Development of Business Intelligence Reports for KPI Management on a Bauxite Mine

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Abstract

This paper describes real time management of mining, stripping, quality, crushing and maintenance of mobile equipment. For this study, business intelligence is used to support decision making, by preparing customized reports containing online, daily and monthly bauxite mine data. For automated report design, the needs of the mining operation, production planning and control, mine planning and mobile equipment management areas were mapped to create dashboards with Key Performance Indicators (KPI) management information. Additionally, the Server Management Studio (SQL) query was created containing data directly collected from dispatch system report server, and the Microsoft Power BI tool was also used to manage and control mining production and stripping indicators. The automated management of indicator's data resulted in KPI data optimization, data conversion into real time information, support to decision making, real time KPI management and information accuracy.

Keywords: Automation, monitoring, data optimization, management, dispatch system.

1. Introduction

As time goes by, the search for technological innovation in the production processes of the companies becomes the rule. Real time management of mining, stripping, quality, crushing and equipment maintenance indicators help dispatch system controllers to make timely and correct decisions about the changes needed relying on increased information accuracy thereby improving data control, optimizing processes through an intelligent database manager, adding efficiency to data control, optimizing processes using the intelligent database manager and resulting also in improved management by using the Power BI tool in the real time strategies of mine and plant and maintenance KPI's to consolidate graphic reports to monitor the achievement of production and physical indexes. Hence, the advancement of the automation of processes and data and, consequently, of machinery, becomes more frequent leading to productivity gains, quality improvement, cost cutting, online data monitoring management, support to the decision making process, increased task implementation safety and better corporate business management strategy. This paper presents the digital transformation of raw data into real time information in the mining, stripping and maintenance processes through optimized reports using Server Management Studio (SQL) queries and the Power BI software, enabling to build dashboards with tables and graphs.

1.1. History of the Industrial Evolution

Before reaching the current status there was a long process of industry transformation generally known as fourth industrial revolution or 4.0 industry.

The first industrial revolution started in the 19th century with mechanization and generation of mechanical energy, allowing the automation of a whole set of manual tasks.

The second industrial revolution was hallmarked by the use of electricity for mass production of goods leading to increasing productivity and the size of the industries. However, production of customized products was still unfeasible.

The third industrial revolution came about in the mid-sixties from automation using electronic systems with low operating costs.

Today we are in the fourth industrial revolution that was triggered by the development of Information and Communications Technologies (ICT). Its technological basis is the smart automation of cyber-physical systems with decentralized control and advanced connectivity (IoT functionalities) [3].

