WILLAMAN SOLUTIONS LLC

PerforMax Plant Optimization™ Scorecard Overview

The PerforMax Plant Optimization scorecard provides operations or plant managers using COMMANDbatch™ with a detailed operational overview of all aspects of the plant production. The Plant Scorecard unlocks information on weigh up time, discharge time, operator alarms, plants events, and more. The consistent format allows side by side comparison of different plants and identification of specific areas of improvement.

As the report contains two different periods, adjustments made to the plant and/or plant automation system can be quantified and measured to assure desired outcomes. Declines in plant performance can be immediately identified and corrected.

This overview explains the four sections currently available with the Plant Scorecard. The Plant Scorecard is currently only available in printed format and will soon be made available for review electronically.

Introduction to Plant Scorecard

The PerfoMax Plant Optimization philosophy is to provide long term, sustainable, and verifiable improvements to the concrete production process. Empowered by financial measurement of savings due to material and time reduction, reduced mechanical wear/tear, more consistent quality, and less response driven activities the producer can make intelligent decisions on where to invest in improvements such as plant equipment, operator training, or process rework.

Using the Plant Scorecard

The scorecard is organized is divided into four sections. Within each section, a comparison of two operating periods are provided. Willaman Solutions advises any operating period reports should be not less than five days' duration due to the current inherent variability of concrete plant production equipment and processes.

The scorecard also incorporates charts for quick assessment of plant performance between the two periods. The chart reflects all the high-level information provided by the detailed table. If there is a question about a chart refer to the detailed table for specifics.

This scorecard spans two periods of nine working days each, as shown in Figure 1.

Plant Performance Scorecard						
Period 1		Period 2			Start	End
10/1/2020	10/21/2020	10/22/2020	10/28/2020	Dates Available:	10/1/2020	10/28/2020
Net Work Days: 15		Net Work Days: 5				

Figure 1- Plant Scorecard Header

Performance Charts

The report provides 15 charts for rapid assessment of plant performance. Figure two (2) is an example of a Plant Scorecard chart and shows the duration from load start until the scales are filled ("weigh time").

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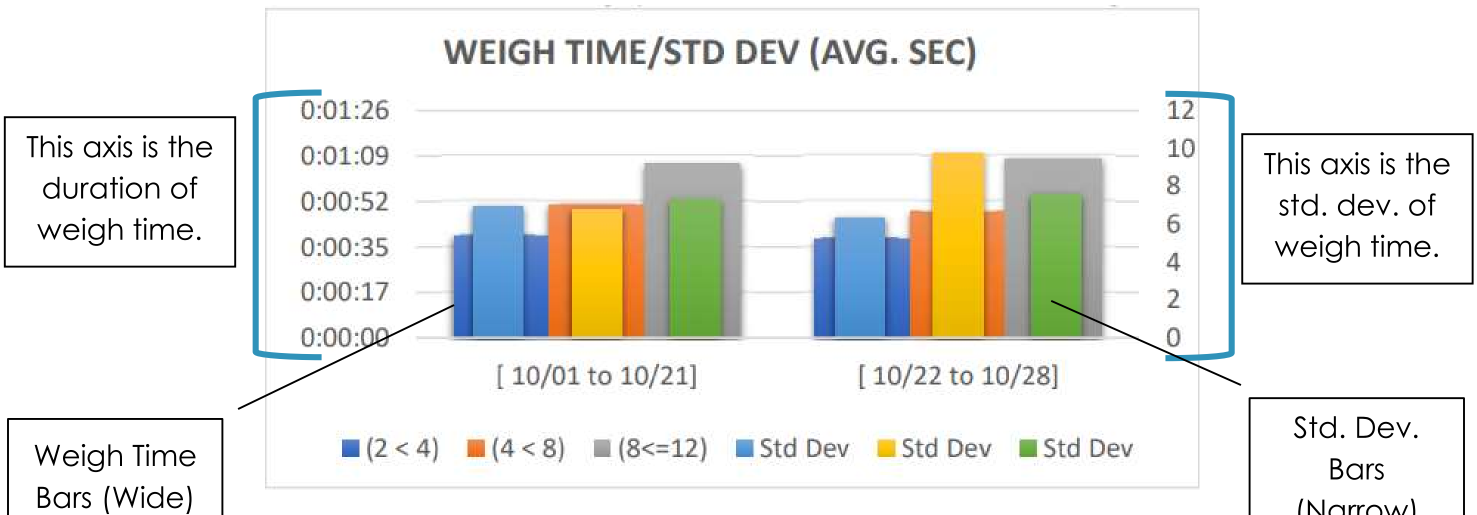

