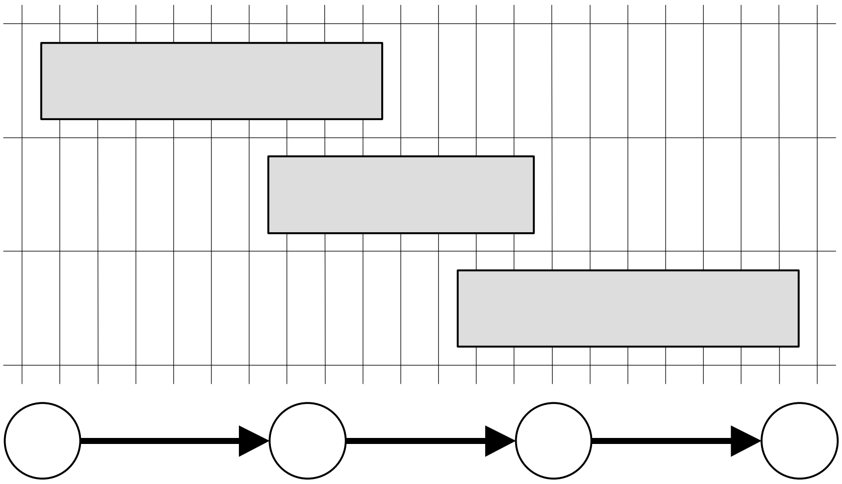
Network Techniques - II.



CPM^{time} - **CPM**$^{time+}$: Overlapping, open network and non-broken activity keep being problematic (Schedules for Production Management ?!)

MPM^{time} **:** (**M**ETRA **P**otentials' **M**ethod)

Activity-on-node typed, deterministic project model with discrete variables and with abilities of handling manyfold and multiple relations

GTM : (**G**eneral **T**ime **M**odel)

Event*-on-node typed deterministic project model with homogeneous relations

* Deadline and/or milestone

METRA Potentials' Method (MPM^{time})

1960 : B. Roy, France, Appl: Nuclear Power Station (originally: start potentials only)

Node :

Activity (with no break in performance)
(Event and milestone have duration of 0)

Edge :

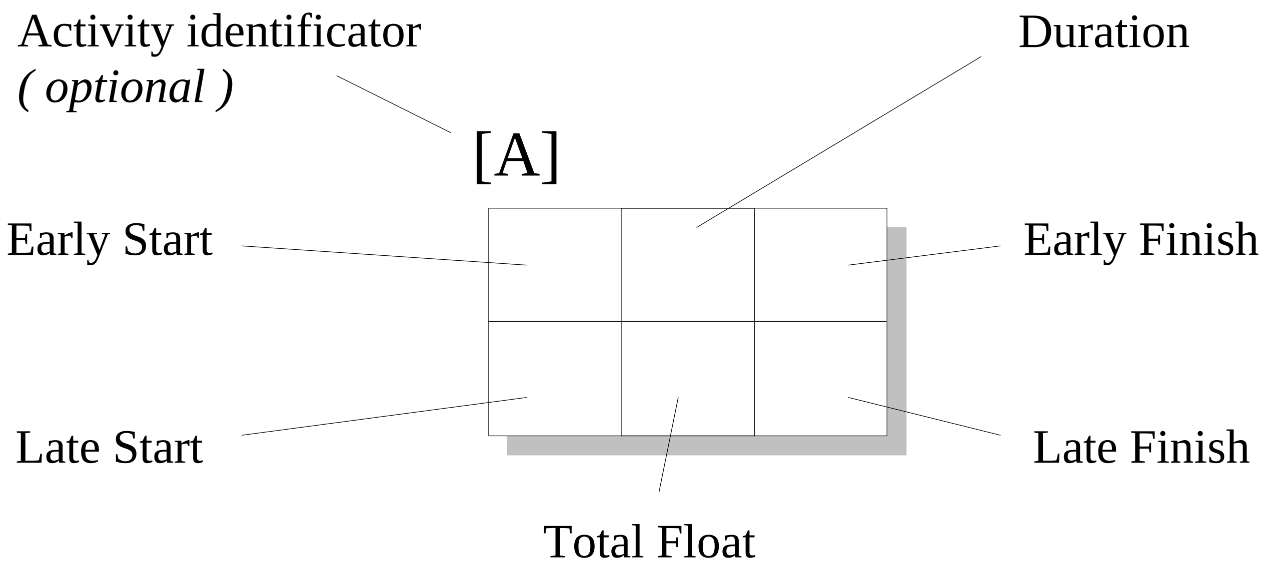
Technical-, technological-, or resource management-born quantified relation

Parameter (weight) :

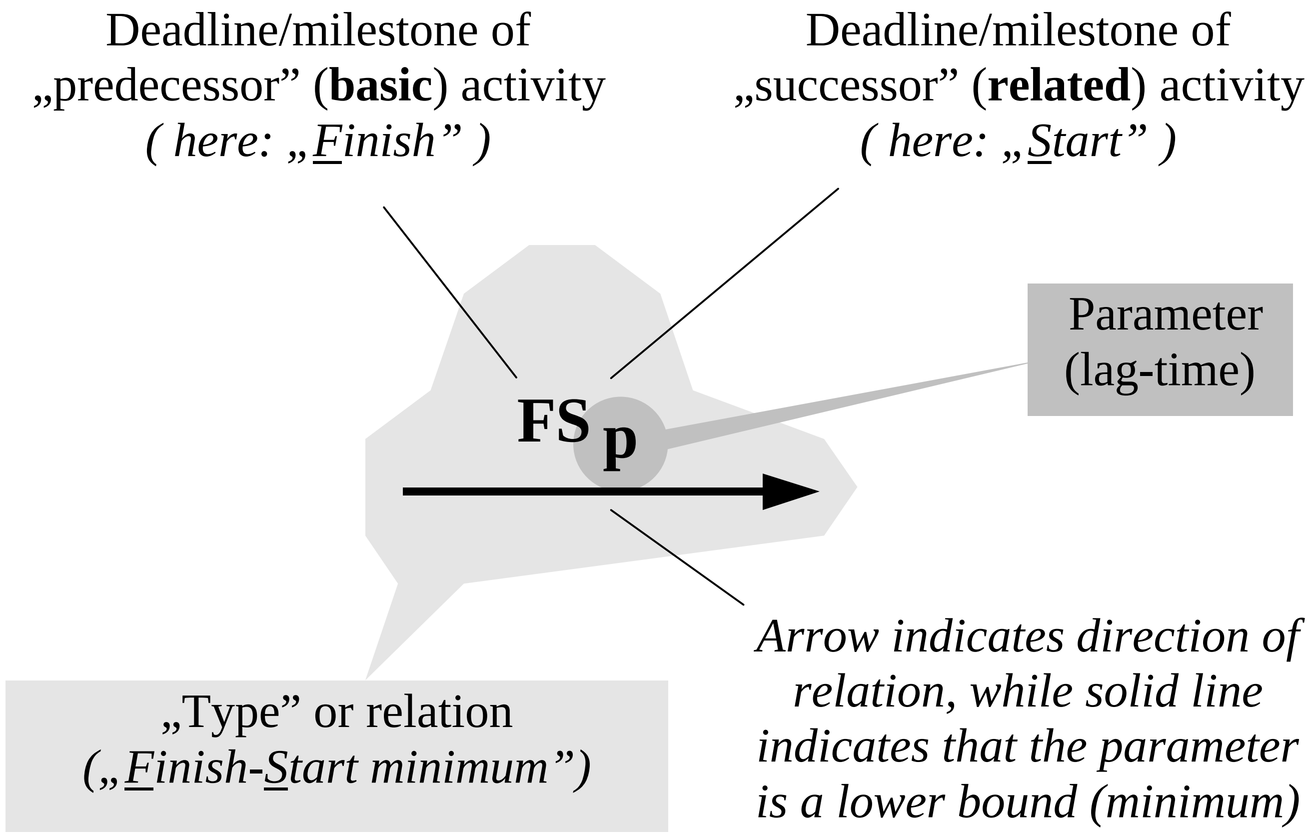
Lag-time, duration and time potential
(deterministic variable)

