How does current Critical Path definitions consider resources?

Is it time for a change?







Mostafa AbdelRazik BIO

- Project Controls Specialist
- 10+ years of experience in Project Controls
- Director of PMIS INC
- Bachelors in Civil Engineering (Carleton U, Ottawa)
- Masters in Construction Management (Concordia U, Montreal)
- PSP, EVP, PMP, Meng
- Active public speaker
- Things you don't know about me..





Introduction



Introduction

- Critical path definitions are listed in different literature
- All current critical path definitions are in terms of time only
- Do labor hours (work effort) have any effect on the critical path?









Background

- A few critical path definitions (AACE RP 49-R06)
 - Longest path through a CPM network where a delay to the path affects the duration of the project
 - Path with lowest float especially when constraints are used in the schedule



Background

- These definitions are in terms of time
- What about criticality in terms of cost or manhours?







Background (A simple brain teaser)

Discipline	Electrical	Piping
Total man hours	50,000	12,000
Resources available	50 workers	10 workers
Start to Finish duration	1,000 hours	1,200 hours
Cost assuming \$120/hr	\$6,000,000	\$1,440,000

- Is piping the critical path or is electrical?
- Do you notice the big difference in the number of resources needed?
- Electrical work is taking less time because it has a lot more resources



Background

Activity	Predecessor	Original Duration (Days)	Resource Type	Headcount	Total Manhours
А	Start Milestone	45	Plumber	4	1,800
В	А	50	Electrician	2	1,000
С	Start Milestone	70	Carpenter	10	7,000
D	A and C	32	Plumber	4	1,280
E	В	105	Electrician	2	2,100
F	D	80	Painter	2	1,600

200d 07-Nov-19 45d 07-Nov-19 50d 08-Jan-20	10-Jun-20 07-Jan-20 26-Feb-20	Plumber Electrician	14780.00 1800.00 1000.00	November 8 10 17 24	Uecember 01 08 15 22	January 29 05 12 19 20 A	February 6 02 09 16 2	March 3 01 08 15 22	April 29 05 12 19 26	May 5 03 10 17 24 31 07
200d 07-Nov-19 45d 07-Nov-19 50d 08-Jan-20	10-Jun-20 07-Jan-20 26-Feb-20	Plumber Electrician	14780.00 1800.00 1000.00	10 11 27	01 00 10 22	A	0 02 00 10 2	0 01 00 13 22	20 00 12 10 20	00 10 11 27 01 0
45d 07-Nov-19 50d 08-Jan-20	07-Jan-20 26-Feb-20	Plumber Electrician	1800.00			A				
50d 08-Jan-20	26-Feb-20	Electrician	1000.00			and the second second				
		Apply of states and apply and a		07-00-0				В		
70d 07-Nov-19	01-Feb-20	Carpenter	7000.00				C			
32d 02-Feb-20	04-Mar-20	Plumber	1280.00				+			
105d 27-Feb-20	10-Jun-20	Electrician	2100.00							
80d 05-Mar-20	23-May-20	Painter	1600.00					+		F
	32d 02-Feb-20 105d 27-Feb-20 80d 05-Mar-20	32d 02-Feb-20 04-Mar-20 105d 27-Feb-20 10-Jun-20 80d 05-Mar-20 23-May-20	32d 02-Feb-20 04-Mar-20 Plumber 105d 27-Feb-20 10-Jun-20 Electrician 80d 05-Mar-20 23-May-20 Painter	32d 02-Feb-20 04-Mar-20 Plumber 1280.00 105d 27-Feb-20 10-Jun-20 Electrician 2100.00 80d 05-Mar-20 23-May-20 Painter 1600.00	32d 02-Feb-20 04-Mar-20 Plumber 1280.00 105d 27-Feb-20 10-Jun-20 Electrician 2100.00 80d 05-Mar-20 23-May-20 Painter 1600.00	32d 02-Feb-20 04-Mar-20 Plumber 1280.00 105d 27-Feb-20 10-Jun-20 Electrician 2100.00 80d 05-Mar-20 23-May-20 Painter 1600.00	32d 02-Feb-20 04-Mar-20 Plumber 1280.00 105d 27-Feb-20 10-Jun-20 Electrician 2100.00 80d 05-Mar-20 23-May-20 Painter 1600.00	32d 02-Feb-20 04-Mar-20 Plumber 1280.00 105d 27-Feb-20 10-Jun-20 Electrician 2100.00 80d 05-Mar-20 23-May-20 Painter 1600.00	32d 02-Feb-20 04-Mar-20 Plumber 1280.00 105d 27-Feb-20 10-Jun-20 Electrician 2100.00 80d 05-Mar-20 23-May-20 Painter 1600.00	32d 02-Feb-20 04-Mar-20 Plumber 1280.00 105d 27-Feb-20 10-Jun-20 Electrician 2100.00 80d 05-Mar-20 23-May-20 Painter 1600.00



Background (What happens if activity C has resource shortage?)

