Equipment Metrics and Benchmarking

Gain the knowledge needed to understand the profit and loss statement, the balance sheet and the benefits of using capital both profitably and efficiently.

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Equipment Metrics and Benchmarking

Session W46
WEDNESDAY MARCH 5, 2014. 3:00 - 4:00pm
Learn about the complexities of metrics and benchmarking in the world of equipment management where few universal definitions, norms and standards exist.

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Equipment Metrics and Benchmarking

How do we define norms and standards.
How do we measure success.

Equipment Metrics and Benchmarking

To confirm what we will say and for more details:

Chapter 9  Performance Measures
Chapter 12  Budgets and Budgeting

www.cempcentral.com
1. Standards
   1.1. What standards do we have, who defines them
   1.2. Data, information and graphics. How do we turn data into actionable information
   1.3. Deployment, availability and utilization. Surely these are the basics, how do we define them
   1.4. Cost benchmarks. How do we define benchmarks and present cost information
   1.5. Fleet age benchmarks. Are there standards, how do we track them
   1.6. Some ideas. Let's get outside the box

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Equipment Metrics and Benchmarking

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Who sets their standards
- International Accounting Standards Board
- Financial Accounting Standards Board
- Generally Accepted Accounting Principles.

Who sets our standards

---

1. Standards

Or, are we all very, very different.

---

Everyone does it differently. Everyone has different requirements.

---
1. Standards

Or, are we all very, very different.

Everyone does it differently
Everyone has different requirements.

<table>
<thead>
<tr>
<th>Scope of benchmarking group</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal to a company or business unit</td>
<td>Definition of data and metrics is consistent and directly relevant</td>
<td>Lack of input from others. Concern about industry standards and trends.</td>
</tr>
<tr>
<td>Among a select group of peer organizations</td>
<td>Are able to compare best practices and measure performance within the peer group</td>
<td>Data and metrics must be agreed within the group. Equipment applications and working environments may differ.</td>
</tr>
<tr>
<td>Across the industry as a whole</td>
<td>Large comparative data set. The comfort of knowing and having an “industry standard.”</td>
<td>Data, metrics, applications and environments can vary to the extent that results have little value.</td>
</tr>
</tbody>
</table>

*Figure 8.1 Companies can benchmark internally, within a peer group or across the industry as a whole.*

2. Data and information

Without data you can do nothing

- Data is to information as bricks are to a house
- Data are the materials from which you build your house
- Know what you want and collect it
- Keep it simple
- Do it thoroughly
We reason with data driven rules. We need to use our data to:
1. Set the rules
2. Calibrate the rules
3. Trigger action

Do we use Intuition or Analysis:

- Experience & Observation (Intuition)
- Data & Information (Analysis)

Most systems are designed to run "the business". What about "our business"?

- Core modules
- Application modules

Who designed them?
Who built them?
What about our input?
2. Data and information

A picture is worth a thousand data points

Edward Tufte

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Contour Plot for Payload vs Load Time

PLT Map
- How big is the footprint?
- How "high" is the peak?
- What is the variation in payload? Load time?
- Are we wasting time to get the lights to change?

---

Equipment Metrics and Benchmarking

1. Standards.
   What standards do we have, who defines them

2. Data, information and graphics.
   How do we turn data into actionable information

3. Deployment, availability and utilization.
   Surely these are the basics, how do we define them

   How do we define benchmarks and present cost information

5. Fleet age benchmarks.
   Are there standards, how do we track them

6. Some ideas.
   Let's get outside the box

---

What I want you to take home
What about downtime?

\[
\text{Availability} = \frac{\text{Hrs capable of working}}{\text{Target hours}} = \frac{(T - D)}{T}
\]

\[
\text{Utilization} = \frac{\text{Hours Worked}}{\text{Hrs capable of working}} = \frac{W}{(T-D)}
\]

1. Deployment, availability and utilization

- **Deployment**: The time a machine is on site and required to work
  - Total ownership period

- **Availability**: The time a machine is required and able to work
  - Time a machine is on site and required to work

- **Utilization**: The time a machine is actually used
  - Time a machine is required and able to work

Figure 9.2 presents the definitions graphically and highlights the following three periods of wasted time:

- **Un-deployed “Off site”**: Period when the machine is not deployed on site.
- **On-shift downtime**: Period when the machine is on site but unable to work.
- **Idle time**: Period when the machine is required to work but is not working.
### 3. Deployment, availability and utilization

Asphalt trucks,
162,483 hours recorded for 62 units = 2,620 hours per unit.
50 hours per week for 52 weeks per year = 2,600 hours per year.

