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INCREASING EQUIPMENT AVAILABILITY WITH CERN's ENTERPRISE ASSET MANAGEMENT PLATFORM

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Abstract

Properly managed asset and maintenance processes is key for minimizing unplanned downtime and to ensure efficient operations of any large-scale technical installation, including particle accelerator complexes. CERN has therefore over the last years significantly increased its use of a commercial EAM (Enterprise Asset Management) platform in order to support such efforts. With its advanced maintenance management functionality and built-in industrial best practices, more than 40 equipment groups at CERN are today relying on this software platform, to manage their installations. This does currently not only cover equipment inventories and work order management, but also storerooms with spare part handling and contract management capabilities for outsourced services. Several initiatives have in addition been launched to strive towards more elaborate maintenance practices such as condition-based and predictive approaches, using additional data sources including SCADA systems and IoT devices. While continuously extending and tailoring the EAM and its use at CERN, a strict policy of zero customization of it is applied, in order to stay 100% compatible with future versions.

BACKGROUND

Using computerized tools for supporting asset and maintenance related processes is nothing new at CERN. The Organization has in fact been using such information systems since the early 1990s [1], but what has accelerated over the last years is to what extent these tools now are used, both in terms of width and depth. Whereas only a handful of equipment groups initially were involved, the community has presently grown into over 40 groups distributed throughout the entire Organization. Additionally, the level of advanced capabilities that currently are leveraged with these tools is also much beyond the original scope.

However, a main principle that remains unchanged, is the overall approach of CERN to use a commercial product to support these efforts. The EAM (Enterprise Asset Management) system in use at CERN has been known by different names over the years, but is today called HxGN EAM [2]. By using a commercial product, CERN has been able to benefit from industrial best practices while minimizing the need of developing, maintaining and supporting its own specific software. In addition, with several other research organizations using the same application, it has not only been possible to exchange about the concepts and methods with peers in the research domain, but also to share solutions, experience and lessons learned.

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EQUIPMENT AVAILABILITY

Equipment availability can in its most simplistic form be defined as the total amount of time the equipment runs, versus the time it was scheduled to run. This is consequently the result of a number of technical parameters and different external causes, but it is to a large extent also strongly depending on the implemented asset and maintenance management practices. An EAM platform, such as the one implemented at CERN, assists in improving such processes by for example tracing, analyzing and optimizing the mix of executed corrective, preventive and predictive maintenance, with the goal to minimize the number of breakdowns or operational interruptions. It also helps in managing spare parts to ensure their availability when needed and to make sure that technical data and other key information, such as documentation, is quickly accessible for equipment that might need immediate intervention.

The following sections of this paper will detail some recent and practical examples of how CERN's EAM have been configured and extended to provide such capabilities.

MOBILE USER INTERFACES

It is important to remember that an EAM platform, with all its functionality and possibilities, will never be better than the data it stores. One effective method to improve data quality is to capture asset and maintenance data as close as possible to the location where it is generated, for example using mobile devices. At CERN, a simplified and highly configurable mobile user interface, called EAM Light (Fig. 1), was therefore developed on top of the commercial platform. A first version was made available in 2012 [3], but EAM Light has since then evolved in several phases and underwent a complete technical overhaul in 2022.

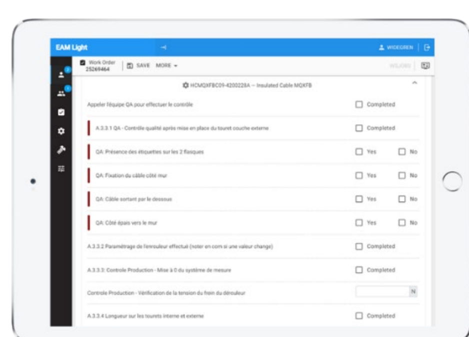

Figure 1: CERN's EAM Light user interface.

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With such a lightweight interface, leveraging the configurability of the underlying EAM system, data entry via mobile devices has been highly facilitated. In fact, the originally set goal was very ambitious and aimed at providing a data capture alternative, both easier and faster than using pen and paper. Today, many users already agree that this is currently the case.

This has, among other things, allowed CERN to massively replace previously used paper forms or unstructured comments with digital checklists. As data entered in a checklist is highly structured, in-depth analysis of data, its trends and correlations with other data sources, can now be carried out. This has opened doors for both condition-based and predictive maintenance practices, which are important pathways towards increased equipment availability.

Currently more than 1 million checklist entries are captured per year at CERN. By doing so, this digitalization of information, has unlocked access to important data that previously was hidden in scanned paper forms or in many cases not stored at all. It is also important to highlight that the majority of this data is entered via mobile devices using EAM Light, which currently is used by around 1500 users per quarter and the overall trend is still growing (Fig. 2).

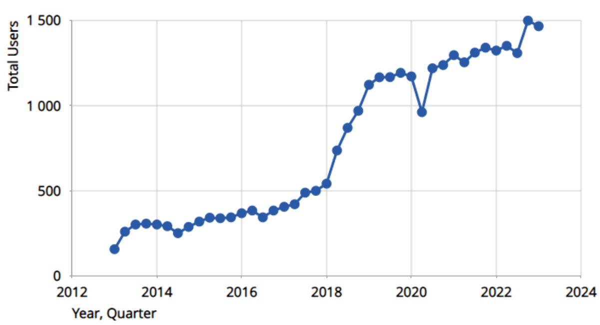

Figure 2: Number of EAM Light users per quarter.

Mobile and simplified interfaces have in addition reduced the delays between data generation and data entry significantly, while also providing key information to intervening personnel in the field, for example during urgent corrective repairs, which has proven important in minimizing the equipment downtime.