Data Date: 30 days from project start											
Activity	Completed work (manhours)	Remaining manhours	Available Man- count	Remaining Duration (Days)							
Α	1,200	600	4	15							
В	0	1,000	2	50							
С	2,100	4,900	7 (Not 10)	70 (original dur)							
D	0	1,280	4	32							
E	0	2,100	2	105							
F	0	1,600	2	80							

Ac	tivity ID	Activity	Original	Actual	Remaining	Start	Finish	Resources	Budgeted Labor	Calendar			2019						2020			
		Name	Duration	Duration	Duration				Units		Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
-	AACE Scenario 1		212d	30d	182d	07-Nov-19 06:00 A	22-Jun-20 16:00		14780h	7 days , 10 hrs/day				-								22,
	A	A	45d	30d	15d	07-Nov-19 06:00 A	07Jan-2016:00	Plumber	1800h	7 days , 10 hrs/day						A						
	В	В	50d	Dd	50d	08Jan-20 06:00	26-Feb-20 16:00	Electrician	1000h	7 days , 10 hrs/day								В				
	С	С	70d	30d	70d	07-Nov-19 06:00 A	02-Mar-20 16:00	Carpenter	7000h	7 days , 10 hrs/day								C				
	D	D	32d	Od	32d	03-Mar-20 06:00	03-Apr-20 16:00	Plumber	1280h	7 days , 10 hrs/day									D			
	E	E	105d	Dd	105d	27-Feb-20 06:00	10Jun-2016:00	Electrician	2100h	7 days , 10 hrs/day											🗖 E	
	F	F	80d	DO	80d	04-Apr-20 06:00	22Jun-2016:00	Painter	1600h	7 days , 10 hrs/day											— 1	F





- Turnaround of an oil and gas refinery in Canada
- 346 activities
- 557 relationships
- Total manhours = 125,989







	Original	Budgeted		
Activity ID	Duratio	Labor Units	Start	Finish
A0202	7	748	15-Apr-19*	24-Apr-19
A0246	7	0	15-Apr-19	24-Apr-19
A0268	19	1894	22-Apr-19	16-May-19
A0290	4	0	13-May-19	17-May-19
A0334	2	0	21-May-19	23-May-19
A0444	28	8405	30-Apr-19	1-Jun-19
A0466	2	0	1-Jun-19	3-Jun-19
A0510	2	0	4-Jun-19	6-Jun-19
A0532	2	0	6-Jun-19	8-Jun-19
A0554	1	0	8-Jun-19	10-Jun-19
A0576	1	0	10-Jun-19	11-Jun-19
A0598	1	0	10-Jun-19	11-Jun-19
A0620	11	919	11-Jun-19	24-Jun-19
A0636	2	127	24-Jun-19	25-Jun-19
A2700	1	86	25-Jun-19	26-Jun-19
A0637	2	138	26-Jun-19	28-Jun-19
A0623	4	302	28-Jun-19	3-Jul-19
A0621	8	627	3-Jul-19	11-Jul-19
A0626	1	72	11-Jul-19	12-Jul-19
A0617	8	635	12-Jul-19	22-Jul-19
A0627	1	43	22-Jul-19	22-Jul-19
A0618	4	295	22-Jul-19	26-Jul-19
A0624	4	312	26-Jul-19	31-Jul-19
A0631	1	90	31-Jul-19	1-Aug-19
A0622	4	297	1-Aug-19	5-Aug-19
A0619	10	829	5-Aug-19	16-Aug-19
A0630	1	112	16-Aug-19	19-Aug-19
A0629	3	255	19-Aug-19	22-Aug-19
A0628	8	627	22-Aug-19	30-Aug-19
A0650	1	0	30-Aug-19	31-Aug-19

- Current longest path
- Need to examine EVERY path
- Is there a software that does that?
- Access database tool was created
- 162,217 different paths were found





