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WHY SHOULD YOU INVEST IN ASSET MANAGEMENT? A FIRE AND GAS USE CASE

H. Nissen, S. Grau, CERN, Geneva, Switzerland

Abstract

At present, the CERN Fire and Gas detection systems involve about 23000 assets and their number is increasing rapidly at the same time as the number of equipped installations grows. These assets cover a wide spectrum of technologies, manufacturers, models, parameters, and ages, reflecting the 60 years of CERN history. The use of strict rules and data structures in the declaration of the assets can make a big impact on the overall system maintainability and therefore on the global reliability of the installation. Organized asset data facilitates the creation of powerful reports that help asset owners and management address material obsolescence and end-of-life concerns with a global perspective.

Historically, preventive maintenance has been used to assure the correct function of the installations. With modern supervision systems, a lot of data is collected and can be used to move from preventive maintenance towards data-driven maintenance (predictive). Moreover, it optimizes maintenance cost and increases system availability while maintaining reliability. A prerequisite of this move is a coherence on the assets defined in the asset management system and in the supervision system.

CERN BE-ICS-AS SERVICE

The CERN *Alarm System* service is responsible for the installation, the maintenance, and the renewal of safety alarm systems at CERN. This includes fire and gas detection systems (Flammable Gas, Oxygen Deficiency, Toxic Gas), emergency telephones (Red Telephones) and the alarm transmission systems to CERN main control rooms (SCR-CERN Fire Brigade, CCC-CERN Control Centre and XCR-Experiment Control Rooms). There are currently 9,687 automatic smoke detectors, 783 automatic gas detectors, 2115 manual break-the-glass devices and 413 emergency telephones installed all over CERN sites, and covering from office buildings to accelerator complexes and experimental halls.

ASSET MANAGEMENT

According to the asset management standard ISO 55000, an asset is defined as: *An item, thing or entity that has potential or actual value to an organisation [1]*

This very general definition can cover many types of assets e.g. Physical, Financial, Human and Intangible assets. In this paper, we will concentrate on the physical assets that are physical objects installed to fulfil a purpose and therefore have a value to the organisation.

Asset Management History

Asset management concepts have existed as long as there have been assets to maintain such as the first early tools used by farmers. A common definition of asset management is: *The practice of managing the entire life cycle (design, construction, commissioning, operating, maintaining, repairing, modifying, replacing and decommissioning/disposal) [1].*

In the beginning, this asset management was an informal system where the asset information was kept by persons involved in the life of the assets. As the number and complexity of assets grew, a more formal way of dealing with the assets was necessary. This led to the first paper-based assets management where important information about the assets was noted down on paper. This included a central list of assets with primary characteristic and local logbooks stored with the assets to note interventions and problems.

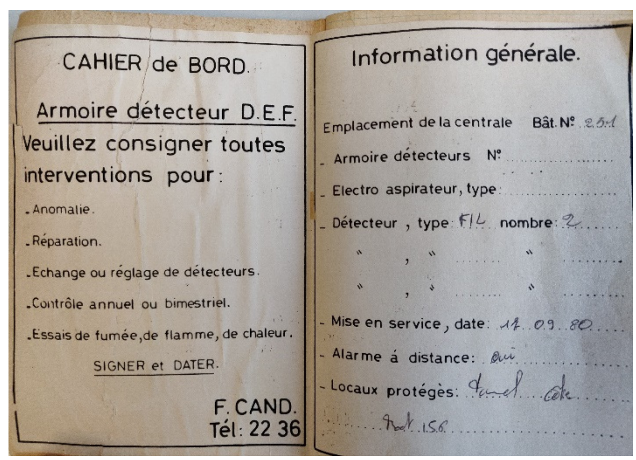

Figure 1: Example of local maintenance logbook.

This paper-based system (Fig. 1) was used for the CERN fire and gas installations from the start of CERN until the introduction of the first computer-based asset management system in the mid-eighties. The information from the former paper-based system was then transferred to a computer system that made the information more generally available to the asset managers. This facilitated the creation of work orders to keep trace of intervention on assets. In general terms, the abbreviation CMMS (Computer Maintenance Management Systems) is used for all the early computer maintenance systems that were very focused on the maintenance aspects of the assets. Since then the CMMS software has steadily been upgraded to reflect the changing need of the organisation and today the software used at CERN is called INFOR[3] Enterprise Asset Management. The main difference between a CMMS and an EAM (Enterprise Asset Management) is that traditionally the CMMS software was exclusively focused on the asset maintenance in the

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form of work orders and equipment records. The EAM software includes all the CMMS functionalities but also multiple business functions e.g. procurement, budgets, warranties, and project management and therefore manage the complete lifecycle of an asset and hence is an enterprise tool.

