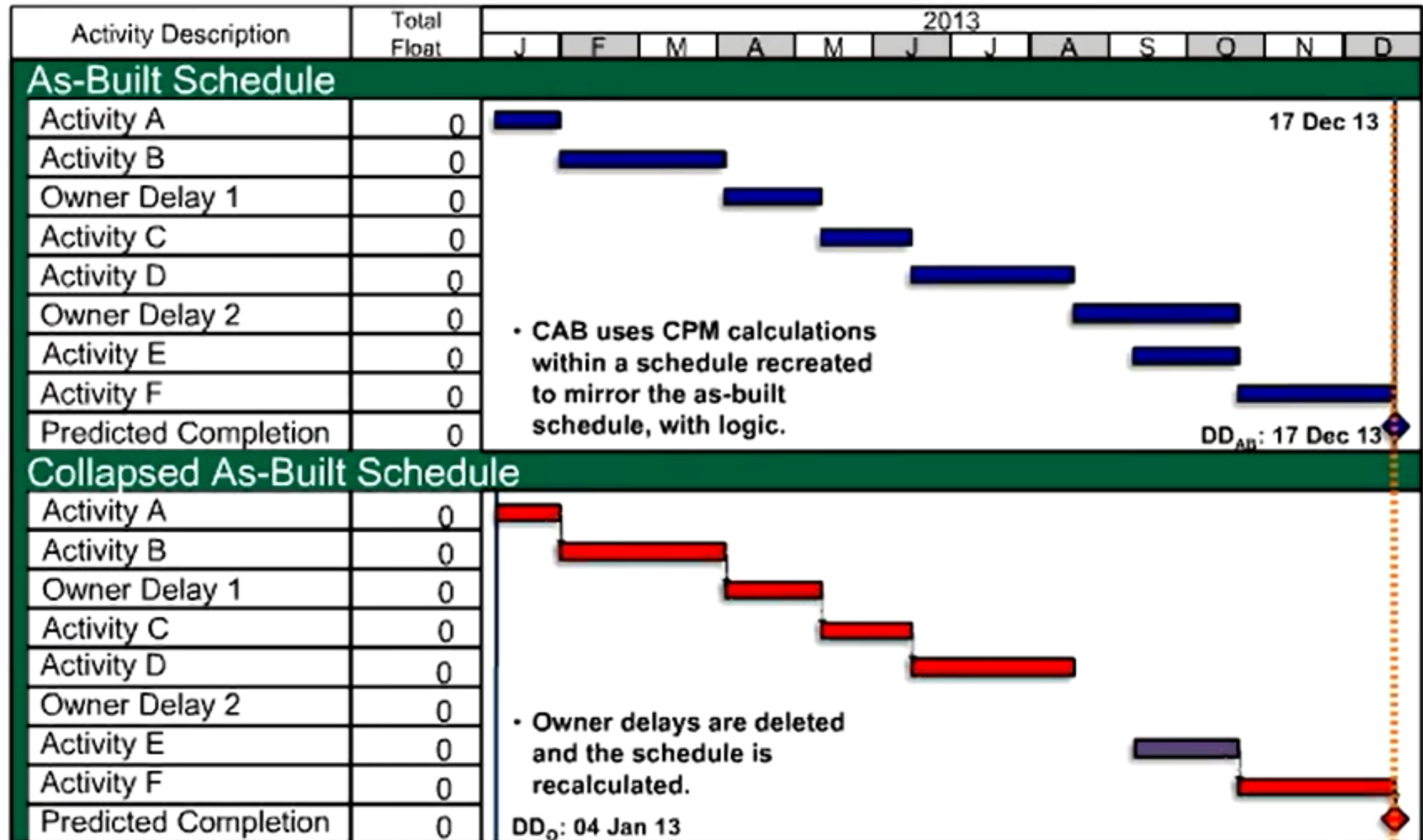
Collapsed as-built analysis – Example



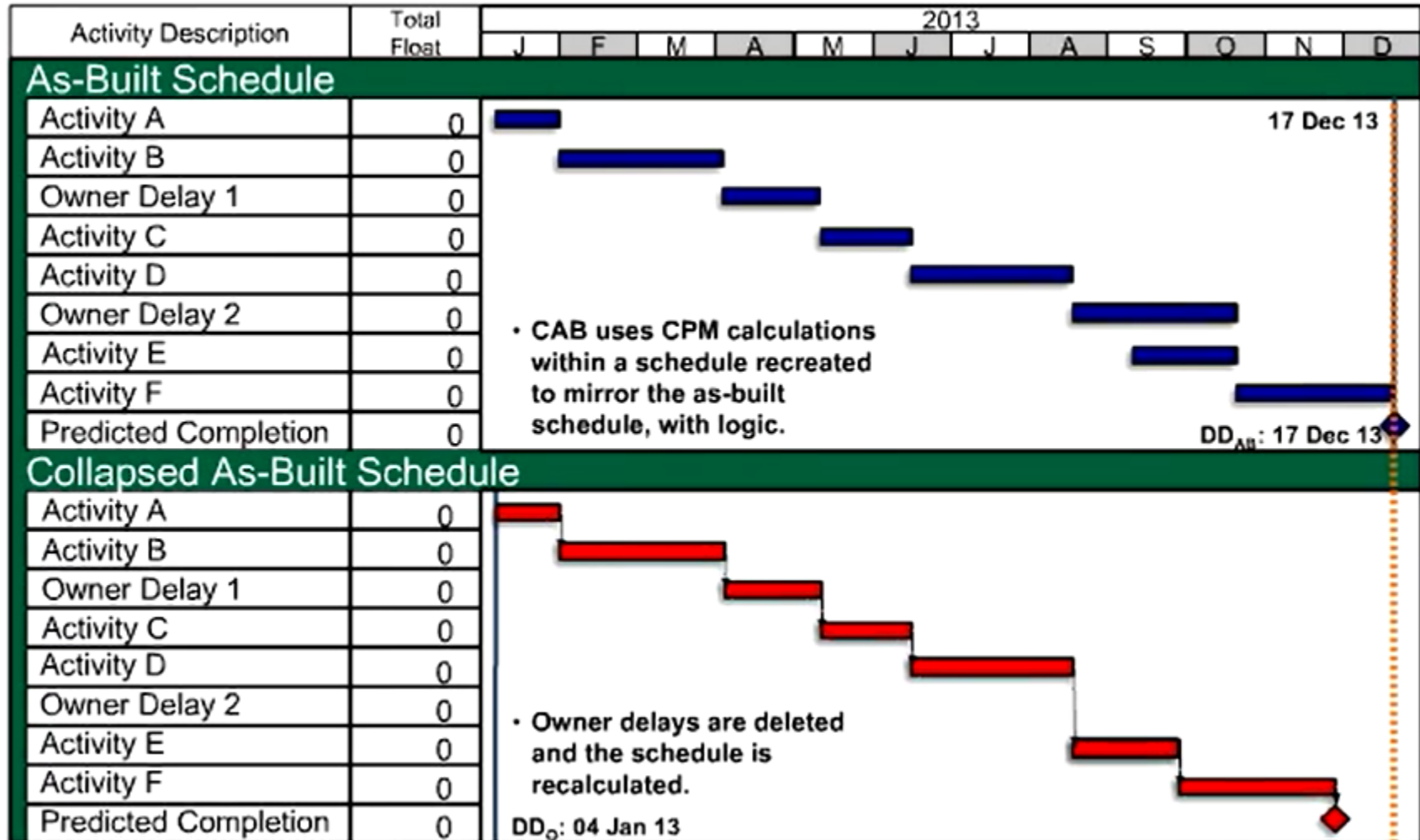
Collapsed as-built analysis – Example



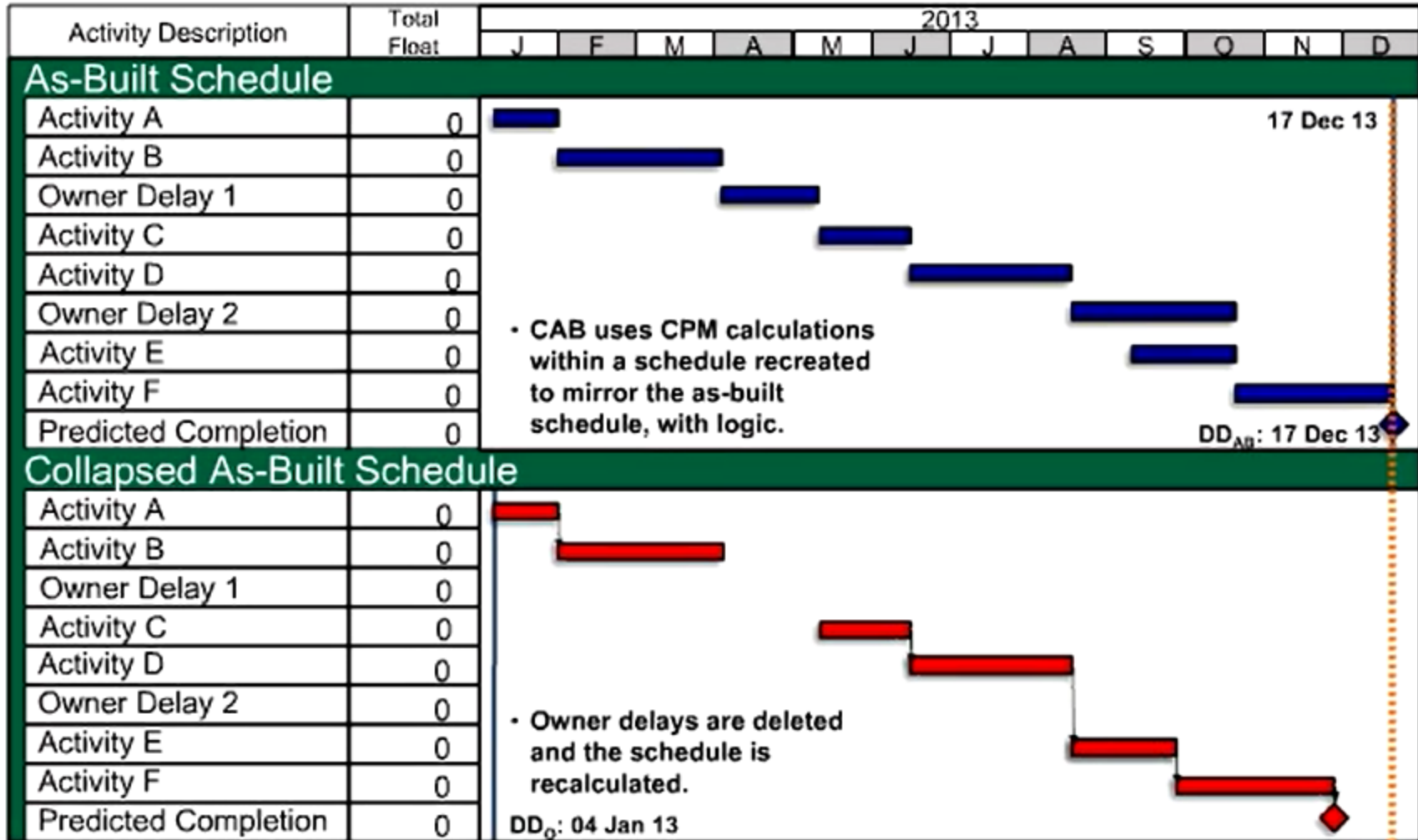
Collapsed as-built analysis – Example



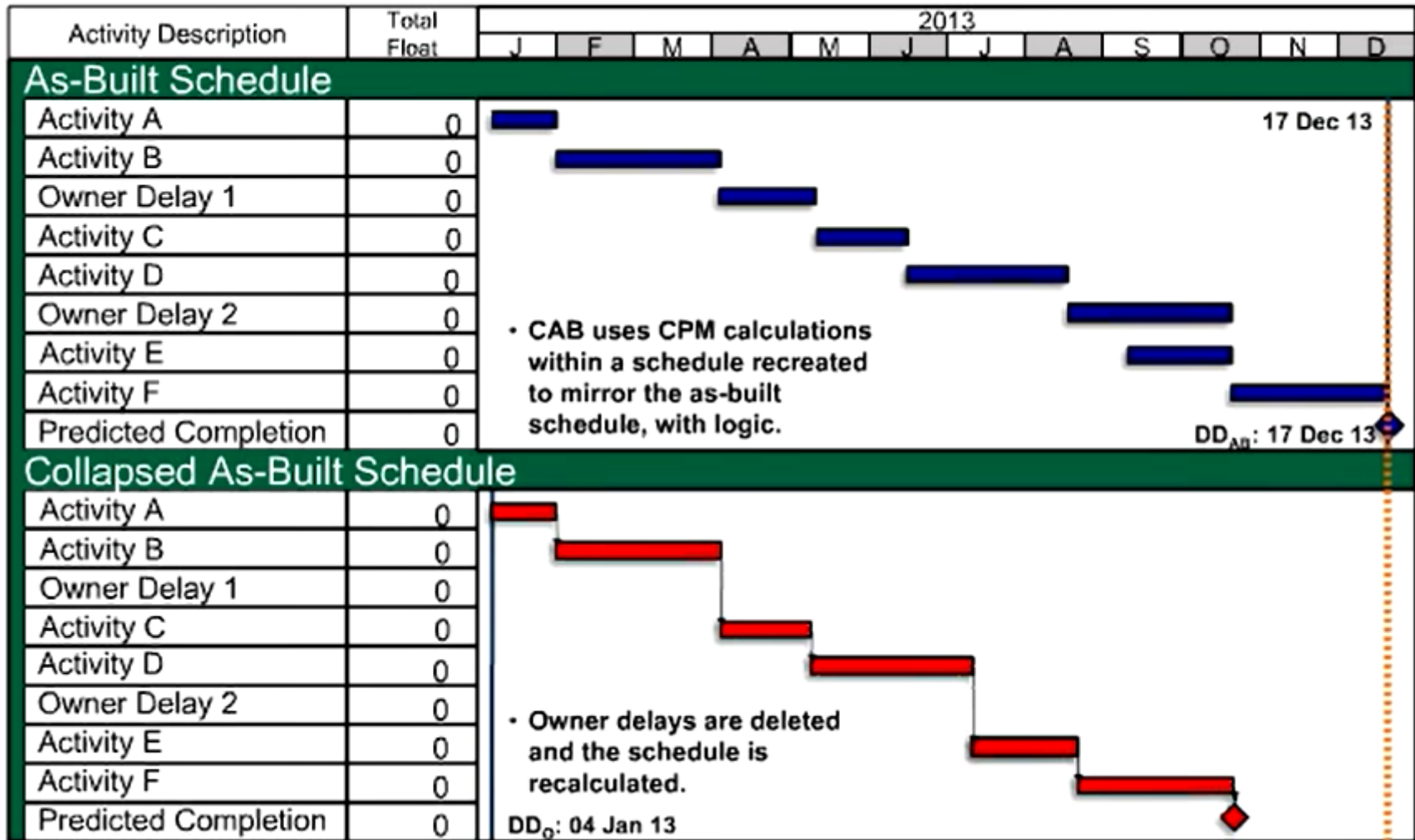