Aim : Schedules for production management, modelling technologies, monitoring progression, change management …
Handling (time consequences of) overlapping (relative in time), restrictions for resource allocation, technological and spatial limitations, etc. …

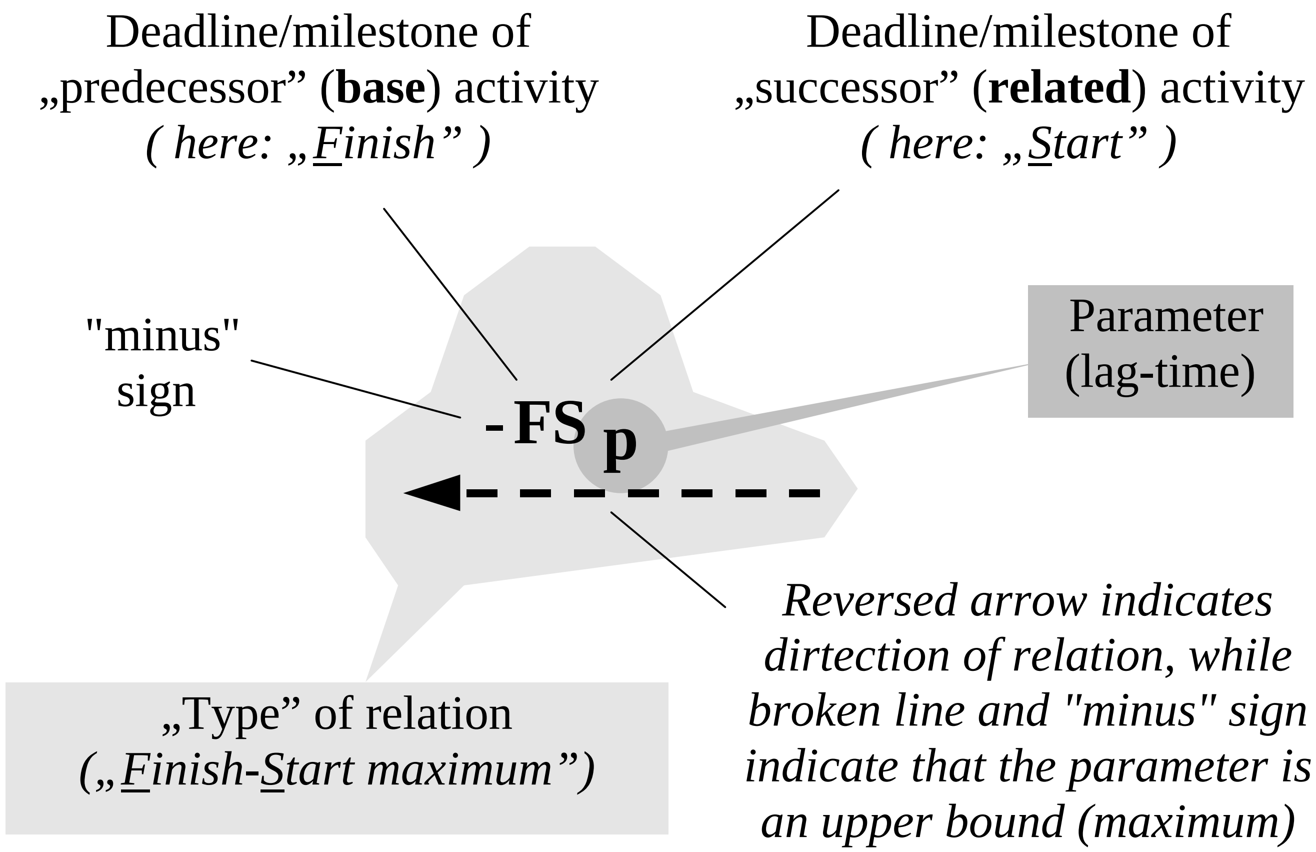
"Activity-on-node"



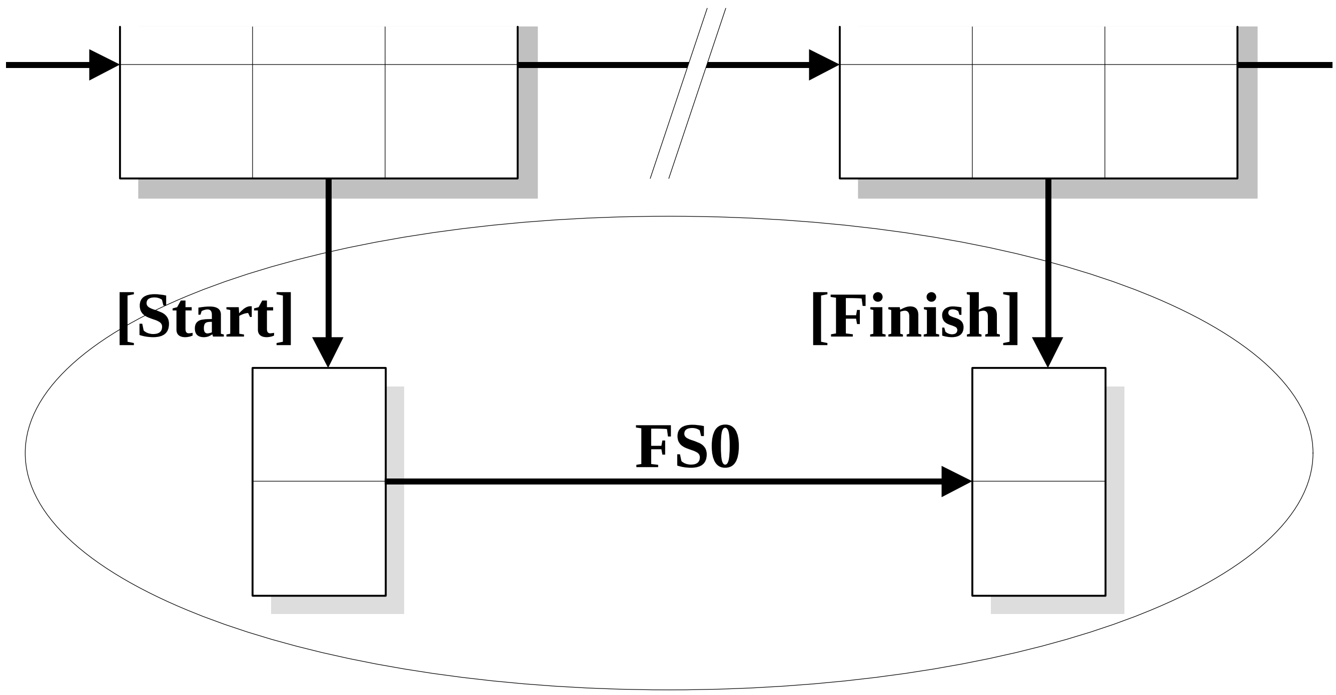
"Relation" (min)



