









Control

- ☐ $\text{Job_Size_in_Man_Days}(t) = \text{Job_Size_in_Man_Days}(t - dt) + (\text{Rate_of_Change_in_Job_Size}) * dt$
INIT $\text{Job_Size_in_Man_Days} = \text{Development_Man_Days} + \text{Testing_Man_Days}$
INFLOWS:
 - ✚ $\text{Rate_of_Change_in_Job_Size} = \text{Rate_of_Adjusting_Job_Size} + \text{Rate_of_Increase_in_Development_Man_Days} + \text{Rate_of_Increase_in_Testing_Man_Days}$
- ☐ $\text{Perceived_Job_Size}(t) = \text{Perceived_Job_Size}(t - dt) + (\text{Changes_in_Perceived_Job_Size}) * dt$
INIT $\text{Perceived_Job_Size} = \text{Perceived_Job_Size_DSI/DSI_per_Task}$
INFLOWS:
 - ✚ $\text{Changes_in_Perceived_Job_Size} = \text{Rate_of_Incorporating_Discovered_Tasks_in_Project}$
- ☐ $\text{Tasks_Discovered}(t) = \text{Tasks_Discovered}(t - dt) + (\text{Rate_of_Discovering_Tasks} - \text{Rate_of_Incorporating_Discovered_Tasks}) * dt$
INIT $\text{Tasks_Discovered} = 0$
INFLOWS:
 - ✚ $\text{Rate_of_Discovering_Tasks} = \text{Undiscovered_Tasks} * \text{Percent_of_Undiscovered_Tasks_Discovered_per_Day}/100$OUTFLOWS:
 - ✚ $\text{Rate_of_Incorporating_Discovered_Tasks} = \max(\text{Rate_of_Discovering_Tasks} - \text{Rate_of_Incorporating_Discovered_Tasks_in_Project}, 0)$
- ☐ $\text{Testing_Size_in_Man_Days}(t) = \text{Testing_Size_in_Man_Days}(t - dt) + (\text{Rate_of_Change_in_Testing_Size}) * dt$
INIT $\text{Testing_Size_in_Man_Days} = \text{Testing_Man_Days}$
INFLOWS:
 - ✚ $\text{Rate_of_Change_in_Testing_Size} = \text{if Fraction_of_Effort_for_System_Testing} > .9 \text{ then } \text{Rate_of_Increase_in_Testing_Man_Days} \text{ else } \text{Rate_of_Increase_in_Testing_Man_Days} + \text{Rate_of_Adjusting_Job_Size}$
- ☐ $\text{Undiscovered_Tasks}(t) = \text{Undiscovered_Tasks}(t - dt) + (-\text{Rate_of_Discovering_Tasks}) * dt$
INIT $\text{Undiscovered_Tasks} = \text{Real_Job_Size_in_Tasks} - \text{Perceived_Job_Size}$
OUTFLOWS:
 - ✚ $\text{Rate_of_Discovering_Tasks} = \text{Undiscovered_Tasks} * \text{Percent_of_Undiscovered_Tasks_Discovered_per_Day}/100$
- ☐ $\text{Actual_Testing_Productivity} = \text{IF Cumulative_Testing_Man_Days} = 0 \text{ then } 0 \text{ else } \text{Cumulative_Tasks_Tested}/(\text{Cumulative_Testing_Man_Days})$
- ☐ $\text{Assumed_Devel_Productivity} = \text{Projected_Devel_Productivity} * \text{Weight_to_Projected_Productivity} + \text{Perceived_Devel_Productivity} * (1 - \text{Weight_to_Projected_Productivity})$
- ☐ $\text{Delay_in_Adjusting_Job_Size} = 3$
- ☐ $\text{Delay_in_Incorporating_Tasks} = 10$
- ☐ $\text{Fraction_Value} = \text{if Max_Size_of_Additions_Tolerated} = 0 \text{ then } 0 \text{ else } \text{Relative_Size_of_Discovered_Tasks}/\text{Max_Size_of_Additions_Tolerated}$
- ☐ $\text{Man_Days_Perceived_Needed_to_Rework_Detected_Errors} = \text{Detected_Errors} * \text{Perceived_Rework_MP_Needed_per_Error}$
- ☐ $\text{Man_Days_Perceived_Remaining_for_New_Tasks} = \max(0, \text{Man_Days_Remaining} - \text{Man_Days_Perceived_Needed_to_Rework_Detected_Errors} - \text{Man_Days_Perceived_Still_Needed_for_Testing})$
- ☐ $\text{Man_Days_Perceived_Still_Needed_for_New_Tasks} = \text{Tasks_Perceived_Remaining}/\text{Assumed_Devel_Productivity}$
- ☐ $\text{Man_Days_Perceived_Still_Needed_for_Testing} = \text{Tasks_Remaining_to_be_Tested}/\text{Perceived_Testing_Productivity}$

