Lessons Learned In Production Cost Management

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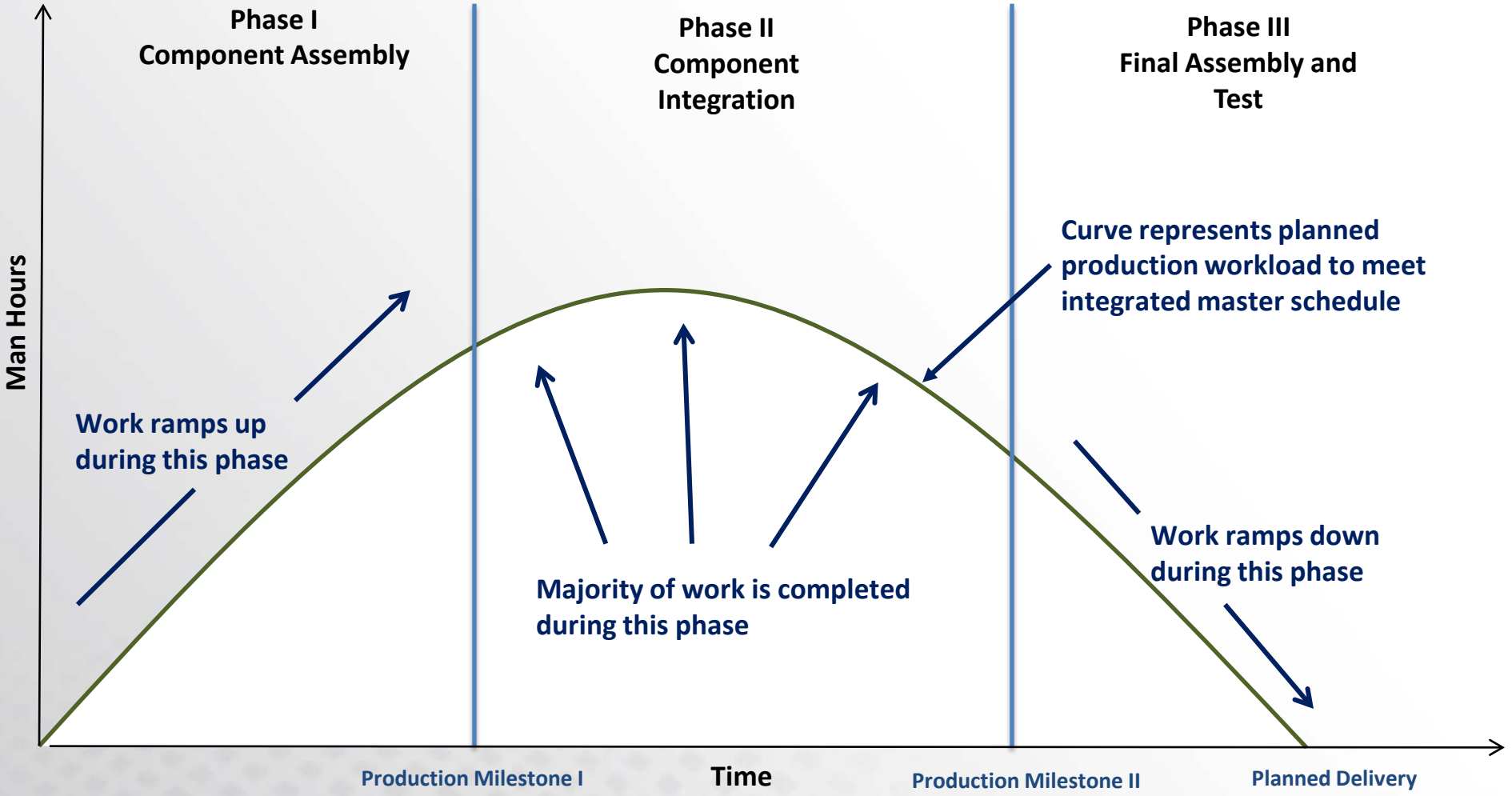
Lessons Learned in Production Cost Management

Background

- A number of high profile acquisition programs have experienced significant cost growth in recent years
- Today's briefing focuses on the **production** aspects of cost growth
  - Costly techniques utilized in an attempt to recover schedule
  - Inefficiencies associated with deferred work
  - Incentives that drive additional costs
- We will introduce a conceptual framework to illustrate the drivers for production cost growth and the reasons that EAC projections often underestimate production costs
- Finally, we will discuss approaches to better manage production cost growth and incentivize cost management

A manning profile is used by production managers to represent planned production hours over time



For example, in shipbuilding the three major phases of production are associated with significant milestones

Block Erection Phase I

Pre-Fabrication of Sections

- Equipment
- Components
- Electrical cables
- Pipes

Pre-Launch Phase II

- Construction planning
- Section assembly
- Ship erection

Lay Keel

Post Launch Phase III

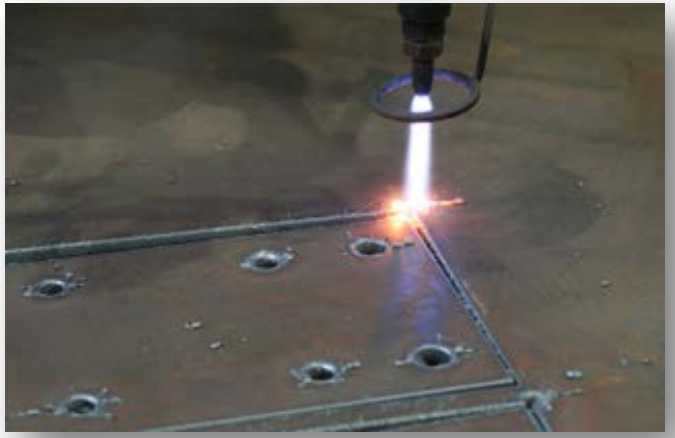
- Detailing
- Modifications

- Dock tests and evaluation
- Sea trials

Final Outfitting

Major production milestones are often incentivized with Award Fee or Progress Payments

Engine installation

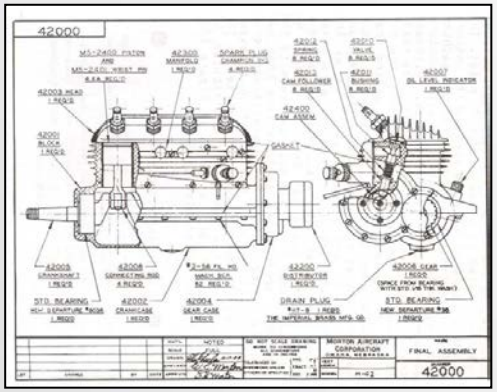


Cutting metal or "Production Start"