Collapsed as-built analysis – Example



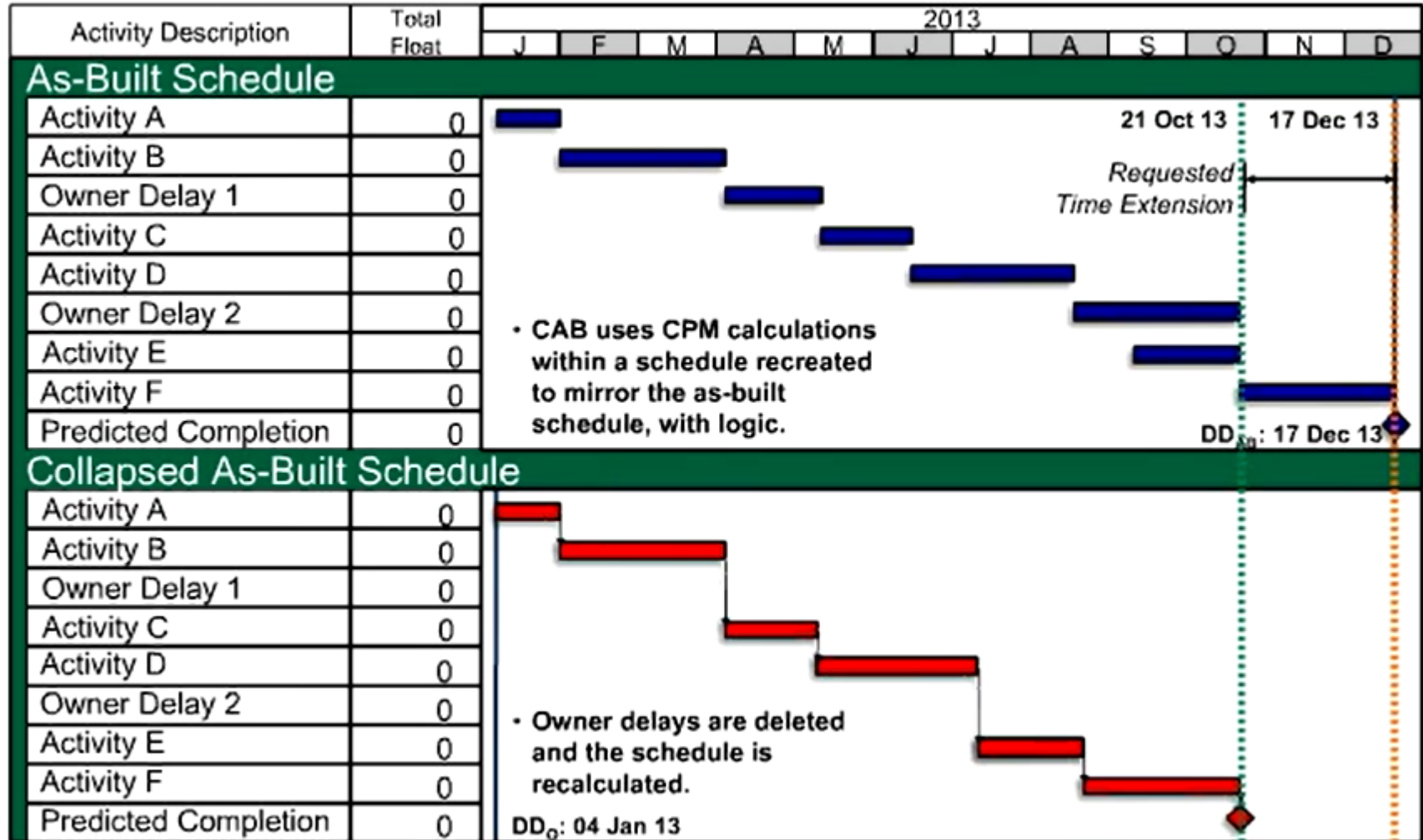
Collapsed as-built analysis – Example



Collapsed as-built analysis – Example



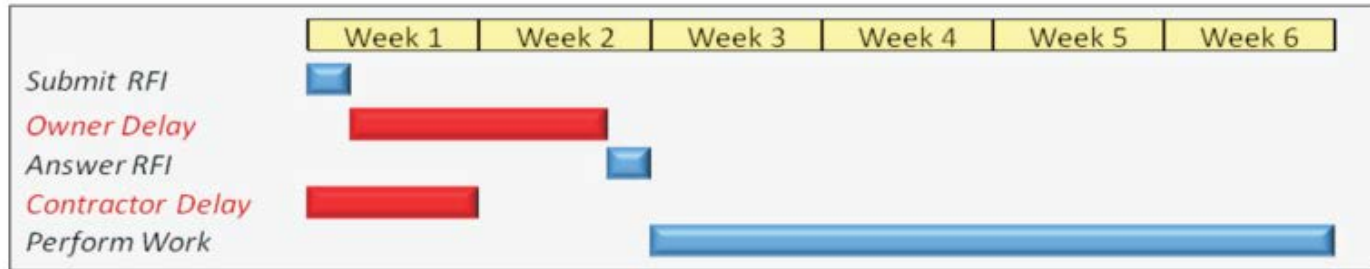
Collapsed as-built analysis – Example



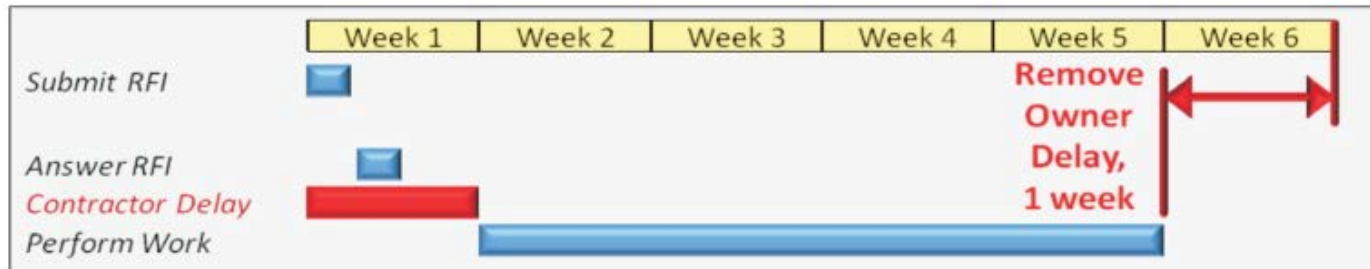
IS IT ALWAYS THAT SIMPLE?

