METHODOLOGICAL ISSUE OF CAD MODELS MIGRATION IN CATIA V5

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Nowadays designing tasks become more complex and involved large engineering populations for participation. Participant parties of design involved into project activity concurrently and not simultaneously. This circumstances set special requirements especially to ensure compatibility and exchangeability of models coming from the different CAD platforms.

First solution of this task was based on creation of various file standards of 3D geometry representation and improvement of export/import ability of CAD systems accordingly. Thus, several common file formats was generated like IGES, STEP, DXF, WRL, SAT, STL, VDA-FS. However, a standard file formats cannot represents the special facilities of CAD; for instance geometrical constraints, parametrical features, etc. Thus this way exists but not recognized as a main approach for concurrent engineering activity.

Next solution entailed creation of so called PDM – Product Data Management system (fig. 1). PDM permits to translate data from one format into another and store/control information model of designing object. However this approach cannot be implemented widely because requires extra resource including engineering manpower for support.

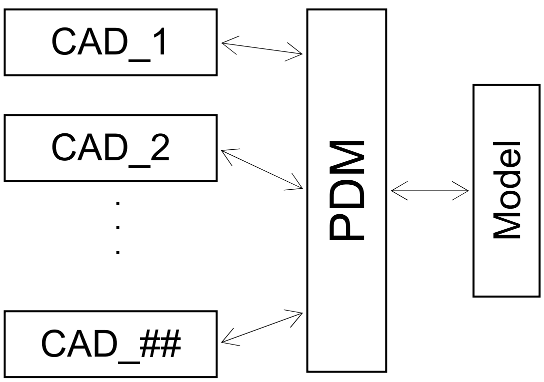

Figure 1. PDM system architecture

Most effective is CAD integration on the base of neutral file formats. For this it is necessary to built special software so called connectors. They enable translation of 3D geometry from one CAD native format into another CAD native format. CAD manufacturers announced several initiatives. SolidWORKS Co. announces SPP – Solution Partner Program [1] in order to integrate with ANSYS, CAMAX, CimLogic, and SRAC on the base of neutral file format, etc.

In European Organization for Nuclear Research (CERN), Geneva, Switzerland, main CAD database was built on Euclid platform. While possibility of Euclid doesn't responds to requirements of modeling of large assemblies it was approved to move into CATIA V5 which is much more strong platform among the nowadays CAD applications.

Models translation were carried out by the special software, so called connector, built by Matradatavision for migration of Euclid objects into CATIA V5. Connector enables to build 2 types of CATIA V5 native files – CGR and CATPart.

CRG – CATIA Graphic Representation is facet-based geometrical model, similar as WRL and enables represent just boundary surfaces of model. CGR is not editable model while contains no solids or parametrical features. Connector built CGR from the Euclid screen model. So, no intelligent feature recognition procedures are going on and as a result generated CGR models are closely corresponds to Euclid models. However, there is a bottleneck with this way and it is approximation. Euclid screen model contains approximation of splines in order to reduce computing recourses. Approximation of boundary cylindrical surface will cause bigger dimensions as origin, while approximation of holes less (fig. 2). Therefore, for relatively big dimensions value of inaccurateness Δ will be commensurable with predicted value. For some models it was measured up to ~30mm.

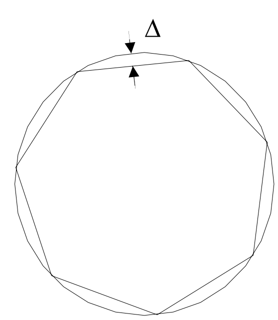

Figure 2. Approximation of holes on Euclid screen model

CATPart – CATIA native standard contains history how geometry was built. Model built on the base of solids and parameterized features connected by constraints. All geometry represented on product tree (fig. 3). For this case connector generates CATIA product tree from Euclid product tree. However, this cause instability of received results while correct translation depends on methods of representation of geometry on the Euclid product tree. In one's turn

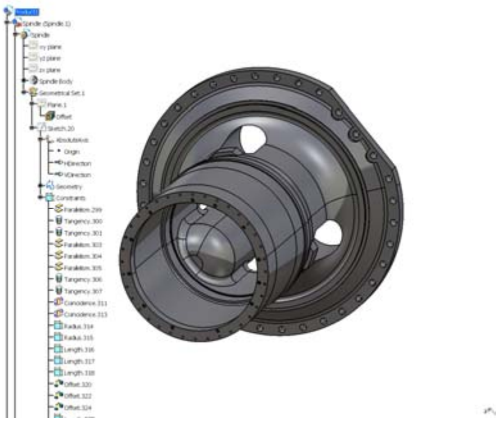

Figure 3. 3D CATIA model with corresponding product tree

designers can built the same geometrical object by using the different methods of modeling which finally will have an influence on CATIA migration results.

