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CAD SUPPORT SECTION: TASKS AND PROJECTS

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Abstract

The CAE section is well known for its daily support of CAD usage at CERN but, in fact, a large part of the section's activity is dedicated to anticipating future needs and dealing with operating systems issues and evolution of CAD software. The section supports more than 200 professional CAD users located all around the site, and it helps many other users at CERN and outside with CAD data exchange. The section is in charge of developing tools to fulfil the specific needs of the design offices and adapting these tools to the changing hardware and software environment. As an example, the section, in collaboration with the MME design office and the survey group, has developed the DMU application, which is used extensively for the LHC integration studies. In the coming years, the big challenge for the section as well as for the design offices will be the introduction of Catia. This project, started last year, is going on to adapt Catia and its data manager SmarTeam to the tools and practices in use today. Catia offers the possibility to federate many of the engineering fields needed in accelerator and detector construction. However, extending the scope of the project to cover these new fields will require commitment from specialists in each discipline.

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1 INTRODUCTION

The CAE section of TS/CSE group is responsible for the support of CAD systems at CERN. This comprises daily user support of CAD designers both individually and in design offices, configuration management of the various commercial CAD systems, and development of CERN-specific applications and utilities to be used in design work. The main CAD software packages supported by the section are AutoCAD, Euclid 3D, and recently Catia V5.

In addition to the daily support and development, a large portion of the section's activities is directed towards anticipating future needs of the designer community as well as dealing with issues rising from the evolution of CAD software, operating systems, and the underlying computer hardware. Deployment of major CAD software within an organization the size of CERN requires a huge investment involving many man-years of work to create a system with which the organization will have to live for the subsequent 10 to 20 years.

2 USER SUPPORT

The CAE section supports a wide community of CAD users located all around the site. There are approximately 600 known AutoCAD users, out of which 120 designers, technicians, and engineers use it for their daily work. The Euclid 3D user community is smaller with a total of 120 registered designers. However, roughly two thirds of them have the software permanently running on their desktops. A half a dozen pioneers comprise a pilot project, which tries to deal with Catia V5.

The current daily support tasks carried out by the section vary from quickly resolving any blocking problems in the supported CAD systems to developing solutions to the less urgent ones and training new CAD designers in the CERN design methodology. The section also helps users at CERN as well as in collaborating institutes and companies to exchange CAD data, to archive drawings produced outside of CERN with a variety of CAD tools, and to visualize and print CERN CAD drawings.

On top of supporting the CAD systems themselves, the team also has to face the daily Windows saga. This is due to the fact that most major CAD system vendors nowadays are concentrating their efforts on Windows platforms. Migrating Euclid clients from Unix to Windows has dramatically reduced the money spent on CAD computer hardware but it has also greatly increased the number of operating system related interventions. Indeed, before moving to Windows, we had a centrally managed installation of identical and dedicated Unix workstations with separated privileges for users and experienced support. Now we have pretty much the exact opposite in every respect.

A notable trend within the CAD community at CERN in the last years has been that the total number of users has strongly increased and simultaneously the turnover has accelerated, i.e., a new CAD designer is less likely to stay in position for as long as earlier. These factors have had a major impact on support load. The ratio of CAD users to support personnel at CERN is very high if compared to the industry (80 to 1 vs. 15 to 1). With the current load, we are not always able to provide the high level of support that CERN design offices deserve. Also, important development work on CAD methodology is being seriously hampered by the team having to spend a large portion of its time solving blocking user problems caused by malfunctioning software. The situation is luckily not too dramatic in case of Euclid and AutoCAD, because the software versions of those systems are fairly stable and the users tend to be experienced. However, it is clear that at this point we are not in a position to face the full Catia V5 migration effort. Solutions to this problem will have to be investigated together with the design offices.

3 SOFTWARE DEVELOPMENT

The CAE section is in charge of developing tools to fulfill the specific needs of the CERN design offices and of adapting these tools to the changing hardware and software environment. In the following list are presented some of the various applications developed in the section over the years:

- The Digital Mock-Up (DMU) application used extensively for the LHC integration studies was developed in collaboration with the MME design office and the survey group. It is being further developed by the IC group to prepare the installation layout drawings.
- The Web Consult utility for CAD data exchange has been in production since the end of 1999. It has achieved 135,000 conversions.
- Docmrp and Scandoc utilities were developed to document and search objects inside Euclid databases. There are now 139,000 references recorded.
- The 3D-standards allow management of versions of official Euclid 3D equipment models with respect to the different coordinate systems in use at CERN. After a difficult start there are now some 4,800 models registered. It is now possible to visit most of the LHC installations interactively with Euclid or Catia.
- CartWeb, coupled with CERN Drawing Directory (CDD), provides a unique tool to manage drawing title block data as well as parts lists and modification lists from Euclid, AutoCAD, and Catia (Figure 1).
- Automatic archival pipelines exist for Euclid, AutoCAD, and Catia, which stamp and archive official drawings depending on the approval status of the drawing in CDD.
- The CERN HP-GL viewer provides a way to display official drawings on all platforms independently of the native CAD system.