Collapsed as-built analysis – Example

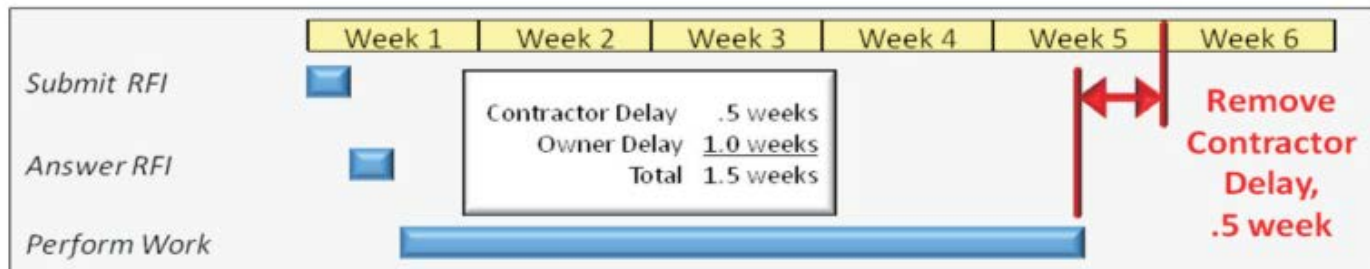
As-Built Schedule with Delays



As-Built Schedule with Owner Delay Removed First

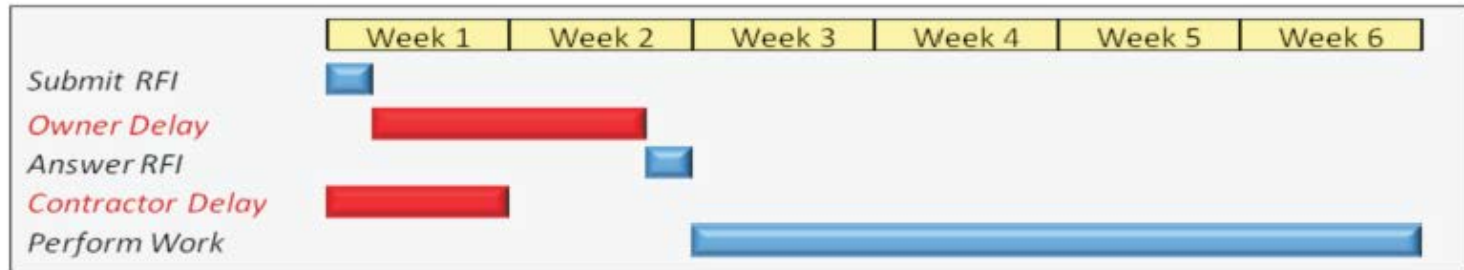


As-Built Schedule with Contractor Delay Then Removed

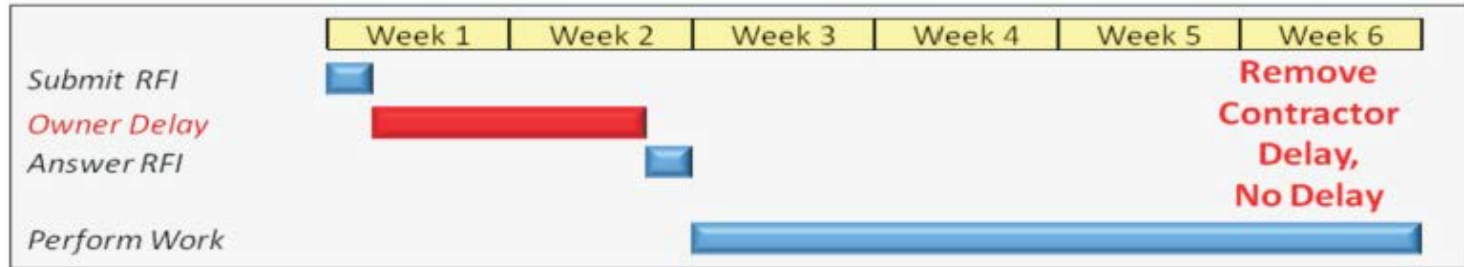


Collapsed as-built analysis – Example

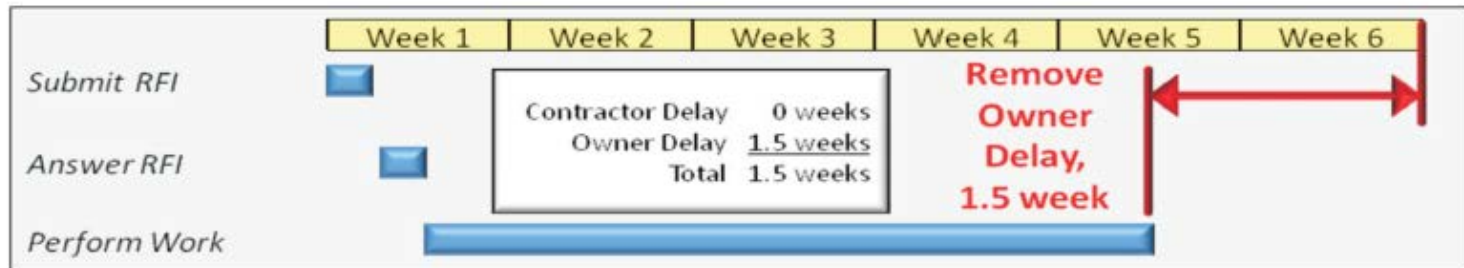
As-Built Schedule with Delays



As-Built Schedule with Contractor Delay Removed First



As-Built Schedule with Owner Delay Then Removed



Collapsed as-built analysis – Pros and cons

- ✓ Often known as “but-for” analysis
- ✓ Easy to understand
- ✓ Does not require **baseline programme**
- ✓ Can isolate impact of EDE from CDE when **iterative applications** applied
- ✓ Used for **after-the-fact** schedule (**retrospective delay impact**)

Collapsed as-built analysis – Pros and cons

- × **Rejected by many courts especially** if the as-built schedule is not well developed
- × **Static analysis (Retrospective critical path)**
 - × Collapsed As-Built Analysis “freezes” the critical path.
 - ✓ It could be improved **if step-based approach and window analysis** used.
 - × The critical path then **changes depending on the “subtraction” made**, but these critical path “shifts” **rarely match** the shifts shown in the **contemporaneous project schedules**.
- × **Subjective** in terms of **actual progress** and **changes** (using all **new logic and progress**)
- × **Ignores plan** because you heavily **rely** on **as-built**
- × **Can be extremely complicated**
- × **Susceptible to manipulation** during as-built logic assignments
- × **Moderate to very high** in terms of **time** and **cost**
- × **No consideration of concurrent delays** if no step-based approach is used.

Collapsed as-built analysis – When to use?

- ☐ The **actual effect** of the delay event is **known**.
- ☐ An **accurate as-built schedule** is available or can be **developed**.
- ☐ A **baseline schedule** is **not available**.

Before using this method, the analyst needs to ask some questions!

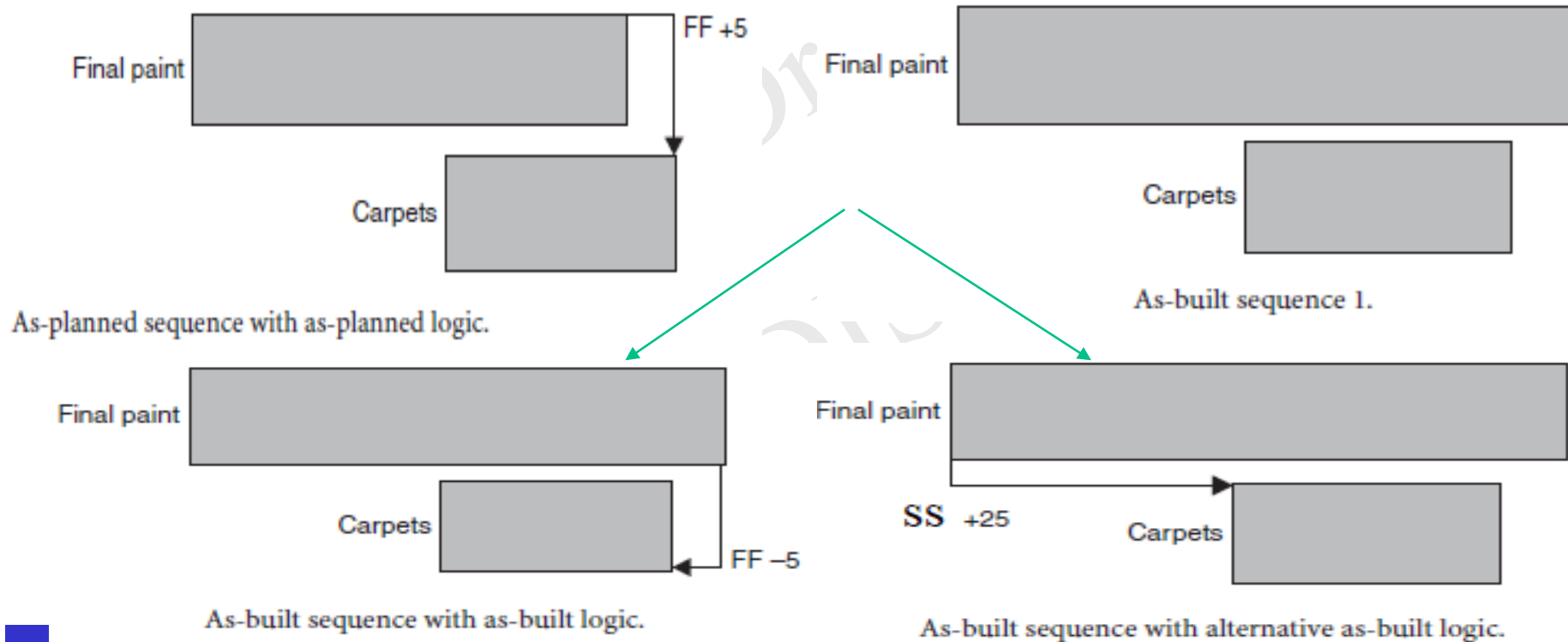
Collapsed as-built analysis – When to use?

Before carrying out the delay analysis, the analyst needs to ask many questions of the data...Let's see!

1. Is there an **appropriately detailed as-built programme** in existence, or does one need to be constructed from base raw documents?
 - ❖ If not, does **sufficient data exist** to allow one to be **reconstructed**?
2. Secondly, **if a detailed as-built programme exists**, can the **start and finish dates** for each activity be **verified**?
3. Thirdly, **once the as-built start and finish dates have been verified**, and corrected where necessary, can **periods of inactivity** be **identified** along any of the **tasks**?
4. Lastly, **if all of the above can be verified**, can the **as-built logical relationships** and **dependencies** between each activity on the programme be **accurately identified** and **simulated** in the base programme?

Collapsed as-built analysis – When to use? – Example

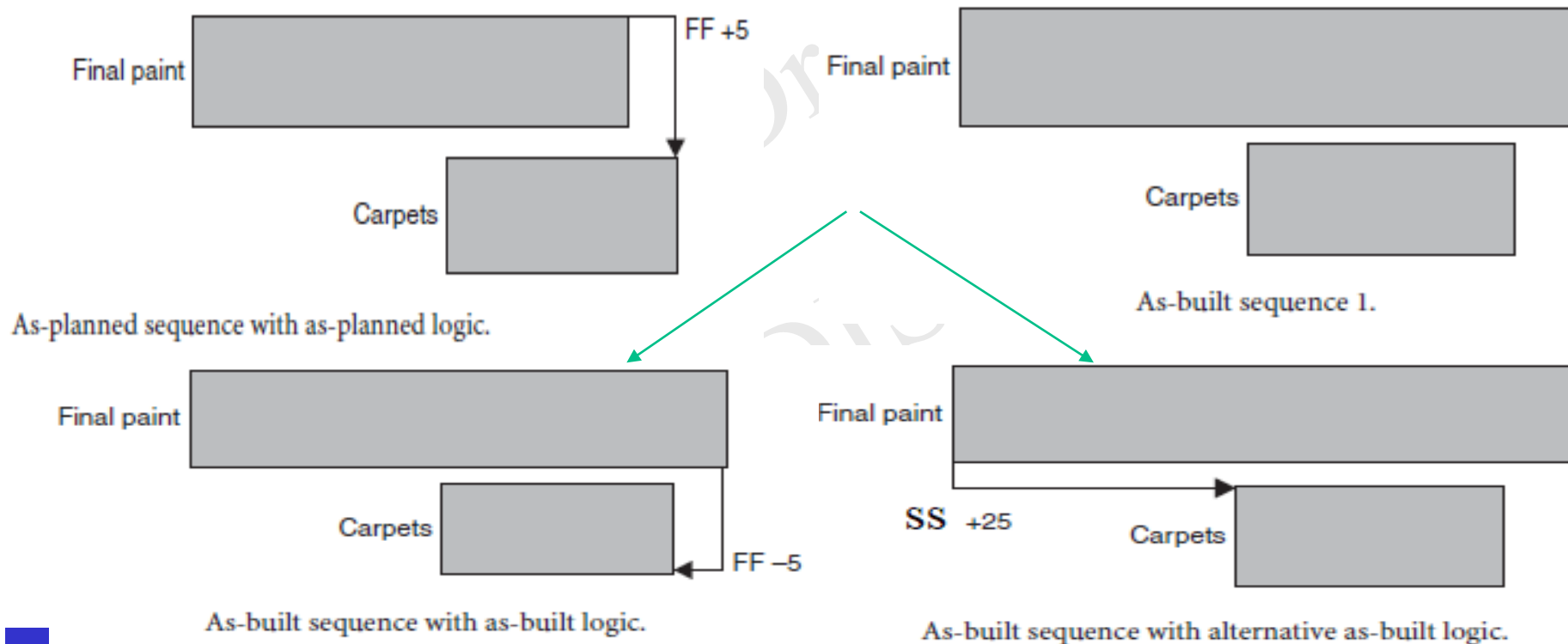
- ❑ In the **CAB base model**, the **‘as-built’ dates** are **actually calculated**.
- ❑ The **start and finish date** of each activity must rely **on its as-built duration** and one of **four types of logical relationships** used in CPM networks to connect related tasks to their successors



Which one?

Collapsed as-built analysis – When to use? – Example

- ❑ The logical relationship illustrated in **SS LOGIC would more accurately represent** what actually happened. **Carpets** commenced following 25 days of Final Paint progress and **finished in accordance with their as-planned duration**. Final Paint on the other hand **overran its as-planned duration**, but with **no resulting delay to Carpets**.