<table>
<thead>
<tr>
<th>Worked on site</th>
<th>81,100 hours</th>
<th>Stand by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deployed on site and available to work</td>
<td>115,000 hours</td>
<td>Down</td>
</tr>
<tr>
<td>Deployed on site</td>
<td>115,000 hours</td>
<td>CR site</td>
</tr>
</tbody>
</table>

Total ownership period: 162,483 hours, 62 units, 50 hours per week for 52 weeks in the year.

- **Deployment** = 115,000 / 162,483 = 70.7%
- **Availability** = 100,500 / 115,000 = 87.4%
- **Utilization** = 81,100 / 100,500 = 80.6%
- **Overall** = 81,100 / 162,483 = 49.3% of a 50 hour week, 52 weeks per year.

And, what are good values:
- **Deployment** = 70.7%
- **Availability** = 87.4%
- **Utilization** = 80.6%
- **Overall** = 49.3% of a 50 hour week, 52 weeks per year.

### Activity metrics
- **Deployment**: Percentage of time the machine is actually deployed on site and required to work relative to the total ownership period.
- **Utilization**: Percentage of time the machine is actually used relative to the time it is on site and able to work.
- **Net Utilization**: Percentage of time the machine is actually used relative to the time it is deployed on site.

### Input metrics
- **Labor Factor**: Repair and maintenance labor hours spent on the machine per hour worked by the machine.
- **Repair cost**: Direct cost of repair parts and labor per hour worked by the machine.

### Output metrics
- **Availability**: Percentage of time the machine is able to work relative to time on site.
- **Down Ratio**: The ratio of a machine's down hours per hour worked by the machine.
- **Reliability**: The frequency with which the machine breaks down and disrupts production.

<table>
<thead>
<tr>
<th><strong>Index</strong></th>
<th><strong>Notes</strong></th>
<th><strong>Formula</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Total ownership period</td>
<td>( T )</td>
</tr>
<tr>
<td>2</td>
<td>Number of times a machine breaks down and requires repair</td>
<td>( V )</td>
</tr>
<tr>
<td>3</td>
<td>Total time on site and required work</td>
<td>( T )</td>
</tr>
<tr>
<td>4</td>
<td>Repair and maintenance labor hours spent operating the machine</td>
<td>( B )</td>
</tr>
<tr>
<td>5</td>
<td>Total cost of repair parts and labor spent on the machine in the period</td>
<td>( P )</td>
</tr>
<tr>
<td>6</td>
<td>Actual hours the machine worked during the period</td>
<td>( W )</td>
</tr>
</tbody>
</table>

Data:
- \( E \) = Total ownership period
- \( V \) = Number of times a machine breaks down and requires repair
- \( T \) = Total time on site and required work
- \( B \) = Repair and maintenance labor hours spent operating the machine
- \( P \) = Total cost of repair parts and labor spent on the machine in the period
- \( W \) = Actual hours the machine worked during the period.
3. Deployment, availability and utilization

The owning costs are, by and large, fixed. They occur on an annual basis and the RATE is therefore very sensitive to hours worked in a given month.

The operating costs are, by and large, variable. They occur on an hourly basis and are proportional to the hours worked. The RATE is thus not all that sensitive to utilization.

Who takes the rewards from over utilization and who carries the risk of under utilization.

