

HPC - The Genesis of SDM

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The first commercial SDM platform was deployed into production on BMW's HPC on 19 December 2000 (ref 1). Virtual Insight, the platform for BMW's CAE Bench solution, had been developed by a visionary team at Silicon Graphics, the HPC provider. The Munich-based SGI Professional Services team had decided to develop a technology framework to enable the development of domain solutions for HPC users. Virtual Insight was designed to enable the automation of data-set management; to assemble sets of data, transfer the data to the HPC and then collect and collate the results. The idea was to reduce the data management overhead on simulation experts whilst providing traceability of results, thus enabling analysts to submit more jobs on HPCs.

BMW and SGI pioneer SDM

At BMW, Dr Michael Holzner and his team had refined vehicle crash simulation to the point that it was sufficiently accurate to replace physical testing for business decisions. This meant that multi-hundred-million-dollar decisions were to be taken based on numerical simulation alone. Only later would these be validated by crash testing of pre-production vehicles. Simulation was now business critical and Dr Holzner successfully argued that a "Simulation Data Management" solution was required to ensure the quality and traceability of business-critical simulations. It was unthinkable that a data or process error could be allowed to adversely impact business decisions of this magnitude. Michael Schlenkrich, then of SGI, managed the project to develop the CAE Bench SDM solution on the Virtual Insight platform to deliver the quality assurance and traceability that Dr Holzner sought. CAE Bench reduced the data management overhead on expert users as predicted by Dr Schlenkrich, who, with Dr Holzner, maintained a focus on helping engineers to do their work throughout the project. The many automation scripts developed by individual analysts were validated and deployed in the SDM solution so that all analysts could benefit.

Audi take SDM to the next level

Dr Holzner left BMW to join Audi and further develop their vehicle simulation capability. He repeated the success of CAE Bench by commissioning a Virtual Insight-based SDM solution for Audi. This time the emphasis was on growing engineering throughput, initially by automating process documentation by automatic meta-data capture. Dr Holzner acknowledged a 35% gain in engineering throughput with the same staff(ref 2). Audi took SDM for automotive vehicle simulation to the next level by co-developing with MSC Software the Simulation Generator which automates the assembly of the FE model. This enables part changes to be incorporated with minimal effort. This approach was then modularised at Audi with the use of LoCo for assembly(ref 3&4) The Audi SDM solution automatically assembles the FE model and collects an average 200 meta-data objects to define the audit trail(ref 5). The

implementation of model assembly, results extraction and the creation of lightweight viewables next to the HPC minimises the data traffic between the analyst's workstation and the HPC. This is an important enabler for HPC or cloud computing. It also enables global working, as analysts can be located anywhere.

SDM helping the Analyst

Analysts are not only freed from the laborious task of recording ~200 items of information per simulation manually, but a capable SDM system can also manage the Information Lifecycle (ILM). Whilst the metadata, key results and viewables are retained, large files of raw data are automatically deleted after a set period, unless the analyst sets a flag to retain them. Some output files are compressed using lossy compression tools such as FEMzip. Reichender reported that BMW currently persists 700 terabytes of mainly compressed simulation data which equates to automatically deleting more than a petabyte per year(ref 1). BMW migrated from its custom CAE Bench solution to the standard, configurable SIMmanager SDM2.0 solution in 2013. Using extended data management automation, BMW recently passed the milestone of 2,000,000 vehicle simulation data sets created and under management. This equates to an 800 gigabyte database holding close to 200 million objects.

Airbus brings SDM to CFD

In the European aerospace domain, the Airbus teams had improved their CFD algorithms to the point that they were "able to deliver quantitative results such as flight drag/lift values with quite a high precision in large parts of the flight domain" in an overnight run, replacing wind tunnel testing. As numerical simulation became the basis for engineering and business decisions, Thierry Chevalier echoed the same thought process as Michael Holzner: once simulation replaces physical testing for important engineering and business decisions "strong data management, with trace-ability and to enable repeatability of numerical simulation" is a high priority. Airbus elected to develop a specific SDM, AeroCity, for their distributed European CFD teams.

Top Down or Bottom Up?

While Audi chose to adopt the first commercial SDM platform and build functionality on top of it, Airbus chose to use a commercial workbench, ModelCentre, and underpin it with a solution built from standard, industrial strength data management building blocks from Oracle(ref 6). Most importantly they built the capability which is at the core of SDM: to create the simulation process history in the database, independent of the individual files. CFD engineers on any site can trace processes and data and then re-run processes when inputs change. They have the freedom to re-run automatically if the change is minor, or repeat the analysis adapting their assumptions and methods to the modified physical situation.