- $\text{Man_Days_Remaining} = \max(.0001, \text{Job_Size_in_Man_Days} - \text{Cumul_Man_Days_Expended})$
- $\text{Man_Days_Reported_Still_Needed} = \text{Man_Days_Remaining} + \text{Reported_Shortage_or_Excess_in_Man_Days}$
- $\text{Max_Size_of_Additions_Tolerated} = .01$
- $\text{Perceived_Devel_Productivity} = \text{Tasks_Developed} / (\text{Cumul_Man_Days_Expended} - \text{Cumulative_Testing_Man_Days})$
- $\text{Perceived_Shortage_in_ManDays} = \text{Total_ManDays_Perceived_Still_Needed} - \text{Man_Days_Remaining}$
- $\text{Perceived_Size_of_Discovered_Tasks_in_Man_Days} = \text{Tasks_Discovered} / \text{Assumed_Devel_Productivity}$
- $\text{Perceived_Testing_Productivity} = \text{smth1}((\text{if Cumulative_Tasks_Tested} = 0 \text{ then } \text{Planned_Testing_Productivity} \text{ else } \text{Actual_Testing_Productivity}), \text{Time_to_Smooth_Test_Prod})$
- $\text{Percent_Devel_Perceived_Complete} = \text{smth1}(100 - ((\text{Man_Days_Reported_Still_Needed} - \text{Man_Days_Perceived_Still_Needed_for_Testing}) / (\text{Job_Size_in_Man_Days} - \text{Testing_Size_in_Man_Days}) * 100), \text{Reporting_Delay})$
- $\text{Percent_of_Job_Actually_Worked} = \text{Tasks_Developed} / \text{Real_Job_Size_in_Tasks}$
- $\text{Percent_of_Job_Perceived_Worked} = (\text{Tasks_Developed} / \text{Perceived_Job_Size}) * 100$
- $\text{Percent_Tasks_Reported_Complete} = \text{smth1}((100 - (\text{Man_Days_Reported_Still_Needed} / \text{Job_Size_in_Man_Days}) * 100), \text{Reporting_Delay})$
- $\text{Planned_Testing_Productivity} = \text{Perceived_Job_Size} / \text{Testing_Size_in_Man_Days}$
- $\text{Projected_Devel_Productivity} = \text{If } \text{Man_Days_Perceived_Remaining_for_New_Tasks} = 0 \text{ then } 0 \text{ else } \text{Tasks_Perceived_Remaining} / (\text{Man_Days_Perceived_Remaining_for_New_Tasks})$
- $\text{Rate_of_Adjusting_Job_Size} = (\text{Man_Days_Reported_Still_Needed} + \text{Cumul_Man_Days_Expended} - \text{Job_Size_in_Man_Days}) / \text{Delay_in_Adjusting_Job_Size}$
- $\text{Rate_of_Incorporating_Discovered_Tasks_in_Project} = \text{delay}(\text{Rate_of_Discovering_Tasks}, \text{Delay_in_Incorporating_Tasks})$
- $\text{Rate_of_Increase_in_Development_Man_Days} = (\text{Rate_of_Incorporating_Discovered_Tasks_in_Project} / \text{Assumed_Devel_Productivity}) * \text{Fraction_of_Additional_Tasks}$
- $\text{Rate_of_Increase_in_Testing_Man_Days} = (\text{Rate_of_Incorporating_Discovered_Tasks_in_Project} / \text{Perceived_Testing_Productivity}) * \text{Fraction_of_Additional_Tasks}$
- $\text{Real_Job_Size_in_Tasks} = \text{Real_Job_Size_in_DSI} / \text{DSI_per_Task}$
- $\text{Relative_Size_of_Discovered_Tasks} = \text{if } \text{Man_Days_Perceived_Remaining_for_New_Tasks} = 0 \text{ then } 0 \text{ else } \text{Perceived_Size_of_Discovered_Tasks_in_Man_Days} / (\text{Man_Days_Perceived_Remaining_for_New_Tasks})$
- $\text{Reported_Shortage_or_Excess_in_Man_Days} = \text{Perceived_Shortage_in_ManDays} - \text{Handled_ManDays}$
- $\text{Reporting_Delay} = 10$
- $\text{Schedule_Pressure} = (\text{Total_ManDays_Perceived_Still_Needed} - \text{Man_Days_Remaining}) / \text{Man_Days_Remaining}$
- $\text{Tasks_Perceived_Remaining} = \text{Perceived_Job_Size} - \text{Tasks_Developed}$
- $\text{Tasks_Remaining_to_be_Tested} = \text{Perceived_Job_Size} - \text{Cumulative_Tasks_Tested}$
- $\text{Time_to_Smooth_Test_Prod} = 50$
- $\text{Total_ManDays_Perceived_Still_Needed} = \text{Man_Days_Perceived_Still_Needed_for_New_Tasks} + \text{Man_Days_Perceived_Needed_to_Rework_Detected_Errors} + \text{Man_Days_Perceived_Still_Needed_for_Testing}$
- $\text{Weight_to_Projected_Productivity} = \text{Multiplier_for_Devel} * \text{Multiplier_for_Resources}$