3. Deployment, availability and utilization

\[
\begin{align*}
T &= \text{Target number of hours per month used in the rate calculation.} \\
W &= \text{Number of hours worked in the month} \\
\$N/hr &= \text{Annual owning costs/target hours = Owning rate} \\
\$P/hr &= \text{Operating rate} \\
\end{align*}
\]

1. Charge \((\$P + \$N) \times W\) - bill to job work phase codes.
2. Charge additional \((T - W) \times \$N\) - debit to equipment utilization phase code.

\[
\begin{align*}
\text{Equipment account receives } \$N \times T + \$P \times W
\end{align*}
\]
### 3. Deployment, availability and utilization

- **T** = Target number of hours per month used in the rate calculation.
- **W** = Number of hours worked in the month
- **$M/mo** = Annual owning costs/working months in the year (time in the shop)
- **$P/hr** = Operating rate

Owning: $M/month

Operating: $P/hr

1. Charge $M plus $P times W hrs - How do you bill M to job work phase codes.
2. Charge $P times W – bill to job work phase codes.

And, how do you do it.
How does it affect your jobs.
How does it affect your equipment account.

### Equipment Metrics and Benchmarking

1. Standards.
   - What standards do we have, who defines them
2. Data, information and graphics.
   - How do we turn data into actionable information
3. Deployment, availability and utilization.
   - Surely these are the basics, how do we define them
   - How do we define benchmarks and present cost information
5. Fleet age benchmarks.
   - Are there standards, how do we track them
6. Some ideas.
   - Let's get outside the box

What I want you to take home
4. Cost benchmarks

Actual cost relative to budget is the most widely used benchmark.

It is a three step process
1. Establish your benchmark rates
2. Collect your actuals
3. Produce actionable information

Calculation or Calibration

Standards reflect the expectations
Actual costs reflect reality.
4. Cost benchmarks
Calculation or Calibration

Standards reflect the expectations
Actual costs reflect reality.

Calculation or Calibration – OK, HOW

Why?

Standards reflect the expectations
Actual costs reflect reality.
4. Cost benchmarks

Actual cost relative to budget is the most widely used benchmark.

It is a three step process:
1. Establish your benchmark rates
2. Collect your actuals
3. Produce actionable information

It is not as easy as it sounds:
Collect actual costs – that is the easy part.
Collect the hours worked to generate the earned value budget
THAT IS THE HARD PART

Actionable information - The curse of the one liner

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Hours</th>
<th>Revenue</th>
<th>Cost</th>
<th>G/L</th>
<th>Hours</th>
<th>Revenue</th>
<th>Cost</th>
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<th>Hours</th>
<th>Revenue</th>
<th>Cost</th>
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<td>225</td>
<td>7,852</td>
<td>392,600</td>
<td>422,016</td>
<td>(29,416)</td>
<td>458</td>
<td>23,358</td>
<td>15,489</td>
<td>7,869</td>
<td>80</td>
<td>4,160</td>
<td>1,600</td>
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<tr>
<td>Z</td>
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<td>160,000</td>
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<td>(67,000)</td>
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<td>(21,622)</td>
<td>120</td>
<td>6,240</td>
<td>35,000</td>
</tr>
</tbody>
</table>

What does this all mean?
Age (too young, too old)
Utilization
Application
Operation
The so what barrier.

Generate earned value budgets for at least 4 principal cost types.
Compare these with actual costs in each principal cost type.
Look deeper. Understand the variances. Act to rectify.
Generate earned value budgets for at least 4 principal cost types. Compare these with actual costs in each principal cost type.

Lock deeper. Understand the variances. Act to rectify.
4. Cost benchmarks

Benchmark owning and operating costs

Figure 12.7

Units above the line have a positive owning cost variance and are well utilized. Units to the right have a positive owning cost variance and are operating within budget.

4. Cost Benchmarks

Benchmark owning and operating costs

Will you have a safe flight if you manage:

$ per hour for owning costs.
How do I recover the fixed costs of ownership.
Depends on utilization and life

$ per hour for operating costs.
How do I recover the costs of running it and fixing it.
Depends on day to day field decisions
1. Standards.
   What standards do we have, who defines them ✓
2. Data, information and graphics.
   How do we turn data into actionable information ✓
3. Deployment, availability and utilization.
   Surely these are the basics, how do we define them ✓
   How do we define benchmarks and present cost information ✓
5. Fleet age benchmarks.
   Are there standards, how do we track them
6. Some ideas.
   Let's get outside the box

5. Fleet age benchmarks
Age benchmarks are critical. There must be a formal process of defining and measuring where we are relative to fleet average age.

