ISBN: 978-3-95450-238-7 ISSN: 2226-0358 doi:10.18429/JACoW-ICALEPCS2023-THPDP021

EQUIPMENT LIFE-CYCLE MANAGEMENT AT EuXFEL

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Abstract

Scientific instruments at the European X-Ray Free Electron Laser Facility (EuXFEL) comprises of a large variety of equipment, ranging from controllers, motors and encoders to valves. It is a false assumption that once a specific equipment had been procured and integrated, that no further attention is required. Reality is much more complex and incorporates various stages across the entire equipment life-cycle. This starts from the initial selection, standardization of the equipment, procurement, integration, tracking, spare part management, maintenance, documentation of interventions and repair, replacement and lastly, decommissioning. All aspects of such a life-cycle management are crucial in order to ensure safe and reliable operation across the life time of the equipment, whether it be five years, twenty years, or longer.

At EuXFEL, many aspects of the described life-cycle management are already carried out with dedicated tools. However some aspects rely on manual work, which requires significant effort and discipline.

This contribution aims to provide an overview of the requirements, and the ongoing efforts to develop and establish a complete life-cycle management at the EuXFEL.

Keywords: life-cycle, documentation, requirements, maintenance

MOTIVATION

Many equipment, controller and controlled entities alike, are chosen and purchased, in scientific facilities without previous life-cycle assessments (see Fig. 1). The reality at many facilities shows that even temporary installations are used for 10 to 30 years or even longer.

Typical scientific and industrial instrumentation are complex and contain many sub-elements. These may be operated efficiently if all sub-components work properly and minimal efforts are needed for maintenance, safety, security and, when parts need to be exchanged or replaced, compatibility exists among hardware models and different versions.

In many cases end-users tend to request to purchase and install, and therefore support, the very same equipment which they already know, due to the fact they have used it in the past, irrespective whether or not they are completely happy of their performances or the added effort needed to introduce these elements into the control system.

This is *in principle* human and natural although not logical and moreover is not making use of technical expertise present within the support groups of the facilities.

There is also a tendency to delegate the design and selection of equipment to external companies without inviting technical experts, present in the same facility, when making contact with these companies. These, in turn, choose equipment and the models of components optimizing for purchase costs or inserting devices they have in stock instead of investigating which type of controlling entities suit the client best, which would offer a solution with optimal purchase and operation costs simultaneously.

Up to this point in time, we have installed scientific and industrial equipment along 6 km of tunnels and in 7 experiment locations (starting around the year 2012). Some of the equipment has been running ever since, with basically 100% duty cycle.

We aim to:

- improve, develop, locate, track and maintain the devices keeping the down time to a minimum and keep historical knowledge
- develop intervention strategies (possibly w/o interference) to exchange devices near end of life-time
- keep track of integrated duty-time of devices and interventions (whether to repair or modify)
- understand which equipment has become or is going to become obsolete (and prepare for possible replacement with equivalent device(s)).

METHODS

The European XFEL GmbH facility, in order to strengthen the efficiency of the centralized technical vetting which is

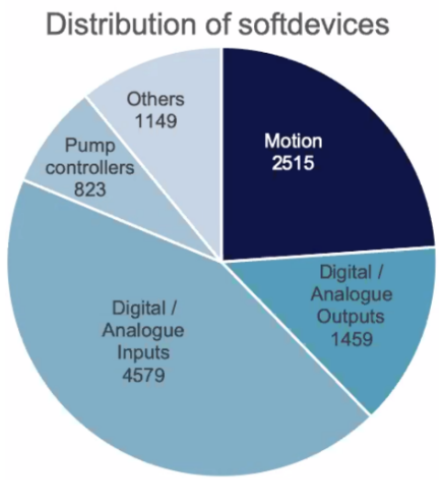

Figure 1: Numbers of devices, subdivided into categories, installed up to know at EuXFEL.

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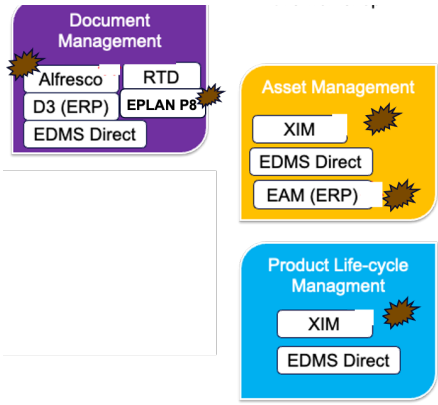

Figure 2: Candidates for software utilities and applications available, at this time at EuXFEL, to be used for the assessments of life-cycle of equipment or aspect thereof.