ATLAS detector is on of the item constructed at CERN. It is complex construction with length 35m, width 22m, high 25m, weight 70'000 tones [2] and consists of more than 3'000 assemblies (fig. 4).

Georgian Engineering center was responsible for migration of 3D models from Euclid to CATIA.

It was worked out models migration life cycle based on the methodology proposed by Georgian engineering center. *Six* stages have been separated and corresponding tasks were distributed between the participant parties (fig. 5).

Migration team was built from 3 participant parties:

1) Georgian Center – CAD/CAM Engineering Center in Georgia partly represented at CERN ATLAS and partly in Georgia
2) ATLAS TCn – Technical Coordination team of ATLAS in face of Euclid designers
3) CAD TS – CAD Technical Support presented by CAD engineers responsible for migration server and connector software.

Piont_A The purpose of point is to detect all existing conflicts – clashes, contacts, critical distances between the model to be migrated and rest of the ATLAS detector environment. Output document is conflict report with the list of conflicts and detailed description of each conflict case. Responsible for stage is Georgian center.

Piont_B After receiving the conflict report with the full list of conflicts Euclid designer at ATLAS TCn analyze each case of conflict and describes status – relevant/not_relevant. Than all relevant conflicts are going to be removed. Output documents are reports with designer comments and updated Euclid 3D model. In case of detection and solution relevant conflicts model to be rechecked on *point_A* and come back to *point_B* with new conflict report.

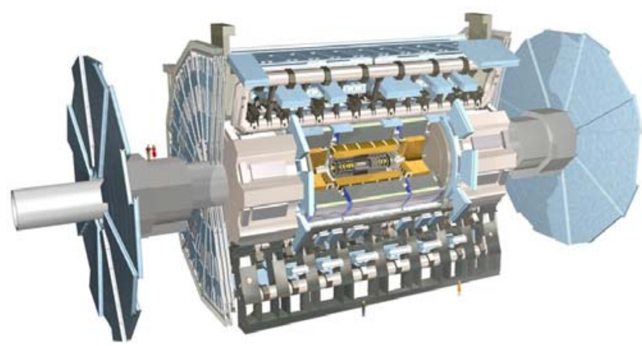

Figure 4. ATLAS detector scaled model without services and support structures

Piont_C The purpose of point is splitting Euclid 3D model into number of separated parts. In general result of translation depends on model complexity. More complexity cause less reliability. Therefore connectors have critical value of complexity. For Euclid_to_CATIA migration connector this value is 32'000 points and it is highly recommended that all migrated models have logical point amount less then given. So, 3D model has to be investigated and in case of complexity more than 32'000 point have to be divided into corresponded parts without description of logical structure of construction. This activity was carrying out by Georgian center in Georgia. All splite models were uploading on the special migration server at CERN.

Piont_D After uploading on migration server models have to registered in special form and prepare for quality control. At CERN there is a special multi-platform resource CDD (CERN Drawing Directory) enables management of drawings [3]. The concept is that for each migrated 3D model corresponding control drawing have to prepare and put into the CDD. Then responsible person have to make quality control and check correspondence and correctness of models/drawings. Above mentioned activity was carrying out by members of Georgian center at CERN.

Piont_E At this point all registered on CDD and approved models are translated into CATIA natives – CGR and CATPart. Engineers from CAD TS at CERN are responsible for creation of log files of translation for each model, activating of software and distribution of corresponding files into databases.