-  Fraction_of_Additional_Tasks = GRAPH(Fraction_Value)
 (0.00, 0.00), (0.2, 0.00), (0.4, 0.00), (0.6, 0.00), (0.8, 0.00), (1, 0.00), (1.20, 0.7), (1.40, 0.9), (1.60, 0.975), (1.80, 1.00), (2.00, 1.00)
-  Multiplier_for_Devel = GRAPH(Percent_of_Job_Perceived_Worked/100)
 (0.00, 1.00), (0.1, 1.00), (0.2, 1.00), (0.3, 1.00), (0.4, 1.00), (0.5, 1.00), (0.6, 0.975), (0.7, 0.9), (0.8, 0.75), (0.9, 0.5), (1, 0.00)
-  Multiplier_for_Resources = GRAPH((1-Man_Days_Perceived_Remaining_for_New_Tasks/(Job_Size_in_Man_Days-Testing_Size_in_Man_Days)))
 (0.00, 1.00), (0.1, 1.00), (0.2, 1.00), (0.3, 1.00), (0.4, 1.00), (0.5, 1.00), (0.6, 0.975), (0.7, 0.9), (0.8, 0.75), (0.9, 0.5), (1, 0.00)
-  Percent_of_Undiscovered_Tasks_Discovered_per_Day =
 GRAPH(Percent_of_Job_Perceived_Worked)
(0.00, 0.00), (20.0, 0.4), (40.0, 2.50), (60.0, 5.00), (80.0, 10.0), (100, 100)





Enter Project Parameters

- ☐ Avg_Daily_MP_per_Staff = 1
- ☐ Perceived_Job_Size_DSI = 42880

Estimation

- ☐ Development_Man_Days = .8*Man_Days
- ☐ DSI_per_Task = 60
- ☐ Man_Days = 2.4*19*(Perceived_Job_Size_DSI/1000)^1.05
- ☐ Real_Job_Size_in_DSI = (Perceived_Job_Size_DSI)/Tasks_Underestimation_Fraction
- ☐ Starting_Work_Force = ((Man_Days/TDEV)/Avg_Daily_MP_per_Staff)*.5
- ☐ Tasks_Underestimation_Fraction = .67
- ☐ TDEV = 47.5*(Man_Days/19)^.38
- ☐ Testing_Man_Days = .2*Man_Days

Human Resources Sector

- ☐ Pros(t) = Pros(t - dt) + (Assimilation_Rate - Quit_Rate - Pro_Transfer_Rate) * dt
 INIT Pros = Starting_Work_Force
 INFLOWS:
 Assimilation_Rate = Rookies/Assim_Delay
- OUTFLOWS:
 Quit_Rate = Pros/Avg_Empl_Time
 Pro_Transfer_Rate = min((max(0,-Work_Force_Gap/Pro_Transfer_Delay))-Rookie_Transfer_Rate, Pros/dt)
- ☐ Rookies(t) = Rookies(t - dt) + (Hiring_Rate - Assimilation_Rate - Rookie_Transfer_Rate) * dt
 INIT Rookies = 0
 INFLOWS:
 Hiring_Rate = max(0, Work_Force_Gap/Hiring_Delay)

OUTFLOWS:

- ☒ Assimilation_Rate = Rookies/Assim_Delay
- ☒ Rookie_Transfer_Rate = min(max(0,-Work_Force_Gap/Rookie_Transfer_Delay), Rookies/dt)
- ☐ Assim_Delay = 80
- ☐ Avg_Empl_Time = 673
- ☐ Ceiling_on_Hires = FTE_Proos*Most_Hirees_per_FTE
- ☐ Daily_MP_for_Training = Rookies*Trainers_per_Hiree
- ☐ FTE_Proos = Pros*Avg_Daily_MP_per_Staff
- ☐ Full_Time_Equiv_Work_Force = Total_Work_Force*Avg_Daily_MP_per_Staff
- ☐ Hiring_Delay = 40
- ☐ Most_Hirees_per_FTE = 3
- ☐ Pro_Transfer_Delay = 10
- ☐ Rookie_Transfer_Delay = 10
- ☐ Total_Work_Force = Rookies+Pros
- ☐ Trainers_per_Hiree = 0.2
- ☐ Work_Force_Ceiling = Pros+Ceiling_on_Hires
- ☐ Work_Force_Gap = Work_Force_Level_Sought-Total_Work_Force
- ☐ Work_Force_Level_Sought = min(Work_Force_Ceiling,Workforce_Level_Needed)

