PERCEPTION® WORK-PAC

Reports

Labor Cost & Work Progress

A Training Guide
This training guide is a supplement to the user manual entitled “PERCEPTION WORK-PAC Labor/Manpower Planning & Cost/Schedule Management,” which provides more details for the user.

Before using this tutorial, the user should first view the PERCEPTION preliminary training tutorial, “Getting Started.”
Other related training tutorials are the following:

1. **PERCEPTION WORK-PAC - Starting From Scratch**
2. **PERCEPTION - Starting A New Project**
3. **PERCEPTION WORK-PAC Work Orders**
4. **PERCEPTION WORK-PAC Manpower Planning & Forecasting**
Training Directory

- Continue
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- Rollups
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- COA
- Trades
- CLINs

- Graphic Reports
- Tracking Costs
- Tracking Progress
- Schedule Variances
- Budget Variances
- Cost vs. Progress
- Manpower
- Work Order Listings
- Performance vs. Estimate
- What To Look for
This tutorial outlines a selection of the labor cost and schedule performance reports that have proved to be the most valuable for managing projects.

These reports provide management with the cost and schedule performance visibility necessary to maintain project budgets and planned schedules.
Tracking & Managing Costs and Schedules

*PERCEPTION* tracks the following cost and schedule information:

- Labor Hours
- Labor Dollars
- Overhead Dollars
- Material Dollars
- Purchased Services
- Total Dollars
In addition, *PERCEPTION* measures and tracks the following:

- Labor Hours per 1% Progress
- Production Process Rates by Stage of Construction
- Weeks Ahead/Behind Planned Schedules
- Trend Weeks Ahead/Behind for 100% Progress
- Forecast & Trend Over-Run/Under-Run
PERCEPTION further tracks different phases of costs and schedules:

- Original Estimated Costs & Schedules
- Baseline Costs & Schedules
- Current Budget Costs & Planned Schedules
- Management Reserves
- Actual Labor Costs & Schedules
- Rework
- Change Orders
Costs and schedules can be summarized by several different project work breakdown structures (WBS) simultaneously:

- By Systems Work Breakdown Structure (SWBS)
- By Product Work Breakdown Structure (PWBS)
- By Shipyard Organization (COA)
- By Contract Line Item (CLIN)
The details of labor cost and schedule information at any level of the project WBS can be viewed on-line by drilling down from the WBS level’s worksheet.

<table>
<thead>
<tr>
<th>Contract</th>
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</tr>
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<tr>
<td>TSHIP CONTRACT</td>
<td>Severn Bulk Carrier (work orders)</td>
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<tr>
<th>Details</th>
<th>Material Status</th>
<th>Overall Status</th>
<th>Indexes</th>
<th>Variances</th>
<th>Notes</th>
<th>Baseline</th>
<th>Options</th>
<th>Milestones</th>
<th>Characteristics</th>
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<table>
<thead>
<tr>
<th>Man-Hours</th>
<th>Rate/Hour</th>
<th>Labor Cost</th>
<th>Budgeted Cost of Work Performed</th>
<th>Budgeted Cost</th>
<th>Estimated at Completion</th>
<th>Reserves</th>
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<td>660,706</td>
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<td>984,817</td>
<td>38522.00</td>
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**Budget + Reserves**

<table>
<thead>
<tr>
<th>Less EAC</th>
<th>Less Rework</th>
<th>Labor Margin</th>
<th>Estimated Remaining Labor</th>
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<tr>
<td>984,817</td>
<td>8,503</td>
<td>113,200</td>
<td>324,111</td>
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<td>19,916,474</td>
<td>16,916,054</td>
<td>147,150</td>
<td>5,453,179</td>
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**Start Date** 09/12/991, **Finish Date** 09/17/993

<table>
<thead>
<tr>
<th>Total Progress</th>
<th>Total Planned</th>
<th>Total Manual</th>
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<tr>
<td>68.04%</td>
<td>68.66%</td>
<td>58.48%</td>
</tr>
<tr>
<td>(Closed 58.40%</td>
<td>(Behind 0.62%</td>
<td>(Behind -0.33% weeks)</td>
</tr>
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</table>

**Number of Work Packages**: 2181

**Budgeted Hours**: 1,018,212.00

**NOTE**: Rework included in ACWP and EAC
An overall status of labor, overhead and material cost status also is available on-line.
Labor Performance Reporting

*PERCEPTION* produces many excellent high-level status and tracking reports.

These reports provide the project manager with the visibility and status of labor costs and schedules. **These reports quickly identify problem areas of costs and schedules.**

The quicker someone recognizes the problems, the sooner they can be resolved and any damage to costs and schedules minimized.
Production Rollups

Most labor cost and schedule performance reports require that a *Production Rollup* be performed prior to users generating updated reports.

The project manager should be responsible for ensuring that rollups are performed regularly and be the basis for any reports issued to management.
The project manager should produce quality labor status and forecast reports to management weekly…without fail:

1. Top level tracking graphics reports
2. Project WBS progress and labor cost reports
3. Project WBS reports for material status
4. Current project manpower planned, versus actual versus forecast to complete.
5. Work Order Listings

And, to compliment these reports, a brief overview of identifiable problems and enacted/recommended solutions.
WBS Performance Reports

This function of tracking and managing requires accurate and timely feedback of costs and schedules which can be measured against a baseline of budgets and planned schedules.

