LOGISTICS OF LEP INSTALLATION

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ABSTRACT

The size of the LEP project, coupled with the tight construction schedules, calls for organised planning, logistics, monitoring and control. This is being carried out at present using tools such as ORACLE the Relational Database Management System, running on a VAX cluster for data storage and transfer, micro-computers for on-site follow-up, and PC's running Professional ORACLE, DOS and XENIX linked to a communications network to receive data feedback concerning transport and handling means. Following over 2 years of installation, this paper presents the methods used for the logistics of installation and their results.

1. INTRODUCTION

The 'Large Electron-Positron collider' (LEP) is already well-known [1]. In the underground tunnel, 27 km long, more than 50,000 different components of various dimensions are being installed. Equipment comes from many places and travels, usually by road, to the LEP sites. Then the components are lowered into the tunnel through one of the six major access pits, by crane and/or special handling devices, and to their final destination by means of a monorail system suspended from the roof of the tunnel. This monorail system was chosen in order to be: independant of the cluttered floor during installation (economic in terms of efficiency), self guided, and unlimited in range since supplied by bus-bars (**Figure 1**).

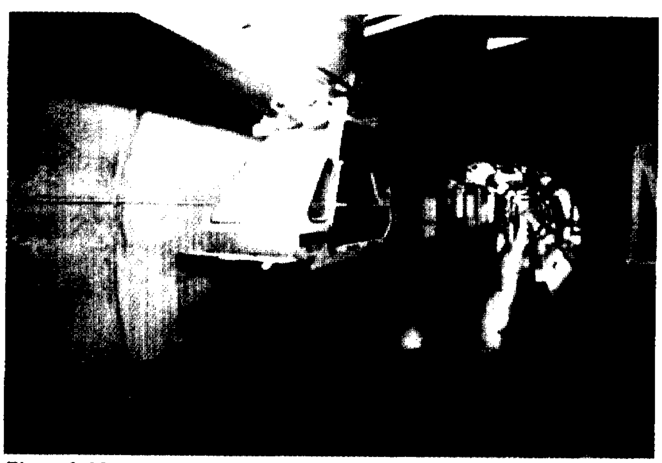

Figure 1. Monorail in the LEP tunnel

1988 is a critical year for installation. Numerous activities are being executed at different LEP sites, and it is becoming increasingly difficult to follow installation progress with precision. Planning, follow-up and data feedback are therefore essential to produce an accurate picture which changes daily.

All these aspects can be termed as *logistics* - the art of managing any large project with an emphasis on such factors as cost-effectiveness, tactics, strategy and control.

2. LOGISTICS: AIMS AND TOOLS

The principle aims of the logistics of LEP installation are to answer the following questions:

WHAT should be installed? (Well defined and in the correct quantity)
WHERE should it be installed? (At its precise position)
WHEN should it be installed? (In the foreseen time delay)
HOW should it be installed? (Undamaged, in the most cost-effective way, and without interference to other pieces of equipment)

With such a large complex project, detailed planning information is required, as are lists of machine parameters, building definitions and handling equipment for the many different groups of people involved with LEP installation. Simulation at any stage of the project in addition to follow-up during the installation are essential features to keep the project on its tracks. A great deal of effort has been devoted to this field within the LEP project [2].

Using a central relational database, planning of installation activities, follow-up, transport of components and personnel movements are computed weekly. This enables short term or long term simulation and adjustement of installation tactics according to various external criteria such as changes in civil engineering planning or the installation rate of any contractor.

All the data are managed with a Relational Database Management System (RDBMS). In 1982, benchmarks were carried out on available RDBMS's; ORACLE satisfied all LEP's requirements and was therefore chosen as the management tool for LEP installation. Currently ORACLE version 5.1.22 runs on VAXes (one VAX 8650 and one VAX 8700) under version 4.6 of VMS. All the tools and facilities of ORACLE, such as SQL*FORMS, SQL*GRAPH, SQL*MENU, SQL*CALC are used for data entry, data access and data presentation. There are more than 150 users and 2 Gbytes of data. The two DB VAXes are part of a general CERN VAX Cluster which groups 7 VAXes (one of the biggest clusters in Europe). Following the success of ORACLE in use for LEP installation, it is now provided as a general service to CERN's computer users on a central VAX as well as on the IBM central computers under VM/CMS.

