

INTEGRATION, CONFIGURATION AND COORDINATION: FROM PROJECT TO REALITY, AT CERN

M. Barberan Marin, S. Bartolome-Jimenez, M. Bernardini, T.W. Birtwistle,
S. Chemli, J-P. Corso, J. Coupard, K. Foraz, S. Grillot, Y. Muttoni, A-L. Perrot.
CERN, Geneva, Switzerland

Abstract

The rigorous process in place at CERN to approve and follow-up the implementation of any modification of the LHC machine and its Injectors is presented in this paper. Our methodology implies the support of three teams, in charge of the configuration management, the scheduling and safety coordination, and the 3D integration studies. At each stage of the project the support of the three teams evolves, to provide the adequate support in the preparation phase and during the technical stops and long shutdowns. The formal roles and the processes used to govern the interaction of the Integration, Configuration and Coordination teams, and their relation to the project teams during the preparation and implementation phases, for activities to be performed in LHC and its injector chain are described and discussed.

INTRODUCTION

During the long lifecycle of the accelerator chain of CERN, a large number of consolidation and upgrade activities are implemented. In order to increase the operation time of the machines, it is crucial to optimise the implementation process of the programmed stops. This is done at CERN, by the ACE group (Alignment, Coordination and Engineering), around three interlinked axes: Integration, Configuration and Coordination. The teams work together from the early stage of any change to highlight possible interferences with existing installed equipment, to register all modifications in corresponding databases, to ensure that dedicated documentation is available, and to plan and coordinate all of the scheduled activities in the respect of safety and quality.

This paper describes the work performed by these three teams and the synergy between their respective activities.

INTEGRATION

Thousands of components are already installed in the narrow environment of each accelerator, and space management is a challenge that the Integration team faces daily. Insertions of, or modifications to, a piece of equipment are discussed in the weekly integration meetings, where all services are represented.

During these meetings, the Integration team coordinates the production of 3D models by CERN technical offices to ensure that a dedicated and exhaustive model is provided for all facilities. Each model is positioned accurately with respect to the CERN survey coordinate system. At an early stage, the project contacts the Integration team to get a map of the area in which a new piece of equipment has to be installed.

The Integration team checks if 3D models of the area of interest are available. In most cases, scans [1][2] of the regions are carried out by the survey team at the request of the Integration team. These scans are compared with the available 3D models, and if needed 3D models are created or updated by the CERN design offices.

The Integration team provide 2D cross-sections (Fig. 1), showing the machine and its services. For all caverns and other areas, 3D integration models are created (Fig.2).

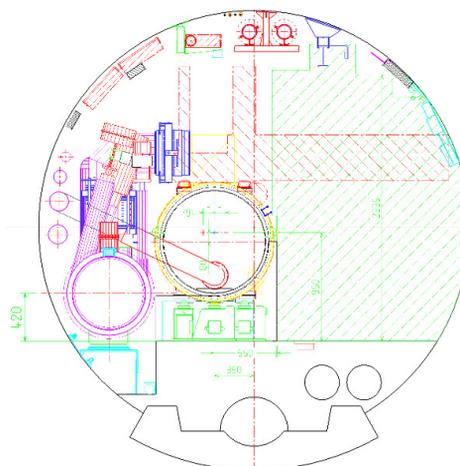


Figure 1: Typical main tunnel cross section.

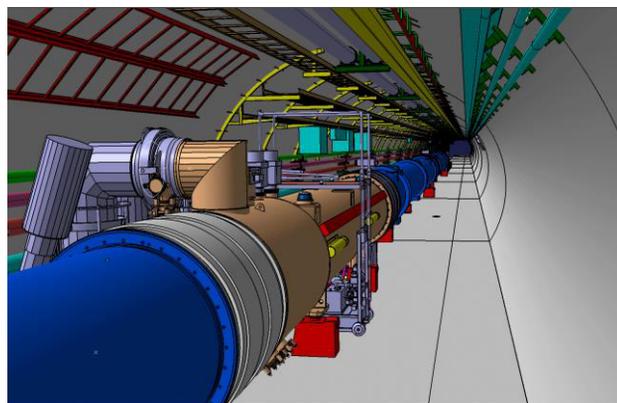


Figure 2: 3D Model picture

The weekly Integration meeting is the dedicated forum for reviewing and deciding on the final integration solution. The integration team then requests the approval of this solution from the main stakeholders, before it is included in a Space Reservation Request (SRR) or Engineering Change Request (ECR) by the Configuration team.