*PERCEPTION* can produce a wide variety of reports that provide visibility of project performance at different levels of detail.
Most modern shipyards manage their costs by way of the project Work Breakdown Structure (WBS).

The WBS summarizes cost and schedule information in various categories and provides a high level view of a project’s performance.

The WBS is an ideal means for identifying areas of a project that may require special management attention to resolve problems that may be adversely impacting budgets and planned schedules.
Possible Contract Work Breakdown Structures

- PWBS:
  - Ship Zones
  - Outfit Zones
  - Grand Blocks
  - Units
  - Blocks
  - Assemblies
  - Sub-Assemblies
  - Mfg Parts

- SWBS:
  - SWBS Groups
  - Ship Systems

- COA:
  - Departments
  - Stages
  - Work Stations

CLINs:
- Contract Line Items

Option to select WBS for Project Roll-Up

A work order may relate to multiple WBS's.

A work order planned to reference more than one element of any WBS may be setup as a Distributed Work Order.
Multi-Ship Program Management
Cost & Schedule Consolidation
For any level of the project’s WBS, *PERCEPTION* summarizes cost and schedule performance:

- BAC: Budget At Completion
- MR: Management Reserves
- BCWS: Budgeted Cost of Work Scheduled
- BCWP: Budgeted Cost of Work Performed
- ACWP: Actual Cost of Work Performed
- EAC: Estimated Cost At Completion
- EAC Trend for 100% Progress
- Planned & Actual Progress
- Calendar Schedule Variance
- Calendar Variance Trend for 100% Progress
A popular WBS is the Ship Systems Work Breakdown Structure (SWBS).

While almost every shipyard has its own version of SWBS, this WBS typically catalogs costs under categories that identify the major engineered ship systems.

Examples of SWBS systems include ship structures, piping systems, electrical, HVAC, etc.
System Work Breakdown Structure (SWBS)
SWBS Summary Progress Reports Available At Group and Account Levels.

Critical Information: Weeks Ahead (or behind), Scheduled Hours Ahead (or behind) & Labor Hours EAC
The SWBS Summary Progress reports provide the following status information:

1. % progress (planned, actual, & current variance from planned)
2. Weeks ahead or behind schedule
3. Current budget hours earned from labor hours charged (BCWP)
4. Current budget hours scheduled as planned (BCWS)
5. Current actual hours charged (ACWP)
6. Current budget hours ahead or behind planned schedule (BCWP-BCWS)
7. Total labor hours budget (BAC)
8. Estimated labor hours at completion (EAC)
9. Estimated labor hours to complete (ETC)
10. Estimated total labor hours savings (BAC – EAC)
PERCEPTION determines WBS level performance from work order performance.
Labor hour performance can be tracked throughout the course of the project’s schedule.

The management tracking graphics report plots the following costs (labor hours):

1. Total WBS level budget (BAC)
2. Estimated total costs at completion (EAC)
3. Actual costs (ACWP)
4. Earned value (BCWP)
5. Time-phased budget plan (BCWS)
If the EAC rises higher than the BAC, then the system is predicting a final cost over-run.

If the earned value (BCWP) is lower than the planned budget plan (BCWS), then the system is estimating that the work is being performed behind planned schedules.

If the actual costs (ACWP) spent is higher than the earned value (BCWP), then the work is over-running its budgets.
The two more important pieces of information for the project manager to monitor are the following:

1. **Current weeks ahead or behind schedule**

2. **Current budget ahead or behind schedule**

3. **Current estimated labor hours at completion (as compared to the total budget)**
PERCEPTION determines the number of weeks ahead or behind schedule from its assessment of progress from work order budget and schedule performance.

PERCEPTION determines the estimated labor hours at completion (EAC) from its assessment of work order budget performance.
Measuring Progress

*PERCEPTION* allows manual progress assessments to be entered against work orders.

*PERCEPTION* also measure progress automatically. Its method is very accurate, and is uniquely objective.
To determine automated progress, the system collects work orders within the given Level of the WBS into three groups:

1. Completed Work Orders

2. In-Process Work Orders

3. Un-Started Work Orders (Including WBS Budget Not Yet Assigned To Work Orders)
Actual progress includes progress achieved from both completed work orders and from in-process work orders.

Actual progress lies between a minimum progress achieved from completed work orders & maximum progress achieve if all in-process work orders were completed as well.
Minimum Progress =

\[
\frac{\text{Total Budget of Completed Work Orders}}{\text{Total Budget for WBS Level}}
\]

Maximum Progress =

\[
\frac{\text{Total Budget of Completed Plus In-Process Work Orders}}{\text{Total Budget for WBS LEVEL}}
\]
SCHEDULE

BUDGET LABOR HOURS

TOTAL BUDGET

100%

PLANNED PROGRESS

0

SCHEDULE

Maximum Earned Value. Maximum Possible Progress

Minimum Earned Value. Minimum Possible Progress

Completed Work Orders

In-Process Work Orders

Un-Started Work Orders

Actual Labor Charges

Minimum Earned Value. Minimum Possible Progress

Maximum Earned Value. Maximum Possible Progress

Completed Work Orders

In-Process Work Orders

Un-Started Work Orders
Total WBS Level Progress

\[ BH_{\text{completed}} + BH_{\text{earned in-process}} \]

Total WBS Level Budget Hours

Where \( BH_{\text{completed}} \) is the sum of budget hours of completed work orders, and

Where \( BH_{\text{earned in-process}} \) is the sum of earned budget hours of in-process work orders (started, but not yet completed).
The earned value of completed work orders is easy to determine.