Behind these success stories there are over 15 man-years of development, testing, and fine tuning in various programming languages: Euclid Fortran (~85,000 lines of code), C (~7,500), C++ (~45,000), Lisp (~4,000), Tcl/Tk (~40,000), Perl (~25,000), csh (~12,000), bsh (~2,500), HTML (~3,000), plus varying amounts of code in VBA, VBScript, ksh, SQL, and Trans3D scripting language.

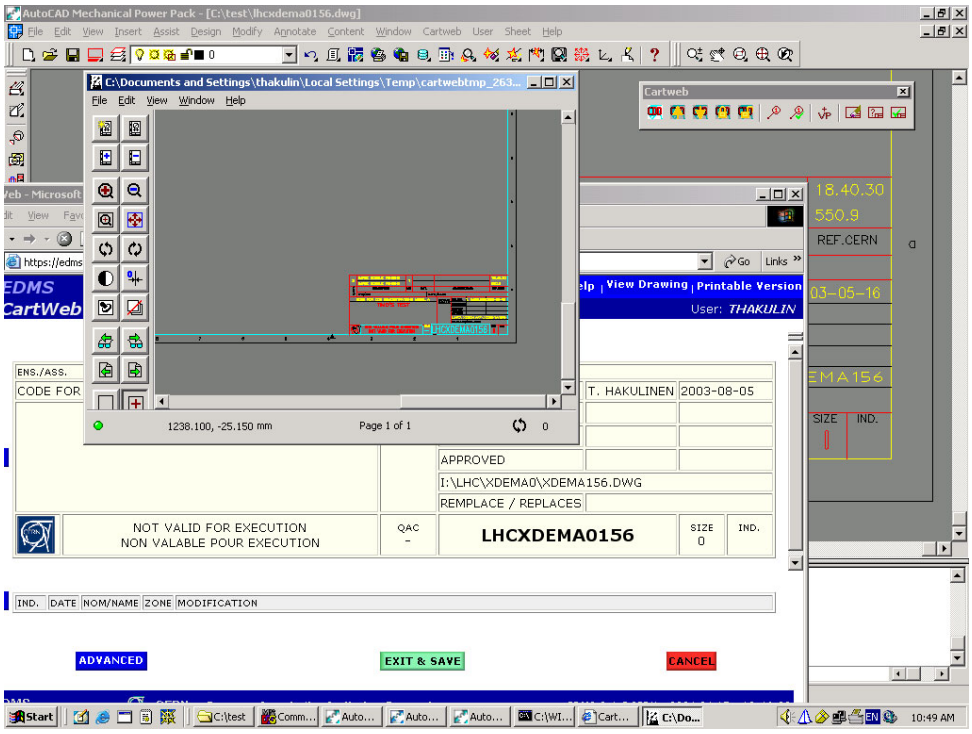

Figure 1: A CartWeb session running on an AutoCAD drawing on Windows with the HP-GL viewer open.

One of the largest ongoing projects in the section currently is the migration of Euclid software and users from Unix to Windows. In the beginning of 2002, to benefit from the good price-performance ratio, the decision was taken to replace the aging Euclid Unix workstations by standard CERN PCs. This project was completed in June 2003. In the beginning of 2003, due to the new strategy of the hardware provider, it was further decided to migrate the Euclid servers from Compaq Unix to Windows. Since then we have been spending most of our development resources on rebuilding on Windows the environment from the Unix servers, which are to be stopped in December 2004. Some 70% of the work is done at the moment and we plan to migrate around September 2004, which leaves us 3 extra months in case of major problems.