Manpower Allocation Sector

- ☐ Cumul_Devel_Man_Days(t) = Cumul_Devel_Man_Days(t - dt) + (Devel_Man_Days_Rate) * dt
INIT Cumul_Devel_Man_Days = 0
INFLOWS:
 - ☒ Devel_Man_Days_Rate = Daily_MP_for_DevTest*(1-Fraction_of_Effort_for_System_Testing)
- ☐ Cumul_Man_Days_Expended(t) = Cumul_Man_Days_Expended(t - dt) + (Expended_Rate) * dt
INIT Cumul_Man_Days_Expended = .0001
INFLOWS:
 - ☒ Expended_Rate = Total_Daily_Manpower
- ☐ Cumul_QA_Man_Days(t) = Cumul_QA_Man_Days(t - dt) + (QA_MD_Rate) * dt
INIT Cumul_QA_Man_Days = 0
INFLOWS:
 - ☒ QA_MD_Rate = Daily_MP_for_QA
- ☐ Cumul_Rework_Man_Days(t) = Cumul_Rework_Man_Days(t - dt) + (Rework_Man_Days_Rate) * dt
INIT Cumul_Rework_Man_Days = 0
INFLOWS:
 - ☒ Rework_Man_Days_Rate = Daily_MP_for_Rework
- ☐ Actual_Fraction_of_MP_for_QA = Planned_Fraction_of_MP_for_QA*(1+Actual_Fraction_Graph)
- ☐ Daily_MP_Available_After_Training_Overhead = Total_Daily_Manpower-Daily_MP_for_Training
- ☐ Daily_MP_for_DevTest = Daily_MP_for_SW_Prod-Daily_MP_for_Rework
- ☐ Daily_MP_for_QA = min((Actual_Fraction_of_MP_for_QA*Total_Daily_Manpower),0.9*Daily_MP_Available_After_Training_Overhead)
- ☐ Daily_MP_for_Rework = min((Desired_Error_Correction_Rate*Perceived_Rework_MP_Needed_per_Error),Daily_MP_for_SW_Prod)
- ☐ Daily_MP_for_SW_Prod = Daily_MP_Available_After_Training_Overhead-Daily_MP_for_QA
- ☐ Desired_Error_Correction_Rate = Detected_Errors/Desired_Rework_Delay

- ☐ Desired_Rework_Delay = 15
- ☐ Perceived_Rework_MP_Needed_per_Error =
smth1(Actual_Rework_Manpower_Needed_per_Error,10)
- ☐ Planned_Fraction_of_MP_for_QA = Planned_Fraction_Graph*(1+Quality_Objective/100)
- ☐ Quality_Objective = 0
- ☐ Total_Daily_Manpower = Total_Work_Force*Avg_Daily_MP_per_Staff
- ☒ Actual_Fraction_Graph = GRAPH(Schedule_Pressure)



(0.00, 0.00), (0.1, -0.025), (0.2, -0.15), (0.3, -0.35), (0.4, -0.475), (0.5, -0.5)

- ☒ Planned_Fraction_Graph = GRAPH(Percent_of_Job_Actually_Worked)



(0.00, 0.15), (0.1, 0.15), (0.2, 0.15), (0.3, 0.15), (0.4, 0.15), (0.5, 0.15), (0.6, 0.15), (0.7, 0.15), (0.8, 0.15), (0.9, 0.15), (1, 0.00)

Planning Sector

- ☐ Scheduled_Completion_Date(t) = Scheduled_Completion_Date(t - dt) + (Rate_of_Adjusting_Flow) * dt

INIT Scheduled_Completion_Date = TDEV

INFLOWS:

$$\text{Rate_of_Adjusting_Flow} = \frac{\text{Indicated_Completion_Date} - \text{Scheduled_Completion_Date}}{\text{Schedule_Adjustment_Time}}$$

- ☐ Indicated_Completion_Date = time+Time_Perceived_Still_Remaining
- ☐ Indicated_Work_Force_Level = (Man_Days_Remaining/(Time_Remaining+0.001))/Avg_Daily_MP_per_Staff
- ☐ Max_Tolerable_Completion_Date = 1e7*TDEV
- ☐ Schedule_Adjustment_Time = 5
- ☐ Time_Perceived_Still_Remaining = Man_Days_Remaining/(Work_Force_Level_Sought*Avg_Daily_MP_per_Staff)
- ☐ Time_Remaining = max(Scheduled_Completion_Date-time, 0)
- ☐ Willingness_to_Change_Workforce = max(WCWF1,WCWF2)
- ☐ Workforce_Level_Needed = min((Willingness_to_Change_Workforce*Indicated_Work_Force_Level+(1-Willingness_to_Change_Workforce)*Total_Work_Force),Indicated_Work_Force_Level)
- ☒ WCWF1 = GRAPH(Time_Remaining/(Hiring_Delay+Assim_Delay))



(0.00, 0.00), (0.3, 0.00), (0.6, 0.1), (0.9, 0.4), (1.20, 0.85), (1.50, 1.00), (1.80, 1.00), (2.10, 1.00), (2.40, 1.00), (2.70, 1.00), (3.00, 1.00)

- ☒ WCWF2 = GRAPH(Scheduled_Completion_Date/Max_Tolerable_Completion_Date)



(0.86, 0.00), (0.88, 0.1), (0.9, 0.2), (0.92, 0.35), (0.94, 0.6), (0.96, 0.7), (0.98, 0.77), (1.00, 0.8)