It is the total budget of completed work orders
The earned value of in-process work orders is not so easy to determine.

Manual methods require a physical assessment of progress of the in-process work orders.
The manual method of determining earned value of the in-process work orders

= Sum [Manual Progress x Work Order Budget]
PERCEPTION uses another method:

The assessment of in-process work order progress based on the actual labor hours spent and how well work orders are keeping to budgets.
The total WBS level progress is determined from the estimated total labor hour at completion (EAC).

*PERCEPTION* uses a method for estimating final total costs (EAC) that has a well-documented track record for being both accurate and consistent.

This method is totally objective.
For example, if work orders are keeping to budgets, every hour spent earns an hour of budget.

This earned value of budget, then is equivalent to earning progress at the percentage rate of the total budget.
However, if the work orders are not performing to budget, *PERCEPTION* will adjust the earned value of budget depending on how far the work orders are performing off budget.
If work orders are performing over budget, the system will not give full credit for earned value of budget by the actual hours spent. Progress for this case will be less than planned.

If work orders are performing under budget, the system will provide more credit of earned budget. Progress for this case will be more than planned.
**PERCEPTION** computes budget variance (over-runs and under-runs), and uses this variance as a measure of what should be expected overall at the completion of the WBS level (i.e., the WBS level’s EAC).

However, this measure is not strictly a direct application of the variance. The measure also takes into account how far into the scope of work the variance has been recorded.
PERCEPTION does not emphasize the impact of early variances upon EAC. As more and more of the scope of work is completed (i.e., as progress advances), the more impact this variance begins to have upon the EAC.

PERCEPTION uses a progress factor to forecast the EAC variance.
PERCEPTION applies the progress factor for EAC. As work orders are completed, the system better learns the extent of cost variance for these work orders.

\[ EAC = BAC + \text{Factor} \times \left[ \text{Variance}_{\text{completed w/os}} + \text{Adjustments}_{\text{in-progress w/os}} \right] \]
As progress advances, PERCEPTION places greater emphasis on recorded budget variance for the EAC.
Example

Completed work orders have over-run their budgets by an overall 35%.

Completed work orders represent 40% of the total WBS Level progress. At this level of progress, the variance progress factor is 0.65 (from preceding curves).

The forecast EAC variance = 35% x 0.65 = 22.75%

\[ \text{EAC} = \text{BAC} \times [1.0 + 22.75\%] \]

**BAC is the Budget At Completion for the WBS Level.**
This factoring process assumes management has the ability to implement some level of corrective actions for remaining work to keep them from over-running their budgets.

Earlier in progress, the system assumes that management has more opportunities to get costs back towards budget.

Later in progress, the system assumes that management has fewer opportunities to get work back towards budget.
The progress factors hit harder for conditions of cost over-runs than for cost under-runs.

Hence, two separate factors are used by the system.
PERCEPTION makes adjustments for special conditions such as in-process work orders significantly over-running more than completed work orders, etc.
Measuring Progress

From EAC and ACWP, $\textit{PERCEPTION}$ computes actual progress:

$$\text{Progress} = 100 \times (\text{ACWP}/\text{EAC})$$
Measuring Earned Value

From Progress and BAC, PERCEPTION computes earned value, BCWP:

$$BCWP = \frac{[\text{Progress} \times \text{BAC}]}{100}$$
For SWBS, each SWBS Account is assessed individually from the performance of work orders cataloged under the SWBS Account.

The performance of a SWBS Group is determined as the summation of the performances of its SWBS Accounts.
If the project has been set using SWBS as the primary WBS, the overall project’s performance assessment is the summation of SWBS Group performances.

Refer to the project’s DETAIL information and the Options tab window where the project’s primary WBS may be selected.
A variety of SWBS (Level 2) progress and cost/schedule status reports.

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### Chesapeake Marine Industries

**SWBS Group Progress Report (PROG02)**

<table>
<thead>
<tr>
<th>Project</th>
<th>Description</th>
<th>Percent Progress</th>
<th>Current Labor Hours</th>
<th>Final Hours</th>
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<tbody>
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<td></td>
<td></td>
<td>Planned</td>
<td>Actual</td>
<td>Ahead</td>
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<td>Steelwork</td>
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<td>67.93</td>
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<td>1</td>
<td>Accommodation Outfit</td>
<td>85.10</td>
<td>85.34</td>
<td>7.24</td>
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<tr>
<td>2</td>
<td>Cargo Systems Outfit</td>
<td>14.07</td>
<td>26.00</td>
<td>11.93</td>
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<tr>
<td>3</td>
<td>Mechanical Systems Outfit</td>
<td>60.60</td>
<td>64.47</td>
<td>13.87</td>
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<td>4</td>
<td>Piping Systems</td>
<td>33.91</td>
<td>32.92</td>
<td>-0.99</td>
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<td>5</td>
<td>Machinery Systems</td>
<td>52.19</td>
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<td>6</td>
<td>Electrical Systems</td>
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<td>7</td>
<td>Production Services</td>
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<td>8</td>
<td>Owner Changes</td>
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<td>62.95</td>
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<td>9</td>
<td>Design &amp; Drawing</td>
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<td></td>
<td>Group Totals for Project - 2002</td>
<td>65.37</td>
<td>67.93</td>
<td>2.57</td>
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</table>
Other Project Work Breakdown Structures

*PERCEPTION* is capable of tracking cost and schedule performance by other work breakdown structures besides SWBS:

1. Product Work Breakdown Structure (PWBS)
2. Chart of Accounts (COA) of Shipyard Work Centers
3. Contract Line Items (CLINs) that identify ship owner’s WBS.
PWBS

Product-Oriented Work Breakdown Structure (PWBS) is used to plan and collect labor costs by production interim products and stage of construction.