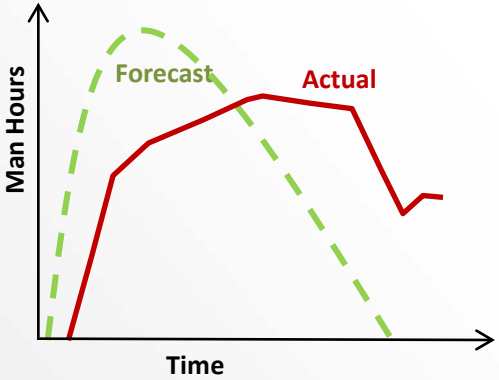
Mating of aircraft components

Production often falls behind schedule for a number of reasons

Late engineering, engineering changes, and scope creep



Optimistic Manpower Estimates



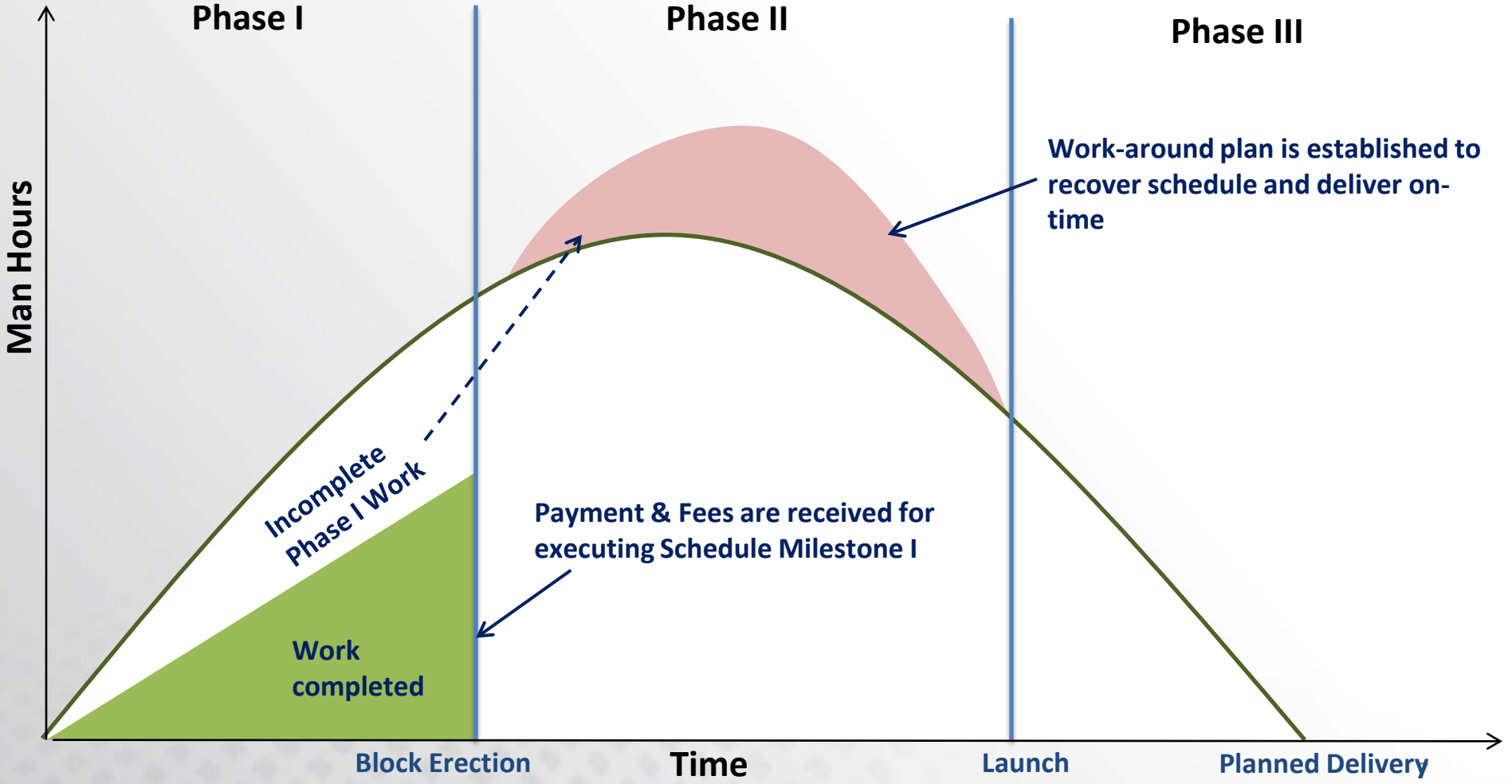
Tooling, equipment, facilities, and process issues

Material Delays

Material and other quality issues

Environmental Issues (e.g., Hurricane Katrina, labor strikes)

To meet major production milestones, incomplete work is frequently deferred to later production phases



Work around plans incorporate approaches to recover schedule which result in inefficiencies

Changes to Manpower Plans

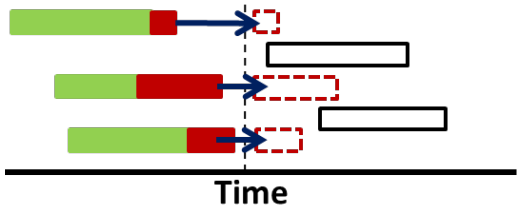
Increased Staffing / Added Shifts

Increased Overtime

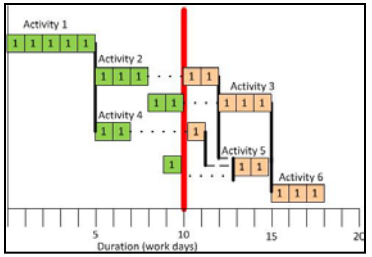
Common techniques used to recover production schedule

Changes to Production Schedules

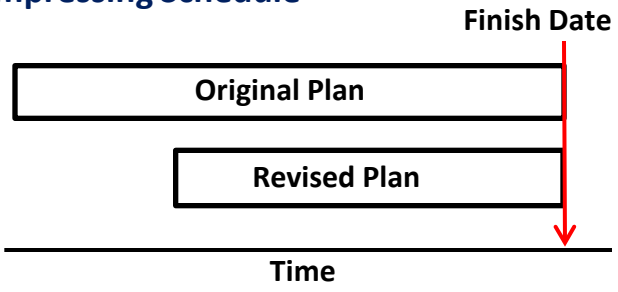
Deferring behind schedule work to later phases



Completing work out of sequence



Compressing Schedule



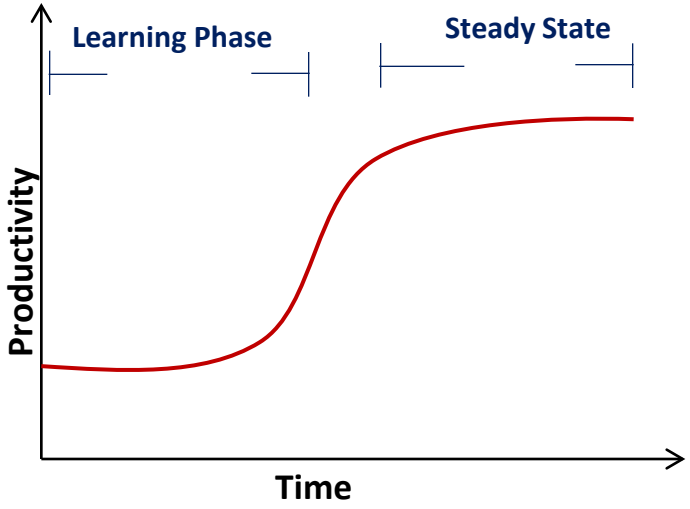
Another often inefficient technique used to recover lost schedule is adding more resources

Training / Mentoring

- Causes crowding in the workplace
- Requires increased supervision and on-the-job training
- Occupies productive resources
- Rarely accounted for in workaround plans