EAM data is also very important when it comes to regulatory compliances as it makes it easier for organizations to provide authorities with needed documentation for compliance.

Asset Organisation

Traditionally, but not exclusively, EAM data is organised in a System, Functional Position and Asset relationship (Fig. 2).

Figure 2: Relation diagram.

An example would be a cooling system (System) that needs a water pump. The water pump is located in a physical position represented by the Functional Position. The actual physical pump installed in the functional position is declared as an asset. This asset will be maintained and replaced when needed to keep the physical position operational. For the fire and gas detection, it was decided stop at the Functional Position layer and not declare the physical assets. This is mainly due to the high number of equipment with a relatively low rate of replacement. In this case the declaration of the physical assets would create more complexity without adding much value.

Reporting

For reporting based on EAM data CERN has chosen to implement a PENTAHO [2] report server that connects to the EAM database in order to run the reports. In the PENTAHO report engine, there are two main types of reports: the *classic report* where the report is constructed based on the data available in the database, and the *aggregated report* which is based on tables that are constructed on the report server for aggregated data e.g. number of work orders per month/year. Both the EAM and the PENTAHO report server are centrally supported tools at CERN and used by a large user group.

WHY RESTRUCTURE THE DATA

Most of the fire and gas detection asset data and our experience came from an older version of EAM and even earlier CMMS software. The approach to using the EAM software was very much limited to work orders and equipment records without using many of the capabilities that were available in the software.

Furthermore, during the last 30 years, the CERN fire and gas detection asset responsible and maintenance contractors had changed many times. This led to many variations in the quantity and quality of the data entered. This does not mean that assets were missing and not maintained but it was very much focused on the core functionalities of maintenance and equipment records. One of the only written rules that were reasonably followed over the years was the naming convention of the assets. This convention had been produced for the construction of the LEP (Large Electron-Positron) collider and later updated for the construction of the LHC (Large Hadron Collider).

Another deciding factor that motivated the work of restructuring and completing the data in EAM was the request to produce a PPE (Property, Plant and Equipment) report in order for the accounting services to take the value of the CERN installations into account. It was agreed with the accounting service that this report should be based on the assets declared in EAM. In the beginning, it was thought that it would be easy to extract this data from EAM but due to the above-mentioned factors, it was quickly realised that this was not the case. The inconsistencies and lack of information concerned mainly:

1. The age of the asset
2. The type of asset

The age of the asset should in principle be easy to extract but due to the lack of rules concerning this data, it suffered from inconsistencies. These inconsistencies mainly centred on what field in the EAM had been used to store this data and how this data had been updated when the equipment was replaced. As the PPE report is based on a fixed price per type of equipment it was essential to identify the different equipment types in the EAM. Again, many inconsistencies were found in the naming of the assets and little use of grouping the equipment in different classes. These problems made the extraction of useful data for the PPE report almost impossible. In parallel reports were also needed by the management to address equipment obsolescence of the installed equipment. The main part of the equipment has a fixed life span. E.g. a fire detector has from the manufacturer a life span of 8 years. After 8 years the correct function of the detector is no longer guaranteed. In order to correctly plan a consolidation budget for replacement, reports were needed to predict the number of equipment to be replaced in the years to come. For these reports, the same problems as for the PPE were found.

These two examples show that our EAM data was not of sufficient quality in order to fulfil the reporting requirement to manage such a large number of assets. Without this data, the decision making was not fact-based but instead based on experience and estimations. It was clear that more data and of a higher quality were needed in order to correct these problems. To not to repeat the same mistakes clear guidelines where needed based on information which needed to be extracted. The goal was to have correct and necessary data in order to fulfil the required data extractions. Decisions based on data are not better than the quality of the extracted data.