Quality Assurance

☐ $Cumulative_Detected_Errors(t) = Cumulative_Detected_Errors(t - dt) + (Count_Detected_Errors) * dt$
 INIT $Cumulative_Detected_Errors = 0$

INFLOWS:

☛ $Count_Detected_Errors = Error_Detection_Rate$

☐ $Cumulative_Errors(t) = Cumulative_Errors(t - dt) + (Generation_Rate) * dt$
 INIT $Cumulative_Errors = 0$

INFLOWS:

☛ $Generation_Rate = Error_Generation_Rate$

☐ $Detected_Errors(t) = Detected_Errors(t - dt) + (Error_Detection_Rate - Rework_Rate) * dt$
 INIT $Detected_Errors = 0$

INFLOWS:

☛ $Error_Detection_Rate = \min(Potential_Error_Detection_Rate, Potentially_Detectable_Errors / dt)$

OUTFLOWS:

☛ $Rework_Rate = Daily_MP_for_Rework / Actual_Rework_Manpower_Needed_per_Error$

☐ $Escaped_Errors(t) = Escaped_Errors(t - dt) + (Error_Escape_Rate) * dt$
 INIT $Escaped_Errors = 0$

INFLOWS:

☛ $Error_Escape_Rate = QA_Rate * Average_ \#_Errors_per_Task$

☐ $Potentially_Detectable_Errors(t) = Potentially_Detectable_Errors(t - dt) + (Error_Generation_Rate - Error_Detection_Rate - Error_Escape_Rate) * dt$

INIT $Potentially_Detectable_Errors = 0$

INFLOWS:

☛ $Error_Generation_Rate = Software_Development_Rate * Nominal_Errors_Committed_per_Task * Multiplier_Due_to_Schedule_Pressure * Multiplier_Due_to_Workforce_Mix$

OUTFLOWS:

☛ $Error_Detection_Rate = \min(Potential_Error_Detection_Rate, Potentially_Detectable_Errors / dt)$

☛ $Error_Escape_Rate = QA_Rate * Average_ \#_Errors_per_Task$

☐ $Reworked_Errors_During_Devel(t) = Reworked_Errors_During_Devel(t - dt) + (Rework_Rate) * dt$
 INIT $Reworked_Errors_During_Devel = 0$

INFLOWS:

☛ $Rework_Rate = Daily_MP_for_Rework / Actual_Rework_Manpower_Needed_per_Error$

☐ $Tasks_Worked(t) = Tasks_Worked(t - dt) + (SD_RATE - QA_RATE) * dt$
 INIT $Tasks_Worked = 0$

INFLOWS:

☛ $SD_RATE = Software_Development_Rate$

OUTFLOWS:


☛ $QA_RATE = QA_Rate$

○ $Actual_Rework_Manpower_Needed_per_Error = Nominal_Rework_Manpower_Needed_per_Error / Multiplier_for_Losses$


○ $Average_ \#_Errors_per_Task = \text{If } Tasks_Worked = 0 \text{ then } 0 \text{ else } \max(Potentially_Detectable_Errors / (Tasks_Worked), 0)$

○ $Average_QA_Delay = 10$


○ $Error_Density = Average_ \#_Errors_per_Task * (1000 / DSI_per_Task)$

- $\text{Nominal_Errors_Committed_per_Task} = \text{Nominal_Errors_Committed_per_DSI} * \text{DSI_per_Task} / 1000$
- $\text{Percent_Errors_Detected} = 100 * \text{Cumulative_Detected_Errors} / (\text{Cumulative_Errors} + .001)$
- $\text{Potential_Error_Detection_Rate} = \text{Daily_MP_for_QA} / \text{QA_Manpower_Needed_to_Detect_an_Error}$
- $\text{QA_Manpower_Needed_to_Detect_an_Error} = \text{Nominal_QA_Manpower_Needed_per_Error} * (1 / \text{Multiplier_for_Losses}) * \text{Multiplier_Due_to_Error_Density}$
- $\text{QA_Rate} = \text{DELAY}(\text{Software_Development_Rate}, \text{Average_QA_Delay}, 0)$
- $\text{Multiplier_Due_to_Error_Density} = \text{GRAPH}(\text{Error_Density})$



Error_Density	Multiplier_Due_to_Error_Density
(0.00, 50.0)	
(1.00, 36.0)	
(2.00, 26.0)	
(3.00, 17.5)	
(4.00, 10.0)	
(5.00, 4.00)	
(6.00, 1.75)	
(7.00, 1.20)	
(8.00, 1.00)	
(9.00, 1.00)	
(10.0, 1.00)	

- $\text{Multiplier_Due_to_Schedule_Pressure} = \text{GRAPH}(\text{Schedule_Pressure})$



Schedule_Pressure	Multiplier_Due_to_Schedule_Pressure
(-0.4, 0.9)	
(-0.2, 0.94)	
(-5.55e-17, 1.00)	
(0.2, 1.05)	
(0.4, 1.14)	
(0.6, 1.24)	
(0.8, 1.36)	
(1, 1.50)	