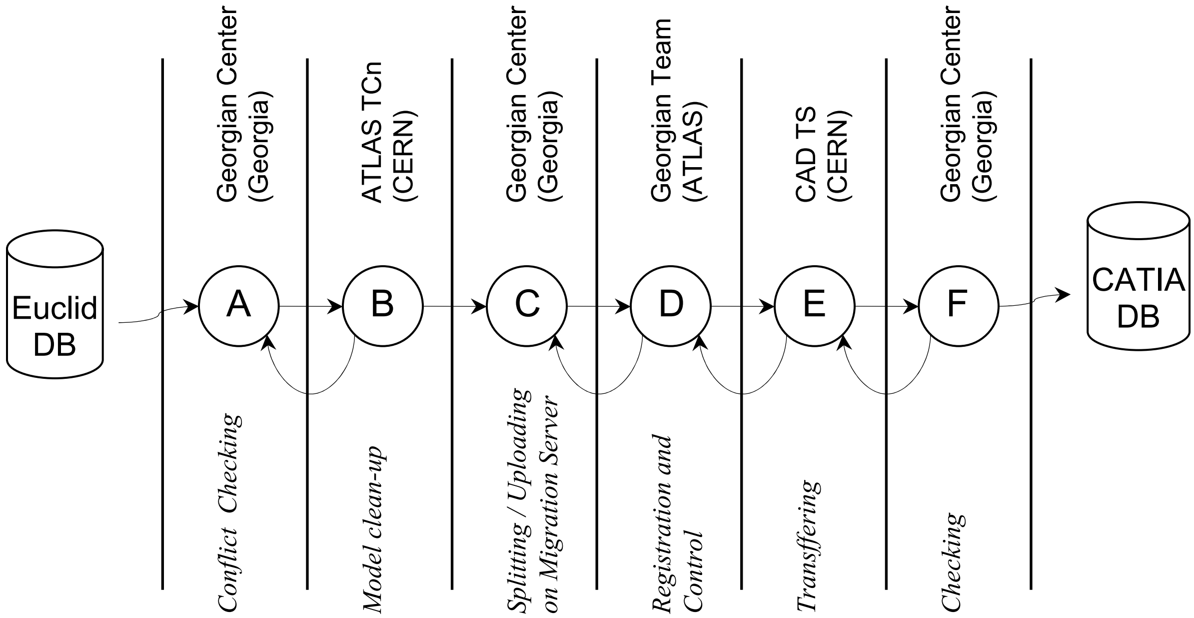

Figure 5. Models migration life cycle

Piont_F The purpose of point is checking results of conversation and estimating quality of migration. Models checking foresee steps as follow:

1) Completeness checking – have to be done to ensure that all components are presented in CATIA model. For generated CGR and CATPart files are comparing using CATIA DMU_Space_Analyze. Output document5 is the completeness report
2) Compare checking – have to be done to ensure that all dimensions are compliant and model has the correct position. While CGR corresponds to Euclid screen representation it's comparing to CATPart using the CATIA DMU_Space_Analyze. Also mass analyze of both models were doing. In special cases control points are measured directly on Euclid and CATIA models and compared. Output document is compare report
3) Approximation checking – have to be done to ensure that approximation value in CGR is less than allowable variation. For this calculating Δ according to measured length of vertex of the approximated polygon. Result is presented in compare report.

Georgian engineering center was responsible for above mentioned activity.

Up to 2'000 ATLAS detector 3D models and corresponding drawings were migrated in CATIA according to life cycle described above. Migration statistic shows that less then 5% of CGR models were failed during migration whereas amount of failed CATParts are much more ~ 55%.

CAD/CAM engineering center with CAD TS made systematical investigation of failed models. It was showing up reasons and they were grouped as follow:

1) Difference of the interpretation of project trees in Euclid and in CATIA. For this group of failed models it is possible to re-open model in Euclid, change project tree and re-submit model into migration pipeline. General recommendations foresee to follow the limitations as follow:
    - reduce hierarchy of parent/children into the project tree. In some cases connector cannot handle correctly the child items which are on 2nd and more level of hierarchy

- put all pipe profiles on the common, so called “starting plane”, while connector not always correctly handled the solids when profile is not on the “path” on “guide curve”.
- Check connections of primitives. In case of auto crossing or open loops (fig.6) of pads profile corresponding features are deactivated by the connector.

