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CASTING EXCELLENCE

INNOVATION & SUCCESS

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OEE
(Overall Equipments Effectiveness)
For the Die Cast Process

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Visi-Trak®

SENSE, MONITOR, CONTROL

What is OEE ?

- OEE, "*Overall Equipment Effectiveness*", is a percentage indicator which represents the global performance of a production resource or set of resources, whether human or technical, during the time in which these are available to produce.

The definition of "classic" OEE

OEE = Availability x Performance x Quality

A x P x Q = OEE

What is OEE ?

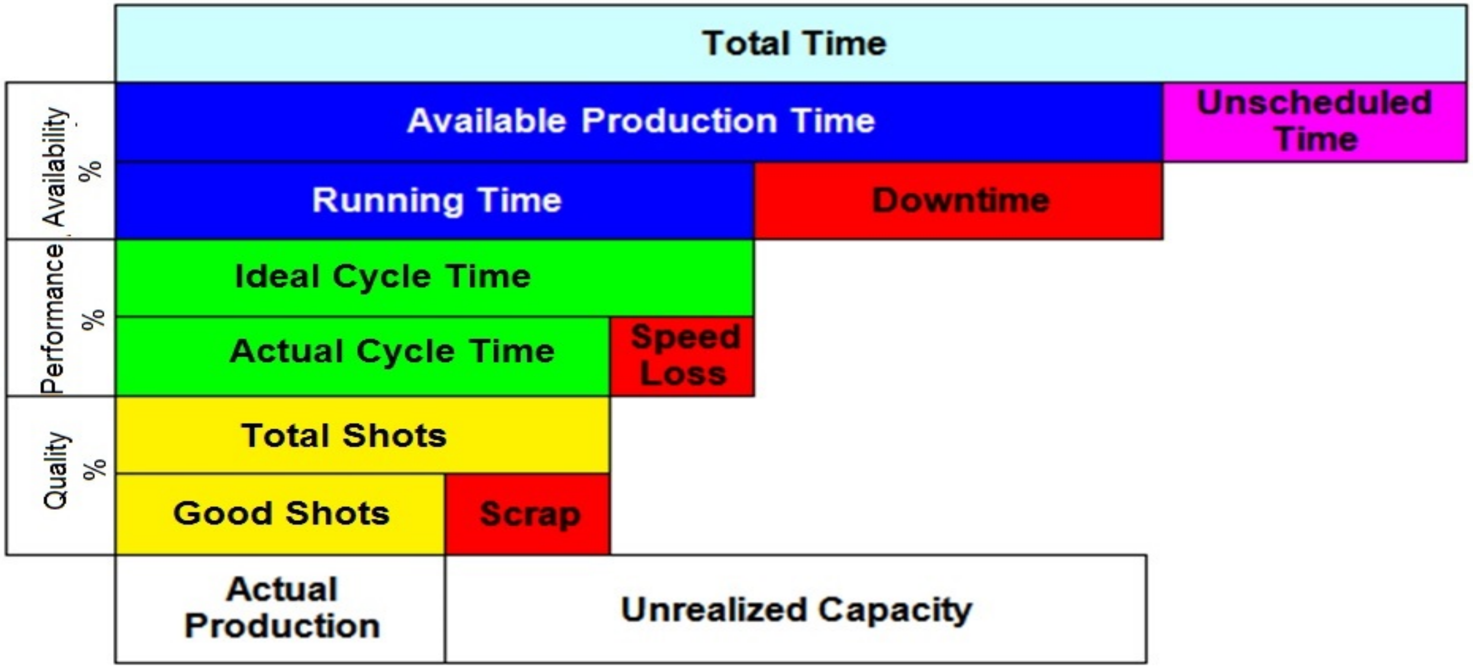
OEE = Availability x Performance x Quality

- **Availability**: The percentage of the actual activity time in which production resource are available;
- **Performance**: percentage of parts produced compared to the theoretical potential rate when the system is operating (corresponding to actual production rate compared to the nominal rate);
- **Quality**: The percentage of compliant parts over the total number of produced parts.