It is a three step process
1. Establish your benchmark ages
2. Collect your actuals
3. Produce actionable information

1. Establishing benchmark ages

It does not matter how you do it – you must know:
HOW LONG YOU PLAN TO KEEP IT
WHEN IT WILL BECOME PROGRESSIVELY MORE COSTLY
WHEN IT WILL BE DONE
5. Fleet age benchmarks

Age benchmarks are critical. There must be a formal process of defining and measuring where we are relative to fleet average age.

It is a three step process
1. Establish your benchmark ages
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Again, it is not as easy as it sounds:
Collect the hours worked to generate the earned value budget and drive the fleet age system – You can mess them both up.
There are, in fact, THREE benchmarks

$ per hour for owning costs.
How do I recover the fixed costs of ownership.
Depends on utilization and life

$ per hour for operating costs.
How do I recover the costs of running it and fixing it.
Depends on day to day field decisions

Hours in inventory.
How do I know when I am in the "red zone" and LTD cost is increasing with each hour worked.
Depends on a combination of owning and operating cost, reliability and productivity.

Equipment Metrics and Benchmarking

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What I want you to take home
6. Some ideas

Owning cost $ per hour to have the machine in your fleet

Hours in inventory Fleet average age relative to "the sweet spot"

Operating cost $ per hour to put to work and keep it working

Labor factor Labor hours spent on the machine per operating hour

Technology gradient Are new machines safer, more reliable and more productive

Red work orders Number of "red work orders" per operating hour

6. Some ideas

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Hours in Service</th>
<th>Hours Out of Service</th>
<th>OEM Hours</th>
<th>Non-OEM Hours</th>
<th>Total Hours</th>
<th>Percent</th>
<th>Floor</th>
<th>Deck</th>
<th>Red Work Orders</th>
<th>Labor Hours</th>
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<tr>
<td>Company A</td>
<td>1200</td>
<td>100</td>
<td>1000</td>
<td>200</td>
<td>1220</td>
<td>95.8%</td>
<td>50</td>
<td>25</td>
<td>12</td>
<td>150</td>
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<tr>
<td>Company B</td>
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<td>900</td>
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</table>
6. Some ideas

The replace decision depends on current inventory and future activity.

Ford F150 mileage travelled

Fleet Repair and Maintenance Hours per Hour Worked

Brooks Pans
Compac tors - Asphalt Tracker Drills
Trench Rollers

Rubber Tire Loaders

Dirt Dozers

Excavators

Trucks - Fuel Artics - Volvo Wheel Excavators

Trucks - Tractors

Backhoes

Graders

Labor Factor
6. Some ideas

Mitchell Curve Category

- Bell B30D - Discard Application
- Poli. (Bell B30D - Discard Application)

\[
y = 0.004x^2 + 19.346x + 1,418,872.556
\]

\[R^2 = 0.912\]

Cumulative Cost vs. Life (Hours)

Mitchell Curve Category

- Bell B30D - Discard Application
- Poli. (Bell B30D - Discard Application)

\[
y = 0.004x^2 + 15.723x + 1,663,942.969
\]

\[R^2 = 0.954\]

Cumulative Cost vs. Life (Hours)

Mitchell Curve Category

- Bell 2706 - Coal (Machines now at Manganese site)

\[
y = 0.004x^2 + 15.723x + 1,663,942.969
\]

\[R^2 = 0.954\]

Cumulative Cost vs. Life (Hours)
1. Standards
What standards do we have, who defines them