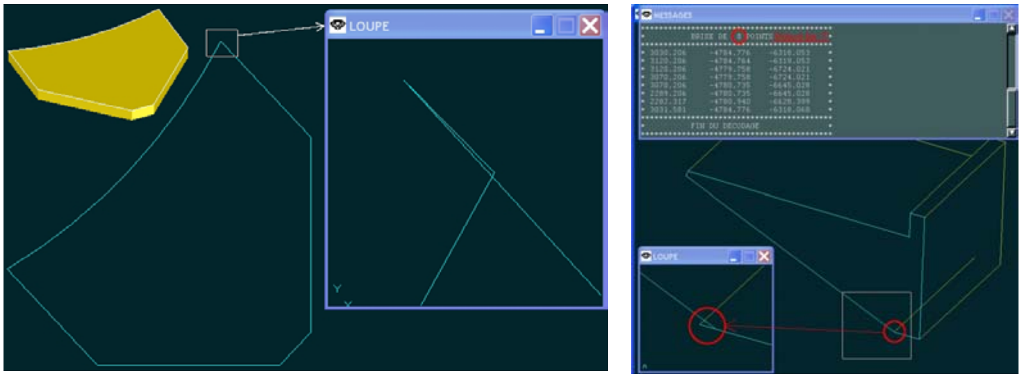

Figure 6. Auto-crossing / open loop faults

- Put “sweep base” in Euclid according to connection angle in case of intersection of *two* segments. While CATIA chooses arbitrary the orientation of one of intersected segment and built swept surface of next segment according to sweep base of chosen segment. As a result if *two* cylinders are intersected in CATIA as an intersection of cylinder with ellipsoid while circular profile of cylinder will be moved into ellipse by the reason of keeping orientation of circle on the 2nd segment according to guide curve of the 1st segment (fig.7).

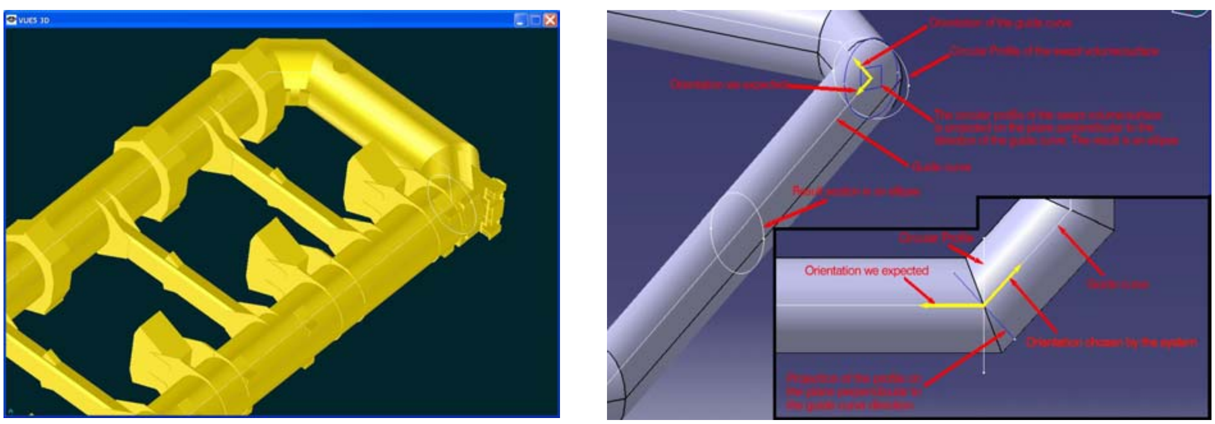

Figure 7. Difference in Interpretation of Swept profiles in Euclid and in CATIA

2) Dimensional compliance. In many of cases migration was failed (no CATPart was generated) by reason of space dimensions and precision defining by designers before designing model in Euclid. Space dimensions 100m cause failure of connector. In other cases space dimension doesn’t compliance with model dimension. As a result precision calculated by Euclid becomes not enough and it is unable to generate CATPart by connector. It is possible to solve all above critical cases by reducing the unit to *mm* or changing dimensional space adapted to model dimensions. Test investigation of dimensional spaces was done. 50m and 5m spaces found as critical for connector while no CATParts were generated for this value. Spaces with 300mm, 500mm and 5’000mm are fine for migration

3) Connector faults. 3D sections entities in sub-assemblies raise the problem of generation of CATPart by connector. If Euclid CGS of 3D section is very complex, connector cannot translate the whole entity. In this

case “Entity #NUM not found” message in the translation report were generated and nothing will be translated into CATIA.