Figure 2 – Typical Plant Scorecard Chart

The wide blue bars represent the average weigh time for loads between two (2) and up to four (4) yards. The wide orange bars represent the weigh time between four (4) up to six (6) yards, and the wide gray bars is for six (6) up to 12 yards. Within each of those bars is a narrow bar that represents the standard deviation (Std Dev) within each group. Standard deviation is the parameter that describes how much variance in Weigh Time the average calculation is "masking."

The next five (5) charts use the same design, with wide bars representing the base information, with the narrow bars providing a complementary measure. These charts provide information on:

Chart Name	Description
Yards per hour / Average Load Size	For the respective Load Size Buckets, what was the average production rate and load size? Useful to compare plant to plant performance
Truck Load time / Standard Deviation	Average total time (by Load Size bucket) from the first material movement to the final driver horn.
Truck Charge time (only) / standard Deviation	Average time the system was in the truck charging mode. Comparing average load times side by side can uncover slower loading plants that might benefit from tuning.
Number of Loads / % Loads with Tolerance error	Shows what percentage of loads have a tolerance error. More errors affect quality and time.
Number of Loads / % Loads with Operator alert	Shows what percentage of loads have some sort of operator alert. More errors affect quality and time and could point to plant material supply equipment issues.

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Material Cost Calculations

All producers generally choose to batch at target or just under target. The charts in figure three (3) provide an estimated material cost because of the batching process. The left chart shows the cost of *over and under batching amounts combined* for the two periods under evaluation. The right-hand chart shows just the over batched quantities. Refer to the Plant Scorecard Table section for more information, but any positive variance represents lost profits.