During installation the data for the follow-up are recorded on-site by means of portable computers and are fed weekly into the main system. More than 15 NEC PC-8201 micro-computers are used, running specialised programs for data entry. Data feedback concerning the personnel access control, monorail movements, lift and crane loads are transferred directly from the different LEP sites to an IBM PC/AT in the "Logistics Control Room", via the LEP network "Token Ring". The transfer is done as a real-time task, using XENIX on the PC to record the data. This PC is connected to a second one which runs ORACLE under MS-DOS. Here, the data are prepared for transmission to the VAX database using the ORACLE tool SQL*STAR.

3. DATABASE ORGANISATION

The data for LEP installation is organised in three main databases: POL, DICLEP and LOI [3]. **Figure 2** shows a simplified overview of the logistics behind LEP installation.

3.1 POL - Planning using ORACLE for LEP

POL is a specialised program using Critical Analysis methods to generate the LEP planning. The data includes details on each installation activity; its codes, description, foreseen duration and its links and constraints with other activities. It allows, in addition, each activity to be provided with ressources (personnel, material, etc.). Then the program calculates the start and finish dates and the margins for each activity. Once installation or an activity has actually started, information is stored on the start date, the percentage done at the control date and finally the end date.

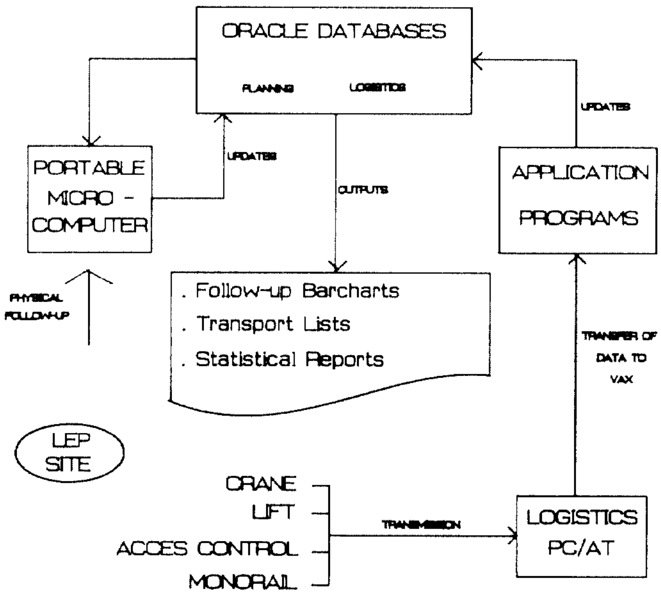

Figure 2. General overview of the logistics behind LEP installation

3.2 DICLEP - DICtionaries for LEP

DICLEP consists of dictionaries of LEP installation details including a dictionary of LEP components, a dictionary of LEP buildings and locations and a dictionary of handling means. Each one contains a list of official LEP codes, descriptions, people responsible and specific characteristics such as size and weight for components and dimensions and position for buildings. These dictionaries are public, so everybody and each application has access to the most recent and valid data.

3.3 LOI - Logistics Of Installation

The data stored in LOI includes a definition of the equipment to be installed, the final position of the component in the tunnel, its date of installation, the access pit where it has to be lowered, installation sequences for different types of equipment and the grouping of components for transport. Application programs are used to calculate the access points and distances for the components to be installed, according to the availability of cranes and/or lifts of each access pit, in addition to the availability and working condition of the monorail system from that access pit to the final position of the component in the tunnel. The programs give the possibility to calculate loads on cranes, lifts and monorail trains and they offer the possibility of manual intervention for a change of access pit or installation date. Similar application programs are used to accomplish simulations on present and future installation conditions depending on various possible sequences of the installation activities.