PWBS allows the shipyard to organize and manage labor efforts more efficiently utilizing modern shipbuilding methods:

1. Pre-Outfitted Hull Block Construction
2. Modular Construction
3. Zone Outfit
PWBS is a WBS that often uses 2-3 levels below the project, but may be extended to 6.

PWBS may be used only where they provide a benefit to the estimating and/or management functions.

Each level of the PWBS can be given an alphanumeric identification (maximum 8 characters).
Product/Process Work Breakdown Structure (PWBS)

- Ship
  - Ship Zones
  - Outfit Zones & Grand Blocks
  - Blocks & Units
  - Assembly
  - Sub Assembly
  - Manufactured Parts

Product Cost Management
Process Cost Management
A variety of PWBS progress and cost/schedule status reports.

<table>
<thead>
<tr>
<th>Project</th>
<th>Percent Progress</th>
<th>Current Labor Hours</th>
<th>Final Hours</th>
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<td>34.49</td>
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<td>13.12</td>
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<td>62.61</td>
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<td>-25.75</td>
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<td>41.06</td>
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<td>38</td>
<td>0.00</td>
<td>32.33</td>
<td>-19.31</td>
</tr>
</tbody>
</table>
Chart of Accounts (COA) may be used to identify shipyard production processes and work centers.

COA is a WBS that can extend down 3 levels below the project.
Chart of Accounts (COA)
Names for the COA levels can be changed by clicking on *Library/Company Parameters* in the main menu and then opening the *Set COA Names* tab window.
A variety of COA progress and cost/schedule status reports.

**WORK-PAC Center Progress Report (PROG14)**

**Labor Hours**

<table>
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<tr>
<th>Work Center</th>
<th>Description</th>
<th>Percent Progress</th>
<th>Weeks Ahead</th>
<th>% Diff</th>
<th>Current Labor Hours</th>
<th>Final Hours</th>
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<tbody>
<tr>
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<td></td>
<td>Planned</td>
<td>Actual</td>
<td>BCWS</td>
<td>BCWP</td>
<td>Actual</td>
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<td>T01 Steel Fabrication</td>
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<td>89.67</td>
<td>-538</td>
<td>-10.43</td>
<td>70,081</td>
<td>62,772</td>
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<tr>
<td>T02 Steel Assembly</td>
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<td>100.00</td>
<td>13</td>
<td>0.00</td>
<td>198,500</td>
<td>196,560</td>
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<tr>
<td>T03 Steel Erection</td>
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<td>-1.11</td>
<td>64,914</td>
<td>64,193</td>
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<td>94.21</td>
<td>-534</td>
<td>-5.79</td>
<td>93,306</td>
<td>56,465</td>
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<td>17</td>
<td>0.00</td>
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<td>13,802</td>
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<td>-28.54</td>
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<td>20,710</td>
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<td>T07 Planning and Control</td>
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<td>75.82</td>
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<td>-24.18</td>
<td>19,326</td>
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<td>100.00</td>
<td>79.66</td>
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<td>-20.32</td>
<td>27,503</td>
<td>21,994</td>
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<td>T10 Production Services</td>
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<td>93.06</td>
<td>-538</td>
<td>-46.94</td>
<td>89,982</td>
<td>47,591</td>
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<td>T11 Carpenter's Shop</td>
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<td>-27.23</td>
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</table>
Trade Status Reports

For shipyards that employ multiple trades per work center or per work order, *PERCEPTION* generates progress and cost/schedule performance trade reports.
## WORK-PAC Trade Progress Report (PROG15)

### Labor Hours

**Contract:** 19950 Tanker to WBS Shells  
**Project:** 0 to ZZZZZZZZ  
**Trade:** 0 to ZZZZZZZZ

<table>
<thead>
<tr>
<th>Trade Description</th>
<th>Percent Progress</th>
<th>Current Labor Hours</th>
<th>Final Hours</th>
<th>Savings</th>
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<tr>
<td></td>
<td>Planned</td>
<td>Actual</td>
<td>Weeks Ahead</td>
<td>% Diff</td>
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<td>AD-HR/P Personnel Manager</td>
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<td>100.00</td>
<td>0</td>
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<td>100.00</td>
<td>0</td>
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</tr>
<tr>
<td>Demol Velder</td>
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<td>100.00</td>
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<td>0</td>
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<tr>
<td>HO-CM-1 Cabinet Maker</td>
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</table>
CLINs

CLINs are cost categories defined by the ship owner’s bid specification.

Many bid specifications require the shipyard to respond directly to the ship owner’s spec sheet organization.

CLINs are likely to be different from contract to contract.
Unlike the WBS, which must be defined as separate sets for each project in a contract, CLINs are defined only under the contract.