- $\text{Multiplier_Due_to_Workforce_Mix} = \text{GRAPH}(\text{Ratio_of_Pros_to_Rookies})$



Ratio_of_Pros_to_Rookies	Multiplier_Due_to_Workforce_Mix
(0.00, 2.00)	
(0.2, 1.80)	
(0.4, 1.60)	
(0.6, 1.40)	
(0.8, 1.20)	
(1, 1.00)	

- $\text{Nominal_Errors_Committed_per_DSI} = \text{GRAPH}(\text{Percent_of_Job_Actually_Worked})$


Percent_of_Job_Actually_Worked	Nominal_Errors_Committed_per_DSI
(0.00, 25.0)	
(0.2, 23.9)	
(0.4, 21.6)	
(0.6, 15.9)	
(0.8, 13.6)	
(1, 12.5)	

- $\text{Nominal_QA_Manpower_Needed_per_Error} = \text{GRAPH}(\text{Percent_of_Job_Actually_Worked})$




Percent_of_Job_Actually_Worked	Nominal_QA_Manpower_Needed_per_Error
(0.00, 0.4)	
(0.1, 0.4)	
(0.2, 0.39)	
(0.3, 0.375)	
(0.4, 0.35)	
(0.5, 0.3)	
(0.6, 0.25)	
(0.7, 0.225)	
(0.8, 0.21)	
(0.9, 0.2)	
(1, 0.2)	

- $\text{Nominal_Rework_Manpower_Needed_per_Error} = \text{GRAPH}(\text{Percent_of_Job_Actually_Worked})$





Percent_of_Job_Actually_Worked	Nominal_Rework_Manpower_Needed_per_Error
(0.00, 0.6)	
(0.2, 0.575)	
(0.4, 0.5)	
(0.6, 0.4)	
(0.8, 0.325)	
(1, 0.3)	



Software Development Productivity Subsector



- Actual_Fraction_of_ManDay_for_Project(t) = Actual_Fraction_of_ManDay_for_Project(t - dt) + (Work_Rate_Adj) * dt
INIT Actual_Fraction_of_ManDay_for_Project = Nominal_Fraction_of_ManDays_for_Project
INFLOWS:
 - ⚙ Work_Rate_Adj = (Work_Rate_Adj_Sought - Actual_Fraction_of_ManDay_for_Project) / Work_Rate_Adj_Time
- Exhaustion_Level(t) = Exhaustion_Level(t - dt) + (Exhaustion_Flow - Exhaustion_Depletion) * dt
INIT Exhaustion_Level = 0
INFLOWS:



 Exhaustion_Flow = GRAPH((1-Actual_Fraction_of_ManDay_for_Project)/(1-Nominal_Fraction_of_ManDays_for_Project))
 (-0.5, 2.50), (-0.4, 2.20), (-0.3, 1.90), (-0.2, 1.60), (-0.1, 1.30), (-5.55e-17, 1.15), (0.1, 0.9), (0.2, 0.8), (0.3, 0.7), (0.4, 0.6), (0.5, 0.5), (0.6, 0.4), (0.7, 0.3), (0.8, 0.2), (0.9, 0.00), (1, 0.00)



OUTFLOWS:

-  Exhaustion_Depletion = if Exhaustion_Flow = 0 then Exhaustion_Level / Exhaustion_Depletion_Delay_Time else 0
- Avg_Nominal_Potential_Prod = (Ratio_of_Pros_to_Rookies*Nominal_Potential_Prod:_Pros)+(1-Ratio_of_Pros_to_Rookies) * Nominal_Potential_Prod:_Rookies
- Effect_of_Work_Rate_Sought = if Work_Rate_Adj_Sought>Actual_Fraction_of_ManDay_for_Project then 1 else .75
- Exhaustion_Depletion_Delay_Time = 20
- Handled_ManDays = if Perceived_Shortage_in_ManDays > 0 then (min(Perceived_Shortage_in_ManDays, Max_Shortage_ManDays_Handled)) else - (Perceived_Excesses_in_ManDays)
- Max_Boost_in_ManHours = 1
- Max_Shortage_ManDays_Handled = (Overwork_Duration_Threshold * Max_Boost_in_ManHours * Full_Time_Equiv_Work_Force) * Willingness_to_Overwork
- Max_Tolerable_Exhaustion = 50
- Multiplier_for_Losses = Actual_Fraction_of_ManDay_for_Project*(1-Communication_Overhead)
- Nominal_Fraction_of_ManDays_for_Project = .6
- Nominal_Potential_Prod:_Pros = 1
- Nominal_Potential_Prod:_Rookies = 0.5
- Overwork_Duration_Threshold = Nominal_Overwork_Duration_Threshold * Multiplier_to_Overwork_Duration_Threshold
- Perceived_Excesses_in_ManDays = max(0, Slack_Time_Growth * (Man_Days_Remaining - Total_ManDays_Perceived_Still_Needed))
- Percent_Boost_in_Work_Rate_Sought = if Perceived_Shortage_in_ManDays > 0 then (Handled_ManDays / (Full_Time_Equiv_Work_Force * (Overwork_Duration_Threshold+.0001))) else (Handled_ManDays / (Total_ManDays_Perceived_Still_Needed- Handled_ManDays+.0001))
- Potential_Productivity = Avg_Nominal_Potential_Prod*Multiplier_Due_to_Learning
- Ratio_of_Pros_to_Rookies = Pros/(Rookies+Pros)
- Software_Development_Productivity = Potential_Productivity*Multiplier_for_Losses
- Willingness_to_Overwork = if Exhaustion_Depletion>0 and Exhaustion_Flow = 0 then 0 else 1
- Work_Rate_Adj_Sought = (1 + Percent_Boost_in_Work_Rate_Sought) * Nominal_Fraction_of_ManDays_for_Project
- Work_Rate_Adj_Time = Normal_Delay*Effect_of_Work_Rate_Sought
-  Communication_Overhead = GRAPH(Total_Work_Force)
 (0.00, 0.00), (5.00, 0.015), (10.0, 0.06), (15.0, 0.135), (20.0, 0.24), (25.0, 0.375), (30.0, 0.54)
-  Multiplier_Due_to_Learning = GRAPH(Percent_of_Job_Actually_Worked)
 (0.00, 1.00), (0.1, 1.01), (0.2, 1.03), (0.3, 1.06), (0.4, 1.09), (0.5, 1.15), (0.6, 1.20), (0.7, 1.22), (0.8, 1.25), (0.9, 1.25), (1, 1.25)