Activity on "most	Start	Finish	On CPM	Total Float
Manhours" path			Longest	
			Path?	
A0381	22-Apr-19*	26-Apr-19	No	2
A0376	26-Apr-19	01-May-19	No	2
A0395	01-May-19	06-May-19	No	2
A0396	06-May-19	10-May-19	No	2
A0462	09-May-19	23-May-19	No	2
A0452	25-Jun-19	26-Jul-19	No	15
A0474	26-Jul-19	29-Jul-19	No	15
A0518	29-Jul-19	31-Jul-19	No	14
A0540	31-Jul-19	02-Aug-19	No	14
A0562	02-Aug-19	04-Aug-19	No	14
A0606	04-Aug-19	05-Aug-19	No	14
A0628	22-Aug-19	30-Aug-19	Yes	0
A0650	30-Aug-19	31-Aug-19	Yes	0





- Three updates were analyzed
- Change in critical path were examined
- "Most man hours path" were checked if it became critical by checking their floats









Case Study (Update 1)

Activities on "most Manhours" path	Start	Finish	On CPM Longest Path?	Baseline Total Float	May 8 Total Float
A0381	15-Apr-19 A	11-May-19	No	2	3
A0376	22-Apr-19 A	12-May-19	No	2	3
A0395	16-Apr-19 A	13-May-19	No	2	3
A0396	15-Apr-19 A	13-May-19	No	2	6
A0462	27-Apr-19 A	21-May-19	No	2	6
A0452	07-May-19A	28-Jul-19	No	15	16
A0474	28-Jul-19	30-Jul-19	No	15	16
A0518	17-Aug-19	20-Aug-19	No	14	1
A0540	20-Aug-19	22-Aug-19	No	14	1
A0562	22-Aug-19	23-Aug-19	No	14	1
A0606	23-Aug-19	24-Aug-19	No	14	1
A0628	26-Aug-19	30-Aug-19	Yes	0	0
A0650	30-Aug-19	31-Aug-19	Yes	0	0





- Four activities on the "most manhours path" have witnessed a big drop in float and hence are becoming near critical
- Not on longest path









Case Study (Update 2)

Activities on "most Manhours" path	Start	Finish	On Longest Path?	Baseline Total Float	Aug 8 Total Float
A0381	15-Apr-19 A	17-Jun-19 A	No	2	0
A0376	22-Apr-19 A	09-Jul-19 A	No	2	0
			No		
A0395	16-Apr-19 A	29-May-19 A		2	0
			No		
A0396	15-Apr-19 A	29-May-19 A		2	0
			No		
A0462	27-Apr-19 A	06-Aug-19 A		2	0
			No		
A0452	07-May-19 A	13-Aug-19*		15	-10
			No		
A0474	01-Aug-19 A	03-Aug-19 A		15	0
			No		
A0518	02-Aug-19 A	06-Aug-19 A		14	0
A0540	13-Aug-19	15-Aug-19	No	14	2
A0562	15-Aug-19	16-Aug-19	No	14	2
A0606	16-Aug-19	17-Aug-19	No	14	2
A0628	17-Aug-19	23-Aug-19	No	0	2
A0650	29-Aug-19	29-Aug-19	No	0	2





- Most of the activities on the "most manhours path" experienced delays
- Multiple activities on the "most manhours path" came very close to being critical with total float values of 1 and 2.
- Activities on the project's longest path are driven by activities on "most manhours path"







Case Study (Update 3)

Activity on "most Manhours" path	Start	Finish	On Longest Path?	Baseline Total Float	Aug 15 Total Float
A0381	15-Apr-19 A	17-Jun-19 A	No	2	0
A0376	22-Apr-19 A	09-Jul-19 A	No	2	0
			No		
A0395	16-Apr-19 A	29-May-19A		2	0
			No		
A0396	15-Apr-19 A	29-May-19 A		2	0
A0462	27-Apr-19 A	06-Aug-19 A	No	2	0
			No		
A3020	13-May-19 A	13-Aug-19 A		15	0
A0452	07-May-19A	13-Aug-19 A	No	15	0
A0474	01-Aug-19 A	03-Aug-19 A	No	15	0
A0518	02-Aug-19 A	06-Aug-19 A	No	14	0
A0540	15-Aug-19	17-Aug-19	Yes	14	0
A0562	17-Aug-19	18-Aug-19	Yes	14	0
A0606	19-Aug-19	20-Aug-19	Yes	14	0
A0628	20-Aug-19	26-Aug-19	Yes	0	0
A0650	30-Aug-19	31-Aug-19	Yes	0	0





- Activities on "most manhours path" have become drivers of longest path.
- "Most manhours path" have shown tendency to becoming critical







Conclusion



Conclusion

- Activities with large number of manhours usually require close attention
- Resource absence can have huge effect on activities with large manhours
- Case study showed tendency of "most manhours path" to becoming critical during project execution



THANK YOU

