



Labor Estimation and Trending in an Operations Environment

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FDF Overview

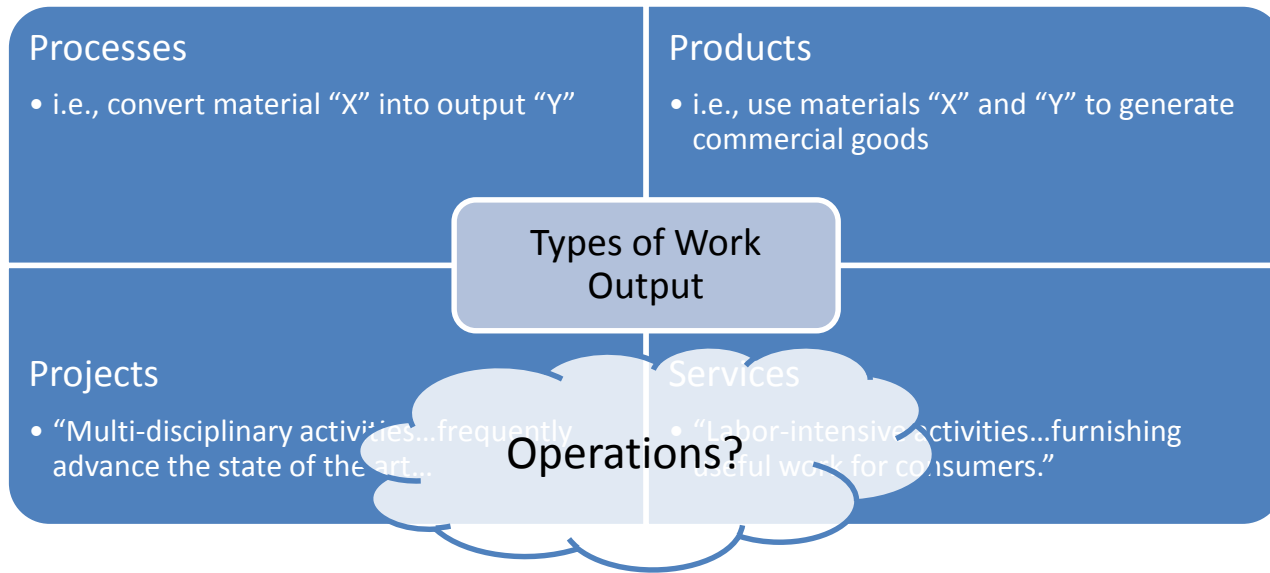
- ***The NASA Goddard Space Flight Center’s Flight Dynamics Facility (FDF) is an established multi-mission support facility that provides comprehensive flight dynamics services for space communications networks, science and exploration programs, and Launch Vehicle (LV) providers***
- ***Human Spaceflight (HSF) prelaunch analysis and real-time operational support for ISS and Visiting Vehicles (VVs):***
 - LV prelaunch analysis and real-time operational support
 - Generation of acquisition data for LV and ISS customers
- ***Navigation for on-orbit missions, during Launch and Early Orbit and Routine phases:***
 - Perform orbit determination (OD) and prediction using commercial and in-house tools
 - Can include predicted maneuver modeling
 - Provide routine acquisition data, scheduling, and orbit events reports derived from OD and predictions

- ***Accurate cost estimation is important...***
 - Too low, and there might not be adequate resources to complete a task
 - Too high, and the proposed work might be cost-prohibitive to the customer
 - Both low and high estimates could also contribute to an unsustainable business model
- ***...challenging...***
 - Requires a broad understanding of the work to be performed, covering input from all contributors
 - Dependent on accuracy of assumptions
 - “Full picture” may not be available from customer, leading to iterative approach
 - Needs to be repeatable and defensible
- ***...and beneficial.***
 - Serves as a gateway to planning in general
 - Identifies resources and tools necessary to perform work
 - Helps identify improvements to productivity

Stewart, R. D. (1991). Why Cost Estimating? In *Cost Estimating, 2nd Edition*. New York, NY: John Wiley & Sons.