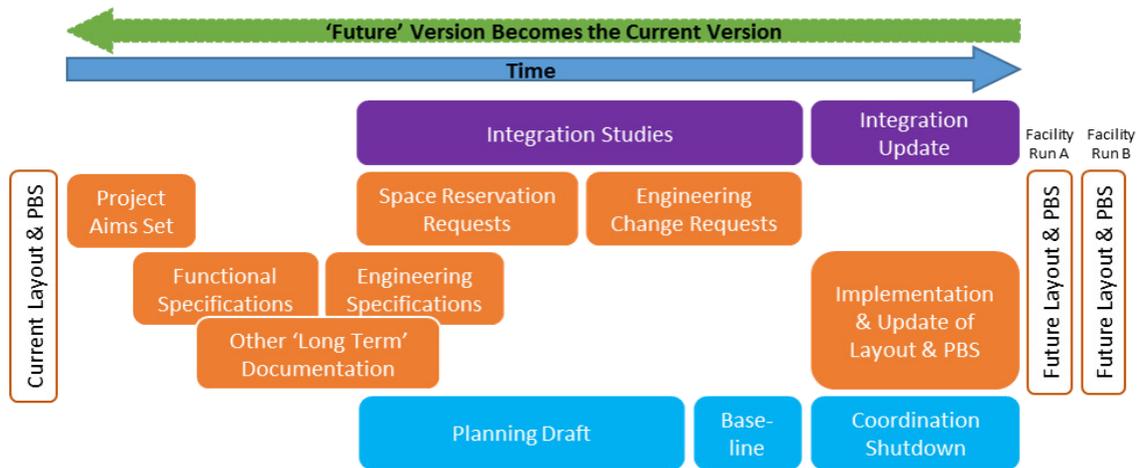


Figure 3: Timeline showing the interaction between the Integration, Configuration and Coordination teams

Being guarantor of the space, the Integration team carefully follows the installation phase, during which 3D scans are performed in key areas in order to compare the models with reality. Any differences are described in a non-conformity report, where the integration team classify them as critical or 'use-as-is'. If critical, a decision is taken to correct or modify the involved equipment.

Tools such as the 360° panoramas (provided by the Configuration team), 3D scans (provided by the CERN survey team) and 360° views (provided by the Integration team) are available and constantly updated to complete the 3D models, and have the most exhaustive data available for all users during periods with no access, or even during shutdowns.

CONFIGURATION AND LAYOUT

In parallel to the integration study the Configuration team ensures that there is a clear and coherent representation of the status of the CERN accelerator complex and projects at a given time; the changes cover the areas related to projects, consolidations and upgrade activities. This is achieved by storing physical layout information and long-term documentation in databases to form a Product Breakdown Structure (PBS), and by managing changes.

The PBS aims to describe all components of a project or facility in as much detail as possible, through a clear hierarchical structure of systems. At CERN, documents such as Functional and Engineering Specifications, Space Reservation Requests (SRR), Engineering Change Requests (ECR) and other long term documentation (procedures, technical reports etc.) are stored in the PBS. This documentation is handled centrally by the Configuration team, who ensure the quality of the documents and their circulation to, and approval by, all stakeholders.

From the early stage of a project, the Configuration team defines the documents to be provided or edited throughout the project lifecycle with the relevant stakeholders (Fig. 3). A change to a project or facility is managed using SRR or ECR documentation.

The integration study carried out by the Integration team is included as part of the SRR or ECR to describe the impact on space. The Configuration team ensure that all other impacts have been assessed, including potential technical conflicts with other equipment, on safety, documentation and schedule (in collaboration with the Coordination team), and that all stakeholders have the opportunity to comment, approve, or reject the change. The change process allows stakeholders and management to track all changes and to work in the respect of safety, quality and schedule; moreover it provides full traceability, by helping to streamline the implementation of changes. The executive committees or project management teams responsible for the concerned facility or project provide the final validation of any SRR and ECR.

