spdm
INTERNATIONAL CONFERENCE
Simulation Process & Data Management

On the development of an in-house database-driven SDM tool, and recent progress with an open source SPDM platform, with a specific example for modelling atmospheric dispersion using CFD

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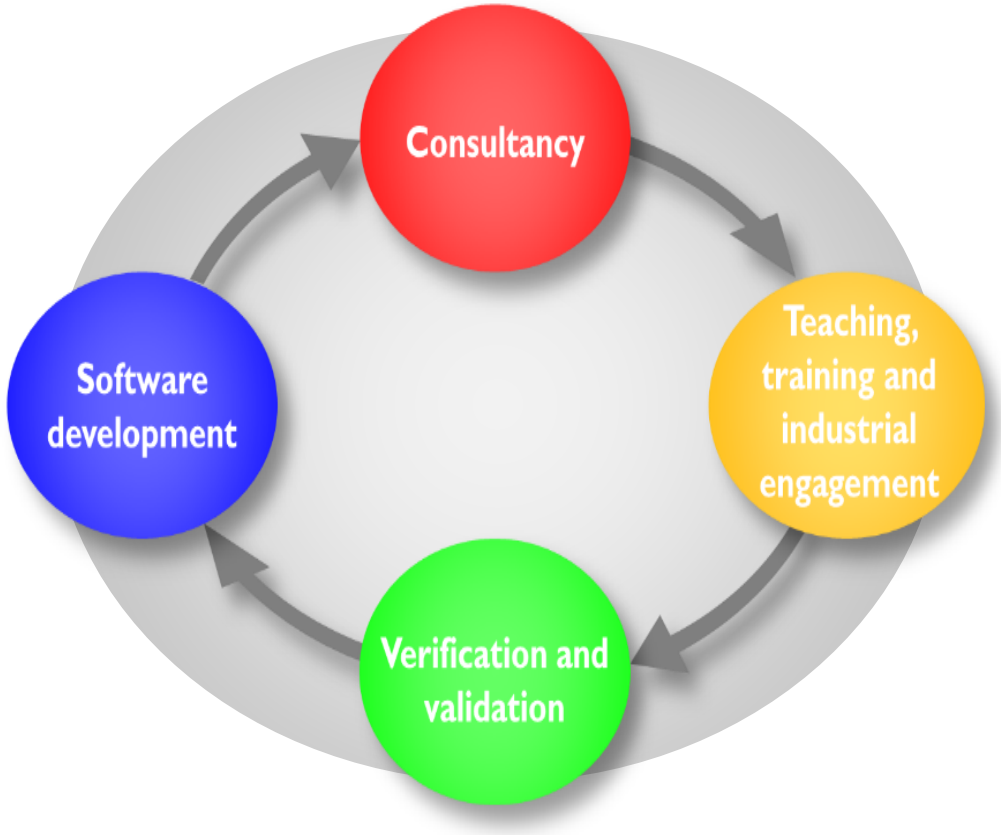
Abercus

Abercus is an independent consultancy specialising in advanced engineering simulation within the energy sector – CFD, FEA, teaching/training and software development.



Introduction

- JET (an acronym for job execution tool) is an early example of an SDM tool – it was developed in 2002
- It uses a relational database to manage the meshing activities, define the CFD physics and solution sequence, and process the CFD predictions in a standard format
- For some years now, Abercus has wanted to develop a new version of the tool with expanded capability, improved flexibility and agility, and improved accessibility.

Introduction

- The current paper provides
  - some background to the development of JET
  - the underlying database structure of the original tool
  - identifies the limitations of the original tool and outlines how some of these limitations have been overcome
  - some of our recent experiences with openSPDM
- Simulation data management should not be thought of as exclusively the realm of large engineering organisations – it can deliver significant benefits to any company, of any size, that is involved in advanced simulation analysis.

Job execution tool (JET)

- The primary motivations for the development of JET were:
  - to ensure that all CFD simulations were set up in a consistent manner, regardless of who was running the analysis
  - to provide an audit trail for the mesh generation process, and provide a mechanism to allow multiple engineers to simultaneously construct complex mesh assemblies
  - to ensure that appropriate monitors and residual histories were extracted from the CFD tools during the course of each simulation, so that the convergence of each simulation could be checked remotely (via a dial-up modem connection, which was state of the art in 2002)

Job execution tool (JET)