4. TRANSPORT LISTS

A typical result of the databases described above is that of the transport lists. These are issued each week from the data inserted or calculated in LOI. These lists give all the information needed by the people responsible for transport and by the installation coordinators. The lists show all equipment to be installed during a given week through a given access pit. The equipment is grouped according to which system it belongs. The transport lists are used by all people involved in LEP installation, i.e. the system managers, the site managers, the installation coordinators, the contractors representatives and by, of course, the transport teams.

5. FOLLOW-UP OF INSTALLATION

Another important aspect of the LOI database is the follow-up of LEP installation which allows for precise management and control of the LEP project. There are three main types of follow-up: transport, installation activities and magnetic components.

5.1 Follow-up of transport

Each week a regular logisitics meeting takes place; in the course of this meeting, attended by all site managers, installation coordinators and transport team leaders, the follow-up of transport actions made during the past week is given and analysed. Moreover the prevision for future transport is discussed on the basis of the lists described above. Up to now more than 11,000 movements of components have been processed, activated and followed-up.

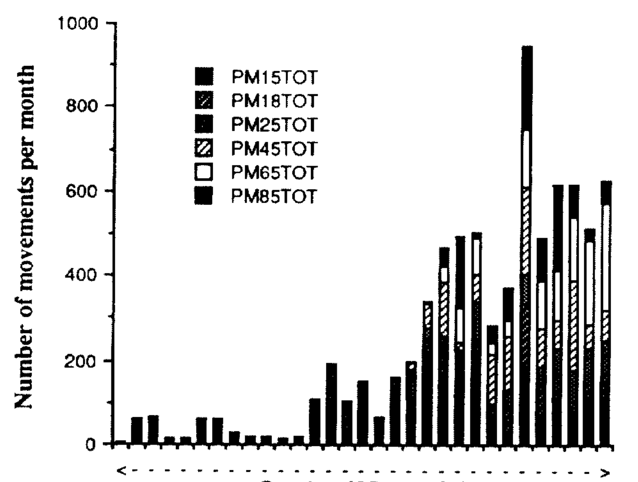

Figure 3. Movements of components for LEP underground installation

5.2 Follow-up of installation activities

This is done in close collaboration with the planning database, as related activities can be easily grouped together to create a file for follow-up of one particular area of LEP. On a week-to-week basis, a precise follow-up is carried out by the site managers on the LEP sites with portable micro-computers containing relevant activities for the particular zone being studied. Once each current activity has been "followed-up" (usually an indication of the percentage of the work which has been completed), the file is stored in the memory of the micro-computer, and later uploaded to the VAX. To date more than 75,000 activities have been followed in this way.

Application programs treat the information, and prepare it for updating either the Logistics or the Planning databases. Using the new percentages for each activity, a barchart representing the planning and the follow-up is presented, which provides a good working document for people who rarely have occasion to visit the work-site and who participate in the weekly installation meeting. The follow-up data can also be grouped together to give an overall impression of the work being carried out (**Figure 4**).

5.3 Follow-up of magnetic components

There are two main stages of follow-up. As the magnets, or magnet assemblies, leave the assembly hall, a fixed camera attached to a micro-computer reads and records the unique serial number definition (bar code). Once the magnet has been installed in the tunnel, the site manager will connect the position of that magnet to its serial number via a bar code reader attached to the portable micro-computer. This is arranged in a file for subsequent upload and update of the VAX database.

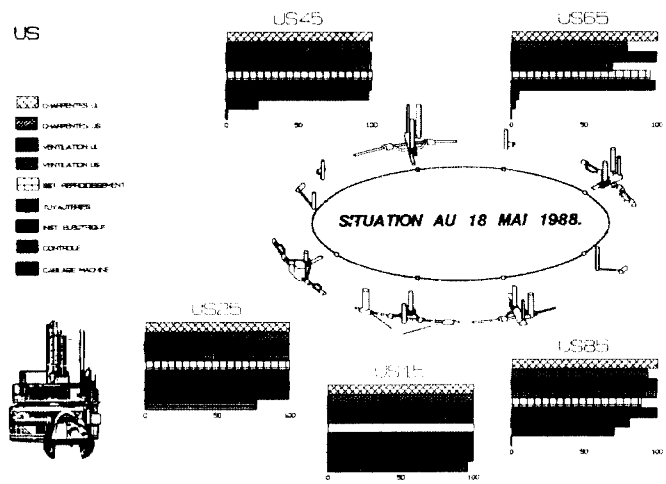

Figure 4. Progress of underground installation (US) to date (18.05.88)

6. FEEDBACK AND STATISTICS

Data feedback is very important for statistical purposes and installation organisation. Data are collected on the personnel accessing LEP underground areas, on the main lifts, cranes and the monorail system.