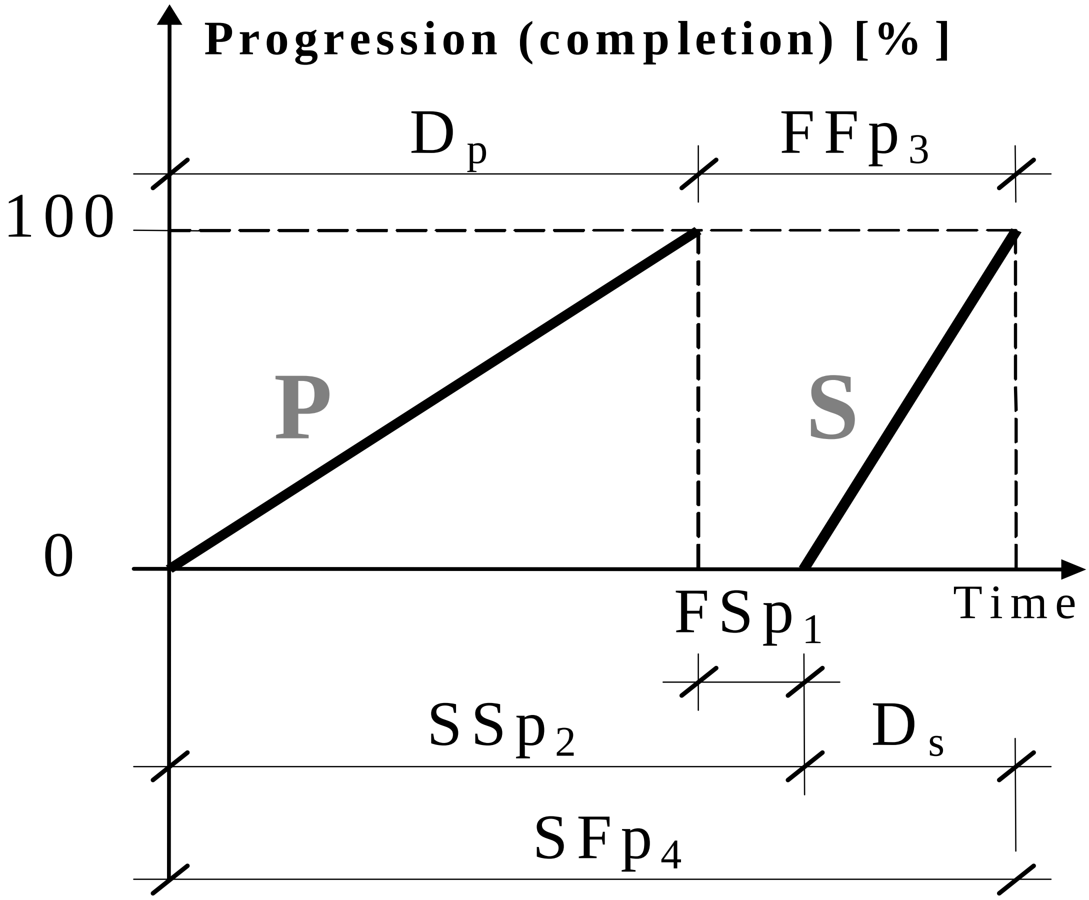
"Relation" (max)



"Hammock/Suspended Activity"



MPM - Basic Relations



Transforming Relations

	FFq	FSq	SFq	SSq
FFp		$q = p - D_s$	$q = p + D_p$	$q = p + D_p - D_s$
FSp	$q = p + D_s$		$q = p + D_p + D_s$	$q = p + D_p$
SFp	$q = p - D_p$	$q = p - D_p - D_s$		$q = p - D_s$
SSp	$q = p + D_s - D_p$	$q = p - D_p$	$q = p + D_s$	