Figure 3 – Material overage/under by period estimated costs

Plant Drop Cycle Performance

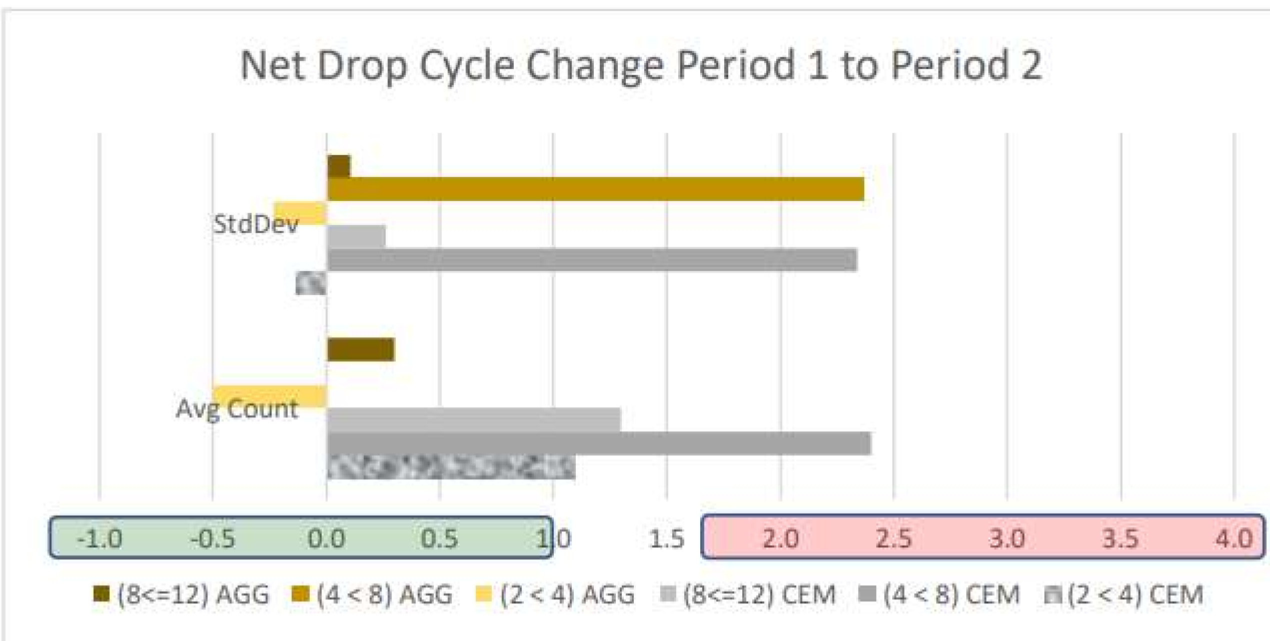

Figure 4 - Net Drop Cycle Change

Figure four (4) provides a visual analysis of how consistently the plant batching is performing between the two periods. In a perfect system, the average count would never change, and the standard deviation would be zero. However, in real life the flow rates of dry materials can vary widely due to load size or by other factors such as bin filling activity. In a stable system, the average numbers should

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bounce around between plus or minus one, with the standard deviation less than one. If this chart shows increasing Average Counts or Standard Deviation (the red section) from one period to another then the batching process is degrading and slowing down. Look for mechanical changes, or the plant automation system needs re-tuned. The need for constant tuning of the plant automation is a sign that the entire system is not working well together and should be investigated for a root cause.

Plant Scorecard Table

The "Materials" section (Figure 5) provides the detailed information about material consumption and identifies areas for long-term savings. The production of concrete within specified material tolerances is required. At the same time, producers are accustomed to a certain amount of over and under batching results, with the hope that in the end it is a "wash."

With the Plant Scorecard a producer can quantify how much material is being over batched and measure the lost material cost. Using other information available from the scorecard, the producer can decide where to invest in plant tuning/training/equipment to reduce material loss due to overages yet be certain other important parameters (i.e. Load Time) is not adversely affected.

Plant: Sample

Material error/costs by period

		[10/01 to 10/21]			[10/22 to 10/28]					
Material	Threshold Range	Over Threshold (Sum/Avg)	Under Threshold (Sum/Avg)	Over/Under Std Dev	Over Threshold (Sum/Avg)	Under Threshold (Sum/Avg)	Over/Under Std Dev	Price Per Ton	Trending Better / (Worse)	Net Material Over / Under Target Cost (Savings)
WATER	'>2' or '<-2'	858 / 0.7	-95 / -0.1	1.3 / 0.5	6 / 0.0	-61 / 0.0	0.3 / 0.3	$ -	$ -	$0.00
FLYFC	'>10' or '<-10'	271 / 0.2	-18 / 0.0	3.9 / 0.6	33 / 0.0	0 / 0.0	1.9 / 0.0	$ 80	$ 8.82	$11.46
CEM1-SILO2	'>10' or '<-10'	534 / 0.4	-9715 / -8.0	7.3 / 13.0	370 / 0.3	-2316 / -1.9	13.3 / 14.4	$ 125	$ (452.17)	-$695.42
NATSAND	'>40' or '<-40'	16869 / 13.9	-17444 / -14.4	150.8 / 26.8	550 / 0.5	-5482 / -4.5	11.0 / 17.0	$ 25	$ 54.46	-$68.83
#57-LIM	'>40' or '<-40'	3476 / 2.9	-16227 / -13.4	19.4 / 20.8	1847 / 1.5	-6042 / -5.0	29.6 / 20.8	$ 25	$ (106.94)	-$211.82
#8-LIM	'>40' or '<-40'	9923 / 8.2	-2744 / -2.3	55.1 / 8.8	770 / 0.6	-762 / -0.6	18.7 / 7.8	$ 25	$ 89.64	$89.84
MANSAND	'>40' or '<-40'	1824 / 1.5	-432 / -0.4	284.1 / 36.6	1704 / 1.4	-600 / -0.5	596.3 / 75.4	$ 25	$ 3.60	$31.20
CEM1-SILO1	'>10' or '<-10'	13282 / 11.0	-9883 / -8.2	176.8 / 15.2	888 / 0.7	-5081 / -4.2	20.4 / 17.1	$ 125	$ 474.52	-$49.58
GGBFS100	'>10' or '<-10'	55 / 0.0	-20 / 0.0	3.0 / 2.1	50 / 0.0	-8 / 0.0	3.9 / 1.3	$ 80	$ (0.28)	$3.08
								(Savings)/Cost from period one to period two	$ 75.37	$ (886.34)
								Not prorated by volume		