Conclusions:

Paper summarizes results of case study of Euclid_to_CATIA migration of ATLAS detector models at European Organization for Nuclear Research - CERN, Geneva, Switzerland. Migration life cycle has been considered and results of migration of 2’000 objects are generalized by systematical approach. Thus, 3 groups of reasons cause faults of migration have been identified and considered.

Sources:

1.CIMWorld Industry Database /NR96370.- www.cimworld.com

2. ATLAS – Episode_1 – A New Hope /Produced by Lawrence Berkeley Lab._CERN, 2006

3. ATLAS Technical Co-ordination, Technical Design report / CERN, 1999.- 591p.

METHODOLOGICAL ISSUE OF CAD MODELS MIGRATION IN CATIA V5

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Compatibility of CAD platforms is the ancient bottleneck in computer aided product modeling technology. Various file formats and approaches of 3D geometry creation and representation using in different CAD packages cause necessity of development of methodological issue of models migration.

In European Organization for Nuclear Research (CERN), Geneva, Switzerland, main CAD database was built on Euclid platform. While possibility of Euclid doesn’t responds to nowadays requirements of modeling of large assemblies, it was approved to move in CATIA V5 which is much more strong platform among the nowadays CAD applications.

Report describe models migration methodology based on the compatibility of neutral project tree. Also results of migration of more than 2’000 Euclid models from CERN CAD database were presented.

CAD მოდელების CATIA V5 სისტემაში მიგრაციის მეთოდოლოგიური კვლევის შესახებ

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ბირთვული კვლევების ევროპული ორგანიზაცია CERN, ჟენევა, შვეიცარია

CAD პლატფორმების თავსებადობა ერთერთი უძველესი და აქტუალური პრობლემაა კომპიუტერული დაპროექტების ტექნოლოგიაში. CAD პაკეტებში როგორც წესი გამოიყენება 3D გეომეტრიის აგების სხვადასხვა მეთოდი. ამასთანავე განსხვავებულია ფაილის ფორმატებიც. შედეგად, აუცილებელი ხდება ერთი პლატფორმიდან მეორეში მოდელების მიგრაციის მეთოდოლოგიის დამუშავება ყოველი კონკრეტული შემთხვევისათვის.

ბირთვული კვლევების ევროპულ ორგანიზაციაში (CERN), ჟენევა, შვეიცარია, CAD მონაცემთა ბაზა აგებულია Euclid პლატფორმაზე. თავის მხრივ, Euclid სისტემის შესაძლებლობები არ პასუხობს ისეთი დიდი საინჟინრო დანადგარების მოდელირების მოთხოვნებს როგორიც ATLAS-ის დეტექტორია. ამიტომ გადაწყდა CATIA V5 პლატფორმაზე გადასვლა, რომელიც დღესდღეობით ყველაზე განვითარებულ CAD პაკეტს წარმოადგენს სხვა პლატფორმებს შორის.

მოხსენებაში წარმოდგენილია 3D მოდელების მიგრაციის მეთოდოლოგია რომელიც ეყრდნობა სისტემის საკუთრივი საპროექტო ხეების თავსებადობის მიღწევის პრინციპს. ასევე მოყვანილია შედეგები 2’000 Euclid მოდელის მიგრაციისა, რომელიც განხორციელდა CERN-ის მოდელების ბაზიდან.

МЕТОДОЛОГИЧЕСКАЯ ОСНОВА МИГРАЦИИ CAD МОДЕЛЕЙ В CATIA V5

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Совместимость CAD платформ является одной из актуальной проблемой в технологии компьютерного моделирования изделий. Различные файловые стандарты а также методы моделирования 3D геометрических фигур используемые в отдельных CAD пакетах обусловливают необходимость разработки методологии миграции в каждом отдельном случае.

В Европейской Организации Ядерных Исследовании, Женева, Швейцария, основная база CAD моделей была построена на основе платформы Euclid. Поскольку возможности Euclid по моделированию больших изделии, каким является детектор ATLAS, сильно ограничены, было принято решение перехода на новую платформу CATIA V5, которая является наиболее развитой системой компьютерного моделирования на сегоднящий день.

В докладе рассмотрена методология миграции 3D моделей которая основывается на принципе внутренней совместимости проектных дерев систем. Также приводятся результаты миграции 2’000 моделей Euclid произведенных из базы 3D моделей CERN.