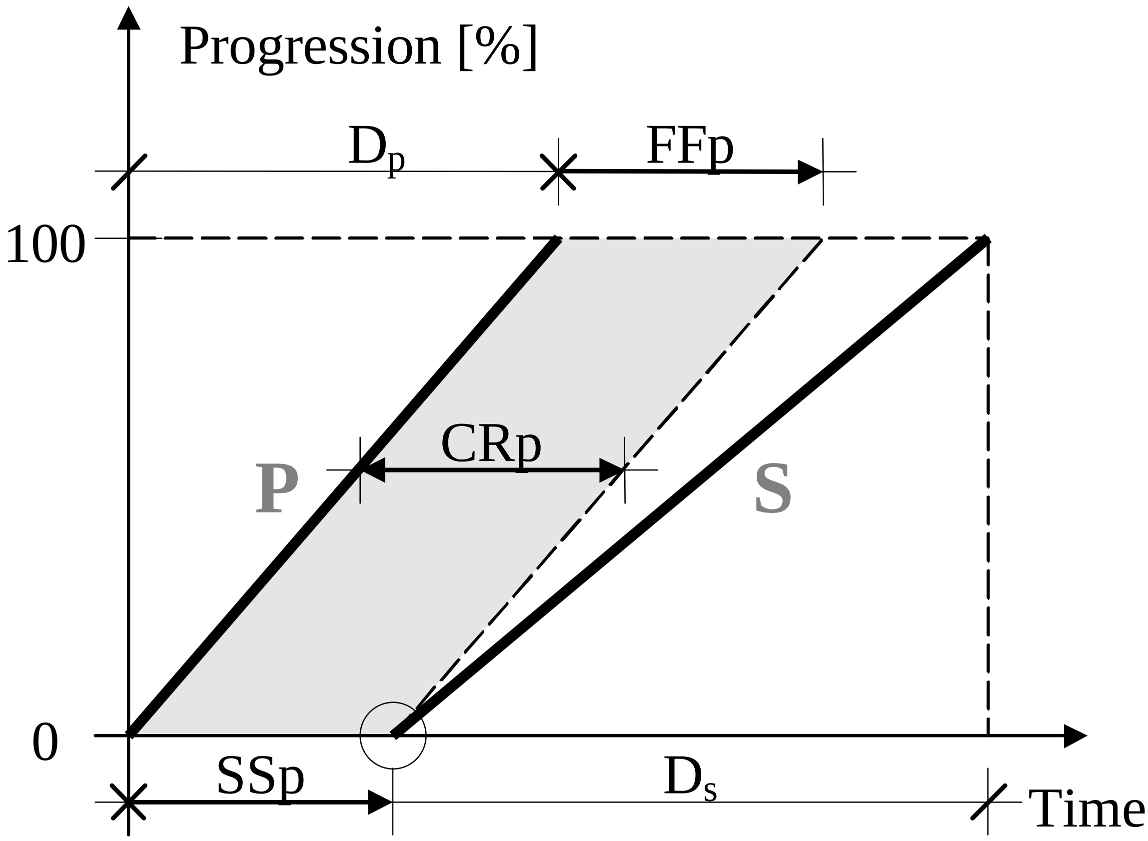
Single Relations

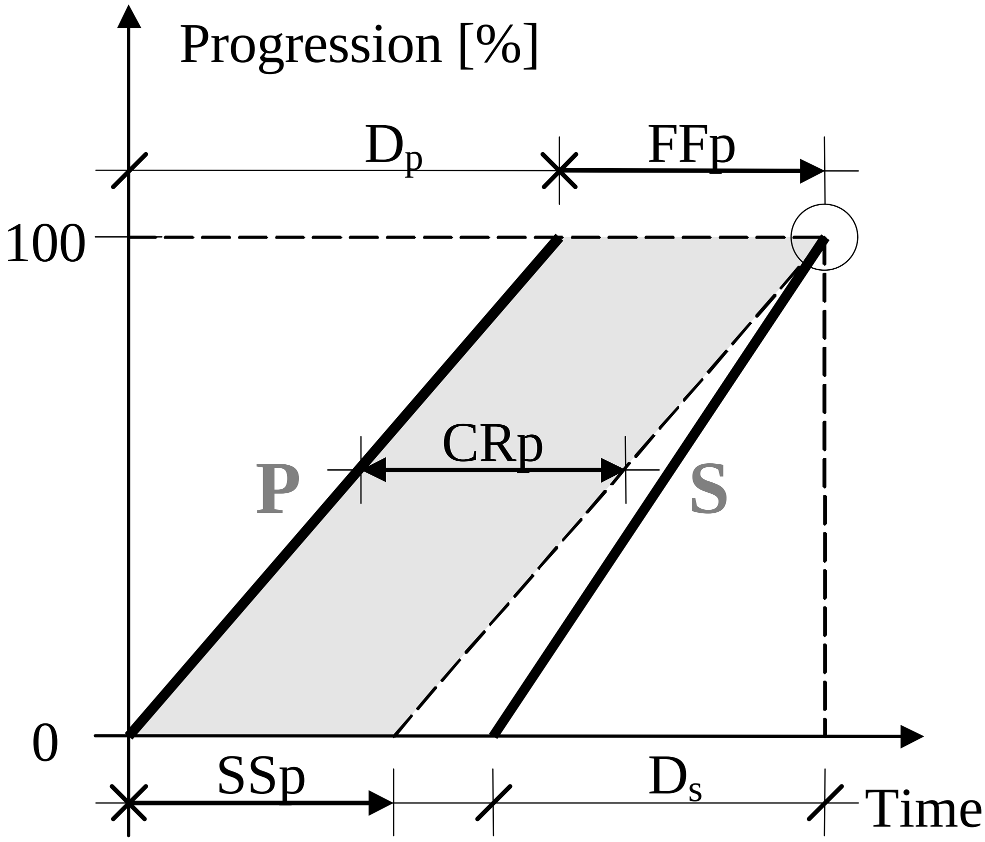
FSp „finish-start minimum *p*”	Successor (related) activity can be started at least *"p"* tu later than predecessor (base) activity is finished	Typically in case of strictly limited resources (usually with parameter of „0”, to assign consecutive processes)
-FSp „finish-start maximum *p*”	Successor (related) activity should be started at most *"p"* tu later than predecessor (base) activity is finished	Typically accompanying an FSp relation, in case of sensitive conditions or strict expectations on effective resource usage
SSp „start-start minimum *p*”	Successor (related) activity can be started at least *"p"* tu later than predecessor (base) activity is started	Typically in case of well synchronized parallel processes, in a large-scale schedule of a project
-SSp „start-start maximum *p*”	Successor (related) activity should be started at most *"p"* tu later than predecessor (base) activity is started	Not typical relation. Solely or together with an SSp relation it can be a useful tool for direct allocation (time or resource)
FFp „finish-finish minimum *p*”	Successor (related) activity should be finished at least *"p"* tu later than predecessor (base) activity is finished	Mostly a count-down typed relation for „administrative”, e.g. handover- or supervisory activities
-FFp „finish-finish maximum *p*”	Successor (related) activity should be finished at most *"p"* tu later than predecessor (base) activity is finished	Not typical relation. Solely or together with an FFp relation it can be a useful tool for direct allocation (time or resource)
SFp „start-finish minimum *p*”	Successor (related) activity should be finished at least *"p"* tu later than predecessor (base) activity is started	Theoretic relation, typically with negative parameter and for to replace a -FSp relation (see: scheduling)
-SFp „start-finish maximum *p*”	Successor (related) activity should be finished at most *"p"* tu later than predecessor (base) activity is started	Theoretic relation, being mentioned to complete the list only. It can be used in case of complicated allocations

Most Frequently Used Combined Relations

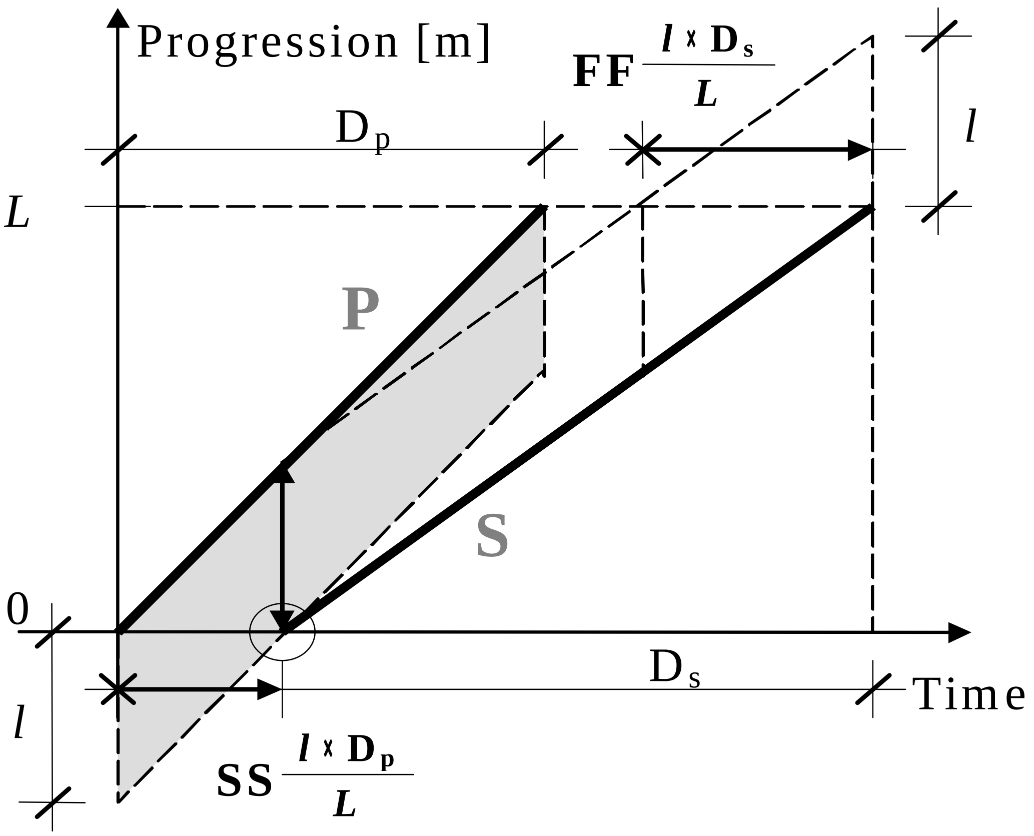
SSp } CRp FFp „(min) critical succession”	A lead-time of at least „p” tu should be provided between the predecessor (base) and successor (related) activity at any rate of completion	Typical relation of technological or resource management-born restrictions (hardening, drying, consolidation, etc.) independent of durations of activities.
-SSp }-CRp -FFp „(max) critical succession”	A lead-time of at most „p” tu can be accepted between the predecessor (base) and successor (related) activity at any rate of completion	**Carefully applied** it can be a useful tool in case of sensitive conditions. Be careful with it ! Applications may result in a misguiding model !
FSp } -FSp „strict/forced succession”	Successor (related) activity must be started exactly „p” tu after predecessor (base) activity is finished	Typically used for direct allocation of succeeding activities.
FS0 } -FS0 „immediate succession”	Successor (related) activity must start immediately after predecessor (base) activity is finished	Typically used for expensive or most significant resources to provide their continuous usage, application or employment
$FF_{f(Ds)}$ } $SS_{f(Dp)}$ „(min) critical approach (in progression)”	Timing of base and of related activities should provide at least f(Dp) tu lead-time between their starts and at least f(Ds) tu lead-time between their finishes. (*Parameters set as function of activity durations*)	Typical tool for to provide room (manipulation/operation area) for succeeding activities. Parameters are set in relation of intensity of performances.
$-FF_{f(Ds)}$ } $-SS_{f(Dp)}$ „(max) critical approach (in progression)”	Schedule of base and related activities is acceptable if it results in at most f(Dp) tu lead-time between their starts and at most f(Ds) tu lead-time between their finishes. (*Parameters set as function of activity durations*)	**Carefully applied** it can be a useful tool for restricting area of manipulation/operation on the construction site. Be careful ! Applications may result in a misguiding model !