Decreases labor productivity

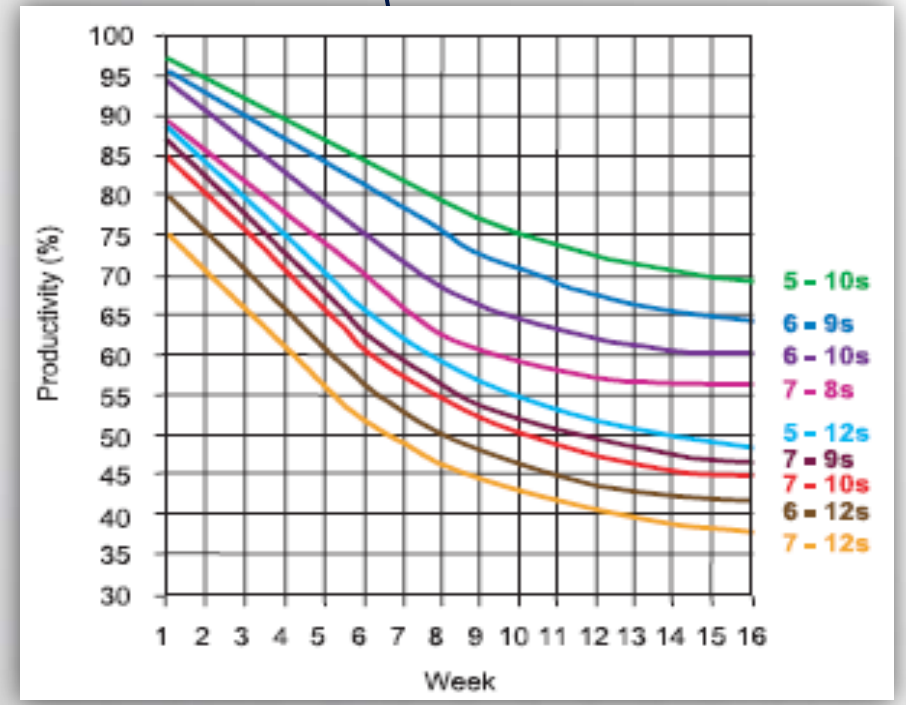
Learning Curves



- Less skilled workers take time to developed adequate skill-set
- Often results in rework that is identified in later, more costly phases of production

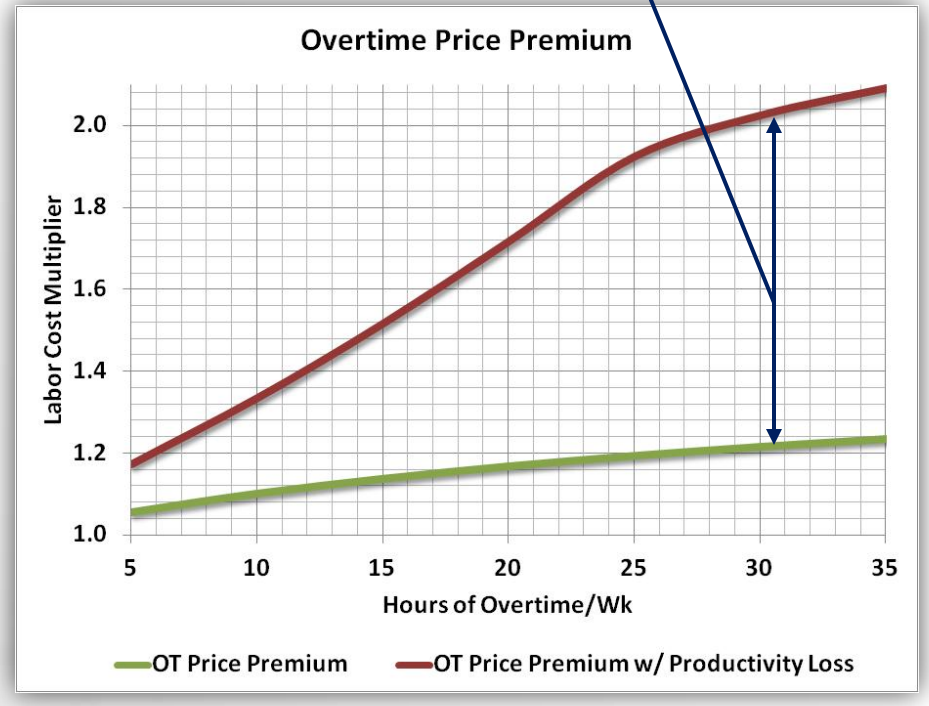
Overtime is effective in short bursts, but ineffective and costly when used throughout lengthy production phases

Labor productivity decreases throughout its duration of use



Source: *Calculating Loss of Productivity Due to Overtime Using Published Charts – Fact or Fiction; Regula Bruines and Zey Emir*

Overtime price premium is often understated because is doesn't account for productivity loss

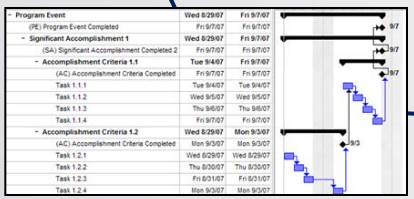


Deferring work and working out of sequence also causes a reduction in labor productivity and causes cost growth

Sub-optimal tool placement

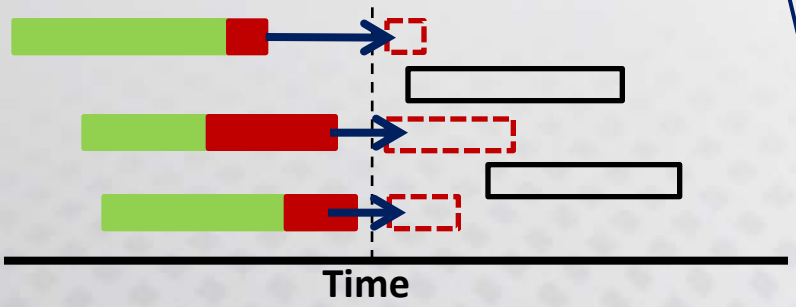
Accessibility issues

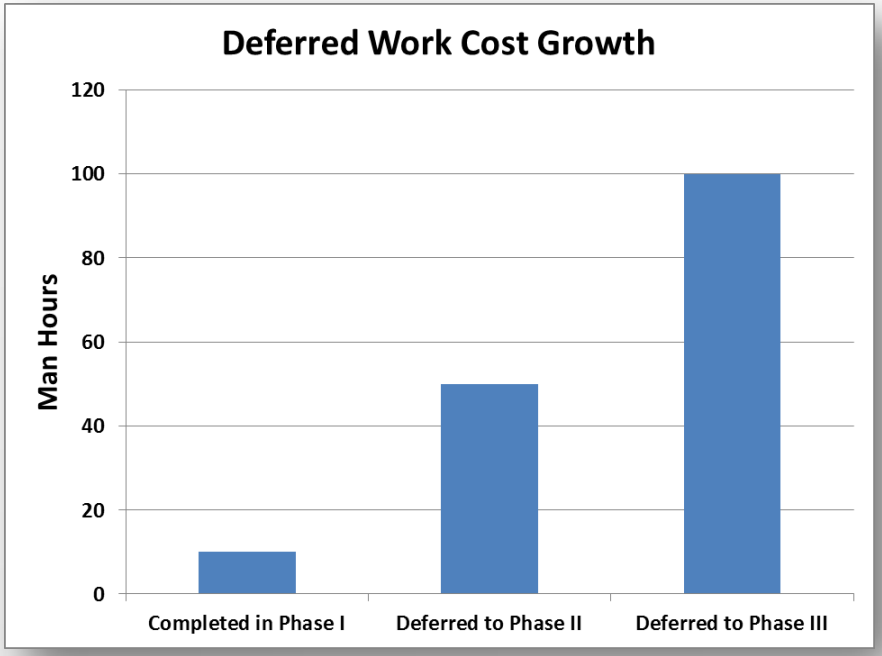
Forces updates to IMS



Incurs time to review work around plans

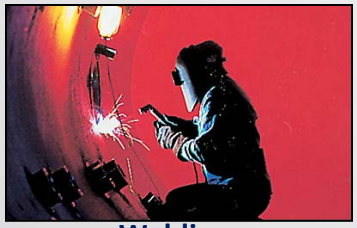
Interferes with planned work





For example, deferring a task like welding will require additional operations and time to complete

Completed as planned in Panel Line:
8 hrs.