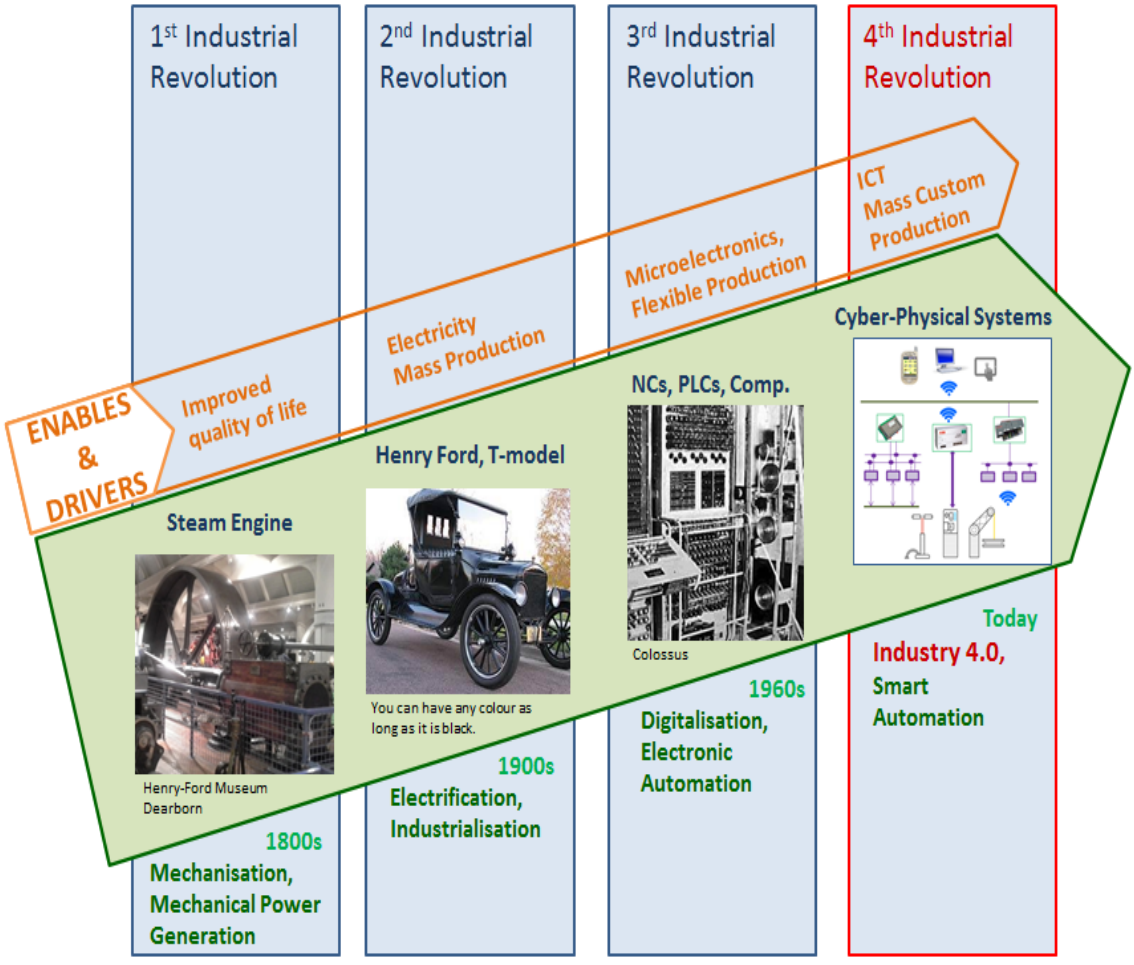

Figure 1. The four stages of the Industrial Revolution [3].

1.2. Server Management Studio (SQL)

The Database of a company is the main data storage safety tool because of high capacity and processing restrictions. A database allows us to collect data with online transactions using the Server Management Studio (SQL) for intelligent database management, enabling real time connection with the database server.

By using the Server Management Studio (SQL), online data queries control and monitor the processes of the optimized indicators as this software enables retrieval of all production, handling, total hours in the mining processes, stripping and maintenance data more efficiently and much faster.

Through the SQL query, less time is needed for a specific query to company customized reports, once, through scripts, we can export data from tables and server functions.

Figure 2. Server Management Studio (SQL).

1.3. Data Visualization

Data visualization and interpretation have an increasingly critical role to play in the corporate world. The need for fast and efficient interpretation of a significant amount of data requires the use of graphic tools to support strategic decision making.

Data visualization is representing data in some systematic form including attributes and variables for the unit of information [2].

Visualization-based data discovery methods allow business users to mash up disparate data sources to create custom analytical views. Advanced analytics can be integrated into the methods to support creation of interactive and animated graphics on desktops, laptops, or mobile devices such as tablets and smartphones [1].

In the mineral industry a significant amount of information is handled on a daily basis, and fast and effective analysis of such data poses a major challenge. To overcome it, we need data visualization techniques and software, as for example, the Microsoft Power BI, which is a business intelligence system for company data management. This tool enables importing data from different sources, as for example, from Excel, internet and the database server, to produce interactive reports for easy visualization of each process indicators. We can also share the reports with company areas with a vested interest in the information through computers and smartphone apps with automatically programmed updates.

Figure 3. Power BI.

1.4. Performance Indicators of a Company (KPI's)

The key performance indicators called KPI's are company-defined indicators used to monitor and manage the operations of each process to the keep the focus on and control the evolution of each process in terms of productivity, quality, production capacity, carriage capacity, fleet sizing and strategies. Through KPI control we can mitigate deviations and maximize the specific gains of each process, as the information the managers need in their areas is made available faster and more effectively, enabling correct decision making and, consequently, positive results in their management areas.