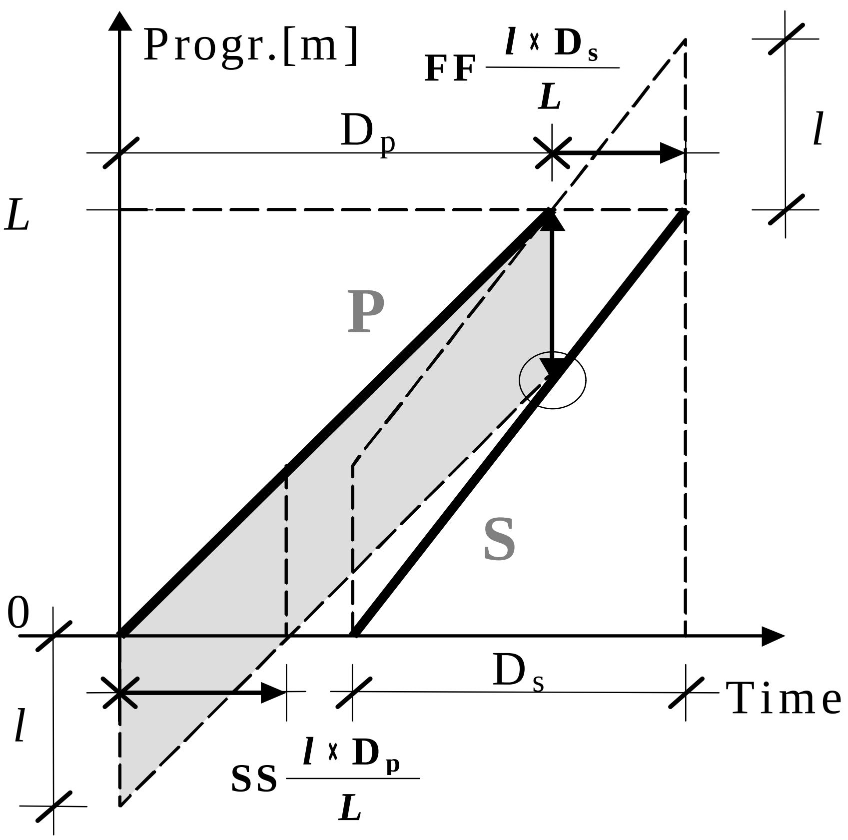
Providing Technological Break



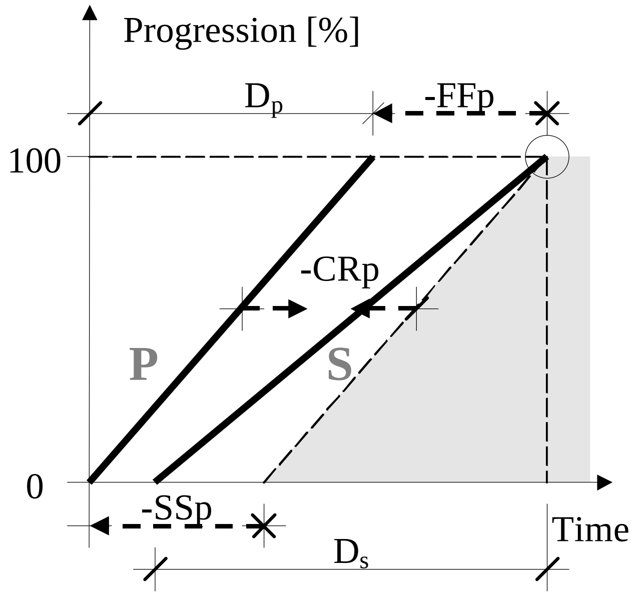


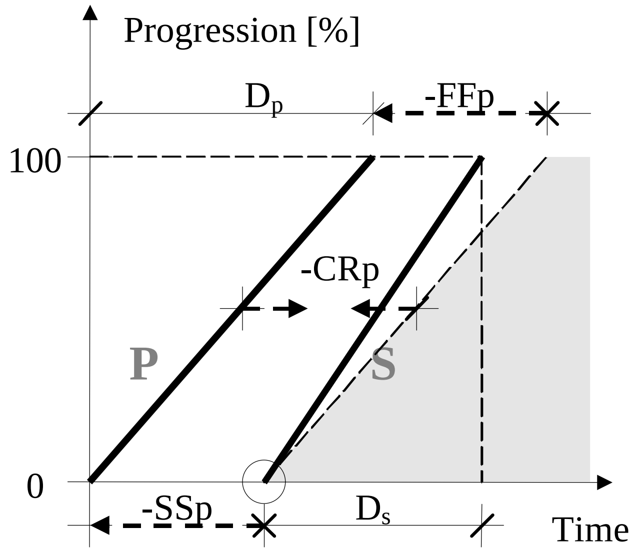
Providing Manipulation Area



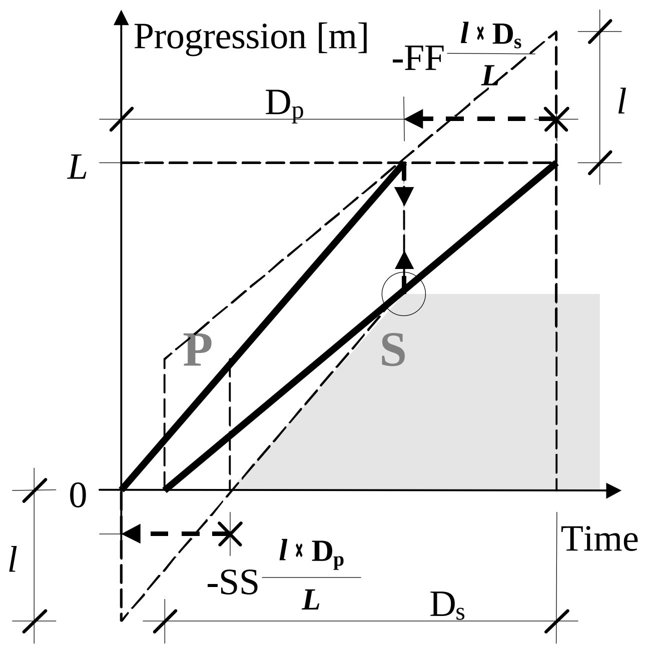


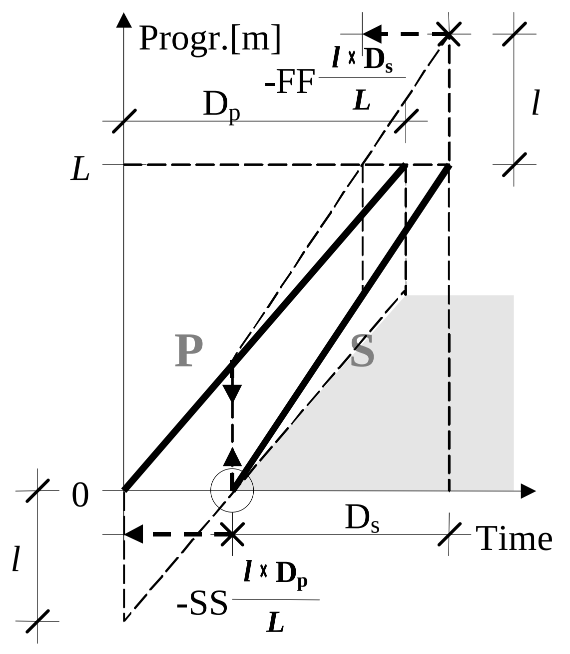