On a project with thousands of activities, the analyst may have to make literally thousands of amendments such as the one demonstrated above!

Collapsed as-built analysis – Practical procedure

❑ There are several ways to perform a Collapsed As-Built Analysis. Two of them are:

1. **Unit subtractive as-built (window analysis)**
2. **Gross subtractive as-built (single base analysis)**

*First, a model of the **as-built schedule**, which is called the **As-Built Calculation Schedule**, is developed with **actual schedule logic** and **actual activity durations**.*

Collapsed as-built analysis – Practical procedure

1. Identify the window for analysis.

- a) If the analysis is a **“single base,”** then CAB model window is the entire project duration.
- b) If the analysis is carried out as a **“window” analysis**, then **justification** for each window needs to be given.

Collapsed as-built analysis – Practical procedure**2. Identify all known delay events in the as-built model.**

- ❖ The owner-caused, contractor-caused, concurrent delays are then identified in the **As-Built Calculation Schedule**.

Example of an Owner-Caused Delay Quantified by a Duration Variance Calculation

Activity No.	Activity Original Duration (WD)	Activity Actual Duration (WD)	Activity Duration Variance Delay (WD)	Delay Responsibility
A	10	10	0	–
B	5	5	0	–
C	10	20	10	Owner
D	5	5	0	–
E	25	30	5	Contractor

Collapsed as-built analysis – Practical procedure

3. Identify the sequence of extraction of delay events in each window.

a) Extracted **all at once**

b) Extracted one at a time on a **“stepped basis”**

✓ The **usual approach** in this case is to collapse activities in **reverse order**, based on the **latest actual finish date** and working back to the **beginning of the window**, one at a time.

✓ The **traditional approach** is to extract **both EDE and CDE** from the same CAB model, with **CDE removed first**, to allow the **contractor the benefit** of any **concurrent** or **pacing** delays.

i. **Calculate delays caused by the owner**

ii. **Calculate delays caused by the contractor**

If delays cannot be demonstrated to be EDE, they are treated as CDE

Collapsed as-built analysis – Practical procedure**4. Identify the method of extracting delay events.**

❖ The process can be carried out by simply

a) **Deleting** the delay events (not recommended)

b) **Dissolving** the delay events (can be done by Primavera)

✓ The delay events' successor activities are tied to their predecessor activities to maintain schedule logic continuity instead of deleting.



c) **Reducing** the delay event duration to zero

Each method could result in a different answer!

The analyst should be consistent in the method of extraction to avoid criticism for inconsistent application of methodology.

Collapsed as-built analysis – Practical procedure

5. Remove the first delay (or set of delays) from the CAB as-built.

- ❖ **Log the movement**, if any, to the CAB calculated completion date.
 - ✓ By **removing delays** that were caused by the delay, the As-Built Calculation Schedule for each schedule window **may or may not collapse**.
 - i. Complete movement
 - ii. No movement or partial movement
- ❖ If **near critical paths** are being tracked, note the **change in float** along the path of the delay event extracted.

Collapsed as-built analysis – Practical procedure**5. Remove the first delay (or set of delays) from the CAB as-built.**

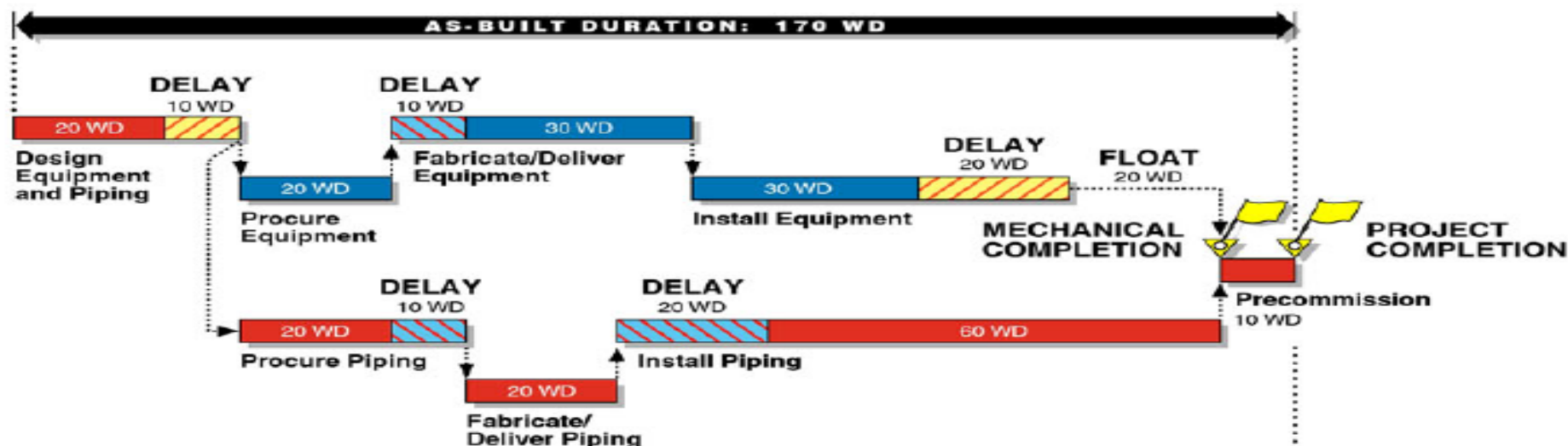
i. **Complete movement:** If the **As-Built Calculation Schedule completion date** **collapses exactly to the duration of the delays**, the **net duration** of the schedule

collapse is the **amount** of EDE, CDE, or neutral!

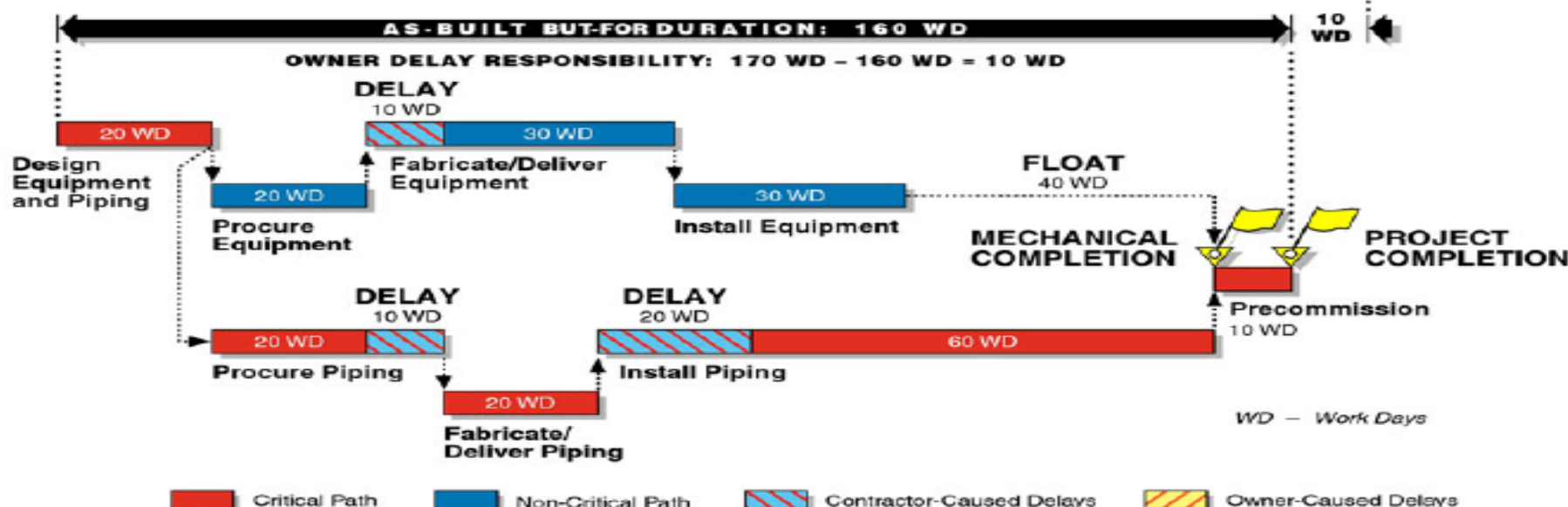
- ❖ Because there were **no concurrent delays** to the **critical path** that were caused by the **others**.
- ❖ EDE may have caused increases to the **contractor's home office overhead costs**, and/or the **contractor's** and its **subcontractors' field office overhead costs**.

Actual time-related cost increases would still need to be demonstrated with **evidence** to prove that the **contractor or its subcontractors** **actually incurred compensable delay damages**.

As-Built Schedule Showing Owner-Caused and Contractor-Caused Delays



As-Built But-For Schedule With Owner-Caused Delays Removed



Note: Because of contractor-caused delays on the critical path, the Project Completion could have been achieved only 10 WD earlier if the owner-caused delays did not occur. Therefore, the owner's responsibility for a compensable delay is 10 WD.

Collapsed as-built analysis – Practical procedure

5. Remove the first delay (or set of delays) from the CAB as-built.

ii. **No movement or partial movement:** If the As-Built Calculation Schedule does **not collapse at all or partially collapse**,

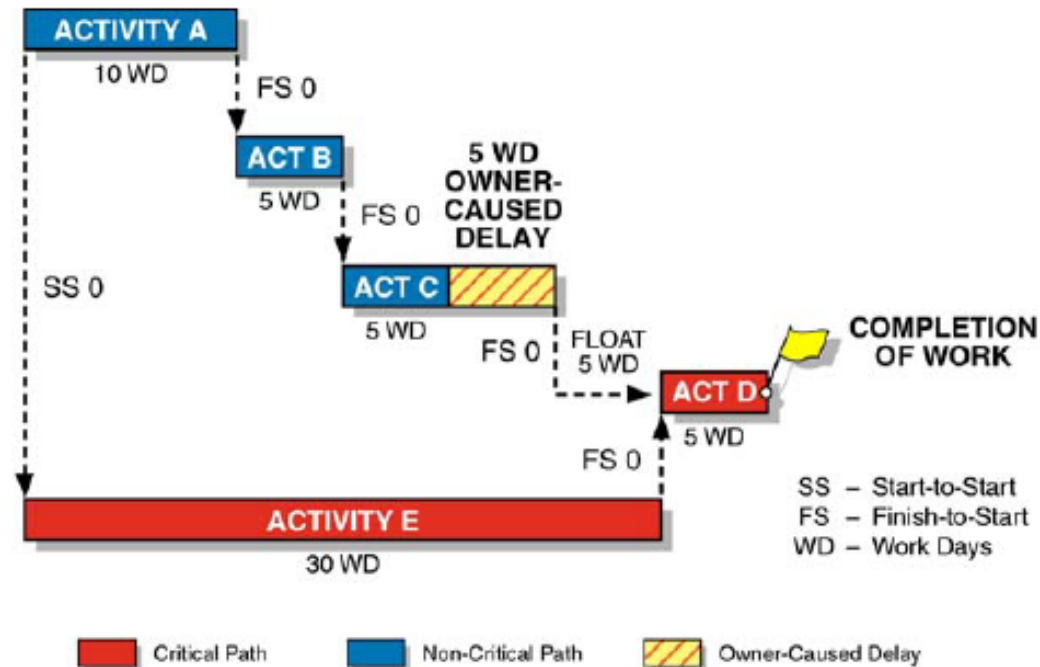
the **caused delays** that were removed were **either**:

a) **Not on the critical path** and, therefore, the caused delay would not have affected the completion date(s).

Collapsed as-built analysis – Practical procedure

In this case, the 5- work day owner-caused delay affected Activity C, which still had 10 work days of available float after the delay occurred because the Activity E and Activity D were the actual critical path to the Completion of Work

Owner-Caused Delays Were Not on the Critical Path



Because the 5 WD owner-caused delay is not on the critical path, removal of the 5 WD owner-caused delay would not have resulted in an earlier completion date.