Classic OEE Model

OEE is therefore a dimensionless number (i.e.,%) which takes into account the three main categories of production losses:

- **Faults, setup and tooling;**
- **Operating work Reduction, downtime and micro downtime ;**
- **Scrap, re-work and start yield losses.**



An improved OEE Model

- The classic OEE model, however, may become difficult to apply in the context of production which presents machines with dimensions, (and particularly with cycle times) significantly different. Same critical application could derive from diversified nature of products and different requirements for single parts. A situation which is quite common in die-casting production facilities.
- **As a response to these requirements OEE, like all efficiency indicators, can be expressed through an OUTPUT / INPUT report.**
  - **resources to produce value for the customer (output)**
  - **defined number of productive resources available (input).**
- The measurement of these elements (input and output) is defined through the concept of **Working Standard Time**: time required for the execution of a given operation through known instruments, tools, operational methods and procedures.
- Thus, an improved calculation of OEE can be implemented as follows:

Improved Calculation of OEE

$$OEE_{☆} = \frac{output}{input} = \sum_{i=1}^{n} \frac{T_{StdWk} * N_{Compliant\ Parts}}{H_{available}}$$

Being *i* the variety of different parts/products/productive resources.

Why introduce OEE as

- The introduction of OEE management/control can have concrete and important effects.
- Typically, a production system that has never faced a project to improve efficiency stands at the OEE values of no more than 50-60%.
- The best producers, however, achieve and maintain over time an OEE of 85%, considered a "world class" goal.

- OEE scores provide a very valuable insight and accurate picture of how effectively your manufacturing process is running.
- It also makes easy to track improvements in that process over time.

An Example: *OEE data for two sequential weeks*

OEE Factor	Week 1	Week 2
OEE	80.1%	80.7%
Availability	89.0%	93.0%
Performance	90.0%	94.0%
Quality	91.5%	87.0%

OEE is improving. Great job!
Or is it?
Dig a little deeper and the picture is less clear.
Most companies would not want to increase Availability by 4.0% at the expense of decreasing Quality by 4.5%.

A Calculation Example:

Now let's work through a complete example using the preferred-OEE-calculation. Here is data recorded for the second shift:

Item	Data
Shift Length	8 hours (480 minutes)
Breaks	30 minutes
Down Time	47 minutes
Ideal Cycle Time Ideal Run Rate	57.0 seconds 0,95 shots / minute
Total Count	394 shots
Good Count Scrap Count	362 shots 32 shots

Calculation 1

PLANNED PRODUCTION TIME

The OEE-calculation begins with Planned Production Time.
So first, exclude any Shift Time where there is no intention of running production (typically Breaks)

Planned Production Time = Shift Length – Breaks = 480 – 30 = 450 minutes

RUN TIME

The next step is to calculate the amount of time that production was actually running (was not stopped). Stop Time should include both Unplanned Stops (e.g., Breakdowns) or Planned Stops (e.g., Changeovers). Both provide opportunities for improvement.

Run Time = Planned Production Time – Downtime = 450 – 47 = 403 minutes

GOOD COUNT

If you do not directly track Good Count, it also needs to be calculated.

Good Count= Total Count – Scrap Count = 394 – 32 = 362

Calculation 2

AVAILABILITY

Availability is the first of the three OEE factors to be calculated. It accounts for when the process is not running (both Unplanned Stops andPlanned Stops).

A = Run Time / Planned Production Time = 403 / 450 = 0,8955 = 89.55 %

PERFORMANCE

Performance is the second of the three OEE factors to be calculated. It accounts for when the process is running slower than its theoretical top speed (both Small Stops and Slow Cycles).