Thanks to attention put into providing a simple and intuitive user interface design, EAM Light has significantly increased the user acceptance of these tools and the implicit formalism that an EAM application introduces. This has proven particularly important in research environments with traditionally rather informal processes, but interest has also been expressed from industries with similar challenges. This was also the reason for publishing CERN's EAM Light developments as Open Source in 2019, making it freely available [4].

MAINTENANCE PROCESSES

The foundation of most EAM platforms is obviously the frameworks for maintenance processes and how these can be streamlined, automated and analyzed for continuous improvements and further optimizations. While the drivers for improving these processes can vary, for example including safety, cost control and regulatory compliance, ensuring equipment availability often remains a core reason.

Some of the steps to achieve this at CERN has been to benefit from the fundamental built-in processes in the EAM platform, such as preventive maintenance plans, conditioned maintenance, maintenance routing and sequencing as well as work order scheduling.

Due to a combination of the evolving EAM functionalities, the introduction of simplified user interfaces and a general need of finding efficiencies, CERN has gradually, yet very significantly, improved and harmonized its maintenance management practices over the last decade.

Using common tools and processes has allowed equipment groups to share best practices and to benefit from common investments and developments. Examples of this are the EAM system integrations developed to streamline work order creation and dispatching from the CERN Control Centre (CCC) or CERN Service Desk, that initially were put in place for individual groups, but now are available for all. More recent examples include common methods of managing and validating outsourced maintenance work in order to facilitate the invoicing processes.

While some of these efforts might not have a direct impact on the equipment availability, it indirectly does, as more efficient maintenance processes allow equipment groups to better manage their limited resources.

SPARE PART MANAGEMNT

Another key factor in increasing equipment availability is to ensure that spare parts are readily available when they are needed, may it be for an urgent repair or for a preventive replacement in order to avoid future potential breakdowns or downtime. Such practices include for example to maintain an updated inventory of spares parts and their current state and physical location in concerned storerooms, but also to automate the replenishment and purchasing processes as well as managing the part interchangeability. The EAM platform at CERN has since long been supporting all this out of the box, as standard functionality. However, until recently, many equipment groups perceived these capabilities as complex, which slowed down the uptake.

To remedy this, the EAM Light framework was once more used as a basis to create a kiosk-like interface to support and simplify some of the most common spare parts processes. This included for example tracing parts leaving and arriving in a storeroom, as well as inventory verifications and integrations with surrounding applications.

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Figure 3: EAM Store Kiosk used for spare parts.

Similarity to the EAM Light interface, the EAM Store Kiosk (Fig. 3) was designed in a way to be used with no or little training. The concept proved highly successful, and the self-service store kiosk is today used by 30 different equipment groups throughout CERN and has boosted the number of traced store transactions to between 100.000 and 150.000 per year. The experienced gains have been both a more accurate traceability of spare parts as well as the ability to faster locate adequate spare parts.

DATA-DRIVEN MAINTENANCE

With a growing percentage of connected equipment that have the ability to communicate over an IT network, the potential of data-driven maintenance has become a highly important factor to consider. CERN has since 2015 been feeding selected information from the SCADA systems into the EAM platform, which allowed groups to move from time-based to usage-based preventive maintenance. However, what has happened over the last years is not only that more equipment has built-in network connectivity, IoT devices and smart sensors have also become more technically capable at much lower prices. This has in turn made it financially possible to monitor more technical installations than before, but also, and in many cases even more importantly, possible to retrofit such capabilities to existing equipment.

The SCADA/IoT gateway to CERN's EAM platform was therefore modernized and extended in 2022 in order to handle more types of dataflows, as well as making it more robust and better coping with temporary network glitches and communication errors. These improvements have paved the way for a series of initiatives, such as data capturing of overhead crane movements using IoT devices communicating over the LoRa network. It has also allowed to support a project of equipping electrical motors with smart sensors that communicate via Bluetooth over CERN's existing campus network [5].

By analyzing the new types of collected data and by making correlations with data from different sources, it is now easier to start moving from condition-based maintenance practices towards predictive and prescriptive maintenance. The first pilot projects carried out have demonstrated that this can be achieved in several different ways. For example, by applying machine learning algorithms on a mix of datasets or by applying more traditional statistical methods in an upscaled and automated manner.

Whereas some of the initial results have been penalized by the limited quality of old data, it is nevertheless obvious that predictive and data driven maintenance will be key for further improving equipment availability for both CERN's accelerator complex, and its technical infrastructure.

CONCLUSIONS & OUTLOOK

With the recent evolution of its EAM platform, CERN has been able to demonstrate that, with a commercial product as a backbone, it has been able to further improve and streamline its asset and maintenance management practices and extend them to an organization-wide scope. Despite the diverse set of initial drivers for the different equipment groups to start implement these practices, increased equipment availability with existing resources has emerged as one of the main motivations.

Going forward, the growing EAM usage will play an important role in the more global effort of consolidating the landscape of engineering applications at CERN into an integrated engineering platform [6]. With even tighter integrations with related applications, and in particular CERN's PLM (Product Lifecycle Management) system, an enforced linking of data generated throughout the different engineering phases will be made possible. This structuring of information is often referred to as the Digital Thread of engineering data and is in turn a prerequisite and foundation for any future steps toward the creation of Digital Twins of accelerators and technical installations at CERN.

Such Digital Twin implementations, with a compound set of equipment meta data, operational data feeds and a graphical 3D representation, leveraged by simulations and machine learning capabilities, will bring a multitude of new possibilities. One of them is without hesitation to bring CERN's equipment availability efforts to the next level.

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