Collapsed as-built analysis – Practical procedure

5. Remove the first delay (or set of delays) from the CAB as-built.

ii. **No movement or partial movement:** If the As-Built Calculation Schedule does **not collapse at all or partially collapse**,

the **caused delays** that were removed were **either**:

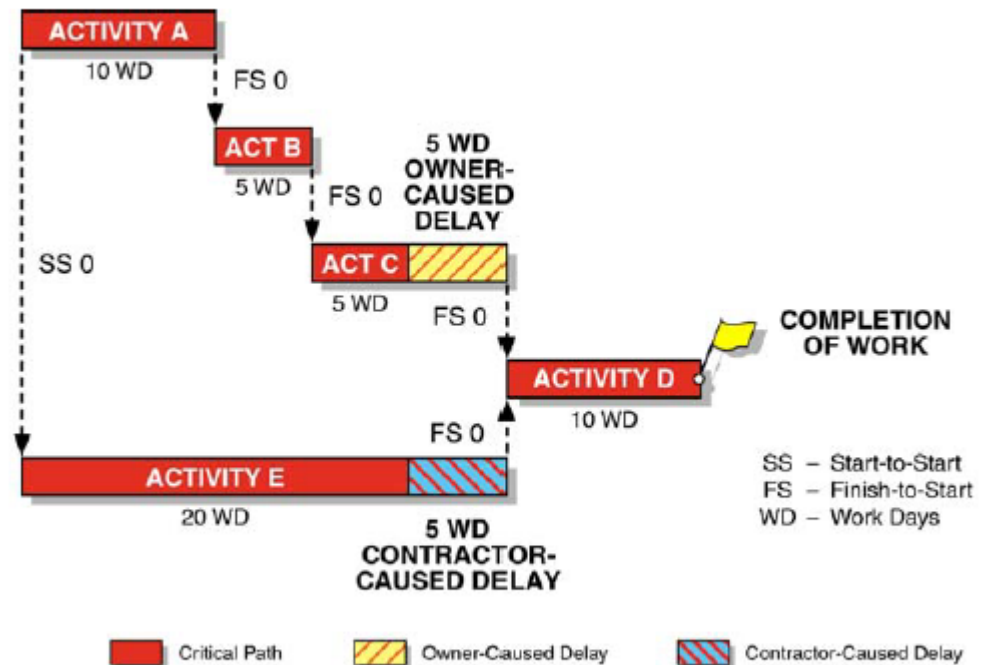
b) **Concurrent** with **other caused-delays** that were also on the **as-built critical path** which prevented the **schedule completion date** from **collapsing** to the **original projected completion** date at the start of the window.

Collapsed as-built analysis – Practical procedure

In this example, the 5-work day owner-caused delay and the 5-work day contractor-caused delay affected two parallel activity paths, were independent delays, and both delays would have extended the completion of the project.

1. Total delays: 5 days
2. EDE: 0 days
3. CDE or concurrent: 5 days
 - ❖ CDE: 0 days
 - ❖ Concurrent: 5 days

Owner-Caused Delays Were Fully Concurrent with Contractor-Caused Delays



Because the owner-caused delay and contractor-caused delay are independent, concurrent, and both equal to 5 WD, removal of the 5 WD owner-caused delay would not have resulted in an earlier completion date.

Collapsed as-built analysis – Practical procedure

5. Remove the first delay (or set of delays) from the CAB as-built.

ii. **No movement or partial movement:** If the As-Built Calculation Schedule does **not collapse at all or partially collapse**,

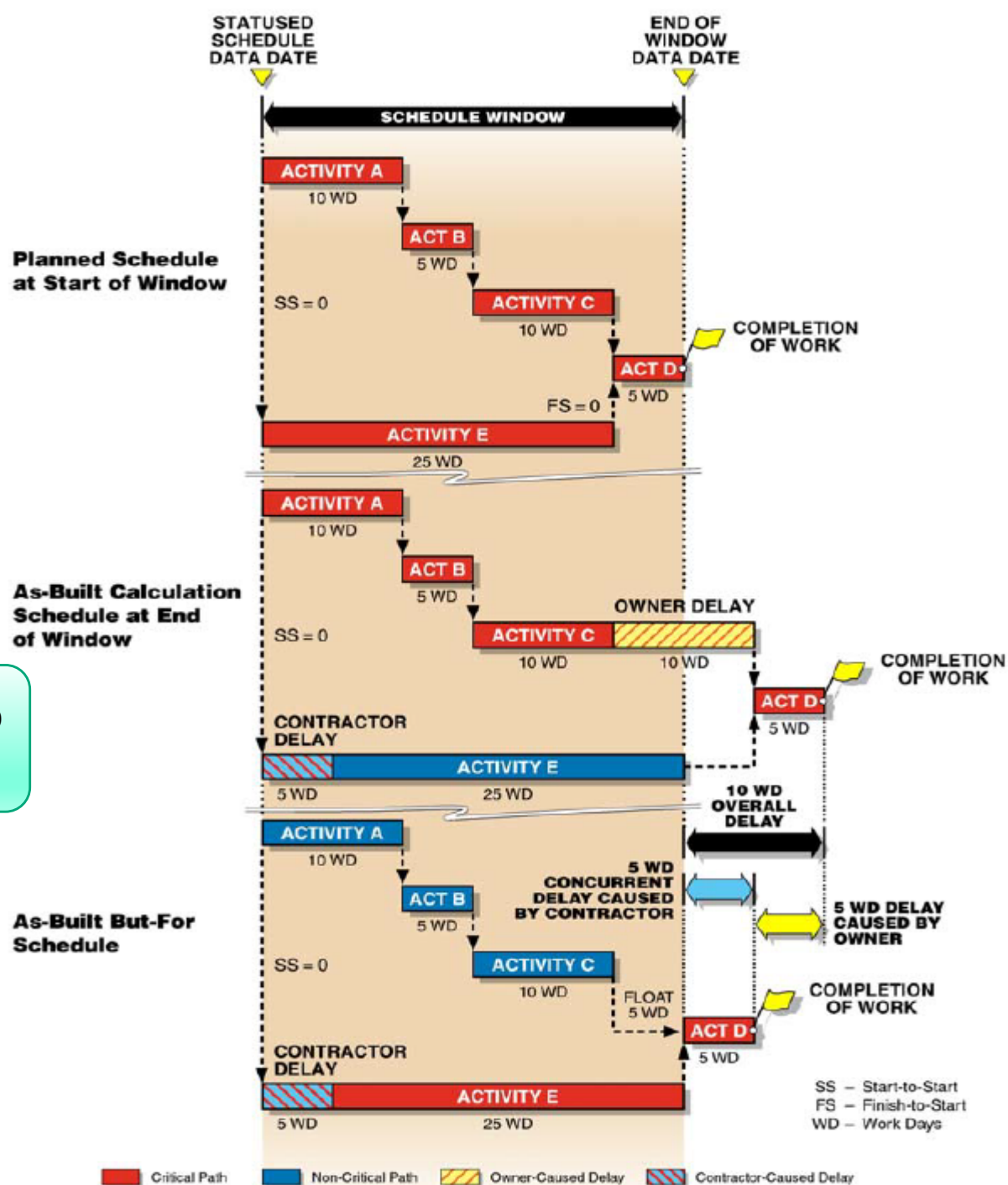
the **caused delays** that were removed were **either**:

c) **Concurrent in part**, but **not for the entire caused delay period**.

□ Stepped basis

- ❖ Total delays: 10 days
- ❖ EDE: 5 days
- ❖ CDE: 5 days

Could stepped basis always help with **concurrent delays**?



Collapsed as-built analysis – Practical procedure

1. Stepped basis

- ❖ Total delays: 5 days
- ❖ EDE: 2 days
- ❖ CDE: 3 days

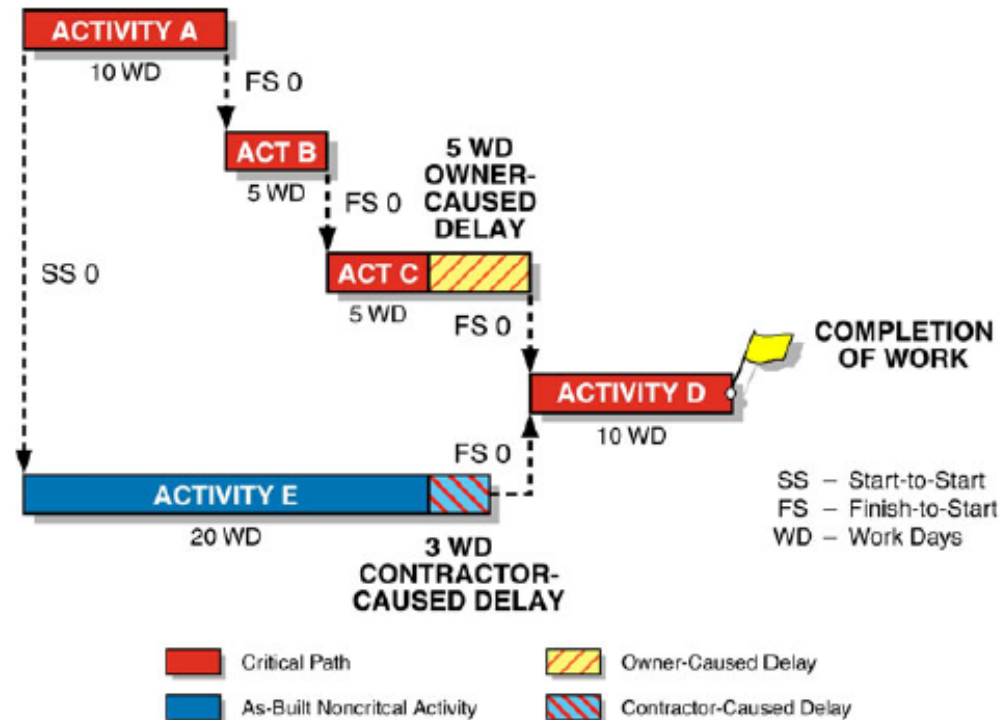
If you extracted based on stepped basis, you **would** have problem with concurrent delays

2. CDE first

- ❖ Total delays: 5 days
- ❖ CDE: 0 days
- ❖ EDE: 5 days

Which one is correct?

Owner-Caused Delays Were Partially Concurrent with Contractor-Caused Delays



Because the 3 WD contractor-caused delay is only partially concurrent with the 5 WD owner-caused delay, removal of the 5 WD owner-caused delay would result only in a 2 WD earlier completion.

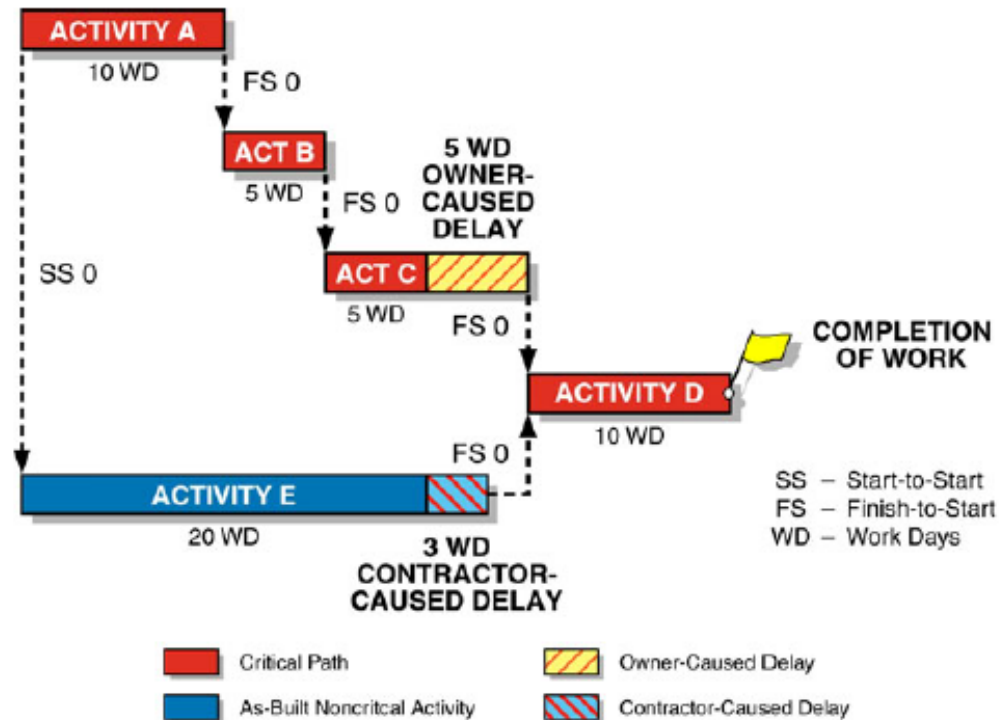
Collapsed as-built analysis – Practical procedure

1. Concurrent delays

- ❖ Total delays: 5 days
- ❖ EDE: 2 days
- ❖ CDE or concurrent: 3 days
 - ✓ CDE: 0 days
 - ✓ Concurrent: 3 days

Concurrent delays need to be considered case by case!