P = Ideal Cycle Time x Total Count / RT =
57.0 x 394 / (403 x 60 seconds) =
0,9287 = 92.87%

Performance can also be calculated based on Ideal Run Rate. The equivalent Ideal Run Rate in our example is 0,95 shots per minute.

P = (Total Count / RT) / Ideal Run Rate = 394 / 403 x 0,95 =

Calculation 3

QUALITY

Quality is the third of the three OEE factors to be calculated. It accounts for casting parts that do not meet quality standards.

Q = Good Count / Total Count = 0,9187 = 91,8%

OEE

Finally, OEE is calculated by multiplying the three OEE factors

OEE = A x P x Q = 0,8955 x 0,9287 x 0,9187 = 0,7640 = 76,40 %

OEE can also be calculated using the simple calculation.

OEE = Good Count x Ideal Cycle Time / PPT =
362 x 57.0 / (450 x 60 sec)
= 0,7640 = 76,40 %

**The result is the same in both cases.
The OEE for this shift is 76,40 %.**

Constant Monitoring of OEE

CONSTANT MONITORING OF OEE
As previously set out, a practical manner and particularly efficient to control the OEE indicators it is to follow a temporal monitoring scheme.

OEE dynamically calculated

- **Since the Beginning of Production**
- **Since Shift start (or possibly since the beginning of the work day)**
- **Since last hour**

To have a panoramic view dynamic, and adhering to the process in real time.

A real Example

Last hour OEE:

- DCM is in production (DCM is assumed to work): Planned Production Time = 60 min
- DCM has been down only for 17 min during last hour
- (Run Time = 43 min)
- DCM has an ideal cycle time of 58.5 sec
- DCM has done 43 shots
- DCM has done 40 good shots and 3 scrap
- A = 43 / 60 = 0.7166
- P = 58,5 x 43 / (43 x 60 sec) = 0.975
- Q = 40 / 43 = 0.9302

OEE (hour) = 0.7166 x 0.975 x 0.9302 = 0.6499 64.99 %

A real Example

Last Shift OEE:

- DCM is assumed to be operating.PPT = 60 min x 8h = 480 min
- DCM has been down for 64 min during shift (Run Time = 416 min)
- DCM has an ideal cycle time of 58.5 sec
- DCM has produced 408 shots
- DCM has produced 380 good shots and 28 scrap
- A   = 416 / 480 = 0.8666
- P   = 58,5 x 408 / (416 x 60 sec) = 0.9565
- Q   = 380 / 408 = 0.9313