Figure 5- Comparison of material batching accuracy by period

This section is divided horizontally into two date ranges. The information is organized side by side for easy comparison. Within each date range the following information is available for each material.	
Column Name	**Description**
Material	The material name
Threshold Range	This parameter provides for setting a "dead band" amount of over and under batching error that is ignored. A good rule of thumb to start is to ignore any errors within two scale graduations.

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Over Threshold (Sum/Avg)	The total and average amount of material batched that exceeded the Threshold Range of the material. This is an area to look for reductions
Under Threshold (Sum/Avg)	The total and average amount of material batched that was under the Threshold Range of the material. The quality control department should provide guidance as to what is expected. The plant automation systems can be configured to batch only to tolerance or to target depending on the manufacturer. Consistent under batching will affect yield.
Over/Under Std Deviation.	The standard deviation provides a measurement of the final material quantity is with respect to the target amount. If the standard deviation is large, then the process is 'out of control' and erraticness is present in the system for that material/device combination.
Price per ton	Estimated cost of the material being evaluated. This is an 'unburdened' rate, the true cost of material is likely higher when all other business handling and processes are considered.
Trending Better / (Worse)	This calculation adds the "Over Threshold" amount and the "Under Threshold" amount together for each period, then adds the two period amounts together. This provides a rough calculation as to the accuracy of the material batching between the two periods.
Net Material Over/Under Target Cost/(Savings)	The net change of material cost (savings/loss) between the two periods. In conjunction with the other calculations this calculation should present savings if adjustments were made in the second period and you want to measure the effect.

Truck Load Time Section

The Truck Load Time by Period section (Figure 6) provides insight into plant function based on four load size "buckets." These buckets are chosen based on general plant and plant automation behavior as load sizes are varied.

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Truck Load Time by period

[10/01 to 10/21]

Load Size	Number of Loads	Weigh Only Complete (mm:ss) (Avg / StdDev)	Load Time (mm:ss) (Avg / StdDev)	Truck Charging Time (mm:ss) (Avg/Std Dev)	Avg. Yds/Hr + Avg. Ld Size	Tol Count/ %Loads
(0 < 2)	107	0:38 / 0:28	1:40 / 0:48	1:02 / 0:42	50.98 / 1.42	56 / 52.3%
(2 < 4)	128	0:39 / 0:19	2:26 / 1:01	1:47 / 0:58	80.16 / 3.26	67 / 52.3%
(4 < 8)	333	0:51 / 0:38	3:22 / 1:12	2:31 / 1:02	117.13 / 6.56	79 / 23.7%
(8<=12)	644	1:06 / 0:39	4:15 / 1:03	3:09 / 0:56	138.77 / 9.83	44 / 6.8%