2. Data, information and graphics.
How do we turn data into actionable information

3. Deployment, availability and utilization.
Surely these are the basics, how do we define them

How do we define benchmarks and present cost information

5. Fleet age benchmarks.
Are there standards, how do we track them

6. Some ideas.
Let's get outside the box

So... What I want you to take home

---

1. Standards

<table>
<thead>
<tr>
<th>Revenue</th>
<th>Customer</th>
<th>Site off takes</th>
<th>Misc.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>$100,000</td>
<td>45,000</td>
<td>18,000</td>
<td>15,000</td>
<td>$85,000</td>
</tr>
</tbody>
</table>

Profit on operations $15,000

Equipment costs
Depreciation $4,600
Leases, loans $2,300
Licence insurance, tax $1,000
Owning costs $7,900
Labor $3,300
Parts and supplies $3,700
Fuel $5,000
Operating costs $12,000

1,000 $19,700 $18,000 $1,700 $13,300

SG&A Costs
Estimating and job planning $4,000
Human resources $1,125
Administration $900
Facilities $1,100
Finance $800
$7,925

Operating income $5,375
Other income and expenses $1,500
Net income before tax $6,875
Tax due $3,555
Income after tax $3,320

---

Or, are we all very, very different.

Everyone does it differently
Everyone has different requirements.

---
Most systems are designed to run "the business" What about "our business"

Core modules
Application modules
Who designed them
Who built them
What about our input

A picture is worth a thousand data points
Edward Tufte

Activity metrics
- How active is the machine? How much is it needed and used?

Deployment
\[ \text{Percentage of time the machine is actually deployed on site and required to work relative to the total ownership period} \]

Utilization
[Percentage of time the machine is actually used relative to the time it is deployed on site]

Net Utilization
[Percentage of time the machine is actually used relative to the time it is deployed on site]

Input metrics
- What resources do I use to keep the machine up and running?

Labor Factor
[Repair and maintenance labor hours spent on the machine per hour worked by the machine]

Repair cost
[Direct cost of repair parts and labor per hour worked by the machine]

Output metrics
- What do I achieve through the use of these resources?

Availability
[Percentage of time the machine is able to work relative to time on site]

Down Ratio
[The ratio of a machine's down hours per hour worked by the machine]

Reliability
[The frequency with which the machine breaks down and disrupts production]

\[ \text{Data} = \text{Total ownership period} \times \frac{\text{Number of times a machine breaks down and disrupts production}}{\text{Time the machine is on site and required to work}} \]

\[ \text{RMh} = \text{Repair and maintenance labor hours spent on the machine} \]

\[ \text{Rpl} = \text{Direct cost of repair parts and labor spent on the machine} \]

\[ \text{W} = \text{Actual hours the machine worked during the period} \]
4. Cost benchmarks

Calculation or Calibration

Standards reflect the expectations
Actual costs reflect reality.

4. Cost benchmarks

Calculation or Calibration – OK, HOW

Standards reflect the expectations
Actual costs reflect reality.

4. Cost benchmarks

Unit level cost information

Standards reflect the expectations
Actual costs reflect reality.
5. Fleet age benchmarks

1. Establishing benchmark ages

It does not matter how you do it – you must know:

- HOW LONG YOU PLAN TO KEEP IT
- WHEN IT WILL BECOME PROGRESSIVELY MORE COSTLY
- WHEN IT WILL BE DONE

Age benchmarks are critical. There must be a formal process of defining and measuring where we are relative to fleet average age.

It is a three step process:

1. Establish your benchmark ages
2. Collect your actuals
3. Produce actionable information

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
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<tbody>
<tr>
<td>Unit number</td>
<td>Current age</td>
<td>Expected age source</td>
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<td>Size 2</td>
<td>Size 3</td>
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<td>5100</td>
<td>&gt; 6800</td>
<td></td>
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</table>
5. Fleet age benchmarks

The replace decision depends on current inventory and future activity.

6. Some ideas

Owning cost
$ per hour to have the machine in your fleet.

Operating cost
$ per hour to put it to work and keep it working.

Labor factor
Labor hours spent on the machine per operating hour.

Technology gradient
Are new machines safer, more reliable and more productive.

Red work orders
Number of "red work orders" per operating hour.
How do we define norms and standards.
How do we measure success.