All detail cost items of the estimate can reference any project WBS and any CLIN.

CLINs are available only on one (1) level.

Each CLIN can be given an alphanumeric identification (maximum 8 characters).
<table>
<thead>
<tr>
<th>CLIN</th>
<th>Description</th>
<th>Budgeted Hours</th>
<th>Budgeted Cost</th>
<th>Actual Hours</th>
<th>Actual Cost</th>
<th>Rework Hours</th>
<th>Rework Cost</th>
<th>Premium Hours</th>
<th>Premium Cost</th>
<th>After Close Hours</th>
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</tr>
</tbody>
</table>

Total for Contract USCG WHEC FRAM: 0 hours, 0 cost
Management Report Graphics

Other high-level reports track a project’s performance throughout the course of its execution.

These can best be reviewed in graphical form.

These reports are accessed via the Project Navigator. Click on Project Navigator button on the tool bar.
Drill-Down the Navigator to the desired project and WBS level. Right-click to open a pop up menu and select Management Graphs.
Make the desired report selection (or select Combined Graphs which will display all the graphs that are available combined into one view).
Tracking Progress

Planned vs. Actual Progress For Contract 47K Tanker Project 1

Perception

ACTUAL PROGRESS    PLANNED PROGRESS    MANUAL PROGRESS
The progress tracking report tracks actual and manual progress (if recorded) against planned progress.

• Planned progress is the percentage of work order labor hour budgets to the total budget and as distributed according to their planned schedules.

• Actual progress is the progress determined by *PERCEPTION* employing the methods described earlier.

• Manual progress is the rollup of manually entered work order progress. When work orders are completed (closed), the system automatically assigns them 100% manual progress.
Progress presented above the planned progress indicates progress ahead of schedule.

Progress presented below the planned progress indicates progress behind schedule.
Tracking & Forecasting

Schedule Variance

Ahead/Behind Schedule For Contract 47k Tanker Project 1

% Progress

Weeks Ahead

-4 -2 0 2 4 6

-4 -2 0 2 4

- CURRENT WEEKS AHEAD  
- WEEKS TREND @ 100% PROGRESS
PERCEPTION measures schedule variance from the distribution of scheduled work order budgets and the current measurement of earned value.

The system determines where in time along the planned distribution of scheduled budget there is a correlation with the currently measured earned value (BCWP).

The planned date for the current BCWP is then measured against the date for the current planned budget expenditure (BCWS). This difference in dates indicates the weeks ahead or behind schedule.
Work being performed with earned values exactly on schedule are presented with zero schedule variance.

• The schedule variances above zero (positive values) indicate that work currently is determined to be weeks ahead of schedule.

• The schedule variances below zero (negative values) indicate that work currently is determined to be weeks behind schedule.
In addition, as the estimated total schedule variance may change week to week, PERCEPTION computes and tracks the schedule variance trends.

This trend information is a measure of how well changes are being introduced into the project to improve schedule performance and resolve schedule problems.
Measuring Trends

*PERCEPTION* tracks cost and schedule performance week by week or month by month.

Using regression formulas and weighting the more recent data more heavily than older data, the system computes trends at completion.

*Trends provide management with an early indication of how effective management efforts are keeping performance to budget and planned schedules.*
Tracking & Forecasting Over-Budget/Savings Variance

Forecast Overrun For Contract 47K Tanker Project 1

Perception

- FORECAST OVERRUN
- TREND OVERRUN
**PERCEPTION** measures and tracks budget variance.

**PERCEPTION** computes the projected total over-all over-run or savings as the difference between the total budget (BAC) and the estimated cost at completion (EAC).

In addition, as the estimated total cost variance may change week to week, **PERCEPTION** computes and tracks the over-run/savings trends.

This trend information is a measure of how well changes are being introduced into the project to improve cost performance and resolve cost problems.
Tracking Cost/1% Progress

Cost of 1% Progress for Contract 47K Tanker Project 1

Manhourse per 1% Progress

Perception

MANHOURS PER 1%  PLANNED MANHOURS PER 1%
Tracking the rate that hours are being spent to accomplish progress is a **good indication of how well budgets have been established for the project.**

A flat tracking of labor hours per one percent progress indicates a well planned and budgeted contract.

It indicates that budgets are fairly distributed to all tasks from the beginning to the end of the contract.

*Tracks that rise rapidly towards the end of a contract indicate a poor distribution of budgets. It also indicates work is being performed poorly in finishing the project.*

*This problem often is indicative of contracts that are heavily loaded with budget at the front end of the construction period in order to more favorably gain earned value recognition, when in fact, there is no real justification for such claims.*
Tracking Performance Indexes
Performance indexes are another method for tracking project performance of costs and schedules.
**PERCEPTION** computes and tracks five different indexes:

- **CPI**: Cost Performance Index \((BCWP/ACWP)\)
- **SPI**: Schedule Performance Index \((BCWP/BCWS)\)
- **FCPI**: Forecast Final Cost Performance Index \((BAC/EAC)\)
- **CSPI**: Current Schedule Performance Index \((ACWP/BCWS)\)
- **CCPI**: Combined Cost Performance Index
  \[
  (0.5 \times CPI \times [1 + SPI + SPI \times (BCWS-BCWP)/BAC])
  \]
- **TCPI**: To-Complete Performance Index
  \[
  (BAC-BCWP)/(EAC-ACWP)
  \]
The Cost Performance Index (CPI) is a measure of current budget performance.