OEE (Last Shift) = 0.8666 x 0.9565 x 0.9313
= 0.7720 77.20 %

A real Example

OEE from Production Begin

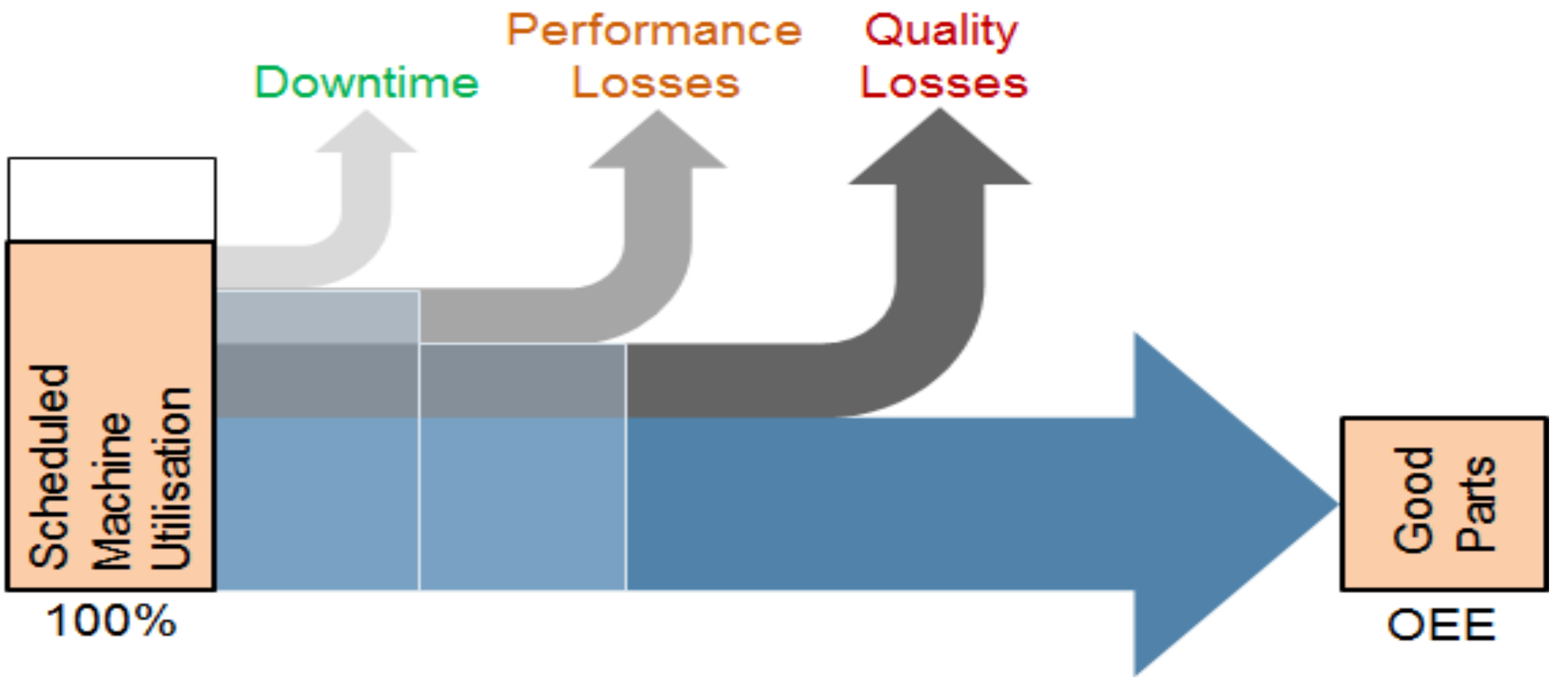
- **Production began 2 weeks ago.**
- **DCM was assumed to be operating 5 days/week on 3 full shifts**
- **Planned Production Time = 480 x 3 x 5 = 14400 min**
- **DCM has been down for 1964 min (Run Time = 12436 min)**
- **DCM has an ideal cycle time of 58.5 sec**
- **DCM has produced 11859 shots**
- **DCM has produced 11444 good shots and 415 scrap**
- **A = 12436 / 14400 = 0.8636**
- **P = 58,5 x 11859 / (12436 x 60 sec) = 0.9297**
- **Q = 11444 / 11859 = 0.96500**

OEE (Production) = 0.8636 x 0.9297 x 0.965
= 0.7747 77.47 %

A quick consideration: the process is having a loss of performance during current shift and particularly during last hour.

Conclusions

After OEE benefits description and calculations examples particular attention must be paid to the practical application of this indicator in monitoring the process and reality of the production of foundry,
The OEE calculation does not automatically improve productivity. It must be combined with a detailed and careful analysis of the reasons for the reduced productivity.