Owner-Caused Delays Were Partially Concurrent with Contractor-Caused Delays



Because the 3 WD contractor-caused delay is only partially concurrent with the 5 WD owner-caused delay, removal of the 5 WD owner-caused delay would result only in a 2 WD earlier completion.

Collapsed as-built analysis – Practical procedure

5. Remove the first delay (or set of delays) from the CAB as-built.

EDE is considered compensable unless it cannot be proved.

Then, the non-compensable delays should be checked if document is **not enough**

The CAB Schedule Delay Analysis that **removes contractor-caused delays** is used to determine the time period between the **actual completion date** and the **as-built but-for completion date** for assessment of liquidated damages by the owner

If delays could not be assigned to EDE, it would probably be considered as CDE



Collapsed as-built analysis – Practical procedure

6. Confirm the residual CAB is reasonable for the purpose of collapsing further.

- ❖ If any **anomalous results** are encountered after collapsing the programme, these require **adjustment** prior to any **subsequent collapsing**.

- ✓ **If** the correction affects the critical path,

it is advisable to make the **same correction** to the **original CAB base as-built programme** and **repeat** the process of extracting delays (Step 5) from the **first delay event**.

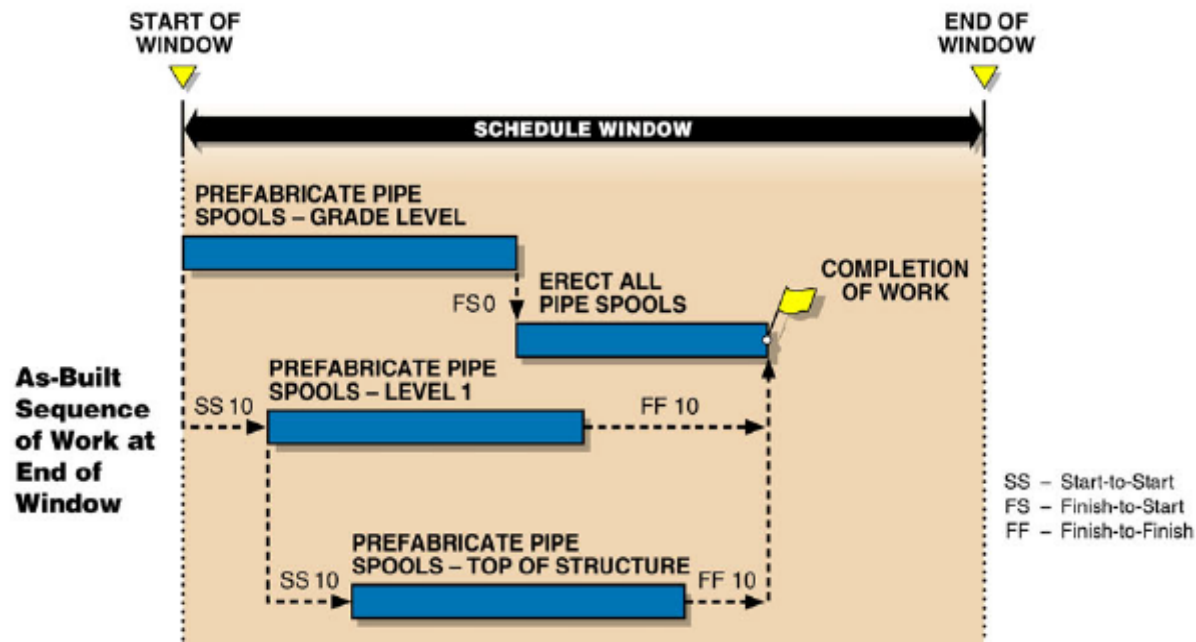
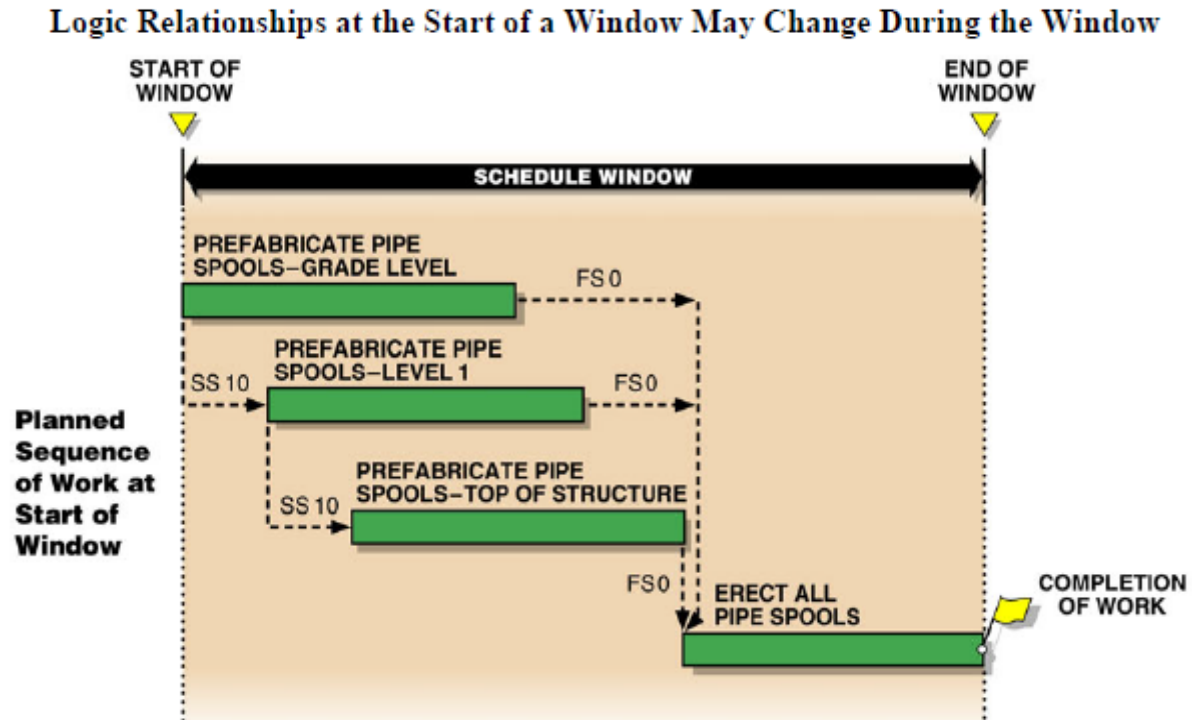
Collapsed as-built analysis – Practical procedure

6. Confirm the residual CAB is reasonable for the purpose of collapsing further.

- ❑ An examination for **out-of-sequence work** should be made of the **logical relationships** in the **statused schedules** that depicted the **actual manner** in which the work was **accomplished** during **each window**.
- ❖ Often, the **actual sequence of work** that was **examined** at the **end of the window** was **different** from the **contractor's planned sequence of work** at the **beginning of the window**.

Therefore, the **logical relationships** between the **schedule activities** in the **as-built schedule** **at the end of a window** are **different** from the **planned logical relationships** between the schedule activities at the **beginning of the window**.

If the **actual sequence** of work indicates that a **different logical relationship** model between the activities is **warranted**, the **analyst** would **adjust** the **schedule logic** in the **As-Built Calculation Schedule** to represent the **as-built conditions**.



Collapsed as-built analysis – Practical procedure

7. Extract the next delay event (or set of delays).

- ❖ **Repeat Steps 5 and 6** again until all delays exhausted.
- ❖ If a **windows approach** is being used, repeat Steps 5 and 6 for those events whose **completion dates** **fall within** the **window** being analyzed.

Collapsed as-built analysis – Practical procedure

8. Record all movement to the calculated completion date from all CAB simulations.
9. Repeat the process in revise chronological order, until all delays have been accounted for and their impact on the CAB model recorded on a liability summary table.

Collapsed as-built analysis – Practical procedure

- ❑ Actual completion date of Jan 18, 2009.
- ❑ The CAB analysis is carried out using multiple windows.
 - ❖ Fragnets 001 and 002 occurred in the first window being analyzed (August 31, 2008).
- ❑ The CAB analysis is carried out using the “stepped-extraction” technique (**No concurrency considered**).
- ❑ Both updates (e.g., UD03) and CABs are used for the analysis.
 - ❖ The contemporaneous progress update UD02, dated July 31, 2008, indicated a loss of 3 days from July 31, 2008 to August 14, 2008.
 - ✓ This is attributable to a CDE of 3 days.
- ❑ A dissolve function in P6 was used.

What happened here?

What is this and why it is attributed to the CDE?

Impact liability table – collapsed as-built technique.

Event (Fragnet)	Event Type	Event Actual Start Date	Event Actual Finish Date	Event Duration (Days)	CAB Base Schedule	Base Schedule Data Date	Projected Completion Date	Net Loss/Gain	Cumulative delay		
									EDE	CDE	Con-current
001	EDE	7-Sep-08	11-Sep-08	4	CAB	31-Aug-08	18-Jan-09				
					CAB	31-Aug-08	18-Jan-09	0			
002	CDE	4-Sep-08	8 Sep-08	4	CAB	31-Aug-08	15-Jan-09	3		3	
					UD03	31-Aug-08	14-Jan-09	1		1	
003	CDE	15-Aug-08	24-Aug-08	9	CAB	14-Aug-08	9-Jan-09	5		5	
					UD02	31-Jul-08	6-Jan-09	3		3	
004	EDE	2-Jul-08	7-Jul-08	5	CAB	30-Jun-08	1-Jan-09	5	5		
005	CDE	2-Jul-08	5-Jul-08	3	CAB	30-Jun-08	1-Jan-09	0			
					UD01	30-Jun-08	5-Jan-09	-4		-4	
006	EDE	5-Jun-08	8-Jun-08	3	CAB	1-Jun-08	5-Jan-09	0			
007	EDE	31-Jun-08	6-Jun-08	3	CAB	1-Jun-08	2-Jan-09	3	3		
Contract Completion Date:							1-Jan-09	1		1	
Totals								17	8	9	0

How To Choose the Methods?