When the CPI is greater than 1.0, work is under-running budgets.

The Schedule Performance Index (SPI) is a measure of current schedule performance.

When the SPI is greater than 1.0, work is being performed ahead of schedule.
The Forecast Final Cost Performance Index (FCPI) is a measure of the estimated final cost performance.

When the FCPI is greater than 1.0, the system is predicting that the project will finish under budget.

The Current Schedule Expenditure Index (CSPI) is a measure of the current expenditures of actual costs relative to the plan.

When the CSPI is greater then 1.0, actual expenditures are being spent at a rate greater than the plan.
The Combined Cost Performance Index (CCPI) is a composite measure of cost and schedule performance.

When the CCPI is greater than 1.0, the project currently is performing better than plan.

The To-Complete Performance Index (TCPI) is a measure of estimated performance for remaining work.

When the TCPI is greater than 1.0, remaining work is estimated to be performed under-budget.
Tracking & Managing Material Costs and Schedules

PERCEPTION manages and tracks project material costs as well as labor costs (hours and dollars).

The project manager should also monitor material costs and schedules to ensure they stay within budgets and planned schedules.
PERCEPTION tracks material costs at various stages and levels of detail:

- Total Committed Costs: Purchases + Stock Used + Stock Reserved
- Total Purchases
- Purchases Received
- Purchases Used
- Purchases Paid
- Stock Used
- Stock Reserved
Tracking Material Costs
Tracking Manpower Requirements

In addition to monitoring project costs and schedules, the project manager should periodically review the impact of project performance and changes upon the shipyard’s manpower resources.
PERCEPTION can generate a variety of manpower analysis reports:

- As Planned in Baseline
- As Currently Planned
- As Actually Expended To Date
- As Forecast to Complete

Manpower can be evaluated by WBS, by shipyard work center, for one project or across multiple projects.

The analysis can combine current back-log with proposed new work.
Tracking Manpower Requirements
(Planned Vs Actual Vs Forecast)
New Work Manpower Modeled On Top Of Active Work Manpower
Work Order Listings

PERCEPTION generates a variety of work order listings.

With the exception of time charge transactions that the system also tracks, work orders represent the lowest level of detail for managing labor hours, costs and schedules.
<table>
<thead>
<tr>
<th>Work Order Heading</th>
<th>Unit</th>
<th>Acct</th>
<th>Auth</th>
<th>Planned Start</th>
<th>Planned Finish</th>
<th>Actual Start</th>
<th>Actual Finish</th>
<th>Sta</th>
<th>Budget Hours</th>
<th>Actual Hours</th>
<th>Over Run</th>
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<th>After Close</th>
<th>Rework Hours</th>
<th>Prog</th>
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<td>02/02/1993</td>
<td>06/19/1993</td>
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<td>01/05/1993</td>
<td>02/02/1993</td>
<td>06/23/1992</td>
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<td>C</td>
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<tr>
<td>WAY 21-30 TOP PACKED</td>
<td>304</td>
<td>N</td>
<td>01/05/1993</td>
<td>01/26/1993</td>
<td>07/21/1992</td>
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<td>C</td>
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<tr>
<td>CLEAR BERTH + HULL</td>
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<tr>
<td>WAY 31-40 TOP PACKED</td>
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</tr>
<tr>
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<tr>
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<td>C</td>
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<td>ROPE + STRAP TIMBERS</td>
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<tr>
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<tr>
<td>SIDE LIGHTS SHOPWORK</td>
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<td>01/20/1993</td>
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<tr>
<td>WAY 41-50 TOP PACKED</td>
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<td>01/02/1993</td>
<td>02/02/1993</td>
<td>10/12/1992</td>
<td>10/30/1992</td>
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<td>0</td>
<td>100.00</td>
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</tr>
</tbody>
</table>
The lists provide the following information about work orders:

1. Description
2. Planned & Actual Start Finish Dates
3. Budget & Actual Charges
4. Over-Run
5. Premium Charges
6. Rework Charges
7. After Close Charges
Additional details of a work order can be viewed online by drilling down from the *Work Order Worksheet*. 

---

**Work Order Details Information for the Production Environment**

<table>
<thead>
<tr>
<th>Contract</th>
<th>TSHIP CONTRACT</th>
<th>Project</th>
<th>2002</th>
<th>Heading</th>
<th>WAY 21-30 TOP PACKED</th>
<th>Issue Date</th>
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<tbody>
<tr>
<td>Center</td>
<td>T33</td>
<td>Work Order</td>
<td>30422</td>
<td>Description</td>
<td></td>
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<td></td>
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<tr>
<td>IPT</td>
<td>Planner</td>
<td>Foreman</td>
<td>Revision</td>
<td>Rev Date</td>
<td>00/00/0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Department</td>
<td>Process</td>
<td>Trade</td>
<td>Drawing</td>
<td>Start Date</td>
<td>01/05/1993</td>
<td>Finish Date</td>
<td>01/26/1993</td>
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<tr>
<td>OA Supervisor</td>
<td></td>
<td></td>
<td></td>
<td>Date of Last Charge</td>
<td>09/10/1992</td>
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<table>
<thead>
<tr>
<th>Zone</th>
<th>Outfit Zone</th>
<th>Unit/Block</th>
<th>Assembly</th>
<th>Sub Assembly</th>
<th>MFG Part</th>
<th>SWBS Group</th>
<th>SWBS Account</th>
<th>CLIN</th>
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<tbody>
<tr>
<td>00</td>
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<td></td>
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<table>
<thead>
<tr>
<th>Labor CER</th>
<th>Labor Rate</th>
<th>Hours</th>
<th>Cost</th>
<th>Budget Material</th>
<th>Actual Material</th>
<th>Product Code</th>
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<table>
<thead>
<tr>
<th>Additional Details</th>
<th>Budget Material</th>
<th>Actual Material</th>
<th>Product Code</th>
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<table>
<thead>
<tr>
<th>WO Type</th>
<th>Manpower Curve</th>
<th>Authorization</th>
<th>Rework Status</th>
<th>Work Order Serial Number</th>
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<td>Discrete</td>
<td>0</td>
<td>NOT Authorized</td>
<td>NOT a Rework WO</td>
<td>468</td>
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</table>