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DATA RESTRUCTURING

In order to restructure the data in the EAM, it was decided to follow a strict process where everything was formalised and approved in a reference document before any changes could take place in the operational system. This provided a global overview of all changes and how they might affect each other. Once the first version of this reference document was approved, the changes were applied to the EAM database. The modifications for this first release were quite substantial, so the process of applying the modifications to the EAM database took several months. The updates were a mixture of database scripts and manual updates with the native interface. Following the first release, there have been several other releases that have included further changes to the definitions but the formal approval process is still followed in order to align maintenance, project and management needs and not rush though changes based on a specific problem. This process, of course, takes quite some time, but it is worth the effort in order to have the right quality of data in the EAM database. The document is divided into five main chapters

- Systems
- Assets Codes
- Classes and Categories
- Hierarchies
- Attributes

The "Systems" chapter deals with the actual naming of the different systems in EAM. E.g. S$FEU for the fire detection system. The first S in the system name is defined in the LHC naming convention as equipment that deals with safety installations.

The "Assets Code" chapter is very similar but deals with the naming of the assets and their system relations. E.g. SFDEI is the asset code for a fire detector. "S" as the first letter also signifies a safety installation. The second letter is the relation to the system. In this example, "F" shows that it is the **F**ire system. The last three letters are an abbreviation of the type of asset E.g. "DEI" is derived from "**DE**tecteur **I**ncendie". In the EAM the asset, code will always be followed by a – and a five number numeric code that must be unique for the assets type. An example of a complete code would be SFDEI-01569.

In the "Classes and Categories" chapter the assets are further divided into types or equipment families (Classes) and manufacturer models (Categories). All valid classes and categories of a given asset code are listed in the document (Fig. 3).

The chapter "Hierarchies" deals with the relation between the different assets and their dependencies. An aspiration detector is dependent on the actual pump that delivers the air to the detector in order to be operational hence they are connected in a parent/child relationship (Fig. 4).

SFDEI général **S**afety – **F**eu – **DE**tecteur **I**ncendie

Class		Catégories		Manufacturer
SFDLI	Détecteur **LI**néaires	**SF-FIRERAY**	Faisceau	HEKA
		SF-ARDEA		
		SF-ARDEA-BOOMRANG		
		SF-FORAV		DEF
		SF-SOLAR		
SFDPO	Détecteur **PO**nctuel	**SF-ADX156**	Détecteur Extinction Friteuse	HEKA
		SF-MCD573MC	Détecteur Ponctuel Coloré	
		SF-ORM130EX-1	Détecteur Ponctuel de Fumée ATEX	
		SF-MMD130EX-1	Détecteur Ponctuel de Fumée ATEX	

Figure 3: Classes, Category definitions.

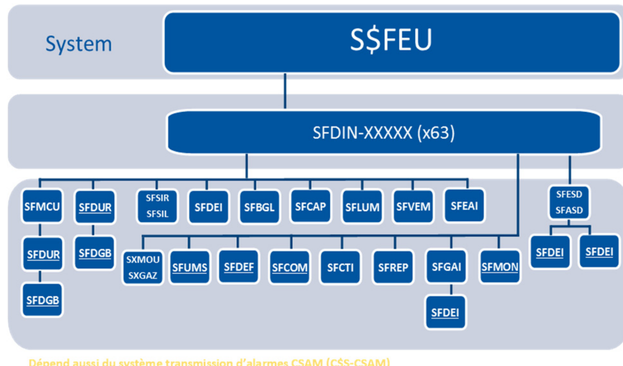

Figure 4: Hierarchies diagram.

The last chapter "Attributes" deals with what information needs to be filled in for each asset, and where in the EAM interface it should be presented. The required information is listed along with how this information should be updated during the life of the assets. A good example of this is the commissioning date of the asset position, as this data is used in several important reports. As a fire detector should be replaced every 8 years, the commissioning date of the asset position in EAM needs to be updated following a replacement in order to correctly reflect the age of the installed asset. The original installtion date is stored in a separate field.

Validation

With this formal definition of the assets and their metadata, everybody should be able to enter information correctly in EAM if the document is followed. This is not always the case as there is a risk of making mistakes. This is mainly due to the high volume of modifications done every day. In addition to this, there is also a big historical backlog of data that does not follow the definitions 100%. In these cases, the reference document provides an important tool to identify the errors by running validation scripts that compare the rules defined in the reference document with the actual data in the EAM database. The output of these scripts are lists of errors in the EAM database that do not follow the prescribed guidelines. Approximately 90 % of the rules defined in the reference document can be checked this way. It is up to the equipment responsible to correct the errors found by the automatic scripts.