Note: Loads exceeding 10:00 (mm:ss) in duration are excluded

[10/22 to 10/28]

Cost / Min $1.25

Load Size	Number of Loads	Weigh Only Complete (mm:ss) (Avg / StdDev)	Load Time (mm:ss) (Avg / StdDev)	Truck Charging Time (mm:ss) (Avg/Std Dev)	Avg. Yds/Hr + Avg. Ld Size	Tol Count/ %Loads	Change in Tol Occurs from Per 1 to Per 2	Change in Load Time (mm:ss) for compared periods	Time Save/(Loss) (hh:mm:ss) Period 1 vs Period 2	Value of Time @$1.25/min
(0 < 2)	29	0:32 / 0:16	1:35 / 0:40	1:03 / 0:43	53.92 / 1.42	7 / 24.1%	-28.2%	-0:05	(2:30)	$ (3.13)
(2 < 4)	34	0:38 / 0:18	2:11 / 0:54	1:33 / 0:51	87.73 / 3.18	1 / 2.9%	-49.4%	-0:16	(8:56)	$ (11.16)
(4 < 8)	108	0:48 / 0:33	3:06 / 1:09	2:18 / 1:01	122.40 / 6.32	6 / 5.6%	-18.2%	-0:16	(28:37)	$ (35.77)
(8<=12)	210	1:08 / 0:47	4:01 / 1:12	2:53 / 1:01	147.18 / 9.85	3 / 1.4%	-5.4%	-0:14	(49:33)	$ (61.94)
									(Savings)/Cost from period one to period two	$ (112.01)

Figure 6

This section is divided vertically into two date ranges and by Load Size "buckets." Within each date range the following information is available about the truck loading process.	
Column Name	**Description**
Number of Loads	The number of loads in this period within that load size bucket.
Weigh Only Complete (mm:ss) (Avg/StdDev)	This is the elapsed time required to fill the plant scales with the materials. Metered materials are not included in this calculation and are generally not a bottleneck. The values of average and std deviation should be considered together, with small std. deviation an important measurement to achieve.
Load Time (mm:ss) (Avg / StdDev)	This is the elapsed time required complete the entire batch and place it in the truck. The values of average and std deviation should be considered together, with small std. deviation an important measurement to achieve.
Truck Charging time (mm:ss) (Avg / Std Dev)	This is the average amount of time the system is in the truck loading mode and is calculated as the total time for the load less the "Weigh Only Complete" time. This number can compare plant to plant performance.
Avg Yds/Hr + Avg. Ld Size	Measures the plant performance throughput. This figure can be impacted by operator and/or truck behavior. Refer to the "Operator Performance" section (Figure 7) for additional information.

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Tol Count/% Loads	A count of the tolerance errors in the loads within this bucket and percentage. A measurement of how accurate the plant and automation system are performing.
Change in Tol Occurs from Per 1 to Per 2	This calculation measures the percentage change in the material tolerance errors between the two periods. This would confirm if adjustments made in the second period were successful.
Change in Load Time (mm:ss) for compared periods.	The difference between the average load time between the two periods.
Time Save/(Loss) (hh:mm:ss) Period 1 vs Period 2	Using the "Change In Load Time" calculated above what was the total amount of time saved/lost when batching the loads in the second period with respect to the performance of the first period?
Value of Time @$/Min	Using the cost or savings per minute, what was the impact of the time saved?