**Change Order ID**

---

*SPAR Associates, Inc.*
Comparing Production Performance With Estimate

The performance of production costs should be monitored and compared against the original estimate.

*PERCEPTION* generates summary reports at any level of the project WBS comparing the estimate against the current budgets, actual costs charged to date, and the estimated costs at completion.
<table>
<thead>
<tr>
<th>Group</th>
<th>Description</th>
<th>Estimated Hours</th>
<th>Production Budget Hours</th>
<th>Actual Hours</th>
<th>EAC Hours</th>
<th>Estimated Material Cost</th>
<th>Budget Material Cost</th>
<th>Committed Material Cost</th>
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</thead>
<tbody>
<tr>
<td>Project 2002</td>
<td>Sevorn Bulk Carrier (work orders)</td>
<td>1,166,520</td>
<td>1,017,598</td>
<td>660,706</td>
<td>984,817</td>
<td>32,084,543</td>
<td>29,193,254</td>
<td>25,302,032</td>
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<tr>
<td>0 STEELWORK</td>
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<td>515,781</td>
<td>474,520</td>
<td>450,719</td>
<td>474,885</td>
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<td>55,222</td>
<td>15,020</td>
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<td>56,413</td>
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<td>1,910,240</td>
<td>1,738,316</td>
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<tr>
<td>3 MECHANICAL SYSTEMS OUTFIT</td>
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<td>23,641</td>
<td>73,453</td>
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<tr>
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<td>62,160</td>
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<tr>
<td>5 MACHINERY SYSTEMS</td>
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<td>30,325</td>
<td>27,899</td>
<td>7,712</td>
<td>23,832</td>
<td>949,100</td>
<td>772,581</td>
<td>1,376,678</td>
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<tr>
<td>6 ELECTRICAL SYSTEMS</td>
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<td>80,027</td>
<td>4,821</td>
<td>55,591</td>
<td>1,609,813</td>
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<td>1,961,189</td>
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<tr>
<td>7 PRODUCTION SERVICES</td>
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<td>195,784</td>
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<tr>
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<td>255,145</td>
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<tr>
<td>9 DESIGN &amp; DRAWING</td>
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<td>21,993</td>
<td>26,064</td>
<td>315,034</td>
<td>206,581</td>
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<tr>
<td><strong>Grand Total</strong></td>
<td></td>
<td>1,166,520</td>
<td>1,017,598</td>
<td>660,706</td>
<td>984,817</td>
<td>32,084,543</td>
<td>29,193,254</td>
<td>25,302,032</td>
</tr>
</tbody>
</table>
The selected reports represent only a small number of reports available from *PERCEPTION*. They generally provide visibility at higher levels of the project work breakdown structure.

The intent of these high level reports is to help the project manager identify general areas of problems within the project.

The project manager should then proceed to lower level reports to identify more precisely the cause of the problems and initiate appropriate remedial actions as may be necessary.
What To Look For

The system provides a wealth of information at all levels of detail.

In order to maintain control over a project, there are specific pieces of information that should be monitored on a regular basis.
Manual Progress Assessments: The system accepts data entries of manual work order progress assessments.

These manual assessments are in addition to the automated progress assessments continually made by the system at all levels of the project WBS.

Differences between the manual and automated progress figures can be observed from various reports and from the progress tracking graphic report.
Planning should review these manual assessments and make a judgment as to whether or not they are reasonable or whether they should be reviewed with the foreman.

Discrepancies may be due to the foreman not fully understanding the work order scope of work.

Correcting of past time charges may be in order.
**Rework:** A work order may be designated strictly for rework.

The system segregates rework charges from normal charges so that their impact upon costs and schedules can be directly assessed.

*Rework should not be used only when budgets are exceeded.*

Rework should be so labeled only for major problems, such as repairing a dropped module.
Rework also can be a valid designation for changes due to engineering changes.

_Rework due to customer changes_ most likely should be designated as a billable change order, not rework.
**Premium Hours:** The system records all premium labor charges by work order.

These charges should be monitored to ensure their added costs to the contract are reasonable and necessary.
**Hours Charged After Close:** When a work order is closed, the system permit additional labor charges against the work order, but these hours are identified as “hours charged after close.”

Oftentimes, late charges are acceptable, such as for miscellaneous pick up work. However, excessive late charges may indicate the following:

- Mischarges, which should be corrected
- Erroneous work order closing, which should be re-opened to allow the system to reset the actual finish date.
Labor Hours Over-Runs: System reports should be evaluated beginning at project WBS and working down. Where over-runs are indicated, an analysis of work orders often begins to tell the reason why there is the problem.