REPORTING

Once the necessary data of the right quality is available in the EAM, it becomes much easier to extract information that is critical for the asset owner and the management. The PPE report is now possible as for each class a lifespan and

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average price is defined. Together with the PPE report, it is possible to calculate the value of our park (Fig. 5).

	Class		
	Class Description		
	SCBG	SCIA	SDGB
	Bris de Glace	Indicateur d Action	jeux de Batteries
Year	Equipment Commissioned	Equipment Commissioned	Equipment Commissioned
1995	-	-	-
1996	57	-	1
1997	8	-	-
1998	60	-	1
1999	13	-	-
2000	271	-	-
2001	111	-	-
2002	75	25	-
2003	51	10	-
2004	177	-	-
2005	496	65	-
2006	33	81	-
2007	51	122	-
2008	57	143	-
2009	31	140	2
2010	18	78	5
2011	63	16	1
2012	45	11	5
2013	35	23	4
2014	189	68	11
2015	49	13	37
2016	48	5	134
2017	98	35	64
2018	126	57	92
2019	11	8	74
Grand Total	**2,173**	**900**	**431**

Figure 5: PPE Report.

It is also now possible to show the evolution of the equipment park over time (Fig. 6). Most fire and gas installations and detectors have a lifetime defined by the manufacturer where the correct function, is only guaranteed if the age does surpass a maximum age defined. This does not mean that the installation stops working at that time and all detectors are tested each year to verify correct function but it is no longer guaranteed by the manufacturer. Therefore, reports (Fig.7) showing the age distribution in classes of equipment are now possible and are essential to predict the replacement costs over the coming years. These two types of reports help to correctly predict resources necessary to maintain the installation and assure correct functioning.

On-site, the maintenance team was using separate excel sheets as a maintenance checklist to guide the technician during the intervention. This was mainly because these sheets contained essential information to the maintenance intervention that was not available in EAM. During the restructuring of the EAM information, the missing information was introduced into EAM. In the future, checklists can be automatically generated from EAM so that a unique source of data is maintained by the maintenance team.