Truck Load Time Distribution Charts

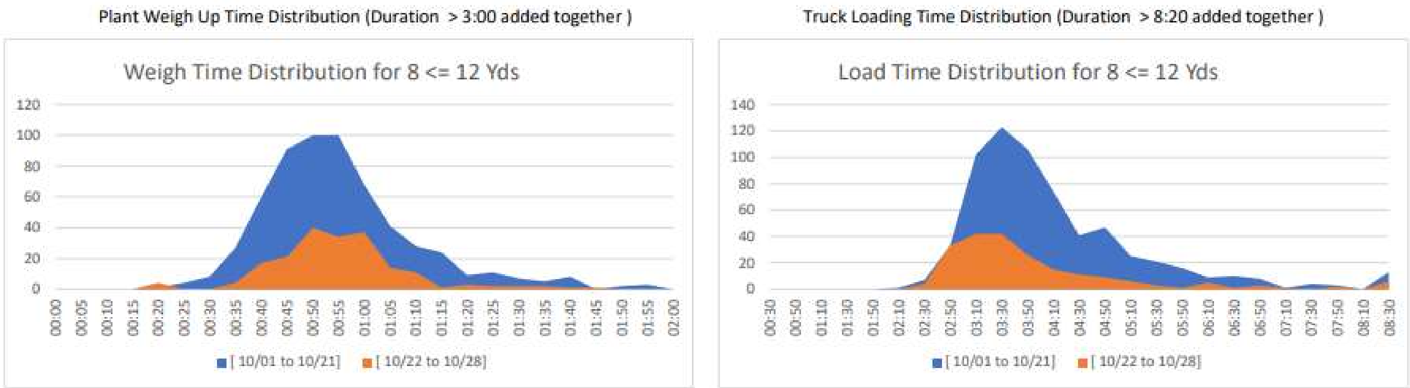

Figure 7 - Weigh Up and Load Time Distribution

According to the table for the two sample time periods the average load time has decreased by 14 seconds. That can add up on a busy morning. While averages and standard deviations are useful, it is helpful to see the charts of the time periods in question to visually ascertain the performance of the plant. Figure seven (7) details the Load Time Distribution for 8<=12-yard load sizes. Similar charts are available for the other load size buckets.

Interpreting these charts requires some statistical prowess, averages can be misleading. For example, Figure eight (8) provides an example of how the average of the Loading time is not the

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same as the where most load durations occur. Although most of the loads are in the 2:50 to 4:30 range, the loads where the duration is greater than 4:30 affect the average. Those loads represent the best opportunity to improve plant throughput.

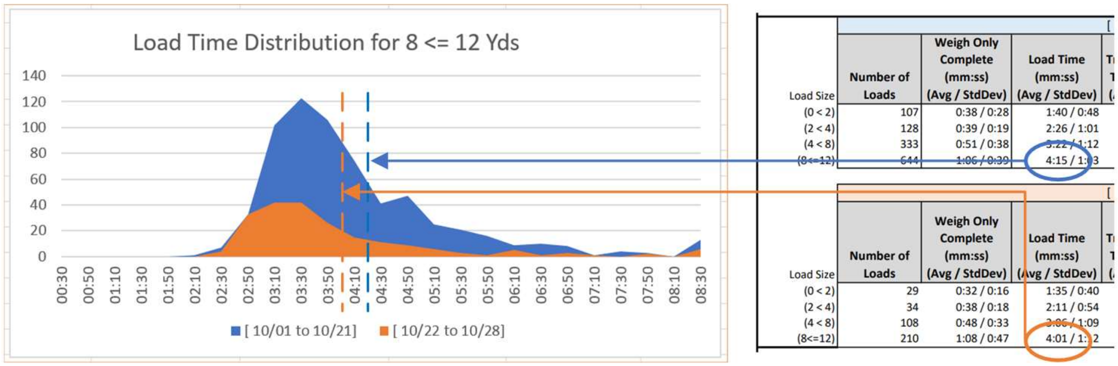

Figure 8 - Relating Data Table to Chart

Figure 9 - Interpreting distribution charts

Figure nine (9) provides guidance about interpreting the distribution charts. These charts provide a sense of the two important measurements: Average Time and Standard Deviation (Std. Dev.) The ability to achieve the average loading time is important as a production metric. However, as shown in the examples std. dev. is just as important. (Note that the plant can only achieve a certain amount of throughput, so the lower limit is ‘greyed out’ as unlikely to occur.