Sensitive Conditions



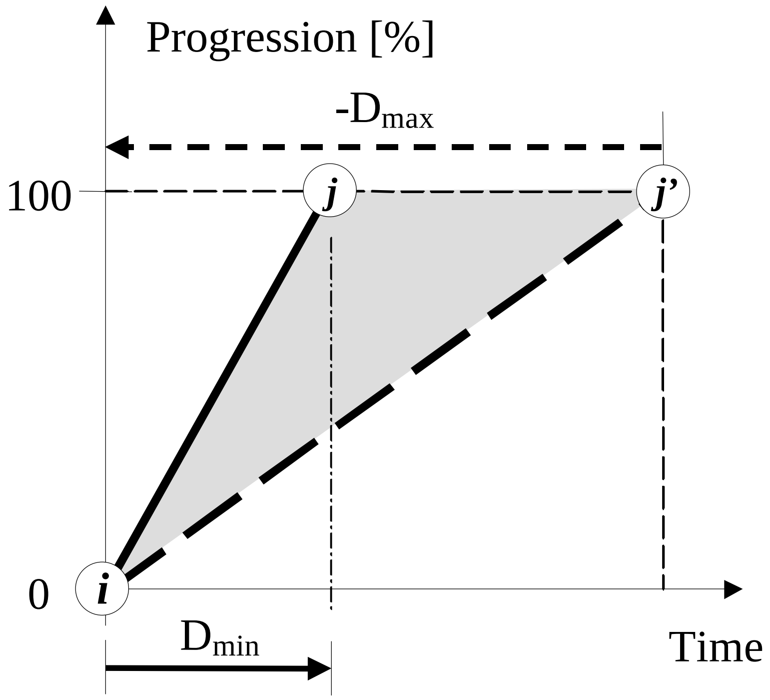


Restricting Manipulation Area

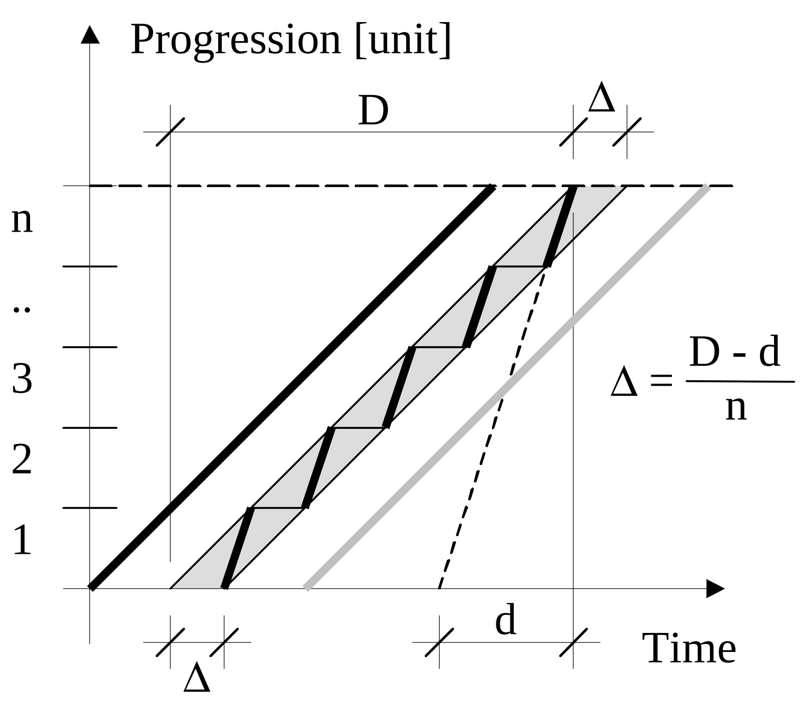




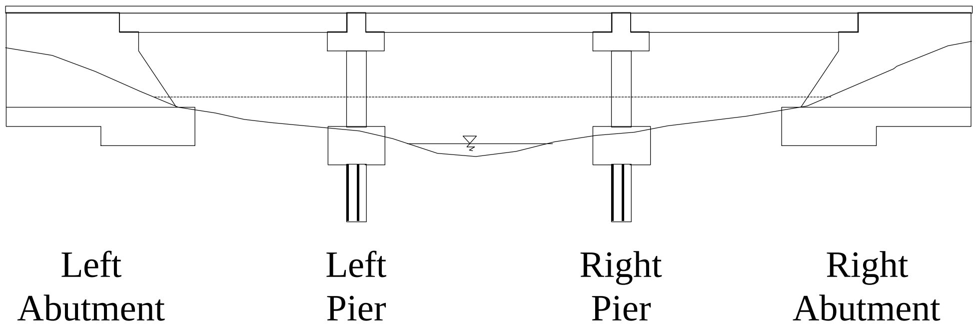
Restrictions on Duration

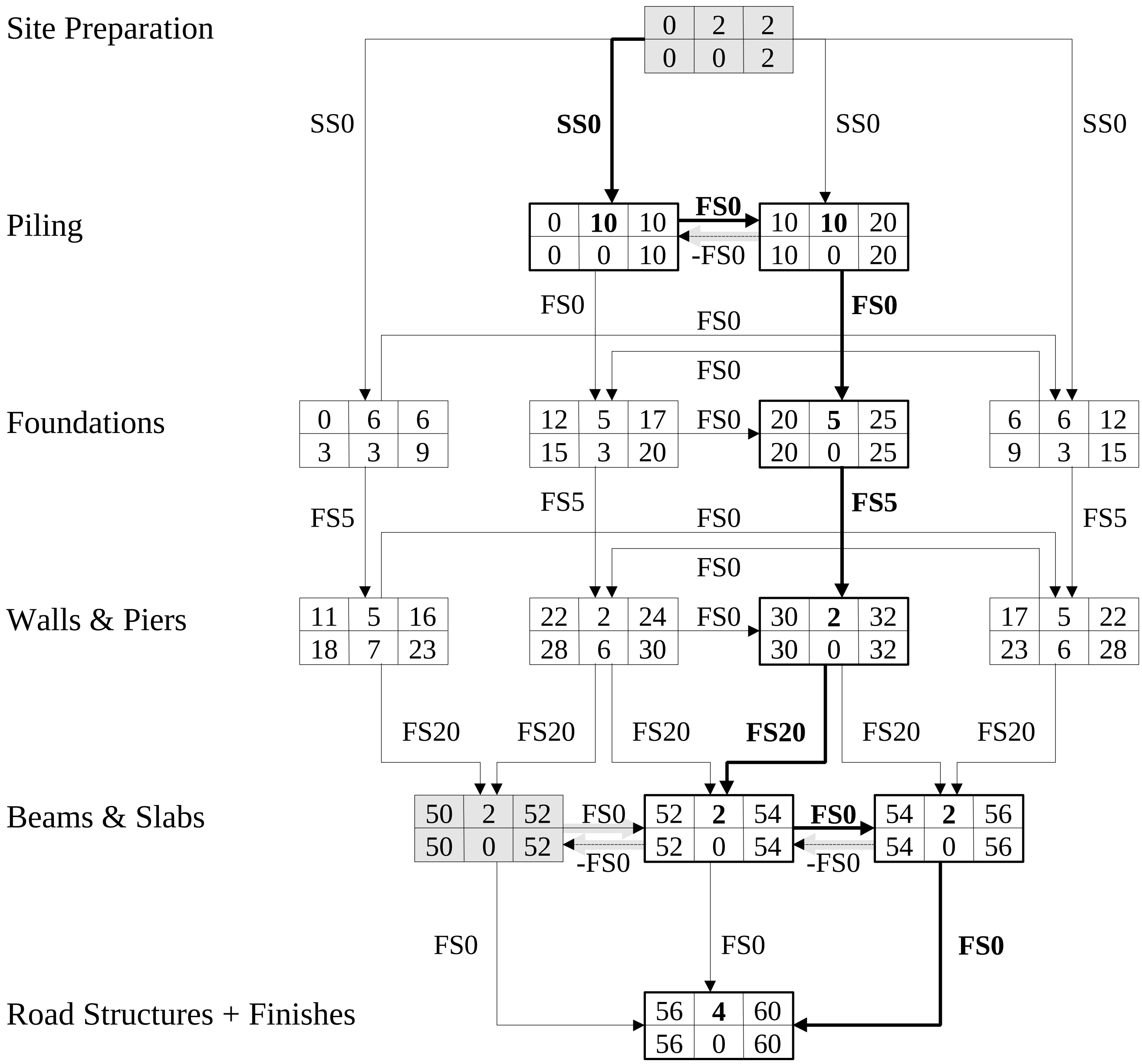