The key performance indicators allow us to manage the performance of each process of a company based on its specific and global targets and, thereby, the organization is capable of real time and accurate monitoring of its indicators to make the correct decisions in order to achieve the set targets.

The indicators can handled through manual control of Excel spreadsheets and also using software automatic data, with information by shift, time, day, month and year. The indicators are also used by managers to mitigate the performance of the processes of their teams along a period pre-established by the company.

Figure 4. Key Performance Indicators.

2. Methodology

The methodology of this study is based on the database of dispatch system report server that contains a full range of information on the processes of mining operations, stripping, mine infrastructure and maintenance, where these data were queried using reports customized by the company.

The dispatch system database contains all the information on production and handling, movements, available hours, worked hours and effective hours that is retrieved by manual web queries based on the needs of each area, therefore turning the preparation of reports more time consuming, prone to process errors and inefficiency, due to individual collection of each data to prepare the reports, generating rework and forwarding of inaccurate, delayed information to the managers. The manual work of retrieving data, generated a backlog of activities and delays in data treatment and generation of corporate reports.

Accordingly, with the purpose of optimizing information data faster and with added accuracy, it was necessary to change system raw data in the dispatch system into real time information to minimize deviations and maximize the management of mine operation indicators, production planning and control, mine planning and equipment maintenance.

Queries were then designed to this end using the Server Management Studio (SQL) to retrieve data directly from the dispatch system report server and also using the Microsoft Power BI tool to manage the indicators by creating dashboards containing online, daily and monthly KPI information, using graphs and tables.

This technological innovation enabled by the Server Management Studio (SQL) and Power BI software optimizes operational performance information, thus helping dispatch controller and

organization managers to make timely decisions to ensure that day targets and, consequently, month and year targets, are achieved.

3. Results and Discussion

Business intelligence is used to support the decision making process based on evidences of process data and planning of subsequent actions, by issuing customized reports with online, daily and monthly indicator data and thereby improving the monitoring accuracy of each area.

With the automation of each process data using the Power BI tool, visual reports were created for the processes of mining, stripping, mine planning, crushing, fatigue events and equipment maintenance.

For the preservation of company information, the data shown in this section are fictitious.

The dashboard panel of the operational report of the fatigue event monitoring system is shown in Figure 5.