In the coming years, the big challenge for the CAE section as well as the design offices will be the introduction of Catia V5 at CERN. This project was started in 2003 after the CERN CAD2000 working group selected Catia V5 to succeed Euclid as the future 3D CAD software at CERN. It is planned that eventually Catia together with its local database system SmarTeam will become the only centrally supported CAD tool at CERN replacing both Euclid and AutoCAD, although Euclid will be used to finish all the design work on the LHC project and AutoCAD will most likely remain in use by external users.

4 THE CATIA V5 PROJECT

Catia V5 is an extremely powerful and versatile CAD system by Dassault Systemes with lots of features and modules for different design tasks. It is a major rewrite of the previous Catia V4 and as such it is relatively new software. On one hand this means that the software supports modern design paradigms and that it is being actively developed. On the other hand, many of the existing modules are not yet fully ready for production use. However, new Catia releases come out at the pace of roughly twice a year, which means that the situation is improving rapidly.

The many features of Catia make it possible to federate many of the engineering disciplines needed in accelerator and detector design. The aim of the CERN Catia project is to adapt the Catia software and its data manager SmarTeam to the existing framework of software and design methodologies at CERN.

A Catia pilot project is underway with the aim of gaining first hand experience with the software in order to develop consistent methodology for Catia use. The pilot project involves the design of the LEIR machine based partially on the old LEAR installation. Catia is used for the mechanical design of new components as well as modelling of the existing ones based on old paper drawings for the purpose of integration. Feedback and experience gained from the pilot project will be indispensable when preparing the full deployment of Catia at CERN.

4.1 Use of Catia at CERN

Since Catia has the ability to support many applications for different disciplines on one platform, this can lead to better sharing of data, fewer data conversions, more coherent methodology, and improved all around working efficiency. With this in mind, the different Catia modules will need to be evaluated to see if they are mature, workable, and conforming to CERN requirements. Afterwards, once a methodology has been written and the modules properly configured, they can be deployed in production. This work will require the expertise and commitment of specialists in each discipline in question.

The first disciplines already to benefit from the introduction of Catia are the basic conceptual and detailed mechanical design, consisting of part and assembly design and drawing creation within the pilot project, ATLAS integration studies done using the DMU module, and LHC installation studies. Catia is being used for collision checks and animations of large assemblies and has already made the pre-existing CERN DMU software, Robcad, dispensable. For the installation of LHC equipment, Catia is used for meshing point-clouds from measurement data obtained with a laser scanner by the TS/SU group. These data together with the corresponding Euclid models are then checked in a Catia session (Figure 2).

It is also possible to use Catia to carry out simple finite element analysis. This allows the designer to perform rough design checks and iterations at an early stage without involving the external Ansys system. For a more detailed analysis later on, Catia can also be used as a 3D modeller for Ansys. The full FEA capabilities of Catia will be evaluated during this year.

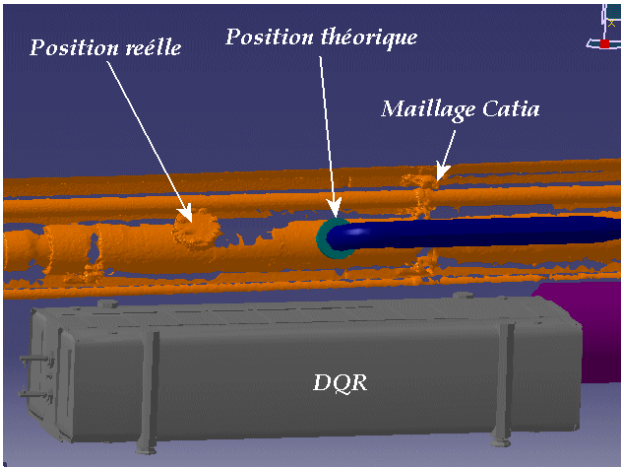

Figure 2: Euclid model and model derived from point-cloud in Catia.

Additional modules exist among others for sheet metal design, welding, metrology, cabling, tubing, manufacturing, and schematics design. These modules are yet to be study and configured for use at CERN.

4.2 CAD data management

Designs created with a complex CAD system such as Catia with many different modules normally consist of many different interlinked files and file types, which need to be stored, tracked, and kept under version control during the lifetime of the design. Designs may also contain application specific and context sensitive metadata, which normally might not be managed by the CAD system itself. Furthermore, in a multi-designer environment such as CERN, where many people work on the same project, it is imperative that CAD data can be share in a consistent, coherent, and secure manner.