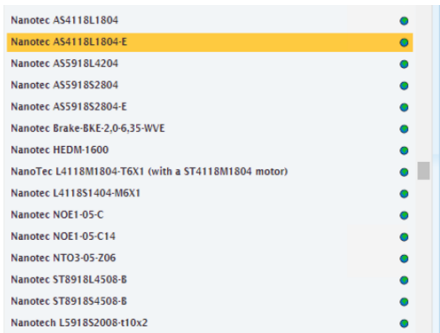

Figure 3: Small sub-set of stepper motors used at EuXFEL extracted from Component Requirement Documents.

already in place, is planning to introduce equipment life-cycle management to assess and where possible minimize risks related to the way electric and electronic equipment is procured and at the same time to efficiently maintain what has been already installed.

PRELIMINARY RESULTS

First steps have been started to catalogue all equipment installed across the facility, including evaluation of singular setups and singleton equipment in use (see Fig. 2), with the aim of defining policies which will significantly reduce these cases in production environments. Redundancy of equipment, by extensive analysis of equivalent functions perform by different hardware in the facility, is also planned to take place.

Furthermore investigations within EuXFEL were carried out to list all already used software tools. These are also shown in Fig. 2. These had been chosen in the past to cover specific aspects of documentation or other types of tasks and are:

- alfresco (document repository)
- ePLAN P8 (electrical documentation)
- Component Requirement Document(s) (CRDs, Word document stored on alfresco)

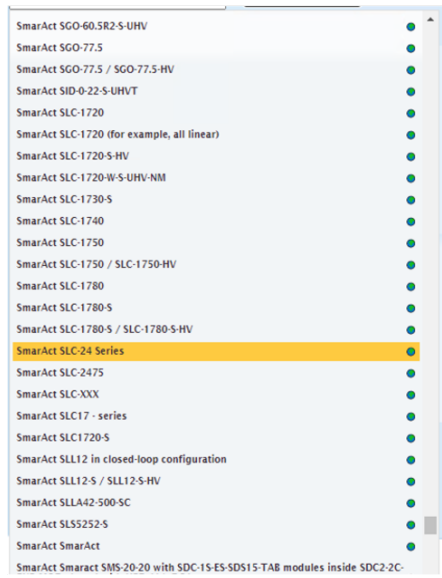

Figure 4: Small sub-set of piezo-actuators used at EuXFEL extracted from Component Requirement Documents.

- Change Requests (PDF form document stored on alfresco and tracked via ticketing system),
- Equipment Requirement Document(s) (ERDs, Work document stored on alfresco, now replaced by Webform based on formsflow.ai)
- EAM/D3 (Infor) (ERP)
- EDMS Direct (document repository shared with the DESY Laboratory)
- eLog, electronic logbook
- XIM (asset management)
- Redmine (ticketing system)

These tools are under investigation to understand and document their pros and cons. The ideal result would be either to integrate these, or a subset of these, or to find a different software product which would achieve a more integrated solution covering all or most of the aspects of the problem of Life-cycle management.

Equipment lists from CRDs, which EuXFEL used to deploy control system, have been extracted (see Fig. 3 and 4, please note the size of the scroll bars but also spurious duplication of names caused by the fact that the input data was inserted by hand without strict validation). This has brought about a large effort and will still need heavy work to complete and have a proper set of equipment without any duplication and with homogeneous names.

The final aim is to develop and eventually populate an integrated data base related solution, which people planning to build an instrument could use in order to choose preferred hardware and possibly estimate how much development effort needs to be planned, if the needed equipment is not part of the already-supported equipment.

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For linear actuators these could be linear tables with equivalent position accuracy but possibly different travel ranges, for standard actuators these could be a list different models of stepper motors from different vendors with similar torque and so on).

Contacts to other facilities [1–5] in the world, and within groups in our facility, have been started to assess how these have addressed such issues, what tools are used or what aspects need be taken care of.

Discussions with few vendors have started in order to evaluate and improve our situation, aiming at removing single vendor dependence and possibly to influence them into providing new, interchangeable and innovative solutions.

CONCLUSIONS AND OUTLOOKS

A large effort has been started to extract from already existing documents the list of installed device (types and models) at EuXFEL. Eventually this information could populate a, still to be defined, integrated equipment data base and define which tool or tools need to be used efficiently to perform all tasks and activities related to improve, develop, locate, track and maintain all installed devices and to develop and eventually establish a complete Equipment life-time management within the EuXFEL facility.

ACKNOWLEDGMENTS

The author would like to thank all involved collaborators and employees of EuXFEL as well as other experts of other facilities, which have been contacted. They have been always willing to offer their opinions, suggestions, feedback and expertise. Without their most valuable input this effort would seem to be *insurmountable*.

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