Nuances from Operations

- ***Operations support in particular provides additional challenges for estimating cost.***



- Unlike manufacturing-based work, it may be difficult to derive a "cost per product"
- Mission supports that appear to be similar may have drastically different underlying assumptions
- For critical operations, a certain level of adaptability to changing circumstances is expected
 - Responding to contingencies or anomalies requires additional support and troubleshooting, and could result in increases to overall cost

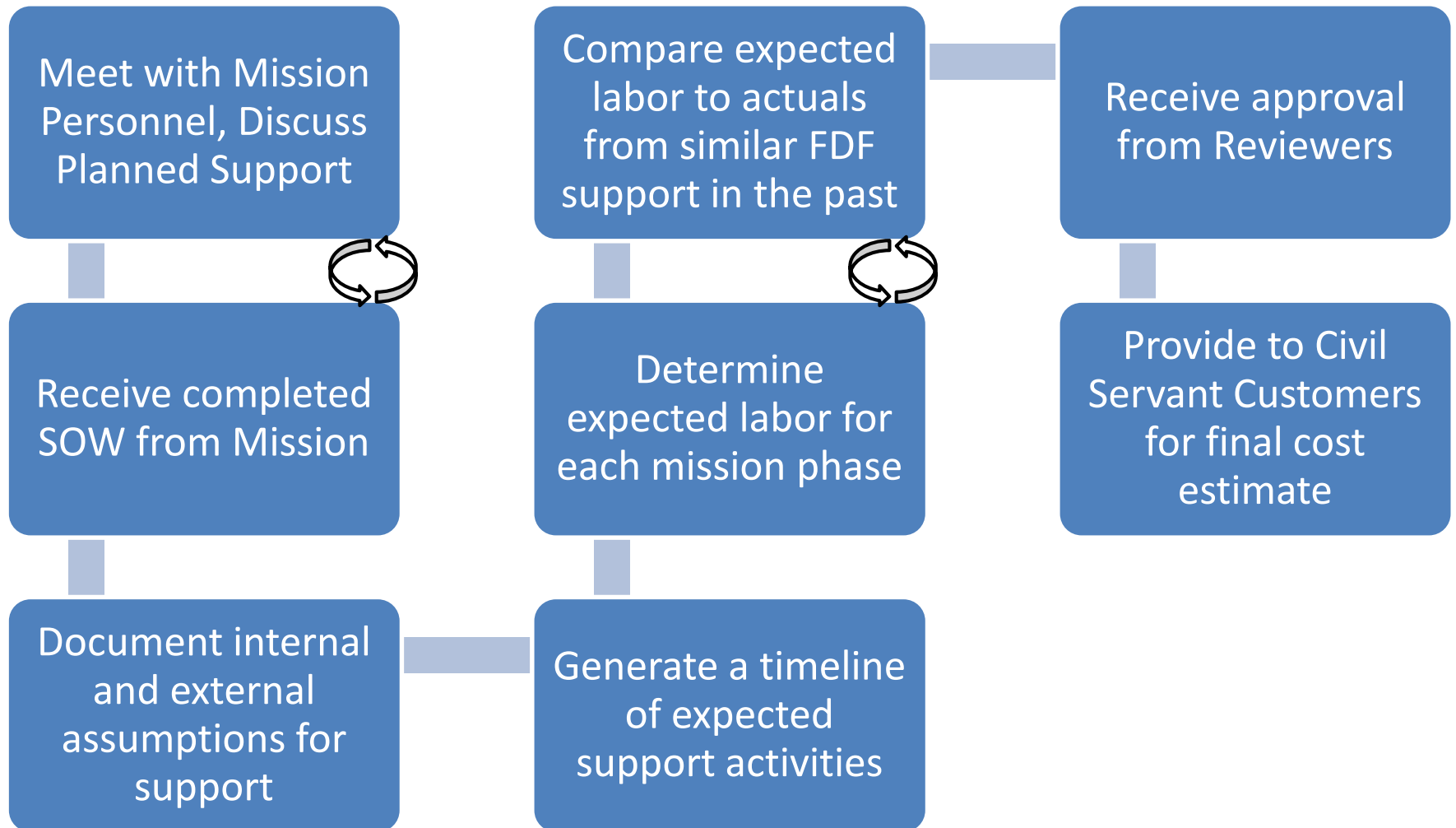
Stewart, R. D. (1991). The Basics of Estimating. In *Cost Estimating, 2nd Edition*. New York, NY: John Wiley & Sons.