Welding

Deferred to Pre-Outfit after paint:
40 hrs.


Strip paint


Welding


Re-paint

Deferred to Build Stage after compartment closeout:
80 hrs.


Strip paint

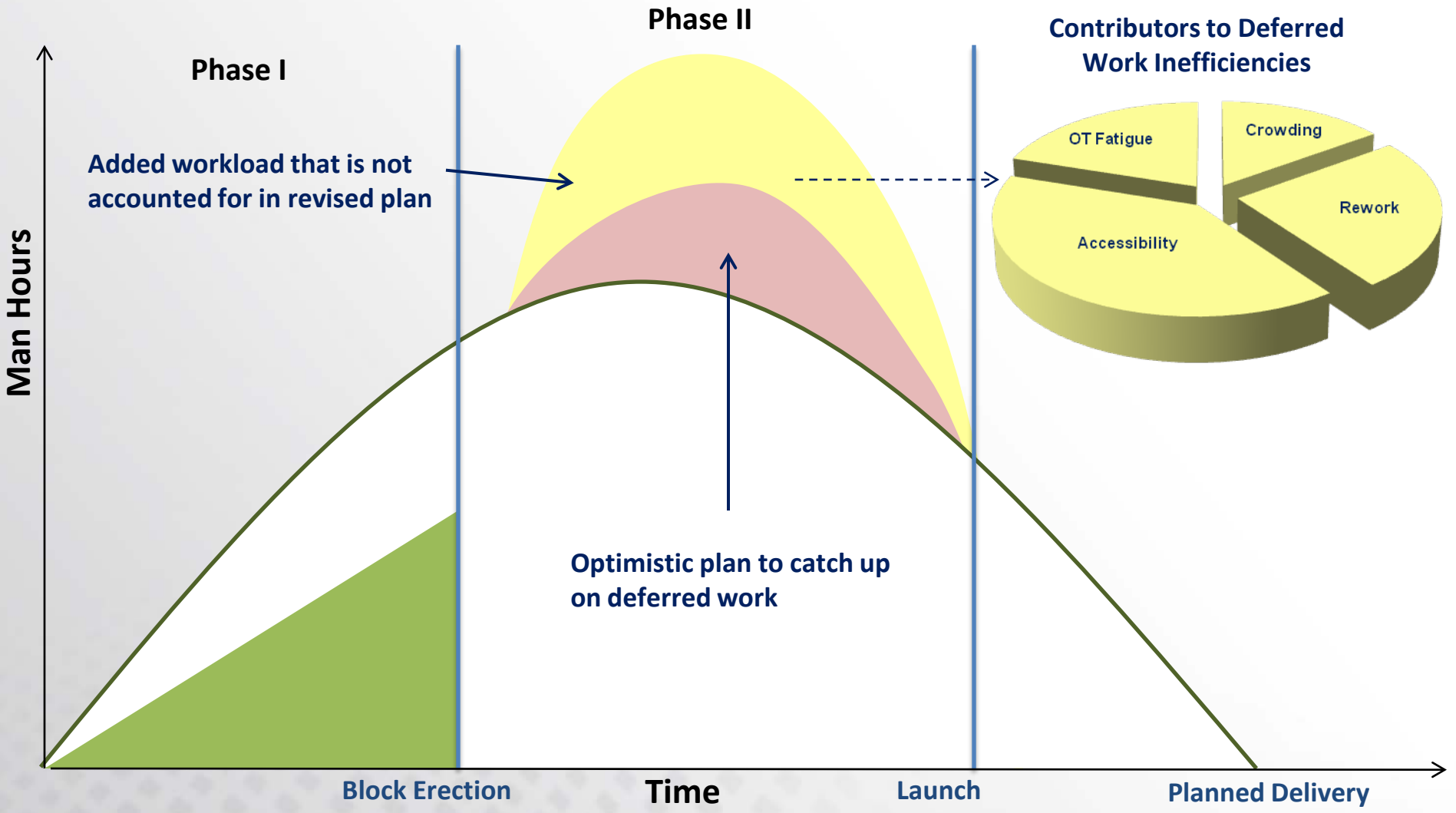

Remove insulation


Welding

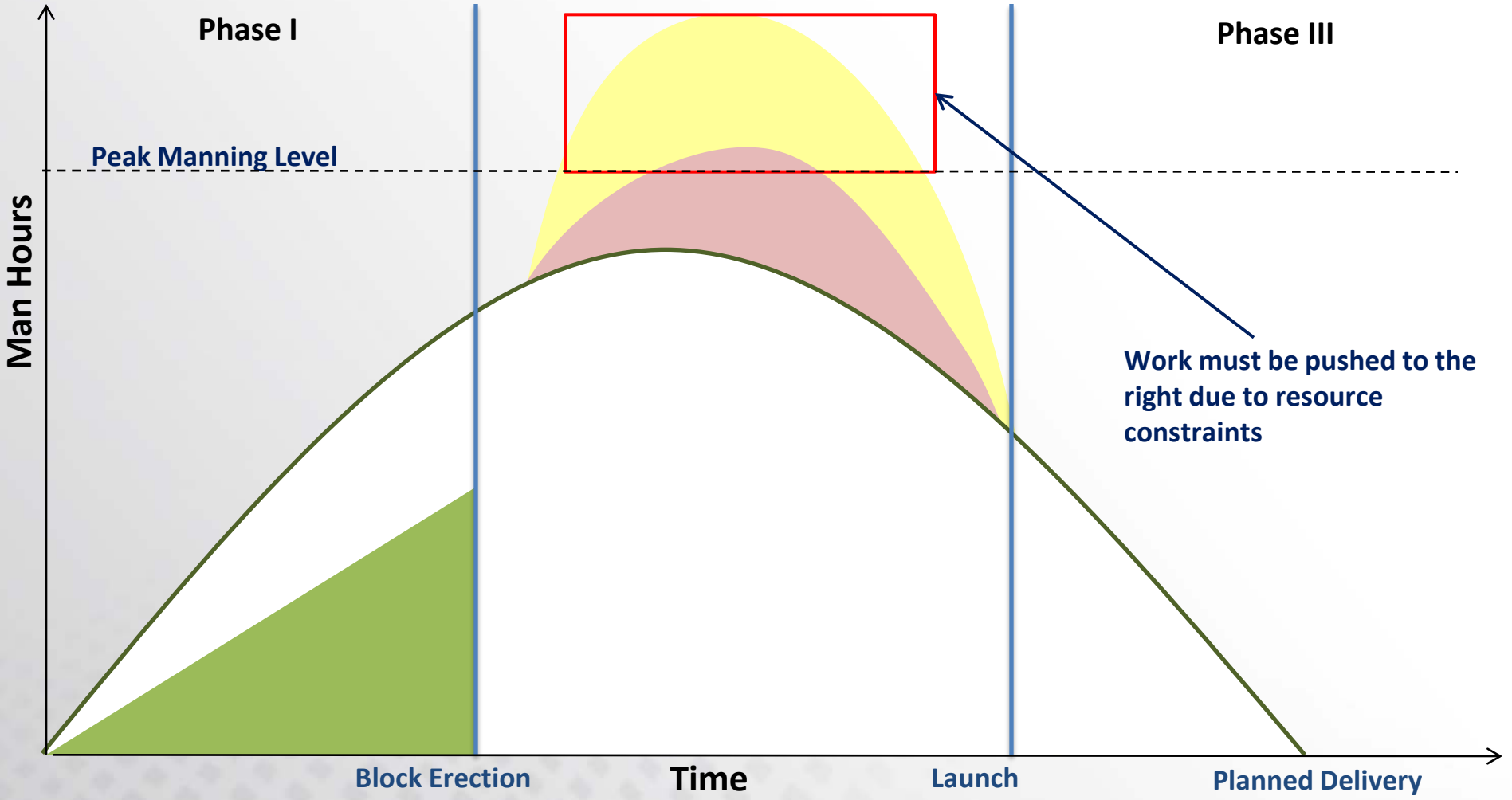

Re-paint


Repair & reinstall insulation