(Comparison Between Methods)

Comparison between methods

Factor	TIA	Planned Vs As Built	Impacted Baseline	Collapsed As Built	Window Analysis
Time Required	Moderate to High depends on data	Minimal unless as-built creation required	Lesser Time required compared to TIA	Moderate to High	Most Time consuming compared to other methods
Level of Effort	High	Minimal unless as-built creation required	Moderate	High	High

Comparison between methods

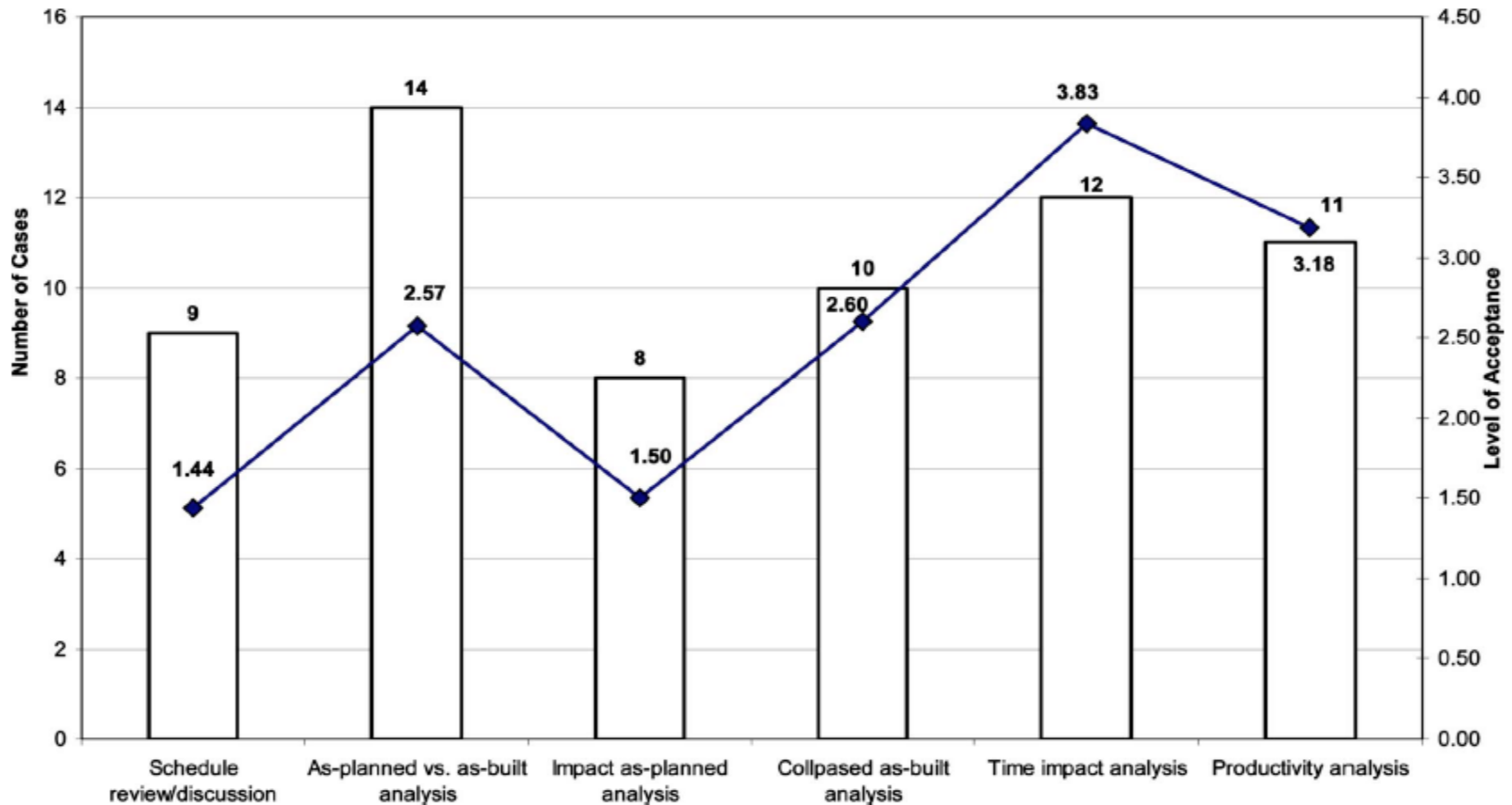
Comparing Factor	TIA	Planned Vs As Built	Impacted Baseline	Collapsed As Built	Window Analysis
Expertise Level Required	High	Moderate	Moderate	Moderate	High
Complexity	High	Low	Low	Moderate	High
Data Requirement	High	Low to Moderate	Moderate	High	High

Comparison between methods

Comparing Factor	TIA	Planned Vs As Built	Impacted Baseline	Collapsed As Built	Window Analysis
Accuracy of Result	More accurate with Perspective Analysis	Low	Moderate	High	High
Prospective or Retrospective Application	Both, Prospective and Retrospective	Retrospective	Both, Prospective and Retrospective	Retrospective	Retrospective

Comparison between methods – Performed in USA

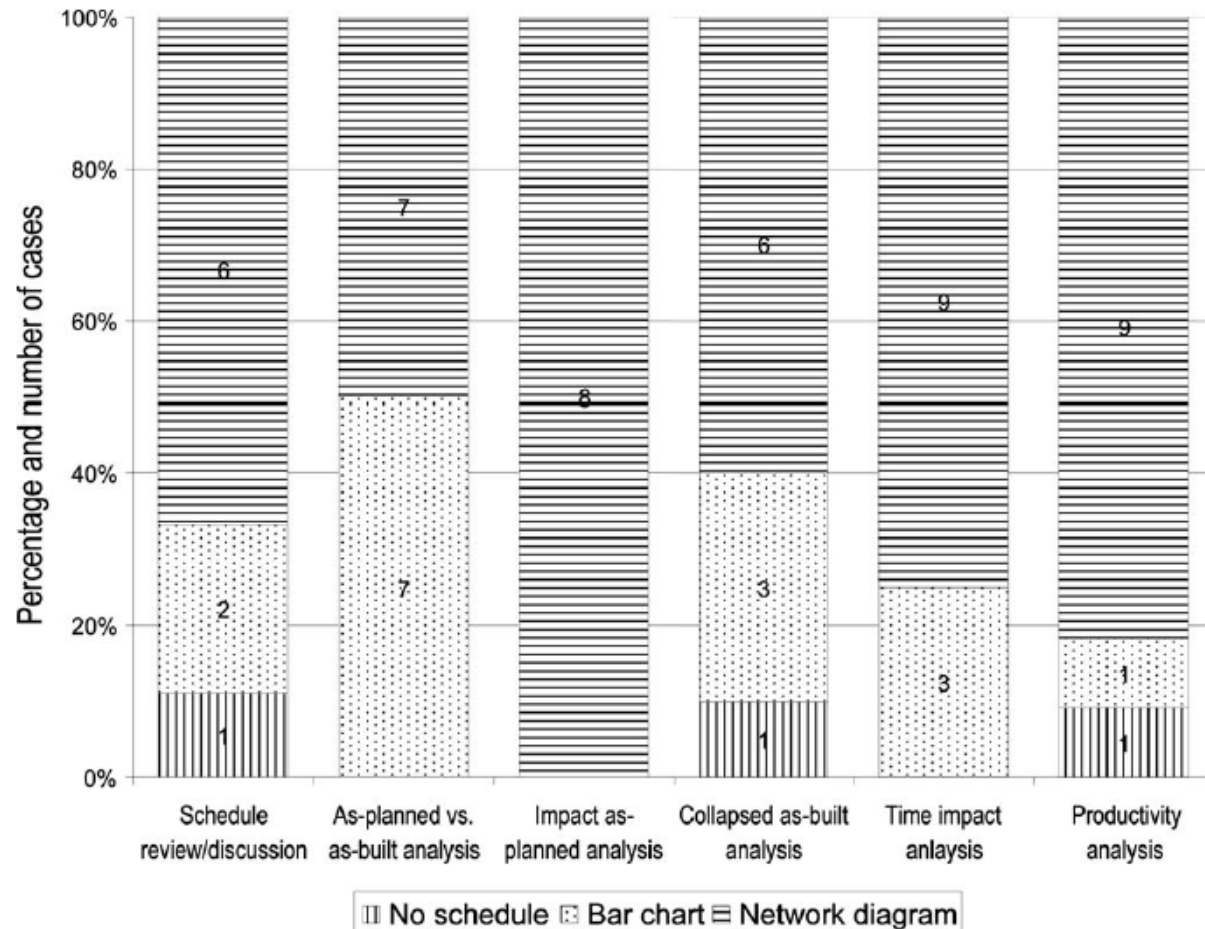
□ Research done by Arditi and Pattanakitchamroon, Analysis Methods in Time-Based Claims, 2008 (**NOTE THAT THIS IS BEFORE AACE 29R-06 2011**)



Delay analysis methods used and acceptance index by courts/boards

Comparison between methods – Performed in USA

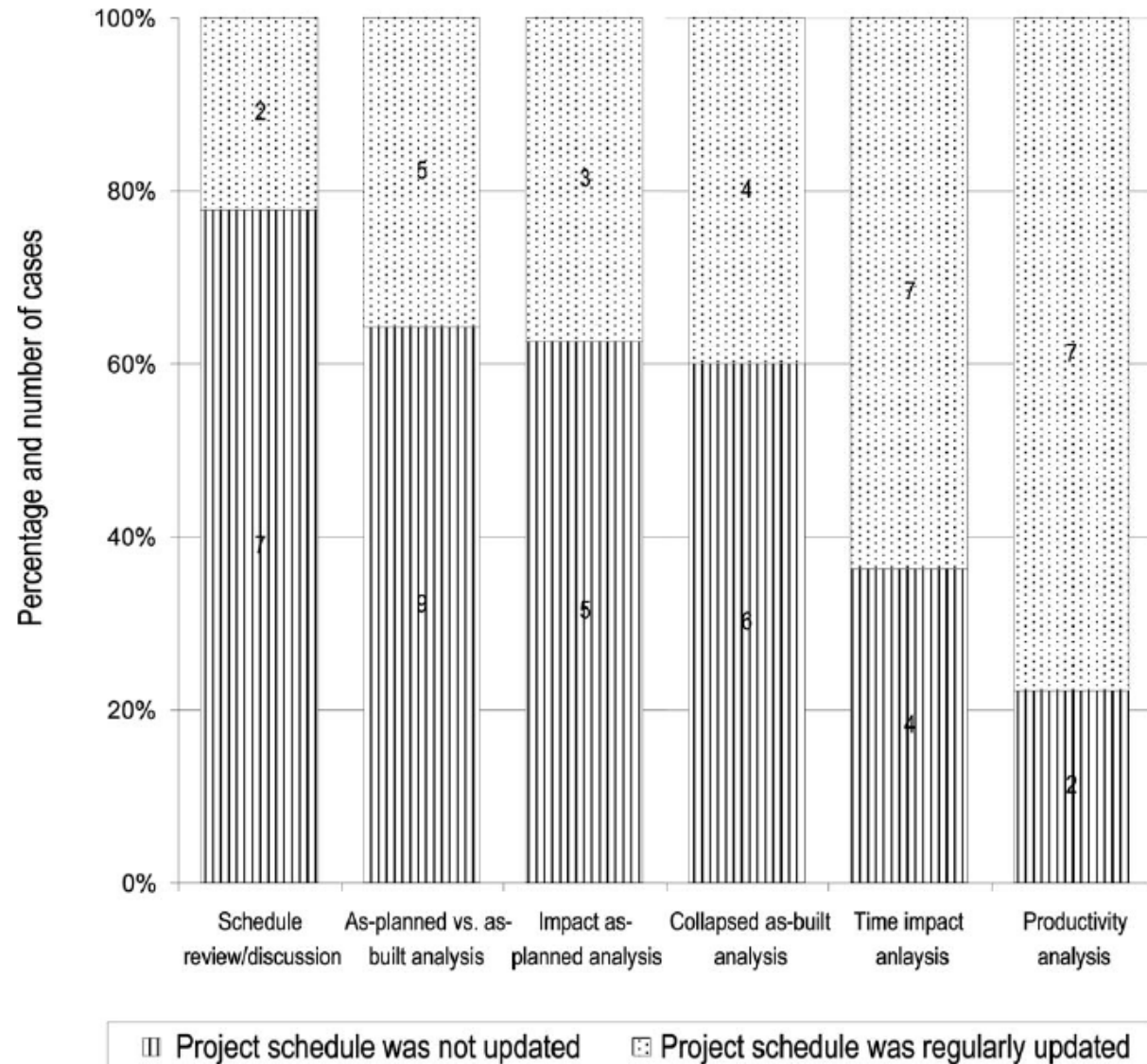
□ Research done by Arditi and Pattanakitchamroon, Analysis Methods in Time-Based Claims, 2008