Labor: Key Driver

- ***Labor estimation is one of the most important inputs for estimating the cost of operations-based work, especially in a pre-established facility***
 - “Other Direct Costs” (ODCs) and shared development efforts in a multi-mission support facility can be applied as a shared overhead cost
 - Workstations
 - Physical facility space
 - Shared software licenses
 - Common software development efforts
 - The labor associated with mission support is a unique input, defined by the needs of the mission itself

Labor Estimate Process: Overview





Statement of Work

- ***SOW is typically the first documented agreement with the mission***
 - Should be kept up-to-date as expectations change, but this is not always possible
- ***Covers high-level work to be performed***
- ***Typically includes support by mission phase:***

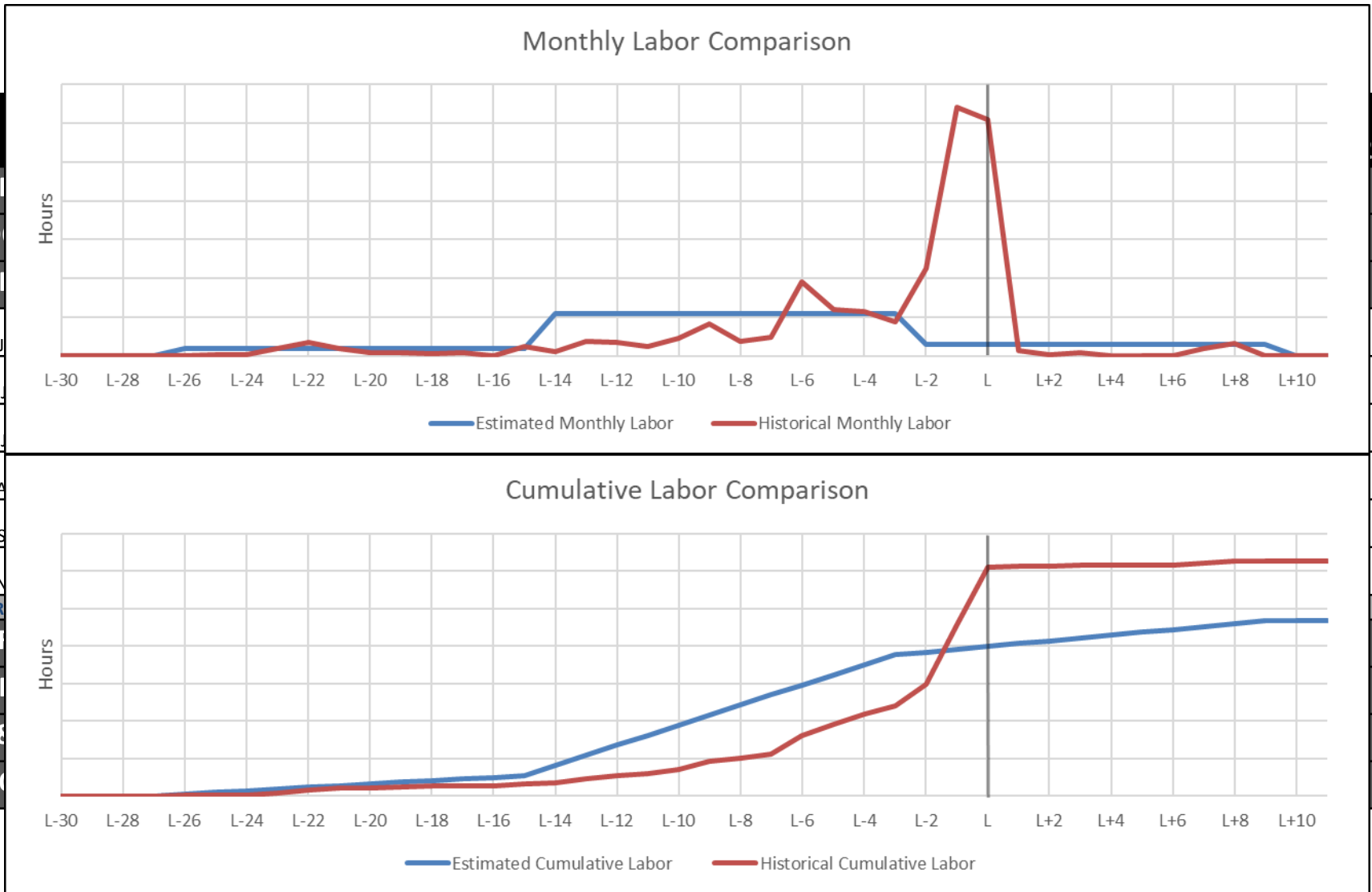
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| <ul style="list-style-type: none">• <i>Introduction</i><ul style="list-style-type: none">– Mission Overview– Operations Concept• <i>Development Support</i><ul style="list-style-type: none">– Pre-mission Support Milestones– Meetings– Documentation– Analysis– Interfaces– Tracking Station Certification | <ul style="list-style-type: none">• <i>Operational Support</i><ul style="list-style-type: none">– LEOP Support and Products<ul style="list-style-type: none">• Maneuver Support– Nominal Operations Support and Products<ul style="list-style-type: none">• Maneuver Support– Contingency Support and Products• <i>Decommissioning</i><ul style="list-style-type: none">– Decommissioning Plan– Analysis– Operations Support and Products– Maneuver Support• <i>Any Additional Support</i> |
|---|--|