- Actual costs (ACWP) exceeding earned values (BCWP) indicate a cumulative to-date over-run condition.

- Estimates At Completion (EACs) exceeding total budgets (BAC) indicate a predicted final over-run condition.

- EAC trends are a result of a regression analysis that the system forecasts for a final over-run condition based upon whether or not they continue to increase or decrease over successive time periods.
Planning should review serious problems with Production to ascertain the causes of over-runs and to develop an effective remedy.

Problems can be caused by poor production performance, unrecognized rework, and impacts of failures, errors and omissions from preceding manufacturing processes, poor engineering, and/or poor budgeting.
Labor Hours Under-Runs: Review of under-runs follows a similar process as for examining over-runs.

Normally, this condition is not a problem unless it is an indication of a misapplication of project budgets.

It also can indicate that Production is not following the production plan, and there may be possible adverse cost and schedule repercussions later.
Behind Schedule: System reports should be evaluated starting at project SWBS accounts. Where schedule delays are indicated, an analysis of work orders under the account often begin to tell the reason why there is the problem.

- Budgeted Cost of Work Scheduled (BCWS) exceeding earned values (BCWP) indicate performance is not keeping up with the scheduled budget plan. The system measures the delay in terms of both labor hours and work weeks directly.

- Planned progress exceeding actual progress is another measure of schedule delay.

- Trends of weeks behind are a result of a regression analysis that forecasts the final delivery delay based upon whether or not delays continue to increase or decrease over successive time periods.
A forecast manpower analysis also will measure the delays in terms of unfinished work piling up around the current reporting date.

This manpower condition is called a “bow wave”, an easily identifiable indication that additional resources need to be applied in order to regain the production schedule. This could be remedied with over-time, new hires, and/or subcontracting.

It also could be an indication that work is being delayed due to unavailable resources such as drawings or materials.

Should the bow wave become excessive, re-planning of work should be addressed as soon as possible.
Ahead of Schedule: Review of schedules being performed ahead of schedule follows a similar process as for examining delays.

Normally, this condition is not a problem unless it is an indication of poor planning and scheduling.

It also can indicate that Production is not following the production plan, and there may be possible adverse cost and schedule repercussions later.
Material Cost Monitoring: Material costs are a major cost of any new construction contract, often about equal or more to labor and overhead costs.

The system generates various reports summarizing the status of material costs. Material estimates at completion (EAC) is developed by the system initially as the material budget.

When committed costs (purchased and stock) exceed the budget, the material EAC reflects this overage.
It is strongly recommended that material cost status be monitored on a regular basis, at least monthly.

When committed costs are within 10% of the total material budget, more focused effort should be placed on these costs, as the system has no way of knowing what material remains undefined and therefore un-purchased.

These undefined costs can become a nasty surprise, blowing the material budget significantly.

Of special interest should be costs of subcontracted work.
Cost Estimate Monitoring: The system provides reports that measures budgets, actual costs and EACs against the contract’s original estimates.

Monitoring against the estimate can be beneficial, especially if large variances are due to significant changes in the scope of work.
Errors & Exception Reports: The system has a variety of error and exception reports that help identify data and performance problems.
Additional Graphics Reports

PERCEPTION provides a wide variety of graphics reports that analyze contract performance:

• Detail Work Order Analysis
• Project Summary Labor Hour Performance
• Shipyard Work Center Performance
• Project Cost & Cash Flow Performance
Click on *Reports/Data Analysis Spreadsheets* for the various analysis options.
Work Order Detail Analyses

Overall Work Order Performance Status

Completed Work Order Performance Status

In-Process Work Order Performance Status

In-Process Work Order Performance Status
### Work Center Performance Analyses

#### Work Center Progress

<table>
<thead>
<tr>
<th>Percent Progress</th>
<th>Planned Progress</th>
<th>Actual Progress</th>
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<tbody>
<tr>
<td></td>
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#### Work Center Current Cost & Schedule Variance

<table>
<thead>
<tr>
<th>Percent Variance</th>
<th>Cost Variance</th>
<th>Schedule Variance</th>
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</thead>
<tbody>
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<td></td>
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</table>

#### Work Center Current Labor Hour Efficiency

<table>
<thead>
<tr>
<th>Ratio Earned Value/Actual Cost</th>
<th>Earned Value</th>
<th>Actual Cost</th>
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<tbody>
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<td></td>
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</table>

#### Current Work Center Schedule Efficiency

<table>
<thead>
<tr>
<th>Percent Hours On Schedule</th>
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<th>Work Center</th>
<th>Work Center</th>
<th>Work Center</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
EAC Tracking Analyses

Tracking Labor Hour Costs

Tracking Various Labor Hour EACs

Tracking Performance Indexes (By Percent Progress)

Labor Hours Per 1% Progress
Schedule Tracking Analyses

- Projected Days Ahead (Behind) Planned Finish Schedule
- Estimated Finish Dates
- Tracking Schedule Variance In Weeks
- Tracking & Comparing Progress
Cash Flow Analyses

Tracking Actual Costs

Total Cash Budget Versus EAC (Labor, Material & Overhead)

Material Cost Status

Tracking Cash Flow Schedules