Delay analysis methods by type of schedule used

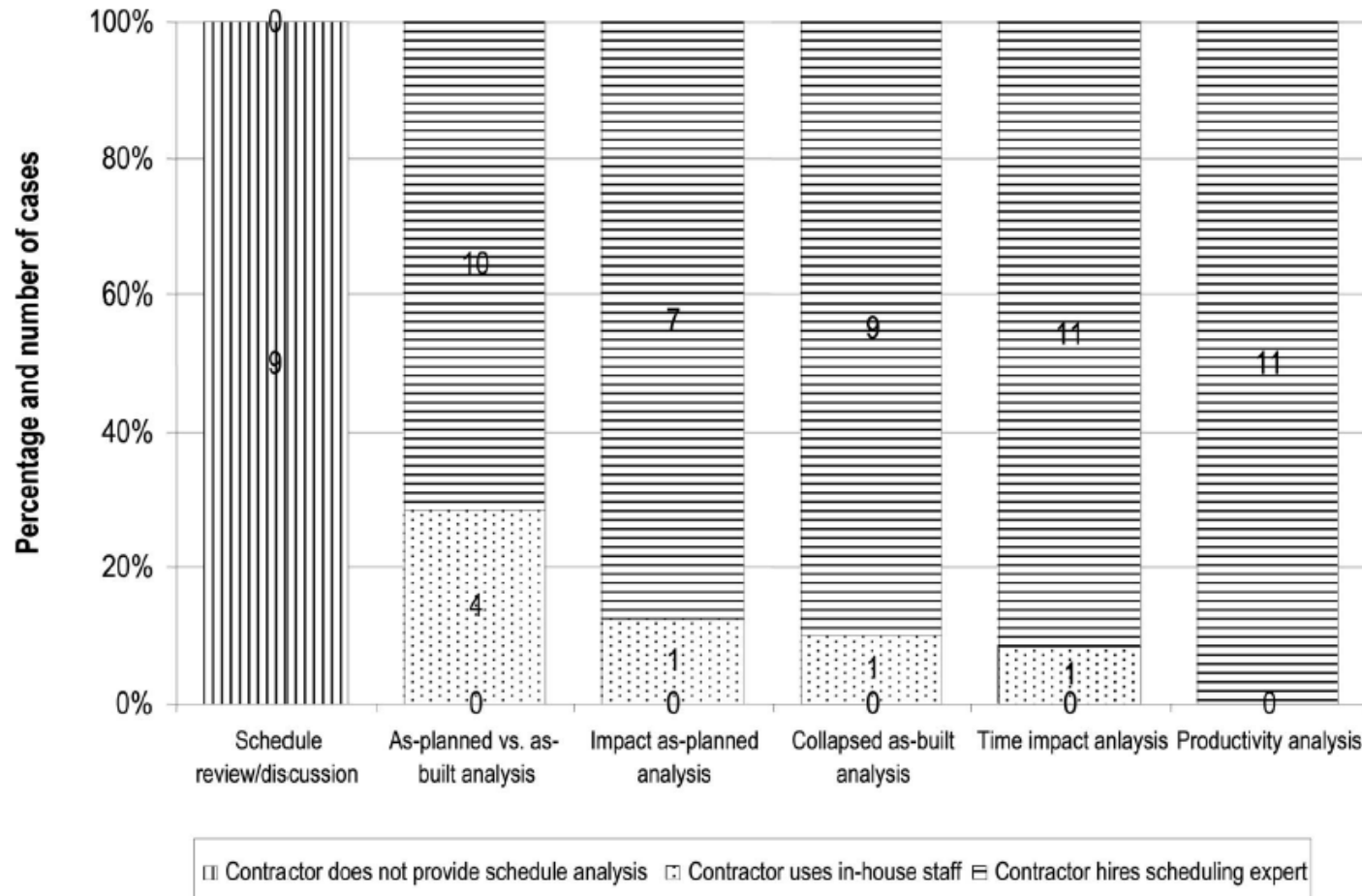
Comparison between methods – Performed in USA

□ Research done by Arditi and Pattanakitchamroon, Analysis Methods in Time-Based Claims, 2008



Comparison between methods – Performed in USA

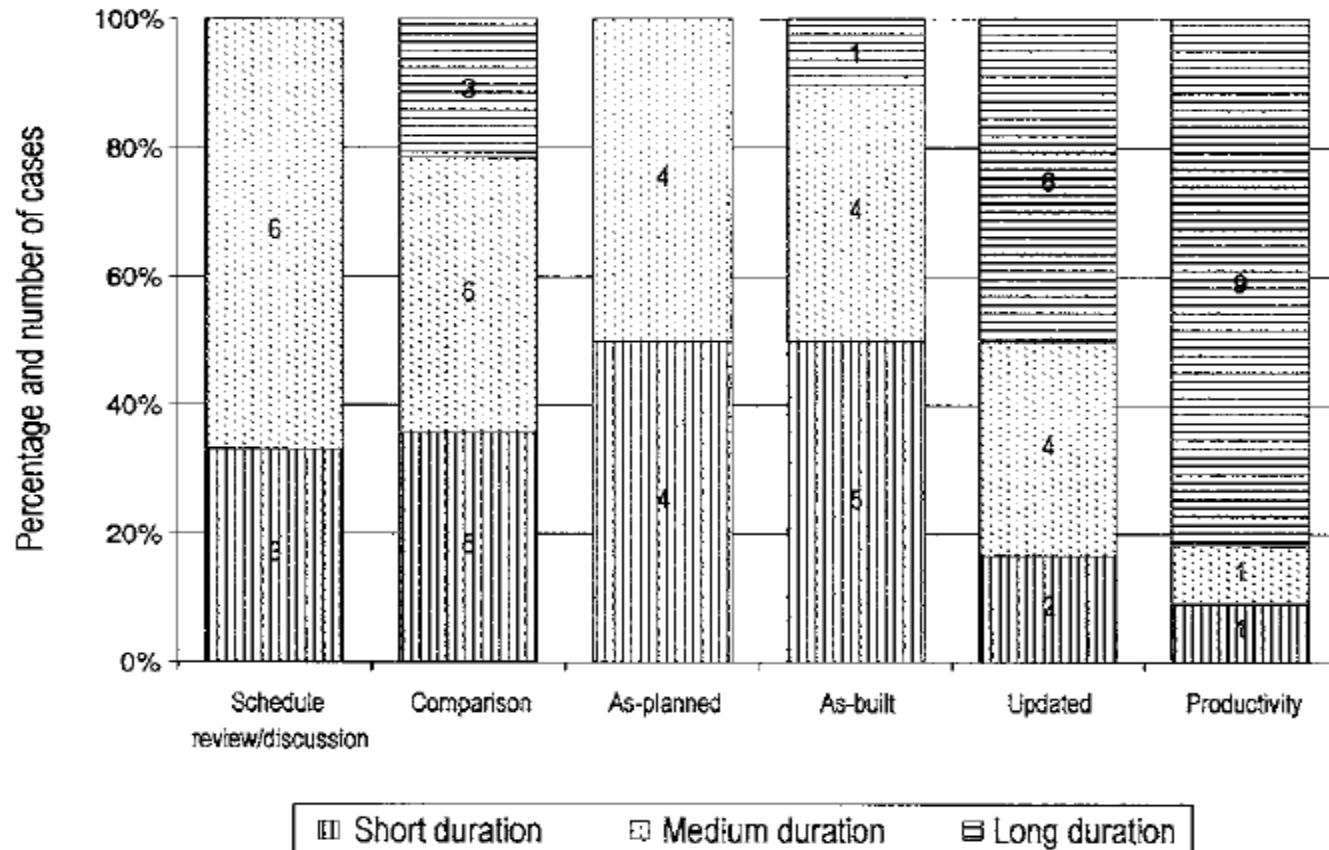
- Research done by Arditi and Pattanakitchamroon, Analysis Methods in Time-Based Claims, 2008



Delay analysis methods by quality of expertise and data used

Comparison between methods – Performed in USA

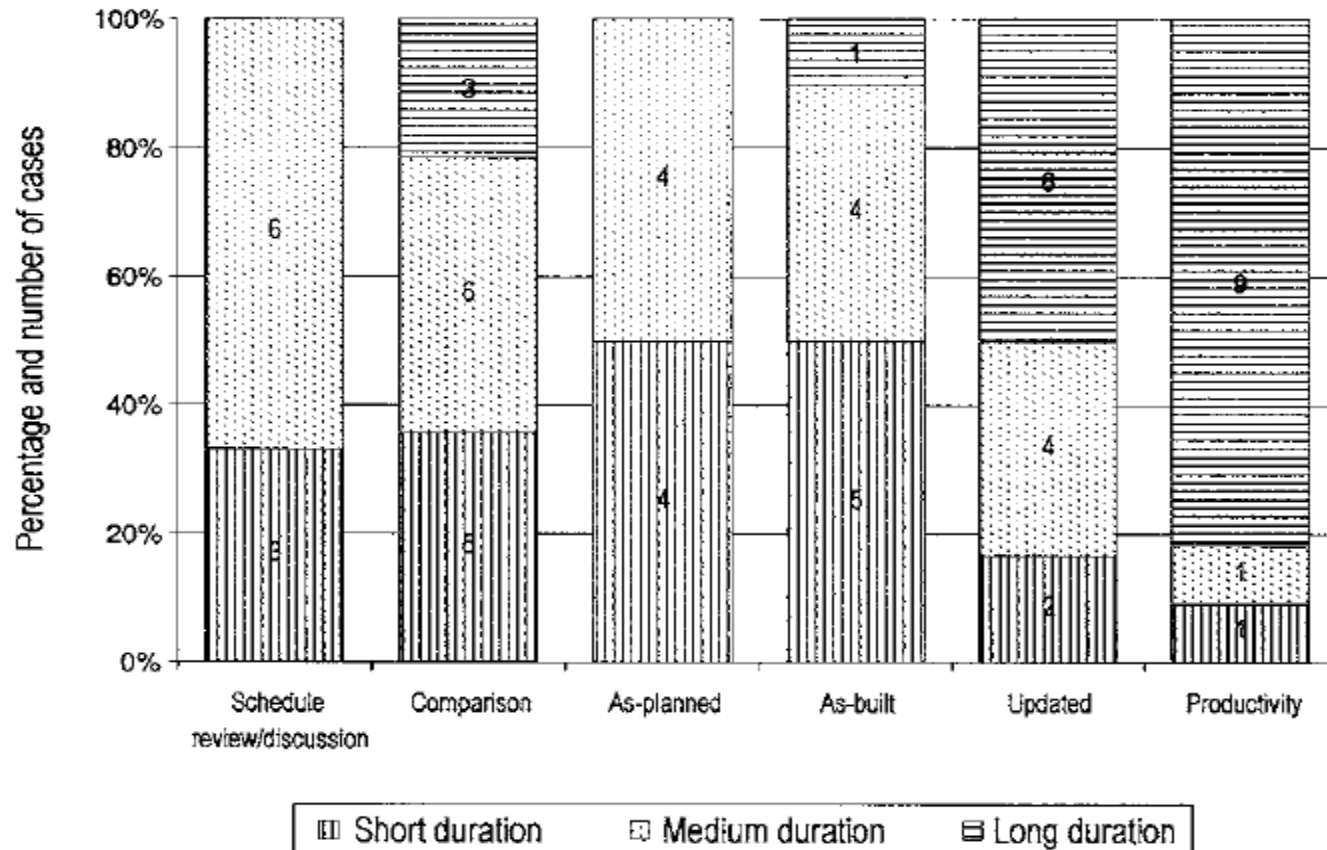
- Research done by Arditi and Pattanakitchamroon, Analysis Methods in Time-Based Claims, 2008



Delay analysis methods by project duration

Comparison between methods – Performed in USA

- Research done by Arditi and Pattanakitchamroon, Analysis Methods in Time-Based Claims, 2008



Delay analysis methods by project duration

Comparison between methods – Performed in U.K.

- ❑ What is the most popular method? Research attempting to answer this question is scares.
- ❑ Braimah, N. & Ndekugri, I. 2008. Factors influencing the selection of delay analysis methodologies. International Journal of Project Management, 26(8):789-799.

Delay Analysis Method	Usage Index	Rank
As-planned vs as-built	65.7	1
Impacted as-planned	59.4	2
Collapsed as-built	54.8	3
Time impact analysis	48.2	4
Net impact	45.7	5
Global	45.5	6
Window analysis	40.2	7
S-Curve	33.8	8

How To Choose the Methods?

(Selection Between Methods)

موسسه مهندسی و مدیریت ساخت علوی پور (ACEMI)

دفتر آموزش



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