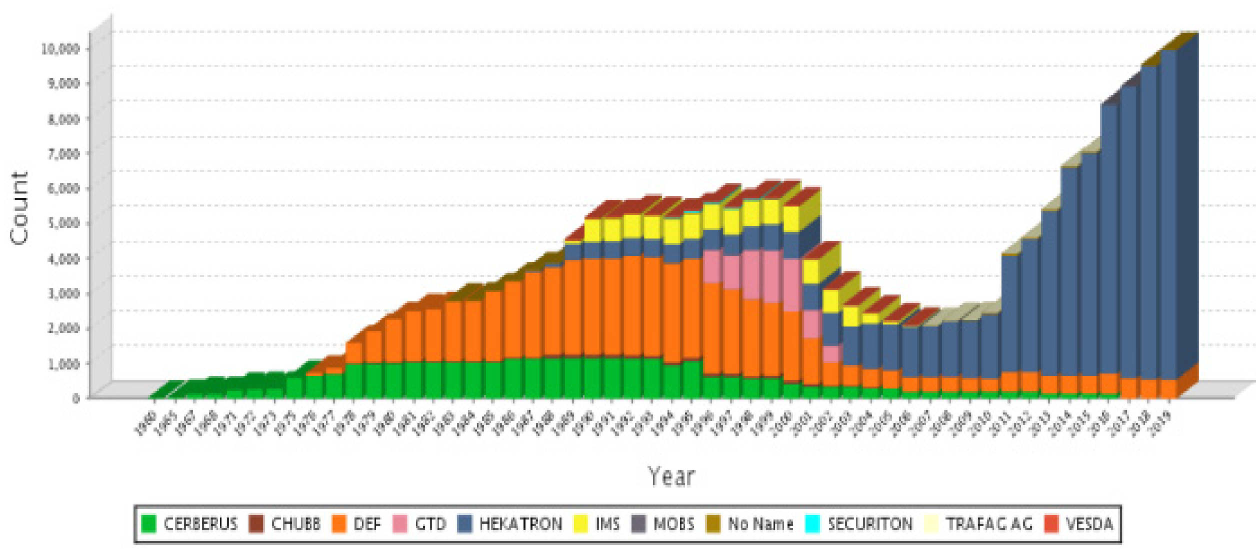

Figure 6: Fire detectors evolution

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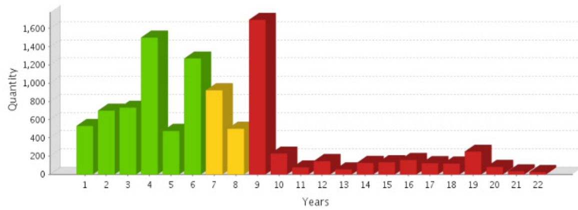

Figure 7: Age Distribution.

DATA-DRIVEN MAINTENANCE

Data-driven maintenance has long been seen as a way of optimising the maintenance cost and increasing system availability while maintaining the reliability of the installation. Research by IBM [4] found that 89 percent of asset failures occur at random, and those are difficult to prevent with planned maintenance. In order to do data-driven maintenance sufficient data must be available for the decision making. Often this data is only available on the automation / SCADA system and not shared with the maintenance system.

In practice, there are several barriers that make the switch from preventive to predictive (data-driven) difficult. Quite often, the same naming convention is not used on the SCADA side as in the EAM system and this makes it very difficult to exploit the SCADA data for maintenance purposes. For fire and gas installations, this was not a problem as all SCADA tags are based on the EAM code. To do predictive maintenance there is information that normally is only available in the SCADA system that needs to be shared to the EAM system. During the restructuring of the EAM data, the missing attributes were defined and how they should be populated.

Airflow Use Case

During the EAM restructuring process, we identified a use case where we could try to implement data-driven maintenance. The use case identified relates to a specific type of fire detector called an Air Sampling smoke Detector (ASD). This type of detector takes the air from a specific location through air sampling pipes and transports it to the smoke sensor location. This type of detection is often used in irradiated areas, as fire detectors are not radiation-resistant. It is also used in places where access is difficult so that the detectors can be placed in a convenient location for the maintenance. The air is transported to the detectors by a pump that sucks the air thought the air sampling pipes. The flow of air through the pipes is monitored to detect if it is too high or too low. A high airflow could indicate a broken pipe and a lower airflow obstruction in the pipe. To prevent a build-up of dust in the pipes they are cleaned every three months. This is triggered by a preventive schedule in EAM. Not all the pipes will have dust in them after 3 months as it depends on the environment where the air is taken from. Instead of cleaning all the pipes every 3 months the airflow measurement could be used to trigger cleaning when the measurement approaches the lower limit (Data-driven maintenance). This would reduce the time spent cleaning the pipes as only the dirty pipes would be cleaned. Before the restructuring of the EAM data, the alarm limits were only kept in the ASD detector itself as a parameter defined during commissioning. As part of the restructuring, attributes were defined in EAM for these values. With the high and low, limit now available in EAM and together with the analogue airflow measurement from the SCADA system, it is now possible to develop a report that lists the ASD where the airflow is approaching the limit. The report can be executed as needed.

Together with our EAM provider, INFOR [4] and the central asset management service at CERN a solution is being developed based on AI (Artificial intelligence) that will automatically generate work orders based measurements and limits. The goal of the automatic solution is that the system will learn over time what constitutes a condition that requires the pipes to be cleaned. Sudden peaks in the measurements should be ignored as they can be caused by maintenance or ventilation changes. Work orders should only be generated where the measurement has gradually been changing over time until approaching the alarm limit.

The SCADA system logs the airflow measurements to an ORACLE database and the INFOR AI module will connect to the database to retrieve the data. Together with the data already stored in the EAM database, this information will be used for the AI module decisions to trigger work orders.

CONCLUSION

The process of structuring and consolidating our EAM data has enabled us to extract much more value from the data. We now have a much better idea as to the nature of the assets we have as well as their attributes. This has enabled us to produce reports that have proven valuable for management in order to correctly value our park and predict future needs.

An added benefit has been that we now have the possibilities to move part of the maintenance to data-driven maintenance and hopefully, in the long term, optimise cost.

REFERENCES

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