 Multiplier_to_Overwork_Duration_Threshold = GRAPH(Exhaustion_Level/Max_Tolerable_Exhaustion)
 (0.00, 1.00), (0.1, 0.9), (0.2, 0.8), (0.3, 0.7), (0.4, 0.6), (0.5, 0.5), (0.6, 0.4), (0.7, 0.3), (0.8, 0.2), (0.9, 0.1), (1, 0.00)


 Nominal_Overwork_Duration_Threshold = GRAPH(Time_Remaining)
 (0.00, 0.00), (10.0, 10.0), (20.0, 20.0), (30.0, 30.0), (40.0, 40.0), (50.0, 50.0)

 Normal_Delay = GRAPH(Time_Remaining)
 (0.00, 2.00), (5.00, 3.50), (10.0, 5.00), (15.0, 6.50), (20.0, 8.00), (25.0, 9.50), (30.0, 10.0)

 Slack_Time_Growth = GRAPH(Total_ManDays_Perceived_Still_Needed/Man_Days_Remaining)
 (0.00, 0.00), (0.1, 0.2), (0.2, 0.4), (0.3, 0.55), (0.4, 0.7), (0.5, 0.8), (0.6, 0.9), (0.7, 0.95), (0.8, 1.00), (0.9, 1.00), (1, 1.00)



Software Development Sector

☐ Tasks_Developed(t) = Tasks_Developed(t - dt) + (Software_Development_Rate) * dt
 INIT Tasks_Developed = 0
 INFLOWS:

 Software_Development_Rate = min((Daily_MP_for_Development*Software_Development_Productivity),Tasks_Perceived_Remaining/dt)


☐ Daily_MP_for_Development = Daily_MP_for_DevTest*(1-Fraction_of_Effort_for_System_Testing)

☐ Daily_MP_for_Testing = Fraction_of_Effort_for_System_Testing*Daily_MP_for_DevTest

 Fraction_of_Effort_for_System_Testing = GRAPH(Tasks_Perceived_Remaining/Perceived_Job_Size)
 (0.00, 1.00), (0.04, 0.5), (0.08, 0.28), (0.12, 0.15), (0.16, 0.05), (0.2, 0.00)

Testing


☐ Cumulative_Errors_Reworked_in_Testing(t) = Cumulative_Errors_Reworked_in_Testing(t - dt) + (Cumulative_Errors_Rate) * dt
 INIT Cumulative_Errors_Reworked_in_Testing = 0
 INFLOWS:

 Cumulative_Errors_Rate = Passive_Error_Detection_&_Correction_Rate+Active_Error_Detection_&_Correction_Rate


☐ Cumulative_Tasks_QA'd(t) = Cumulative_Tasks_QA'd(t - dt) + (QA__RATE - Testing_Rate) * dt
 INIT Cumulative_Tasks_QA'd = 0
 INFLOWS:


 QA__RATE = QA_Rate


OUTFLOWS:

 Testing_Rate = min(Cumulative_Tasks_QA'd/dt,Daily_MP_for_Testing/Testing_MP_per_Task)