Estimation Example: Bottom-Up

ASSUMPTION	HRS	STAFF	FREQ/ YR	TOTAL/ YR	FY17	FY18	FY19	FY20	FY21
PRE-MISSION COORDINATION EFFORTS									
DOCUMENTATION									
PRE-LAUNCH INTERNAL ACTIVITIES									
TRAINING									
PRE-LAUNCH SUPPORT									
L&EO SUPPORT									
POST-EARLY-ORBIT SUPPORT									

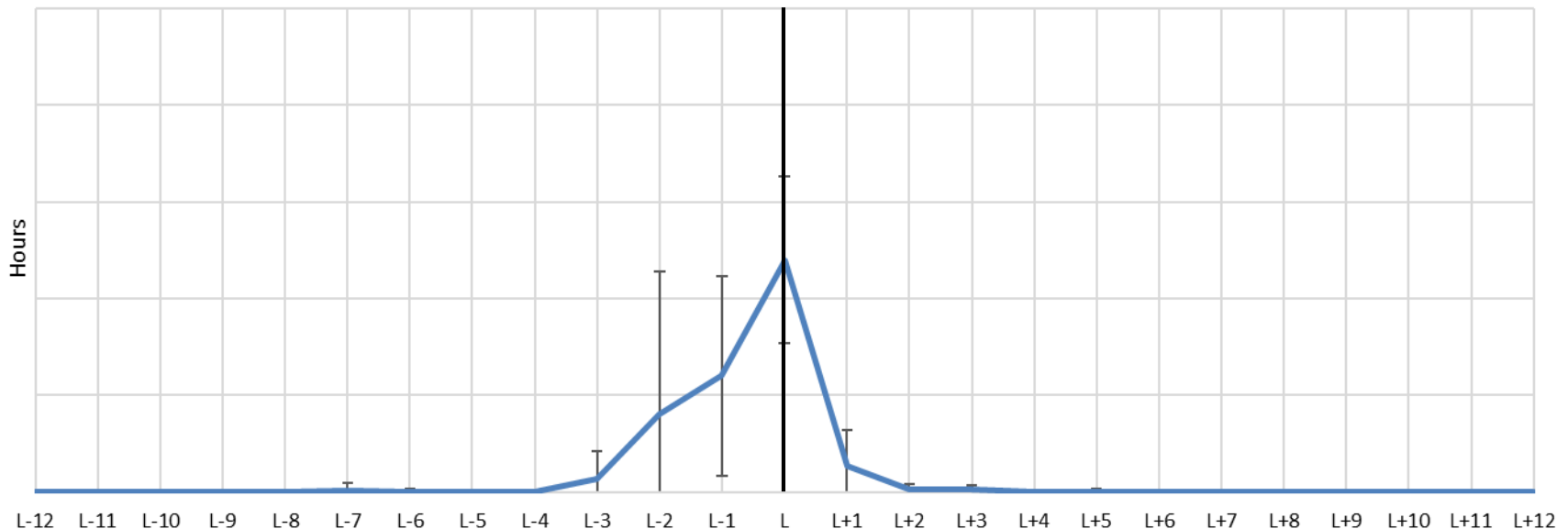
Estimation Example: Bottom-Up



Estimation Example: Top-Down/Parametric

- **Once there is an understanding of the average support profile for a given launch vehicle, a yearlong profile can be generated**
 - Given “X” Delta launches, “Y” Atlas launches, etc... per year, an overall labor profile can show the total labor needed
 - Estimated dates for launch can show how labor will fluctuate over the course of the year