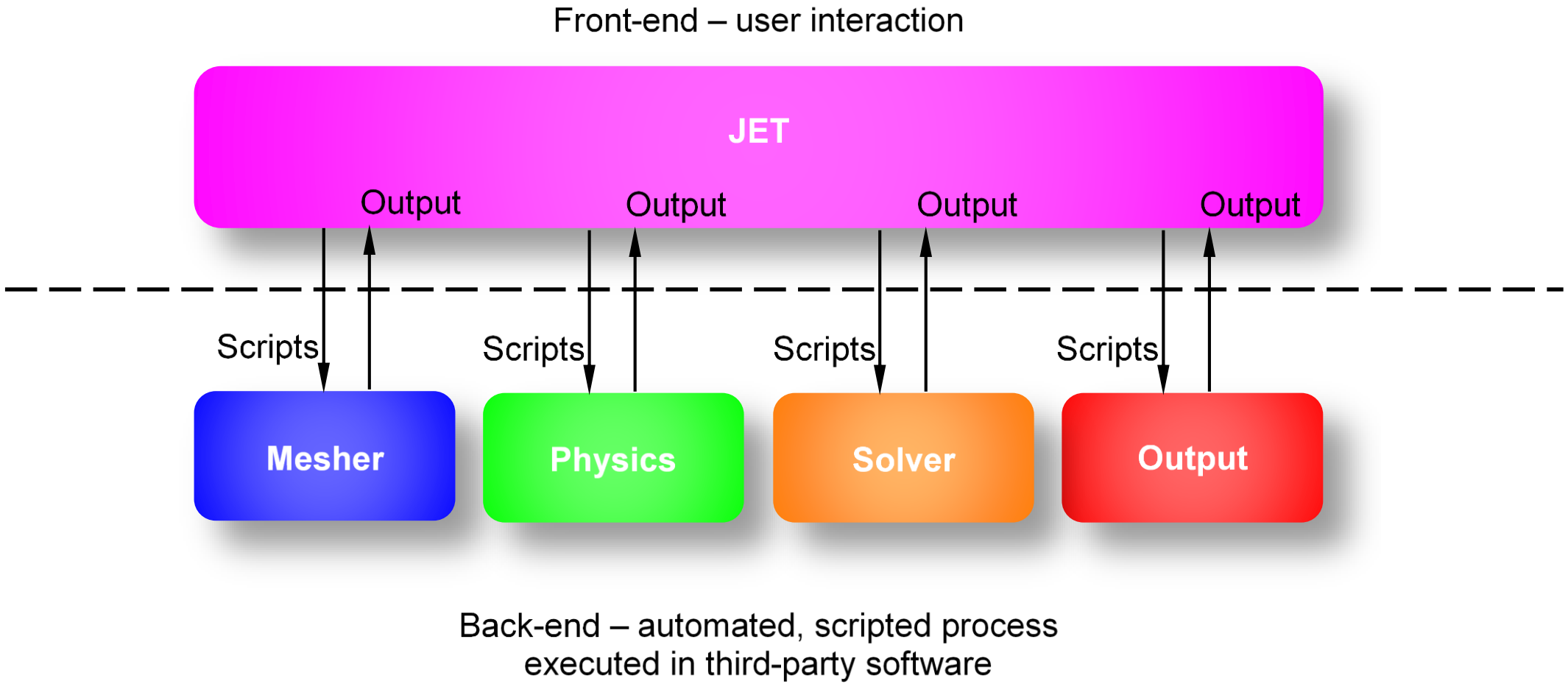
- The primary motivations for the development of JET were:
  - to capture several novel features relating to the post-processing (for example, automatically defining camera positions relative to the wind direction, and automatically creating a standard form of output that was termed *projection contours*)
  - to automate post-processing, through the use of standard page templates, so that the CFD predictions for large numbers of individual cases could be automatically compiled as appendices to project reports.

Job execution tool (JET)

- Capturing knowledge and experience within predefined parameterised workflows
- There are two types of user:
  - super user – an experienced individual responsible for the development of the parameterised workflows
  - ordinary user – anyone using JET to undertake simulation work for live projects.

Job execution tool (JET)

- Glass box approach



Job execution tool (JET)

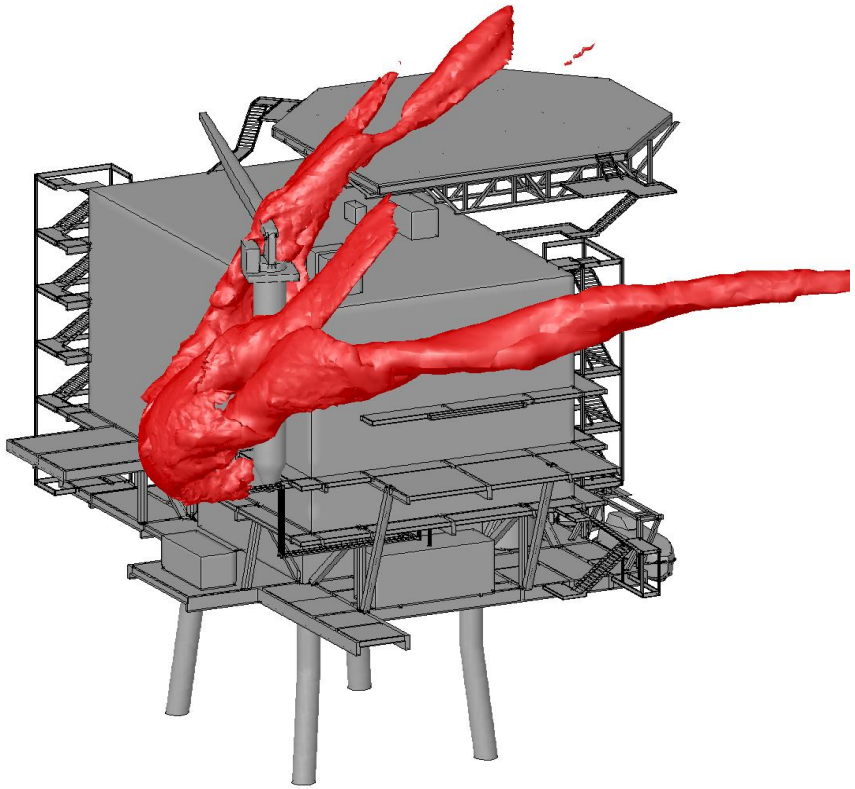
- Scripting
  - a record of every action within every simulation sequence undertaken within the company is maintained
  - any simulation can be repeated exactly, if necessary, by anyone at any time.