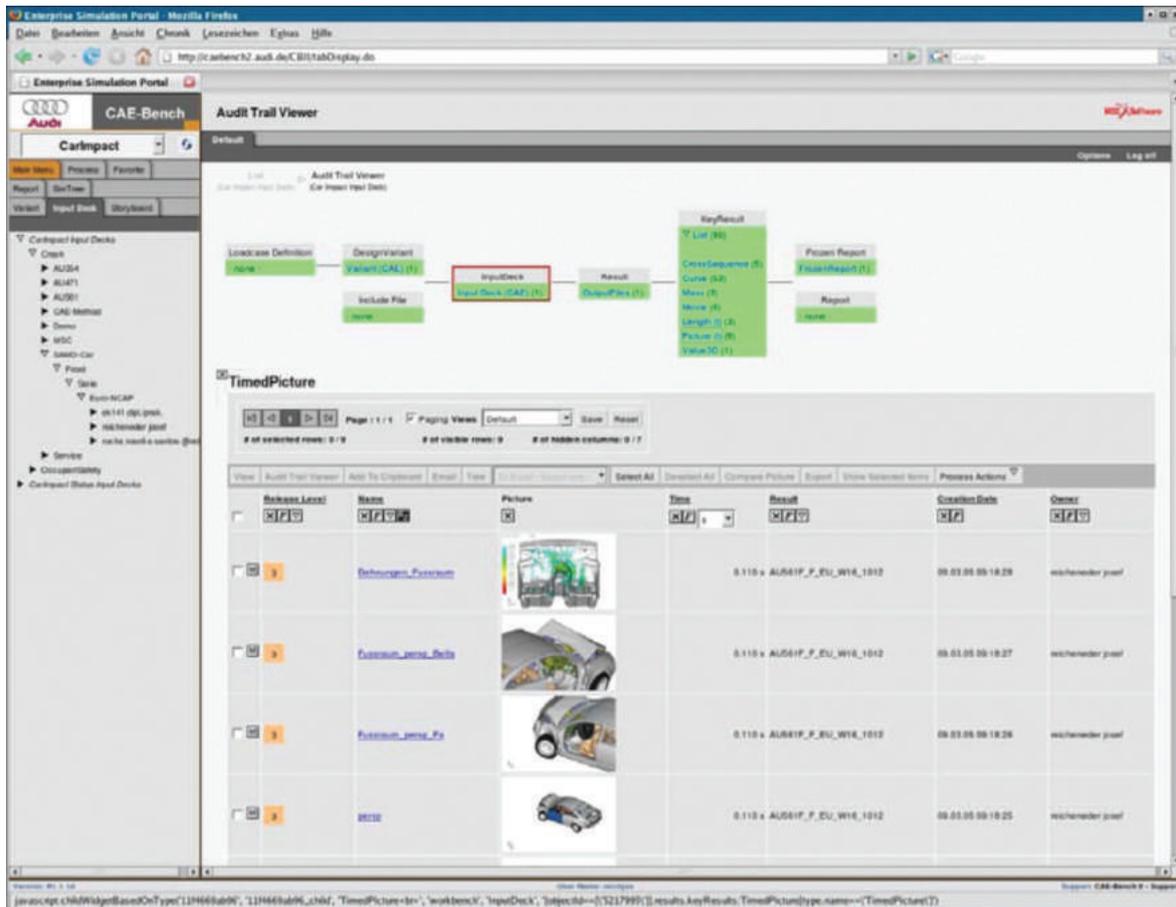


Figure 1: Access to Intellectual Property through search or audit trail at Audi (ref 3)

At the recent SimBest conference in Manchester, England, Nadir Ince of GE Power asked the audience "How long it would take them to find the data to re-run that analysis?" without an SDM solution. At BMW, Audi and Airbus a decade or more of simulation data and millions of results are available instantly through a browser see figure 1. The Intellectual Property of the engineering organisation is searchable, accessible, traceable, verified and secured. Beyond appropriate governance, increased productivity and the elimination of laborious non-value added tasks, it's access to the IP from the HPC that is the true added value of SDM.

References:

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NAFEMS SDM Bibliography

These presentations are now accessible to NAFEMS members through the NAFEMS SDM bibliography on the SDM WG web-page nafems.org/SDMWG which contains some 200 papers. I would like to thank the staff members at BMW, Audi, Airbus and MSCSoftware as well as all those from other organisations who took the time to present their SDM projects and lessons learnt.

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