This table summarizes how to interpret the charts:

Chart Name	1 std. dev.	2 std. dev.	3 std. dev.

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Poor Distribution	65% of loads will have a loading time between 4:51 and 7:09	95% of loads will have a loading time between 4:51 and 8:18	95% of loads will have a loading time between 4:51 and 9:27
Good Distribution	65% of loads will have a loading time between 4:38 and 6:18	95% of loads will have a loading time between 4:38 and 7:08	95% of loads will have a loading time between 4:51 and 7:58

Why is this important? With the ability to measure and maintain predictable standard deviations the dispatch teams will have higher confidence with the ability of the plant to produce to the required volume. As such, the company can take more orders for a certain period of time, improving utilization.

Plant Efficiency Section

	Plant Drop Cycle Efficiency by Period				Equivalent Change in Cycles
	[10/01 to 10/21]		[10/22 to 10/28]		
Load Size	Avg / StdDev	Max	Avg / StdDev	Max	
(0 < 2)	34.0 / 11.9	72	34.4 / 12.1	61	47
(2 < 4)	34.0 / 7.0	68	34.6 / 6.3	52	76
(4 < 8)	29.9 / 6.8	59	31.1 / 9.7	82	389
(8<=12)	28.3 / 7.3	64	29.2 / 7.6	68	569
	Cycles difference from period one to period two				1082

Figure 10 – Plant efficiency

This section (Figure 10) provides insight into plant function again based on four load size "buckets." This section allows analysis of how efficiently the system is batching the load of concrete based on the total amount of cycles or steps required. Each cycle can be important; every movement of material from a bin/silo to a scale requires a scale settle delay time, typically 2 to 4 seconds each. Reducing the number of cycles to load the truck directly impacts truck loading time. This information can be used to interpret the 'Truck Load Time' and 'Material error/costs by period' sections outlined above.

As before, this section is divided horizontally into two date ranges and vertically by load size "buckets." The information is organized for easy comparison. Within each date range the following information is available about the plant batching process.

The top table in this section provides the average, standard deviation, and maximum number of plant cycles that occurred for all batches in that load size bucket. A plant cycle includes anything that the plant automation system performed during the process: material feeds/discharges, admix dispenser control, belt start/stop, etc. The column (Equivalent Change in Cycles) measures the change (for better or worse) between the two periods <u>based on the number of loads in the first period,</u> i.e., the difference between the average drop cycles from period 2 to period 1 multiplied by

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the respective number of loads in period 1. This is done as to provide the relative effect of a parameter change as it would have affected the first period. As shown here, a small change in plant cycles can add up to large numbers over time which then affects mechanical wear and equipment longevity.

Be advised the type of mix designs can influence these calculations. If one plant is running only two aggregates in their mixes, and another plant is running three, then the second plant is going to look statistically "worse" because of an increase in the average drops. This may not be statistically relevant, but the reader is advised to keep this in mind.

The next figure (11) provides insight into how each material group is performing by showing the average and std. deviations of the drop cycles. This can serve several purposes. For an individual plant, significant changes to the number of drop cycles between periods suggest that some mechanical or plant automation system parameter adjustment is necessary. For a group of plants, the operations manager can easily see what plants are performing better than others.

	Plant Drop Cycles by Material Type			
	[10/01 to 10/21]		[10/22 to 10/28]	
Load Size	1 AGG	2 CEM	1 AGG	2 CEM
(0 < 2)	3.0 / 2.5	8.7 / 8.1	2.6 / 1.8	10.2 / 8.3
(2 < 4)	3.1 / 2.1	5.9 / 4.6	2.6 / 1.9	7.0 / 4.4
(4 < 8)	2.7 / 1.8	3.6 / 4.3	2.7 / 4.2	6.0 / 6.6
(8<=12)	2.2 / 1.9	2.8 / 3.9	2.5 / 2.0	4.1 / 4.2
Load Size	3 WAT	4 ADX	3 WAT	4 ADX
(0 < 2)	3.8 / 0.8		3.9 / 1.3	
(2 < 4)	4.0 / 0.6		3.6 / 1.9	
(4 < 8)	3.9 / 1.0		1.6 / 1.1	
(8<=12)	4.2 / 2.4		1.1 / 0.6	