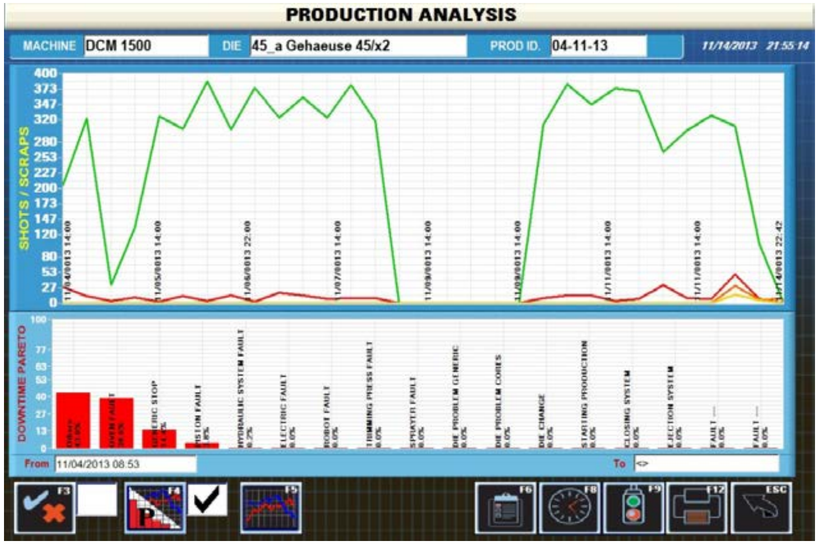


Conclusions

Here below some specific indications to implement actions for improving OEE index specifically for Die Casting.

Ways To Improve Uptime

- Effective preventive maintenance
- Shot control
- Increase tool life
- Monitor and control die temperature using heat units
- Decrease setup time
- Accurate Downtime Analysis

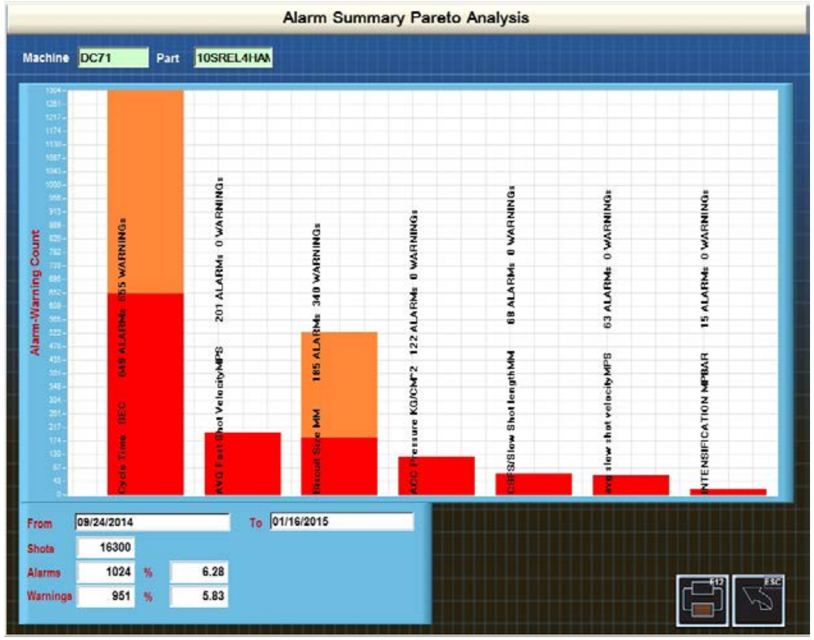


Ways To Improve Performance

- Decrease cycle time. First implement systems for cycle time analysis dividing cycle time into technical steps (clamping, pouring, injecting, opening, extracting, spraying, trimming etc.)
- Minimize brief interruptions. Analyze short downtime origins. Decrease flashing with low impact.
- Process control and temperature control: manage thermal balance in die with thermographic monitoring systems.