The Configuration team uses versions of the PBS to represent a facility at a given time. Documentation is stored in the version corresponding to the time when the equipment will be installed or the change implemented. Following the approval of an SRR or ECR, the Configuration team also update the facility layout, recorded in the 'Layout Database', in the relevant future version corresponding to the facility at the time the SRR/ECR will be implemented.

The physical implementation of a change is tracked by the CERN Coordination team. Once implemented, the Integration, Configuration and Coordination teams, in conjunction with the responsible equipment owner, check that the implemented change matches the description in the documentation. The Configuration team acts to get the change documentation updated accordingly, and then updates the facility layout for the current time, and also moves the documentation into the 'current facility' PBS.

SCHEDULING AND COORDINATION

For each facility of the accelerator complex, a coordinator is named within the Coordination team. They organise regular coordination meetings, to schedule and manage activities (and co-activities) in the short and medium term, during technical stops or long shutdowns; the duration of the stops is variable between one day and

two years. The coordination meetings ease the follow up, the progress of the activities and gather all the stakeholders; moreover safety aspects and issues are discussed. The facility coordinators follow the quality assurance process and work in close collaboration with the Integration and Configuration teams to ensure that the planned works are checked and validated within the 3D integration studies, the installation drawings are kept up to date, the ECR documentation is edited, and the actions are correctly implemented. Moreover, from time to time, they provide ad hoc support to equipment groups in order to ensure the smooth progress of work.

Prior to the start of a Shutdown or a technical stop, a major effort of preparation is performed in order to manage co-activities, to optimise the schedule and to level the resources across the different machines.

This period of preparation is highly crucial since it is necessary to define the critical activities, the constraints for logistics, and the optimal planning to achieve all the objectives of the stop in the respect of safety and within the allocated time window. It is structured in four consecutive steps:

1. Declaration of the activities with priorities [3] and gathering all the information from the stakeholders and the ECR;
2. Definition of the shutdown frame with the critical activities, hardware tests and commissioning;
3. Definition of the draft detailed schedule including the access and safety constraints;
4. Validation of the baseline schedule.

The safety aspects are taken into account at the early stage by evaluating the methodology of works proposed, with respect to risks introduced by the activities or the environment. Work Package Analysis (WPA) are established to evaluate safety aspects, by realising risk assessments and defining compensatory measures

As part of the final process of validation of the work detailed in an ECR, the facility coordinators check and validate the schedule information.

During Shutdowns, different tools are used to follow up the progress of all the activities. Specific key performance indicators (KPI) are implemented to allow the visualisation of any deviations and delays, such as dashboards, broken lines and progress curves [4].

In addition to the activities described above, the coordination team gives support to the different Groups, to schedule their own activities during the period of the technical stops and shutdown, and to realise resource levelling across the machines.

Once the Shutdown is finished, a post-mortem document is prepared to collect the stakeholders feedback, activities cancelled, activities postponed, and to identify improvements that shall be implemented in the future programmed stops.

METHODOLOGY AND INTERACTION

The three teams work in interaction with the main objective to provide a centralised source of documentation and to ensure high quality process management of changes and projects at CERN (Fig. 4).

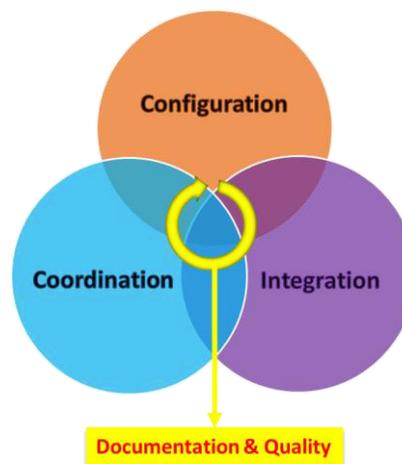


Figure 4 Interaction between the three sections

This methodology has been implemented during the installation of the LHC, in the first Long Shutdown (LS1) and later on, in the last Year Extended Technical Stop (YETS), always with successful results.

CONCLUSION

The Integration, Configuration and Coordination teams work collectively to manage a large amount of modifications and projects.

A methodology and interaction has been implemented to optimise efforts and to centralise the information to obtain a global picture of the work to accomplish and the status of the CERN facilities.

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