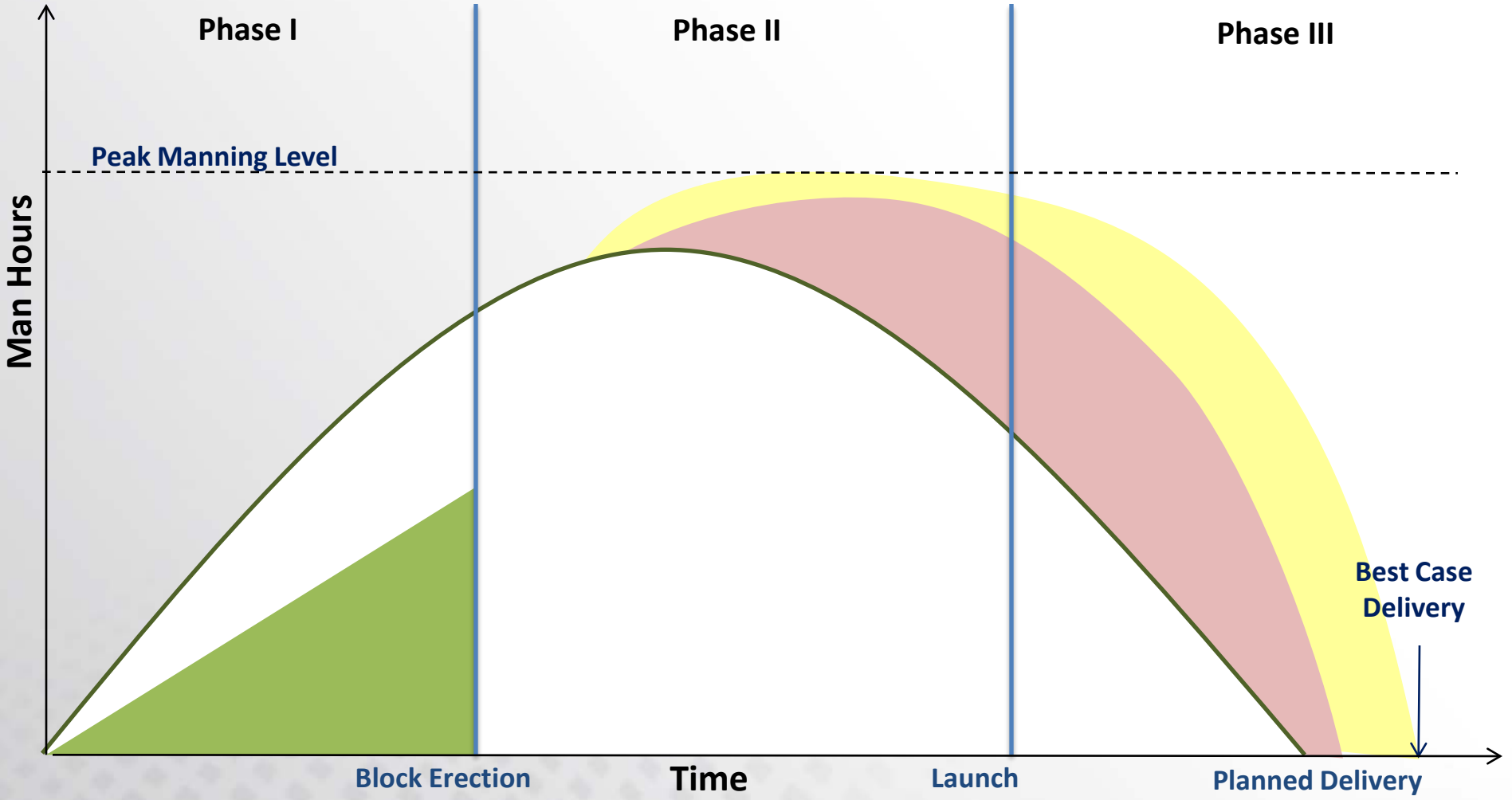
Plans for recovering schedule often fail because these inefficiencies are not taken into account



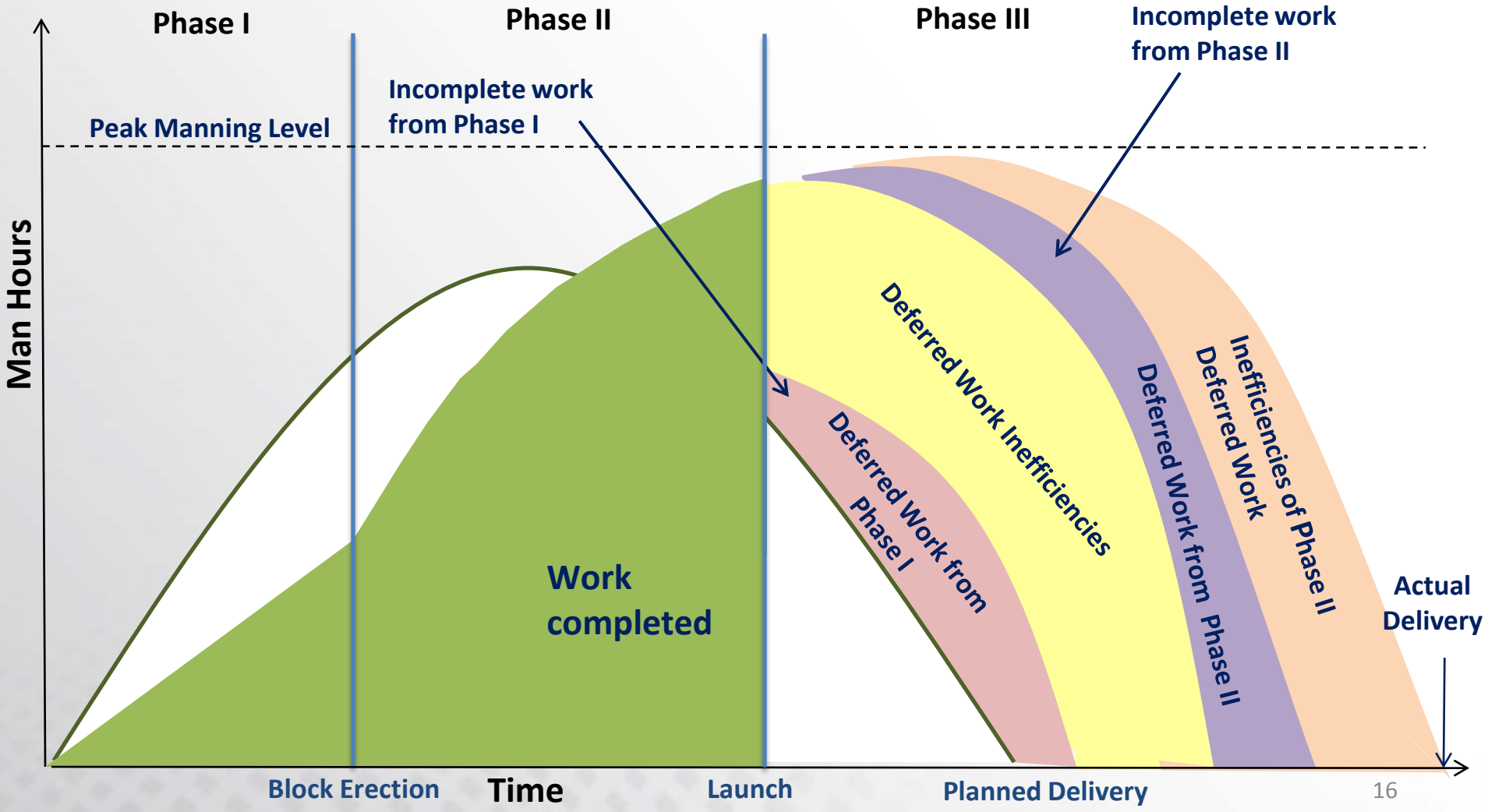
Inefficiencies make recovering schedule infeasible because it would require manning beyond a realistic level