Virtual Deceleration / Paradox /

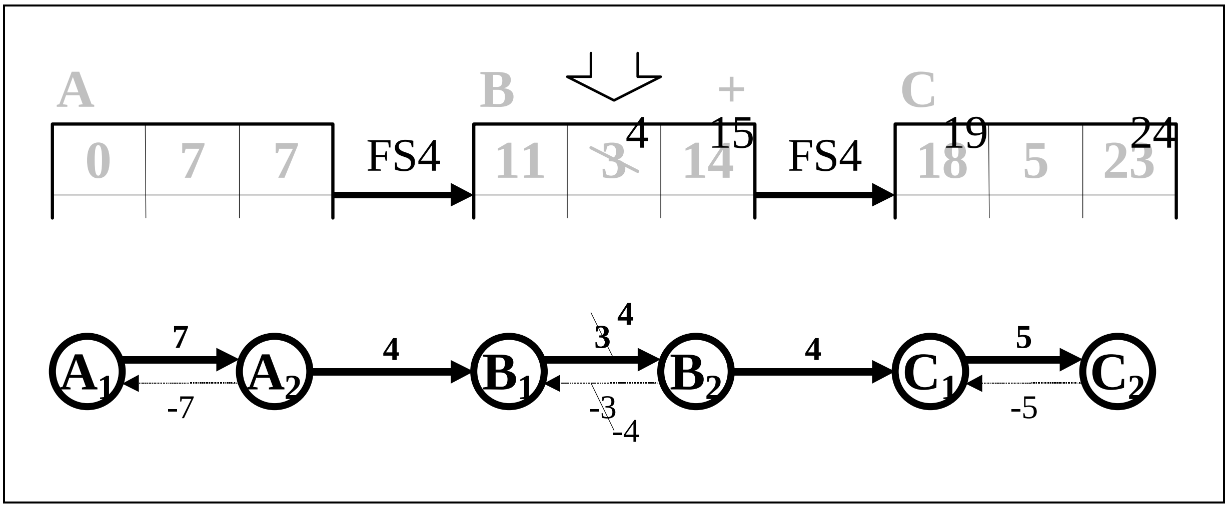


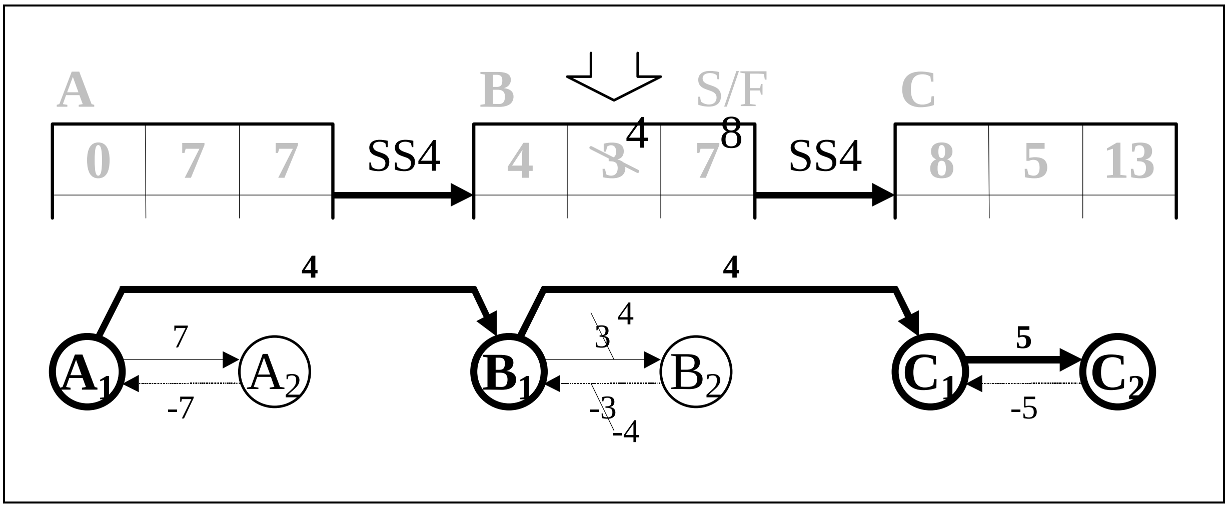
MPM Network Problem:

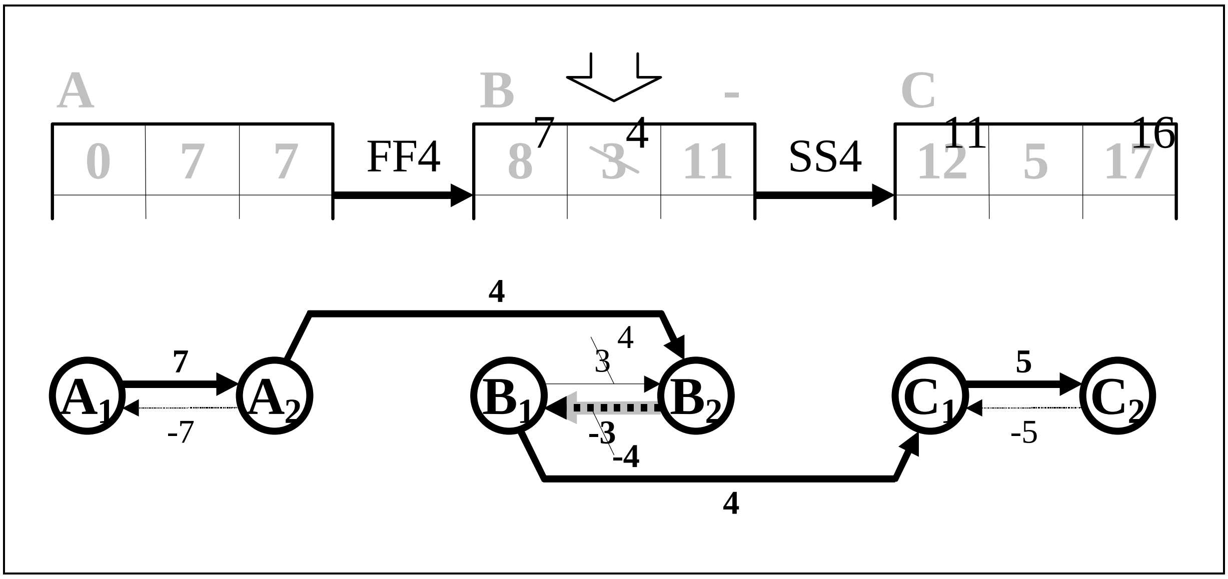




Behavior/Type of (Critical) Activities







General Time Model (GTM)