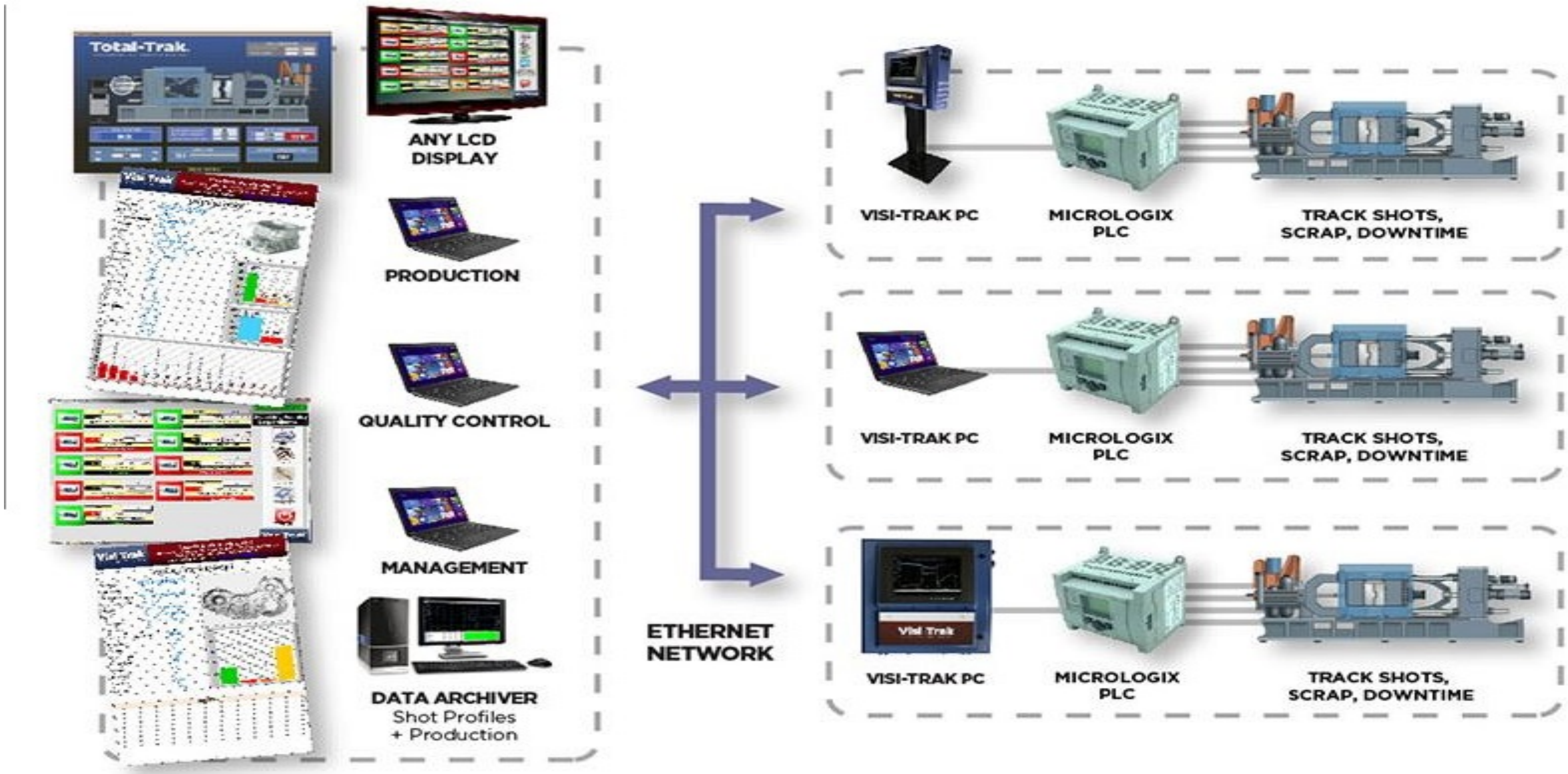
Ways To Improve Quality

- Detect problem in real time using process control systems.
- Set high/low limits to key parameters and then countermeasures in a timely manner
- Repeatability
- Implement data collection and SPC Statistical Process Control to detect process variations.
- Implement Pareto Analysis over Scrap.



To Produce Economically In High Pressure Die Casting

- understand the cost portions of a die casting production
- know the sensitivities for cost reduction



Thanks for your attention and for the patience that you have granted.

References

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