Managing all Catia design data is the job of SmarTeam, which is the local data manager for Catia. SmarTeam is tightly integrated with Catia, which means that it knows about all Catia data types and is able to automatically keep track of all the links between CAD files so that the use of SmarTeam is as transparent to designers as possible. The metadata are stored in an Oracle database and the CAD files themselves are kept on a separate centrally managed vault server.

The role of SmarTeam at CERN is strictly to manage the internal CAD design data during the actual design phase and to store the native files of all finished designs for the future. EDMS/CDD will remain the repository of all official drawing data and act as the public interface towards collaborating institutes and supplier firms. The official approval process of drawings produced from Catia designs will be carried out in CDD with the approval status reflected back to SmarTeam to allow all the relevant versions of the design files to be locked accordingly. For the official designs, the SmarTeam high level project tree hierarchy will reflect the CDD equipment code structure to facilitate mapping of metadata between the two systems. Within the actual SmarTeam equipment folders designers are then free to organise their work as they see fit.

SmarTeam is currently being tested and used internally within the section. The next step is to introduce it to the Catia pilot project to allow the actual LEIR design data to be stored there.

4.3 Integration of Catia into CERN infrastructure

To make Catia work well in the CERN environment, installation and configuration procedures have been developed to ensure a uniform installation on all machines. Installation of Catia uses the normal Windows application installation mechanisms and Catia configuration options are being centrally managed. Work is also underway to make Catia work with several CERN specific applications.

The most urgent CERN applications from the designer's point of view are the title block editor CartWeb to allow editing of CERN standard title blocks and drawing archival to allow finished designs to be officially approved. A temporary solution for editing title blocks was provided for the pilot project while a native Catia interface to CartWeb was being developed. A fully functional version of CartWeb for Catia is currently being tested in the development environment. The automatic archival pipeline for Catia drawings also exists and is being tested.

Integration and migration of Euclid 3D standards to Catia is underway. The Euclid 3D models are converted to full Catia native format as well as to a more compact simplified representation format useful for building digital mock-ups in Catia. The converted 3D standards are updated every night and there are currently more than 4,400 models stored in the Catia standards database. The success rate of the conversions to the simplified representation format is about 99% and to the full format about 90%. However, within the files successfully converted to the full format there may still be errors. Therefore, for migration of any full Euclid models to Catia, manual checking will always be necessary afterwards.

As the approval, process of drawings will be handled by EDMS/CDD, the interface and data exchange protocol between SmarTeam and EDMS are to be developed. Work is underway for defining this interface. The approval process for designs managed by SmarTeam can be initiated from the SmarTeam interface. Any supporting documents for the approval, including the official drawing file as well as a portable 3D representation, will be transferred from SmarTeam to EDMS. As the approval process proceeds, the approval status will be reflected in SmarTeam. When the approval process is active and after a successful approval, all the corresponding design files will be frozen in SmarTeam so that a new version of the design has to be created in order to edit it. Completion of the final implementation of the SmarTeam-EDMS interface is foreseen for the coming autumn.

4.4 Support and methodologies

Possibly the biggest challenge facing the Catia project is that of development of consistent methodologies for the large number Catia modules and the subsequent effort needed in user support. Given the eclectic nature of Catia, consistent and tested methodologies are an absolute necessity to ensure interoperability between designs. These methodologies can only be properly defined as experience is gained on the various design disciplines over a considerable amount of time.

In order to distribute the support load, we believe that what is needed in the design offices are special 'expert users'. These should be experienced users, who have gone through all the relevant Catia training, are willing to help and advice other users in everyday design tasks, encourage the exchange and sharing of experience, and are able to solve common problems. This should dramatically reduce the number of interventions by the CAD support team. The other functions of the expert users would be to act as a link between the support team and the designer community, and to help in defining Catia design methodologies relevant to their field.

The need for expert users is especially pronounced for the disciplines other than standard mechanical design, i.e., those areas where the CAD support team have little experience. Examples of such disciplines are piping and cable schematics. In order for the expert users to be really effective, the role of the expert users must be officially recognised to permit them to devote the needed time.

4.5 Training

The last big issue is training for the Catia users. All Catia users should receive training before being allowed to work on official designs. An on-line tutorial comes with the software, which can be used to brush up on one's Catia skills, but it is obviously no substitute for proper user training by a competent teacher. So far training courses for the support team and a total of twelve pilot users have been bought

from outside. However, in-house training will have to be developed for CERN specific methodologies and applications. In the future it may even be reasonable to develop basic user courses in-house to replace externally bought training. Whether to eventually do this, will have to be seriously studied and the choice made based on cost and resources required.