1997 : Hungary, Z. A. Vattai,
Multi-project management (MÁV)

Node :

Event (a specific moment in time)
(start, finish, milestone, deadline)

Edge :

Relation/comparision/restriction assignment
(process, activity, idle-time, lag-time, etc. as technical interpretation)

Parameter (weight) :

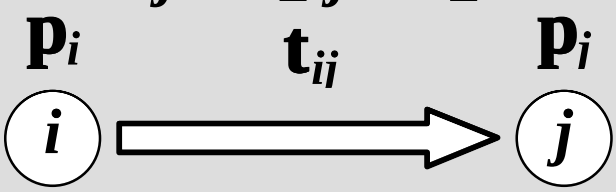
Restriction parameter, lower bound value, time-potential
(deterministic variable)

Aim :

Releasing restrictions of traditional scheduling techniques (PERT,CPM,MPM), to develop flexible technological models and stabil logical structures for projects of typified (logical/technological) elements

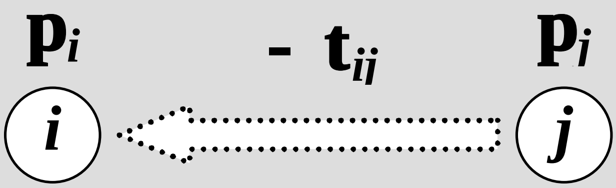
Homogenizing relations

t_{ij} £ p_j - p_i



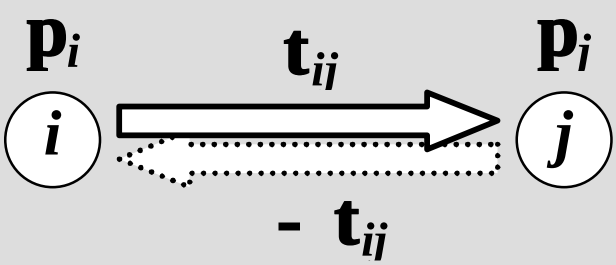
p_j - p_i £ t_{ij} $/\cdot(-1)$

$$-\tau_{ij} \leq \pi_i - \pi_j$$

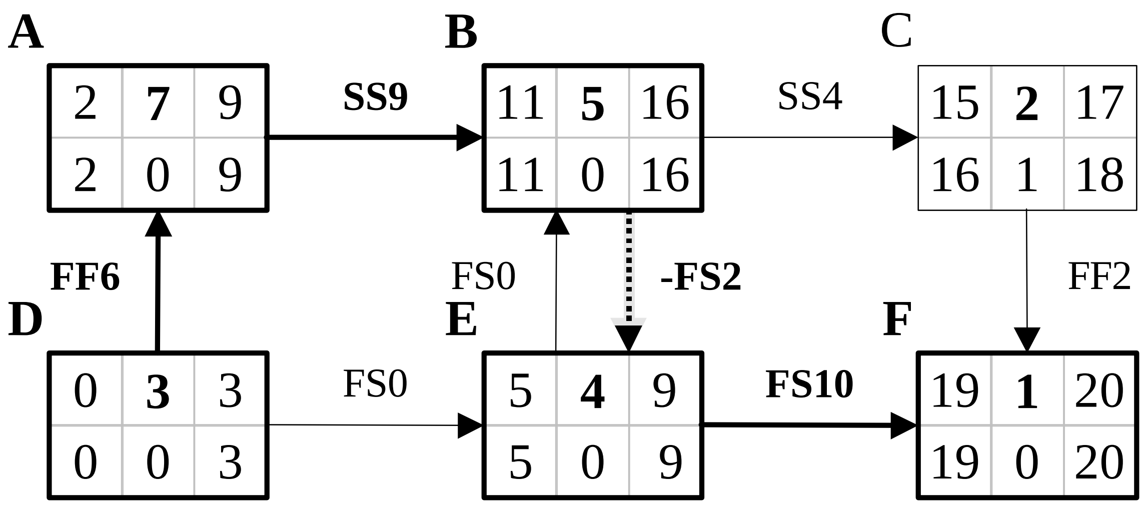


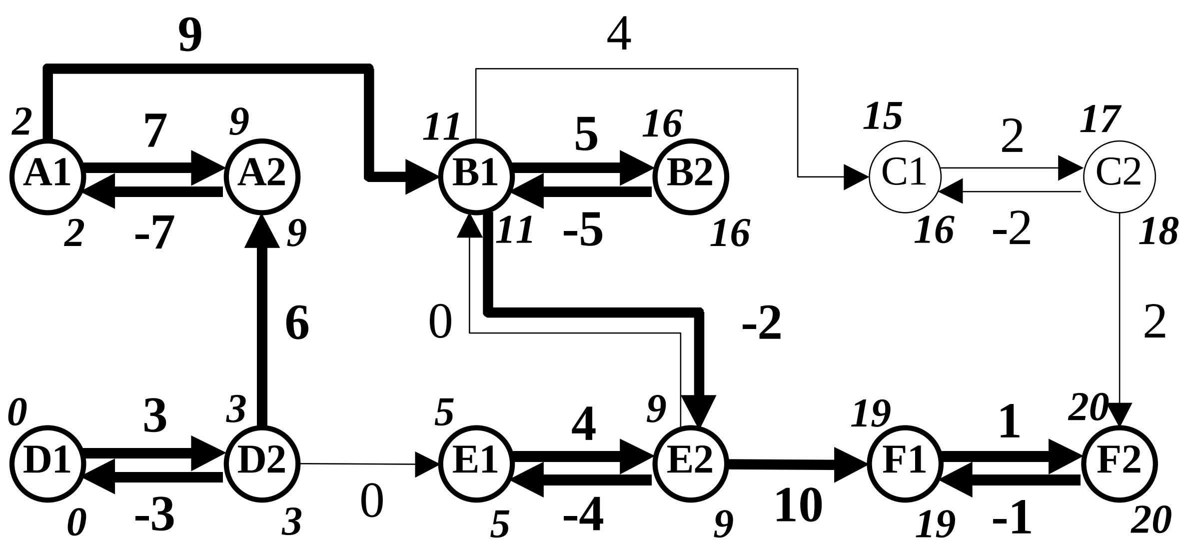
p_j - p_i = t_{ij}

$$\tau_{ij} \leq \pi_j - \pi_i \leq \tau_{ij}$$



MPM^{time} ® GTM Problem





	A1	A2	B1	B2	C1	C2	D1	D2	E1	E2	F1	F2	π^{max}
A1	2	7	9										2
A2	-7	9											9
B1			11	5	4					-2			11
B2			-5	16									16
C1						2							16
C2					-2							2	18
D1							0	3					0
D2		6					-3	3	0				3
E1									5	4			5
E2			0						-4	9	10		9
F1											19	1	19
F2											-1	20	20
π^{min}	2	9	11	16	15	17	0	3	5	9	19	20	

FOUR "MAGIC QUESTIONS"
from network techniques

1., Duration of an activity having no float in an activity-on-arrow typed project model get increased by δ. What will be its effect on the overall execution time of the project ?

2., Duration of an activity having no float in an activity-on-arrow typed project model get decreased by δ. What will be its effect on the overall execution time of the project ?

3., Duration of an activity having no float in an activity-on-node typed project model get increased by δ. What will be its effect on the overall execution time of the project ?

4., Can emerge any situation when an activity having no float simultaneously behaves as *"positive-"*, *"negative"*, *"start-"*, and *"end-critical"* ?