Average Labor Profile





Typical Estimation Challenges

- ***Customer may not know what exact flight dynamics support is needed for a given mission***
 - Additional conversations needed to refine assumptions
- ***Customer may need Labor Estimate with very short notice, sometimes only a few days***
 - Emphasizes the need for templates and historical trending
- ***Similar mission support may not be available for comparisons***
 - Complete and detailed documentation of assumptions is always important
- ***Long View Labor Estimates***
 - Many unknowns, including requirements
 - Typically significant launch slips (multi-year, in some cases)
 - Harder to project capabilities with longer lead time
- ***In ALL cases, iteration and updates in response to new information is critical for keeping labor estimates accurate***

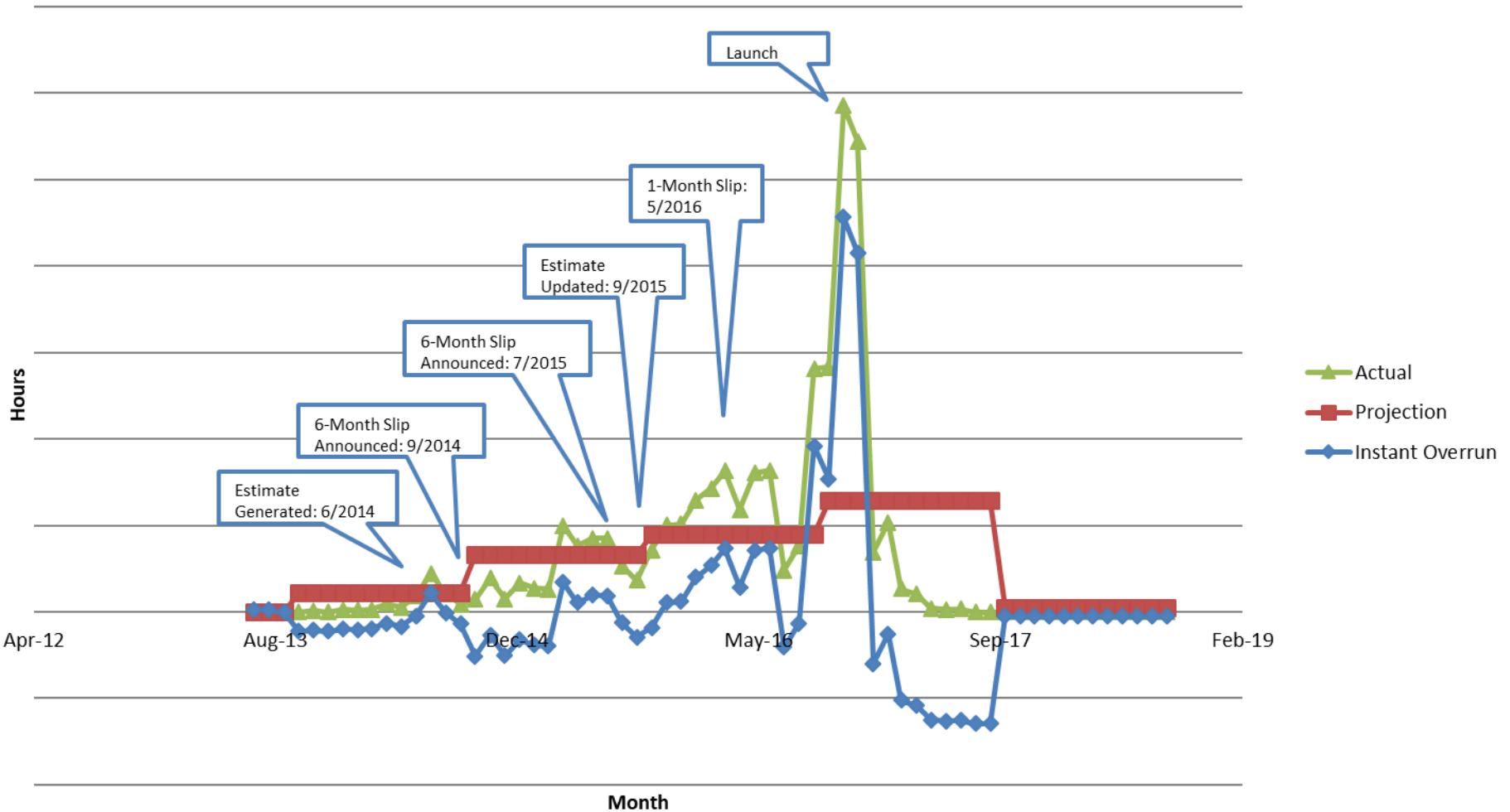


Quarterly Tracking

- ***Once labor has been estimated, routine monitoring becomes important to stay abreast of drivers that may change the overall cost***
- ***Each month, actual hours charged are received and trended against the most recent estimate of labor for the mission***
- ***“Apples to apples” comparison:***
 - If estimate was only for Navigation Operations, only Navigation Operations charge codes are examined
 - If estimate accounted for software development support, then Navigation Operations and Software charge codes are examined
- ***Information presented quarterly to Civil Servant Customers***
 - Context is provided showing drivers for change in the estimate
 - Recommendations are provided, regarding the potential need for updates