The deferred work must be pushed to the right due to resource constraints, thus impacting schedule

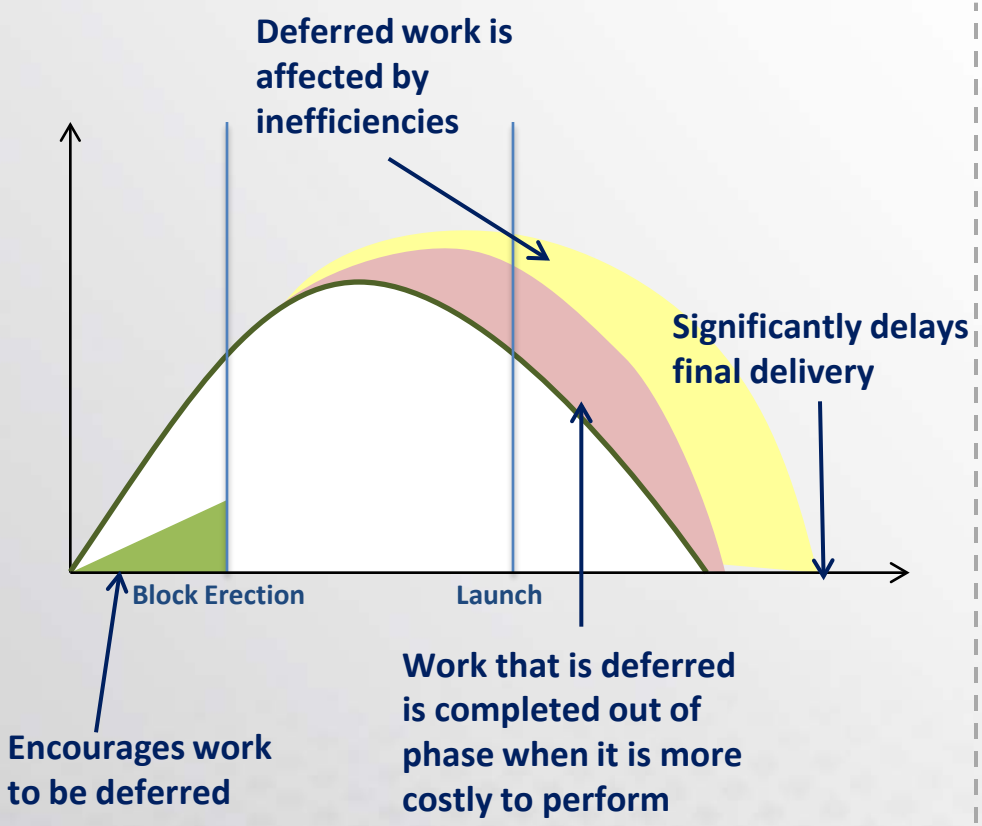


Resource constraints will also likely prevent completion of Phase II work, further prolonging delivery



Managing milestone dates can limit cost growth without significantly impacting final delivery dates

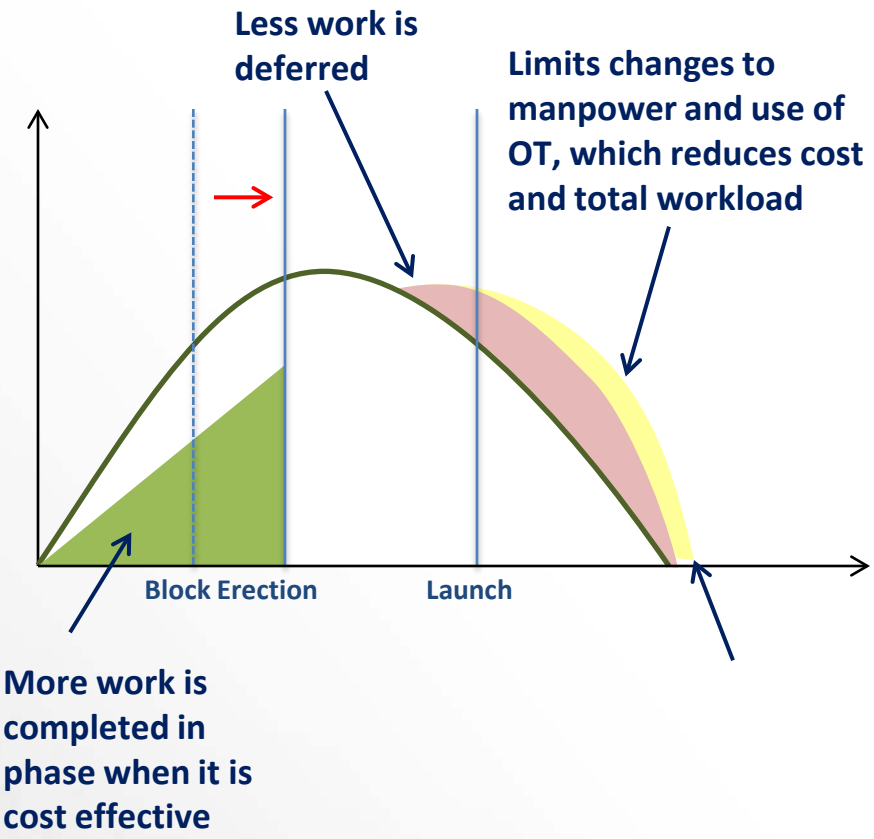
Fixed Schedule Milestones



- Late delivery and cost overruns come as a surprise due to optimistic assumptions

Vs.