- ☐ Cumulative_Tasks_Testeds(t) = Cumulative_Tasks_Testeds(t - dt) + (Testing_Rate) * dt
 INIT Cumulative_Tasks_Testeds = 0
 INFLOWS:
 ❖ Testing_Rate = min(Cumulative_Tasks_QA'd/dt,Daily_MP_for_Testing/
 Testing_MP_per_Task)
- ☐ Cumulative_Testing_Man_Days(t) = Cumulative_Testing_Man_Days(t - dt) +
 (Cumulative_Testing_MD_Rate) * dt
 INIT Cumulative_Testing_Man_Days = 0
 INFLOWS:
 ❖ Cumulative_Testing_MD_Rate = Daily_MP_for_Testing
- ☐ Undetected_Active_Errors(t) = Undetected_Active_Errors(t - dt) + (Active_Error_Gen_Rate +
 Active_Error_Regen_Rate - Active_Error_Detection_&_Correction_Rate -
 Active_Error_Retirement_Rate) * dt
 INIT Undetected_Active_Errors = 0
 INFLOWS:
 ❖ Active_Error_Gen_Rate = (Error_Escape_Rate+Bad_Fix_Gen_Rate)*
 Fraction_Escaping_Errors_that_will_be_Active
 ❖ Active_Error_Regen_Rate = Software_Development_Rate*
 SMTH1(Active_Error_Density,Time_to_Smooth_Active_Error_Density)*
 Multiplier_to_Regen_Due_to_Error_Density
- OUTFLOWS:
 ❖ Active_Error_Detection_&_Correction_Rate = min(Testing_Rate*
 Active_Error_Density,Undetected_Active_Errors/dt)
 ❖ Active_Error_Retirement_Rate = Undetected_Active_Errors*Active_Errors_Retiring_Fraction
- ☐ Undetected_Passive_Errors(t) = Undetected_Passive_Errors(t - dt) +
 (Active_Error_Retirement_Rate + Passive_Error_Gen_Rate - Passive_Error_Detection_&
 _Correction_Rate) * dt
 INIT Undetected_Passive_Errors = 0
 INFLOWS:
 ❖ Active_Error_Retirement_Rate = Undetected_Active_Errors*Active_Errors_Retiring_Fraction
 ❖ Passive_Error_Gen_Rate = (Error_Escape_Rate+Bad_Fix_Gen_Rate)*(1-
 Fraction_Escaping_Errors_that_will_be_Active)
- OUTFLOWS:
 ❖ Passive_Error_Detection_&_Correction_Rate = min(Testing_Rate*
 Passive_Error_Density,Undetected_Passive_Errors/dt)
- ☐ Active_Error_Density = if Cumulative_Tasks_QA'd = 0 then 0 else Undetected_Active_Errors/
 (Cumulative_Tasks_QA'd)
- ☐ All_Errors = Potentially_Detectable_Errors+Detected_Errors+Reworked_Errors_During_Devel+
 Undetected_Active_Errors+Undetected_Passive_Errors+Cumulative_Errors_Reworked_in_Testing
- ☐ All_Errors_Reworked = Cumulative_Errors_Reworked_in_Testing+
 Reworked_Errors_During_Devel
- ☐ All_Errors_That_Escaped_or_Were_Generated = Undetected_Active_Errors+
 Undetected_Passive_Errors+Cumulative_Errors_Reworked_in_Testing
- ☐ Bad_Fix_Gen_Rate = Rework_Rate*Percent_Bad_Fixes
- ☐ Passive_Error_Density = IF Cumulative_Tasks_QA'd = 0 then 0 else Undetected_Passive_Errors/
 (Cumulative_Tasks_QA'd)
- ☐ Percent_Bad_Fixes = .075
- ☐ Percent_of_Tasks_Testeds = Cumulative_Tasks_Testeds/Perceived_Job_Size

- ☐ Testing_Effort_Overhead = 1
- ☐ Testing_MP_per_Error = .15
- ☐ Testing_MP_per_Task = (Testing_Effort_Overhead*DSI_per_Task/1000+Testing_MP_per_Error*(Passive_Error_Density+Active_Error_Density))/Multiplier_for_Losses
- ☐ Time_to_Smooth_Active_Error_Density = 40
- ☒ Active_Errors_Retiring_Fraction = GRAPH(Percent_of_Job_Actually_Worked)
 
 (0.00, 0.00), (0.1, 0.00), (0.2, 0.00), (0.3, 0.00), (0.4, 0.01), (0.5, 0.02), (0.6, 0.03), (0.7, 0.04), (0.8, 0.1), (0.9, 0.3), (1, 1.00)

- ☒ Fraction_Escaping_Errors_that_will_be_Active = GRAPH(Percent_of_Job_Actually_Worked)
 
 (0.00, 1.00), (0.1, 1.00), (0.2, 1.00), (0.3, 1.00), (0.4, 0.95), (0.5, 0.85), (0.6, 0.5), (0.7, 0.2), (0.8, 0.075), (0.9, 0.00), (1, 0.00)

- ☒ Multiplier_to_Regen_Due_to_Error_Density = GRAPH(smth1(Active_Error_Density*1000/DSI_per_Task,Time_to_Smooth_Active_Error_Density))
 
 (0.00, 1.00), (10.0, 1.10), (20.0, 1.20), (30.0, 1.32), (40.0, 1.45), (50.0, 1.60), (60.0, 2.00), (70.0, 2.50), (80.0, 3.25), (90.0, 4.35), (100, 6.00)