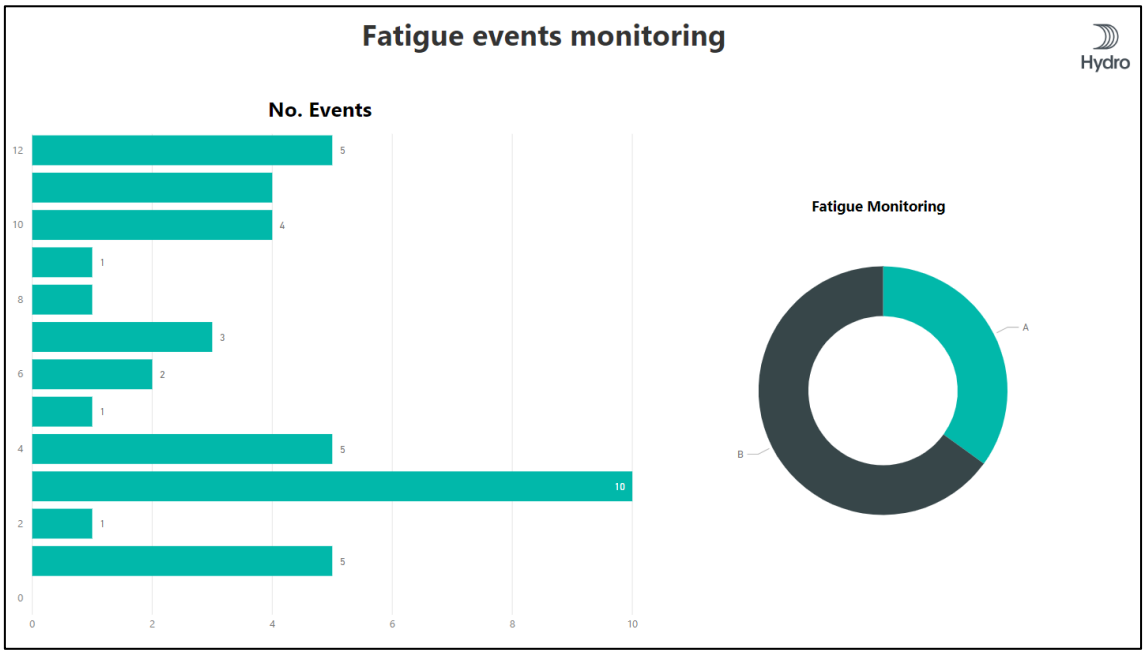

Figure 5. Mining and Stripping Indicators.

For the mining processes reports, were prepared on production, cargo control, supply and crusher feed comparison indicators as these are key indicators for Run of Mine (ROM) production, mine tail handling and the use of mining and stripping equiment.

Examples of the reports resulting from mine performance indicators are presented in Figures 6.