Flexible Schedule Milestones



- Late delivery is expected and schedule changes represent a realistic and cost effective plan

Gold Card Formulas often fail to accurately project production EACs

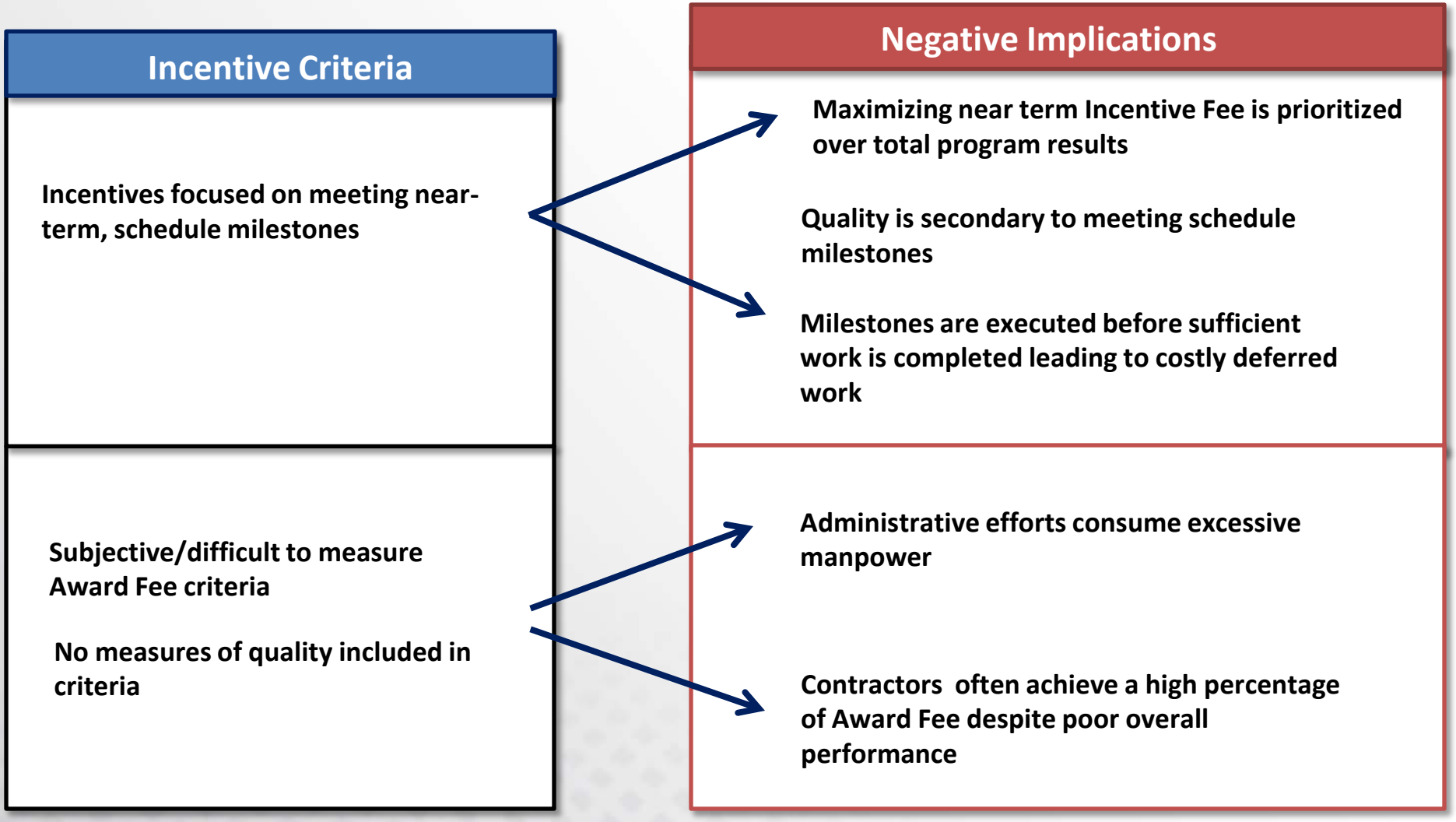
 # ESTIMATE @ COMPLETION (EAC) = Actuals to Date + [(Remaining Work) / (Performance Factor)]

$$EAC_{CPI} = ACWP_{CUM} + [(BAC - BCWP_{CUM}) / CPI_{CUM}]$$

$$EAC_{Composite} = ACWP_{CUM} + [(BAC - BCWP_{CUM}) / (CPI_{CUM} * SPI_{CUM})]$$

- EAC formulas rely on the use of past performance data to project future performance
  - Don't fully account for production inefficiencies that result from deferred work, overtime cost premiums / fatigue, and workaround plans
  - Early CPIs / SPIs are not as meaningful because many of the complex integration tasks have yet to be worked
  - Tasks are often "cherry picked", with difficult tasks being deferred to the last minute resulting in inflated CPIs
  - Rework is more costly later in the production build cycle
  - Progress or % complete is often overstated early in the build cycle, inflating BCWP

Incentive Fee Criteria often lead to behaviors that drive up production costs



Incentives can be improved by emphasizing end of contract cost, schedule, quality, and performance criteria

Incentive Criteria	Revised Incentive Approach
~~Incentives focused on meeting near-term, schedule milestones~~	Hold 80% of Incentive to the end of contract and tie it to objective cost, schedule, quality, and technical performance
Incentivize end of contract performance (i.e. results vice activity)	Base period incentives on successful completion of contract deliverables
~~Subjective/difficult to measure Award Fee criteria~~	Institute an objective scoring method that emphasizes cost, schedule, quality and/or technical performance
~~No measures of quality included in criteria~~	Aggregate/Objective Incentive Pool requires less administrative effort to manage
Objective incentive criteria utilizing an aggregate Award Fee pool	

Below is an example of objective incentive fee criteria as applied to a missile production program

Definitized Structure

- Simplified delivery decrements
  - For each week late, the available incentive fee was reduced
- Quality determined to be linked to Open Items
  - If one or more Open Items related to a Production deficiency existed, the available incentive fee would be reduced each week it was not satisfactorily addressed
  - For each Open Item related to a Development shortcoming, no reduction would be assessed
  - Required detailed plan for how Open Items would be determined

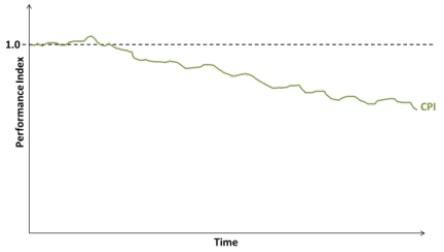
Negotiating Percentages

- Following delivery of a system and closure (or a plan for closure) of all Open Items, the Contractor would be entitled to an amount of the potential fee pool
- Determined that this pool would only be a portion of the profit for the Contractor
  - Contractor would still receive some amount of fee even if equipment is delivered late with Open Items
  - Contractor could still receive profit in the form of under-runs on the "Share Line"
- Percentages were not variable based on system design maturity

Near-term efforts can be balanced with long-term results by applying objective factors to a reserved "Incentive Pool"

Cost Factor

CPI based on original contract baseline + negotiated scope changes = 0.80

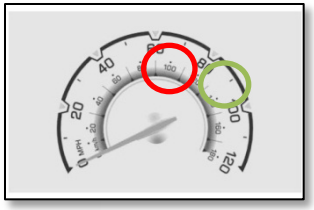


Schedule Factor

$$\frac{\text{(Planned Completion Date – Planned Start Date)}}{\text{(Actual Completion Date – Planned Start Date)}} = \frac{350\ \text{Days}}{390\ \text{Days}} = 0.89$$

Performance or Quality Factor

% of Key Performance Indicator Achieved = $\frac{60\ \text{Knots}}{80\ \text{Knots}} = 0.75$