The personnel details are recorded from an access card which is read each time a person enters a LEP underground area (14 different access points). A unique identification number, coupled with details of the date and time of entry and exit means that statistics can be derived indicating the average number of hours worked per unit of time specified in a particular area. This information is used to produce the *LEPimeter* which is shown in **Figure 5.** This is calculated from the ratio of the number of hours actually worked against the number of hours estimated to complete LEP installation (the addition of the duration of each activity in the planning database). Of course this is merely an estimate, but to date it has proved to be reasonably accurate.

Data concerning the handling devices are collected by regularly reading the status of the lifts, cranes and the monorail by OS9 software in a G64 crate and storing it in a hard disk system. This crate is on a MIL-1553 multi-drop communications network. The data collected on the hard disk are summarised, and logs are created for each handling device on a day-to-day basis. The data are then transformed to a DOS format to enable loading to ORACLE.

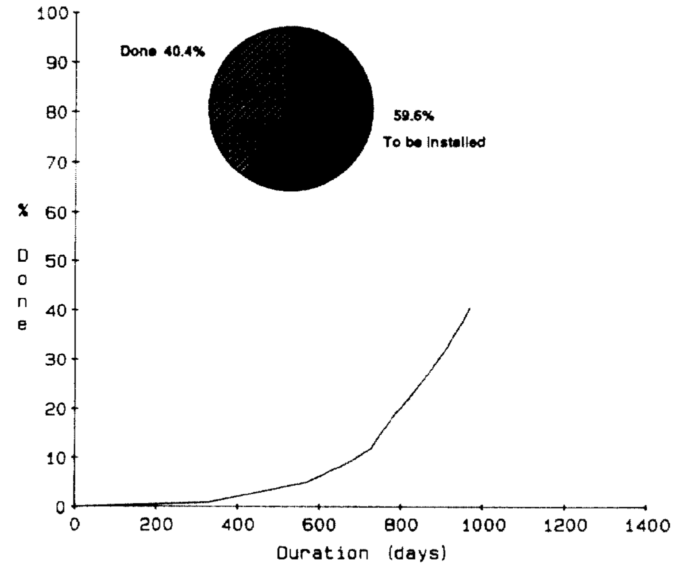

Figure 5. The LEPimetre to date (26.05.88) and its evolution since the beginning of the installation

Application programs have been written in FORTRAN, PASCAL and SQL to interpret data, and update the relevant tables in the databases. Many assumptions have been made including the charge of different handling means, the capacity of lifts and the capability of such services as transport and delivery. From the data that are "fed-back" from the work-site and the transport follow-up, it can easily be seen where these assumptions are wrong, and they can be changed according to the reality.

Different statistics and several important documents are produced from all the data fed-back. It is useful to follow the trends on the different handling devices to try to optimise future usage. Also by following the lift loads, shifts can be organised to avoid long queues at peak times. These documents, together with the barcharts already mentioned (an average of 50 of which are produced per week), are all used as working documents in the weekly LEP installation meeting held between the representatives of the sub-contracted companies, and all the people responsible for LEP installation.

7. CONCLUSION

The size of the LEP project, the number of components of some 60,000 tons in weight to be installed, and the tight construction schedules calls for organised logistics. Since the start of installation (October 1985), it has already been seen from the follow-up and feed-back data that installation trends do not always follow those foreseen in the planning. In those cases, if the system is well structured, adaptation to the planning or to the logistics of installation allows for actual trends to be defined in the overall structure, thus fully controlling installation and keeping the milestones fixed. Continuing with this work and introducing logic adaptation where necessary based on fact, it is our aim to meet the LEP construction deadlines.

References

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