Figure 11 – Material Group Drop Cycle Counts period comparison

Operator Alerts Section

This section provides measurement of external interruptions (Figure 12) the operator must process while operating the plant.

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	Operator Alerts by Period			
	[10/01 to 10/21]		[10/22 to 10/28]	
Load Size	ScaleEmpty	SourceEmpty	ScaleEmpty	SourceEmpty
(0 < 2)	36 / 34%	0	6 / 21%	4 / 14%
(2 < 4)	26 / 20%	1 / 1%	2 / 6%	1 / 3%
(4 < 8)	65 / 20%	1 / 0%	3 / 3%	7 / 6%
(8<=12)	107 / 17%	4 / 1%	2 / 1%	2 / 1%

Figure 12

"Scale Empty" events are messages to the operator that the material scale value at the start of the batching is either over or under the allowed empty tare range. This usually can be an easy fix and the plant automation parameters should be reviewed.

"Source Empty" events are when a drop cycle feed expires out due to lack of material. This could indicate a mechanical problem or a systemic material replenishment issue.

Operator Performance

The last section of the report (Figure 13) provides measurement about the operator activity. As mentioned earlier, there are other factors in addition to the plant automation that affect plant production.

	Operator Performance			
	[10/01 to 10/21]		[10/22 to 10/28]	
	Total	Avg/Load	Total	Avg/Load
Ticket in Queue Duration (m:ss)	4:22:28:23	5:52	1:7:46:47	5:00
Ready To Disch Wait (m:ss)	0:00	0:00	0:00	0:00
Notification Confirm Wait (m:ss)	5:31:10	0:16	1:08:53	0:11
Operator Alert Count	865	0.71	94	0.25
Feed Abort Events Count	50	0.04	7	0.02
Ingredient Hold Event Count	224	0.18	34	0.09
Manual Feed Event Count	27	0.02	0	0.00
Water Trim Count	255	0.21	78	0.20

Figure 13 – Operator Performance Metrics

This section is divided horizontally into two date ranges and vertically by Load Size "buckets." Within each date range the following information is available about events that affect the operator efficiency.	
Column Name	**Description**

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Ticket in Queue Duration (mm:ss)	This is the total time after tickets were created (i.e. sent by dispatch) but the batch was not started. Large delays here affect delivery time.
Ready to Disch Wait (in mm:ss)	This is the duration of time the plant automation system had the batch ready to discharge into the truck (i.e. material is 'in the scales" but was delayed due to the operator not authorizing the discharge.
Notification Confirm (mm:ss)	This is the amount of time the plant automation system waited for the operator to respond to an error message. This delay may hold up the production process. As discussed above, some of these events can be eliminated by parameter adjustments.
Tolerance Error Count	Total count of tolerance errors by period. These are useful to monitor as each one serves as an 'interruption' to the operator's attention. It also provides plant by plant comparison of performance.
Feed Abort Events Count	The number of times the operator was required to intercede in the plant automation process. This likely required some manual intervention by the operator which is always a source of potential error.
Ingredient Hold Event Counts	The number of times the operator was required to intercede in the plant automation process. Generally, this points to inadequate material handling process in the plant or faulty equipment.
Manual Feed Event Count	The number of times the operator added material into the load by hand. Adding material by hand is an opportunity for quality control breakdown.
Water Trim Count	For companies concerned about water control in the concrete, this provides a measurement of how much your company is depending on the operator to adjust the water in the load.

*** End of Overview ***

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