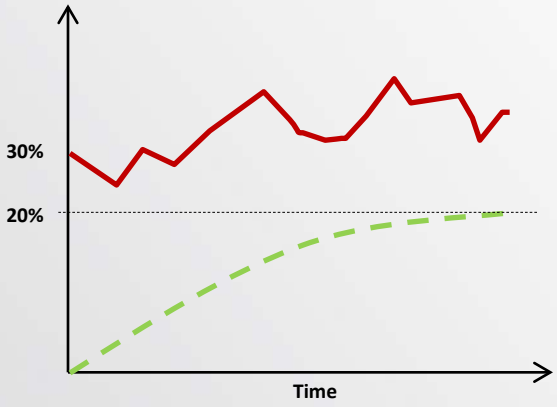


% of incentive that is awarded at end of contract

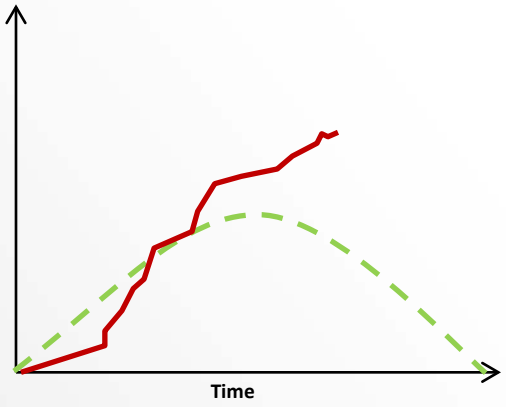
0.81 x ($10,000,000 x 80%) = $6,480,000

Several metrics are indicators of potential production cost growth that require management attention

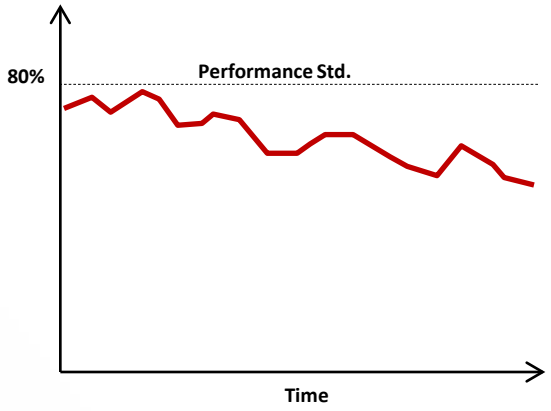
Actual OT vs. Plan



Manning Level vs. Plan



Productivity



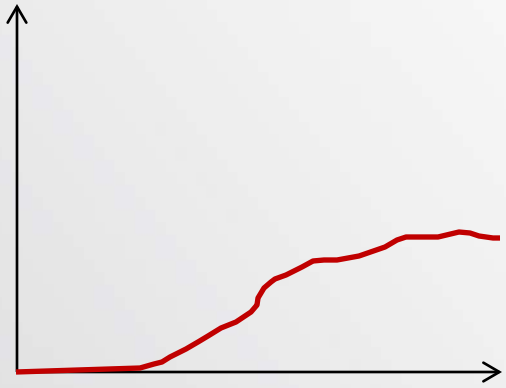
Excessive overtime
- Leads to worker fatigue and reduced productivity
- Indicates that the baseline and / or recovery plan is not realistic
- Could indicate a shortage of needed skillsets

Manning levels over Plan
- Causes Crowding
- Reduces Productivity
- Increases Supervision / Management costs

Productivity below Plan
- Indicates overly optimistic or unrealistic planning assumptions
- Often results from costly approaches to recover schedule

Several metrics are indicators of potential production cost growth that require management attention

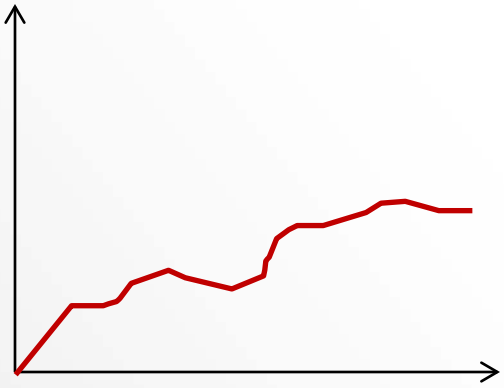
Deferred Work



Increasing Deferred Work

- Leads to costly inefficiencies later in build cycle
- High levels should call EACs into question
- Rarely measured but has a significant impact on downstream production cost

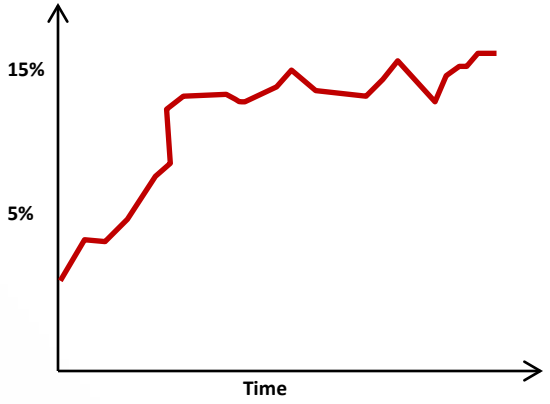
Engineering Changes



Engineering Changes

- Result in costly production disruptions
- Often require work-around plans or schedule delays to accommodate
- May warrant a production schedule delay to control costs

Defect Rate

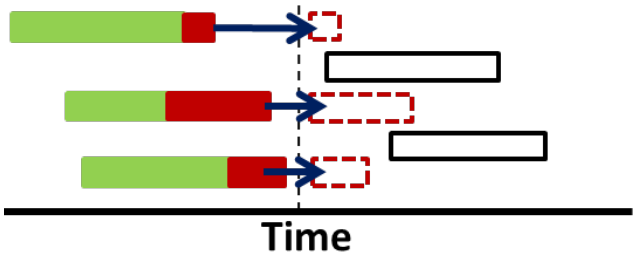


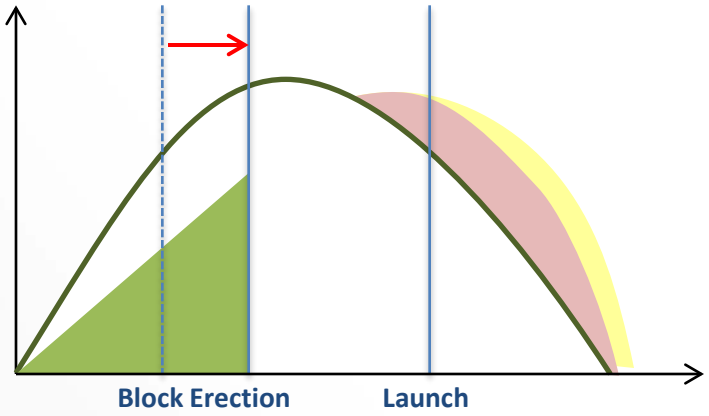
Defect Rates

- More costly later in the build cycle
- Often result from attempts to recover schedule
- May indicate schedule is too aggressive

Production Cost Lessons Learned Summary

- Techniques to recover schedule can lead to later schedule delays due to the increased workload associated with inefficiencies
- Program Managers need to closely monitor production metrics and adjust production schedules to control costs
- Revising the schedule early in the build cycle can reduce costs without dramatically impacting delivery dates
  - How much are we willing to pay to deliver 4 months late instead of 5 months late?
- Deferred work is rarely measured but may be one of the best predictors of production cost growth
- Incentivizing production milestones often increases deferred work and leads to cost growth
- Incentives should focus on end-results vice interim milestone achievement





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Questions?

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