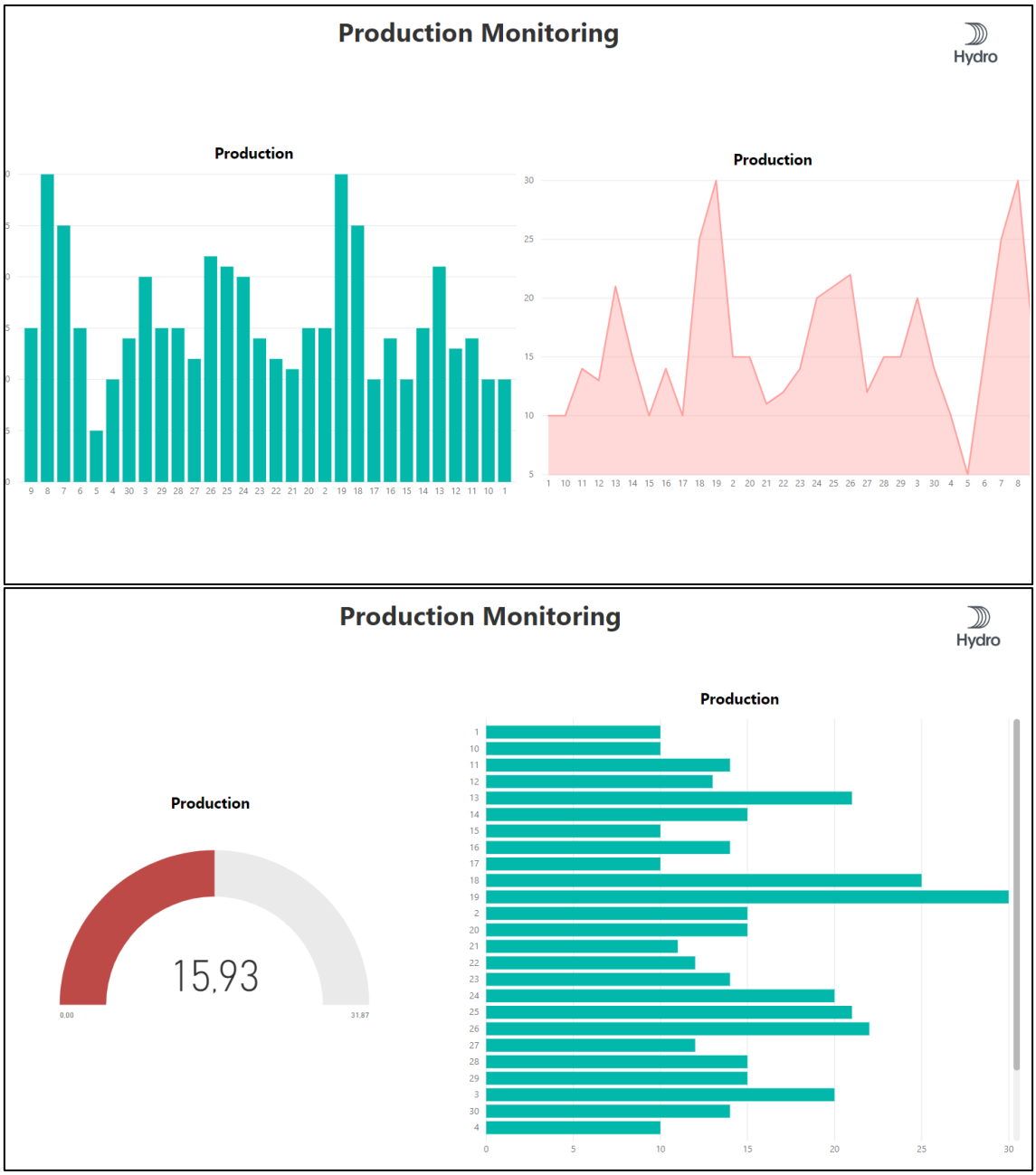

Figure 6. Mining and Stripping Indicators.

Pareto reports were produced on the operational losses for analysis of main losses during unproductive hours and operational delays. The objective of this type of management is to minimize the deviations that impact mining and stripping processes, thus reducing the operational losses in effective hours.

By managing the operational losses in real time, dispatch system controller can act effectively on the strategies and simulations using the automated dispatch system to minimize unproductive hours and operational delays.

Examples of operational loss indicator reports are presented in Figures 7 and 8.

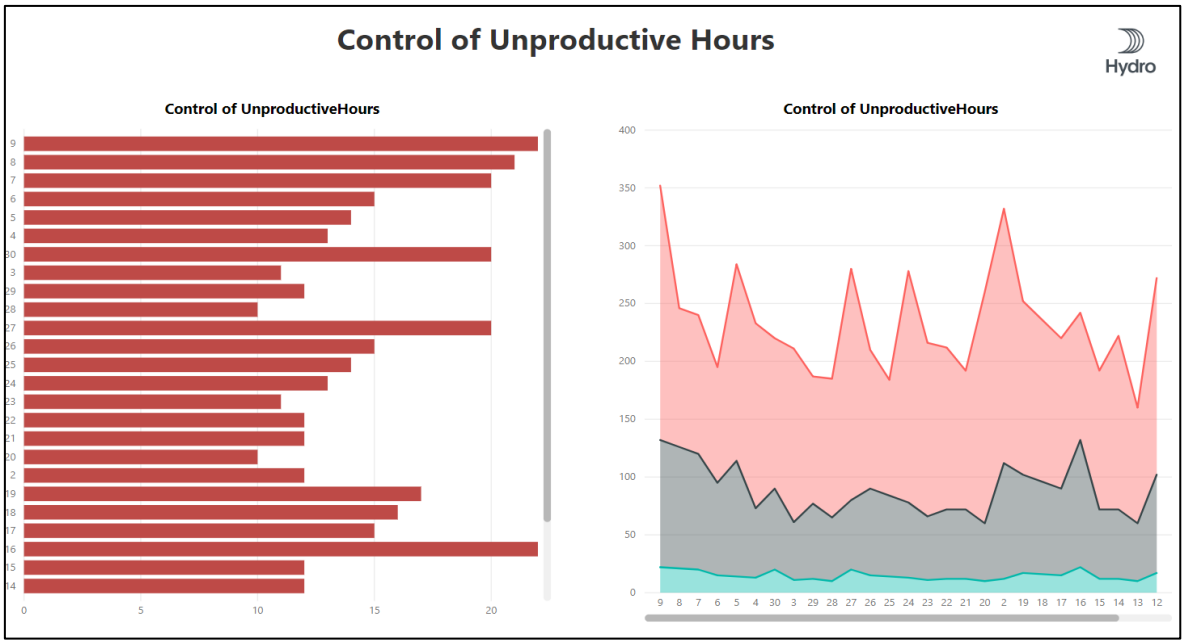

Figure 7. Control of Unproductive Hours.