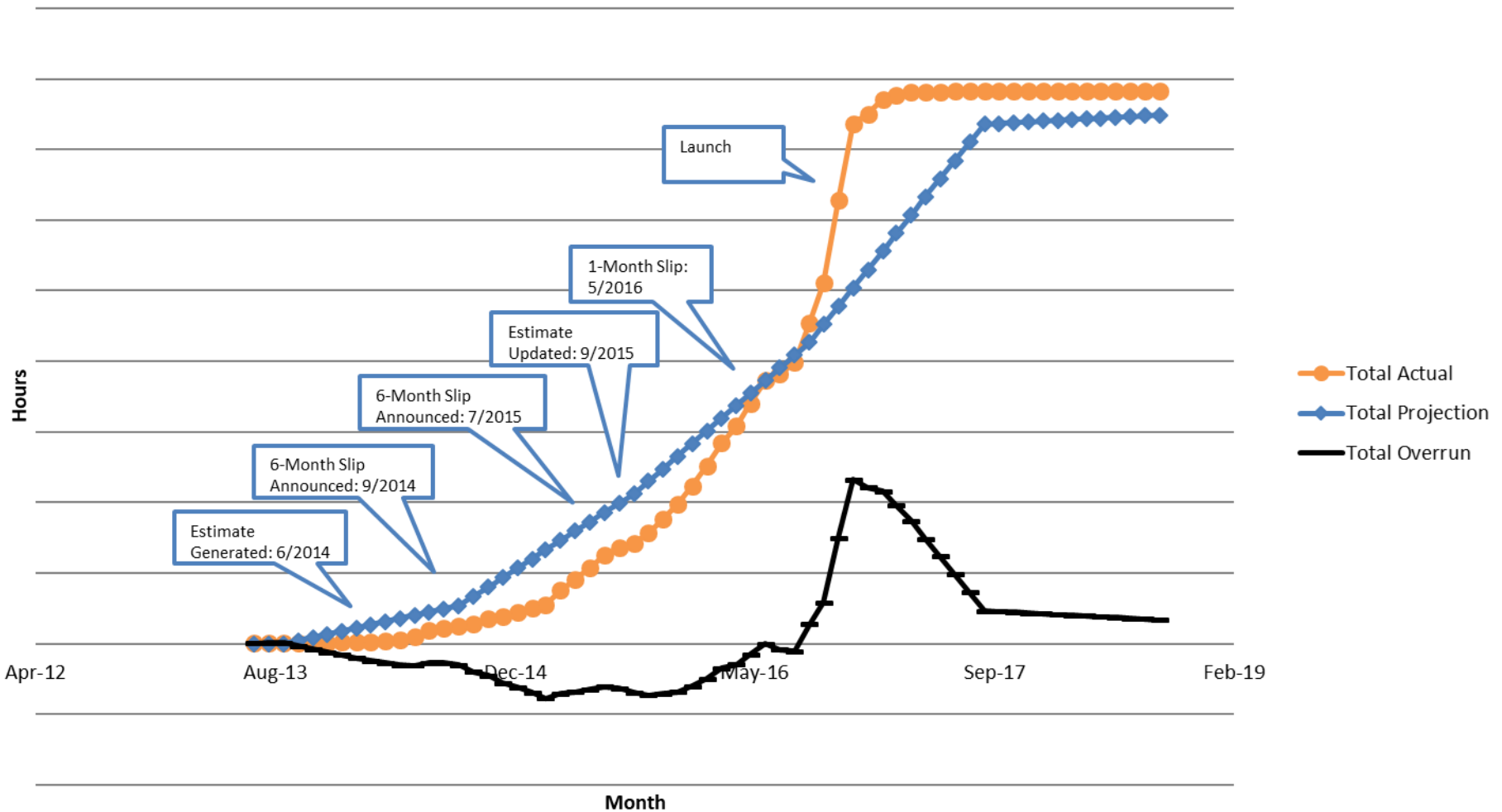
Example Trending

Actuals vs. Projection



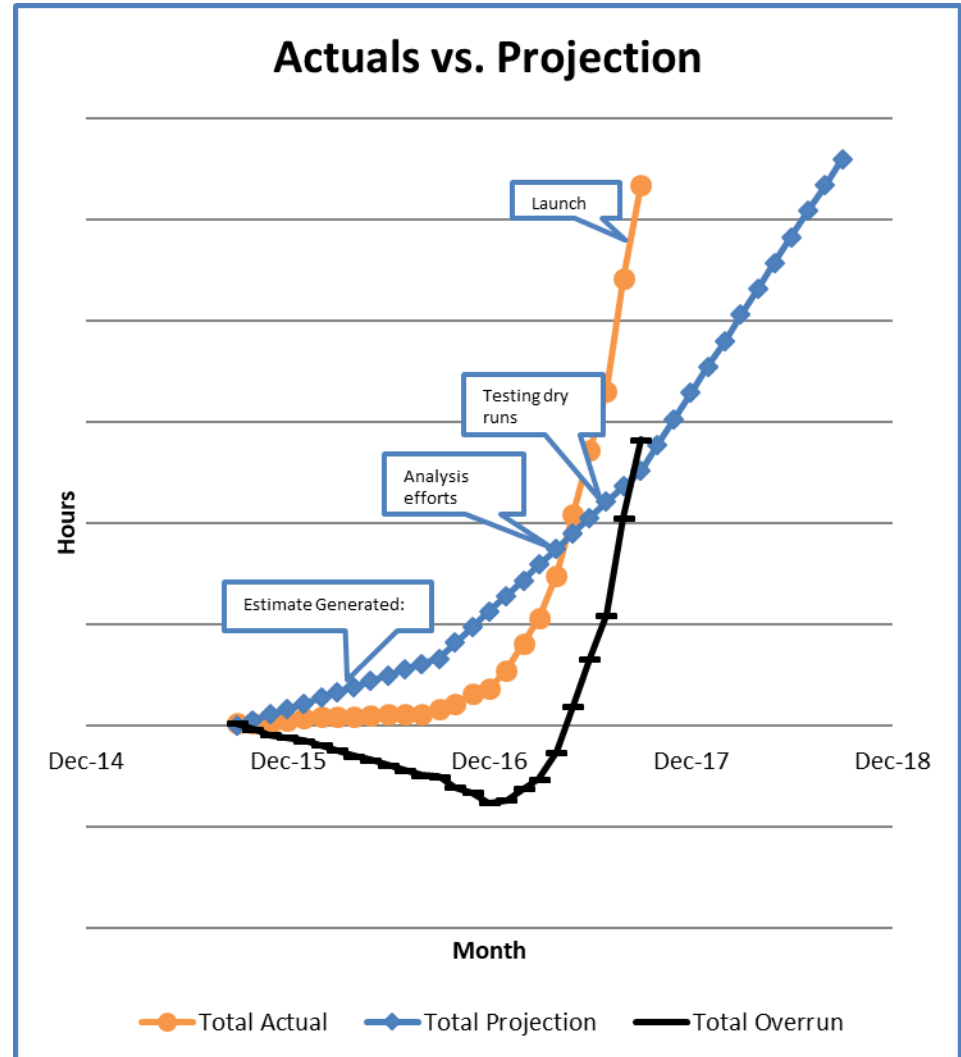
Example Trending

Total Actual vs. Projected



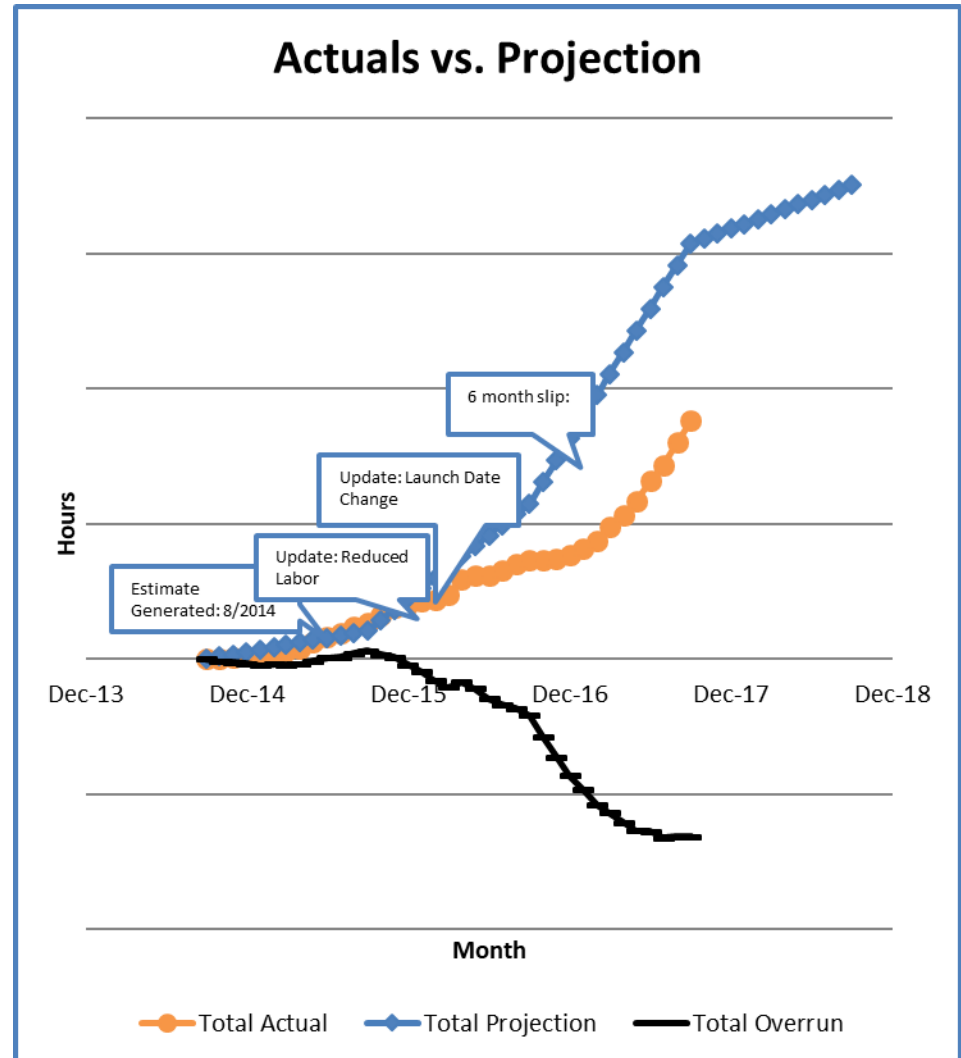
Example Trending: “Hot” Case

- *Running slightly “hot” due to extensive analysis requests not originally included in labor estimate and assumptions*
- **Lessons:**
 - Constant communication and iterations based on new information are always important



Example Trending: “Cold” Case

- **Due to launch slips, mission support followed closely behind a similar support earlier in the year**
 - Same team providing support, resulted in lower effort for training
 - Similarities in support resulted in reuse of support tools and scripts, resulting in lower effort for setup
- **Lessons:**
 - While launch slips extend the time before launch, resulting in increased labor for recurring activities, “convergence” can result in reduced overall labor
 - Repeatability can significantly impact accuracy of estimation





Learning and Refining

- ***After support is complete, review of the labor expended over time becomes useful for the generation of future labor estimates***
 - How has the actual support differed from the assumptions in the estimate?
 - How have external drivers impacted the way in which support was provided?
 - Was less effort needed to complete the same tasks? Have innovations in support reduced overall effort?
 - Are there any overall/general trends that need to be incorporated into future labor estimates?
 - Different effort associated with different networks?
- ***The more estimates we can generate and evaluate, the more accurate the estimates should be***

Questions?





Acronyms

- ***FDF: Flight Dynamics Facility***
- ***ISS: International Space Station***
- ***LV: Launch Vehicle***
- ***OD: Orbit Determination***
- ***ODC: Other Direct Cost***
- ***VV: Visiting Vehicle***



References

- ***Stewart, R. D. (1991). Cost Estimating, 2nd Edition. New York, NY: John Wiley & Sons.***