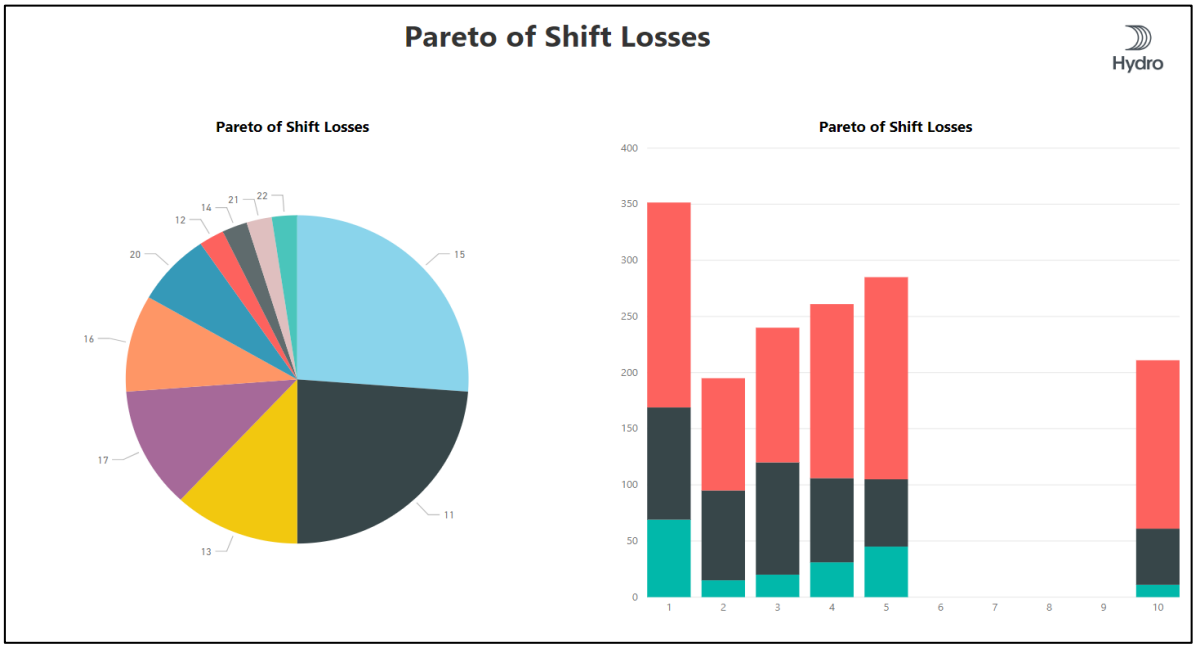

Figure 8. Pareto of Losses.

The automation of crushing feed quality data in real time enables accurate control of how the mine is feeding the processing plant, allowing fast and efficient strategic decisions.

The objective of real time quality control is to monitor the formation of ore blend from crushing feed and, consequently, to minimize the variability of planned versus achieved quality. Accordingly, the actions taken, and the procedures adopted to provide support in real time optimize the decision making process in the quality control, dispatch, geology and mine planning areas.

These are some of the actions implemented along the study: addition to the weekly mining plan of information on share (%) per mine and inventories to be used daily to feed crushing; set up of

quality database for each mining front; monitoring by the dispatch system with online update of feed to crushing accomplished along the day; design of the decision matrix based on planning and assessment information.

The implementation of the proposed actions/procedures resulted in improved service to the client (Processing Plant) according to the quality considered in the weekly and monthly forecast, increased synergy between the areas, lower variability of planned versus achieved quality and enabled real time quality control and higher information accuracy. Additionally, you can assist decision making, optimize the response time for adjustment of deviations and online monitoring of mass and share (%) of crushing feed.

Figure 9 shows examples of reports resulting from crushing feed quality indicators.

Figure 9. Crushing Feed Control.

4. Conclusion

Data automation using business intelligence tools resulted in increased accuracy of monitoring of the mining, stripping, quality, crushing and mobile equipment maintenance activities at the Bauxite mine. The use of this tool also enabled to program automatic updates.

Access to real time process information was enabled by preparing reports optimized with the Server Management Studio (SQL) and Power BI in the dispatch system and in the management and control of mining and stripping indicators, respectively.

Real time management and, above all, the interactive management of the indicators presented in this paper proved to be of utmost importance to support the decision making process and to the planning of activities at the Bauxite mine, thus ensuring information accuracy.

5. References

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