Job execution tool (JET)

- Consensus
  - the process of developing a workflow is an opportunity for the super users to discuss how to simulate the flow application
  - this discussion should include a properly documented predictive capability assessment
  - hopefully a consensus can be reached
  - if not, open questions should be recognised and documented
  - capturing alternative workflows facilitates comparison between them (can be akin to blind benchmarking)

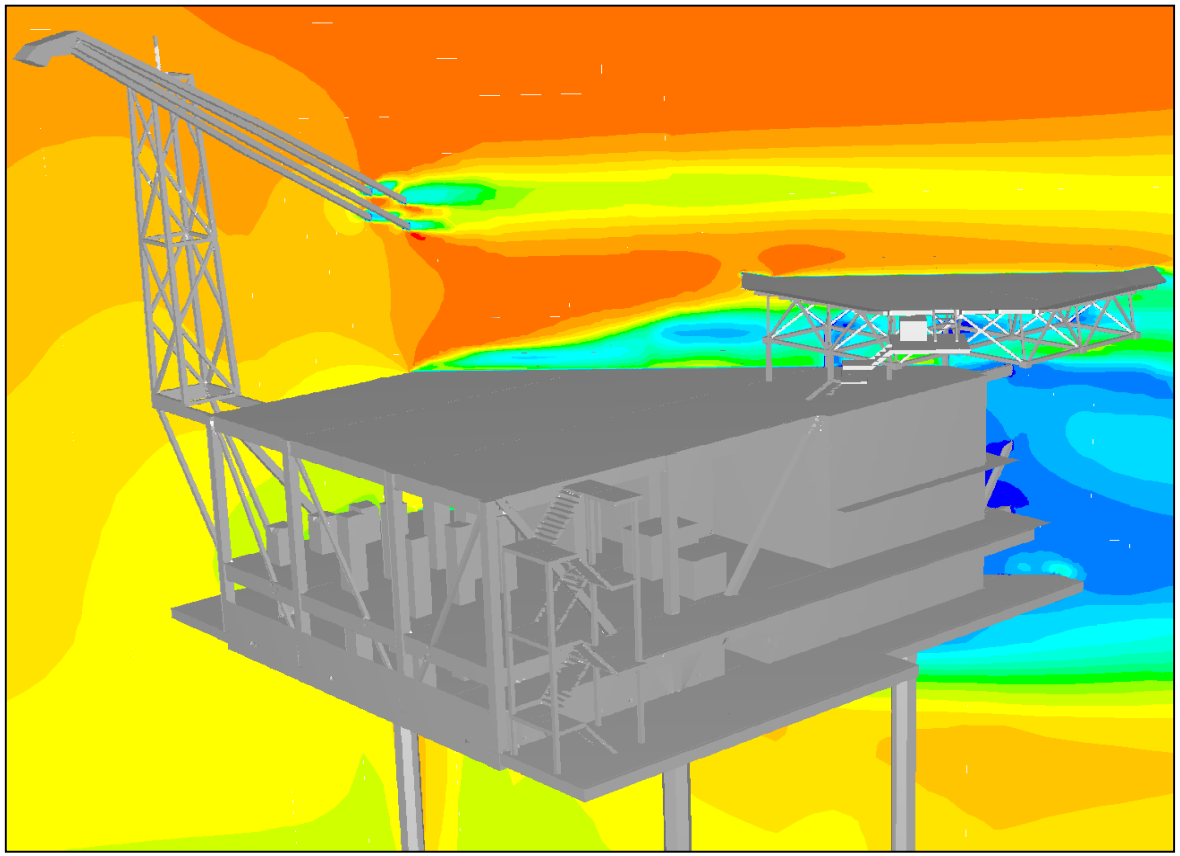
Initial applications

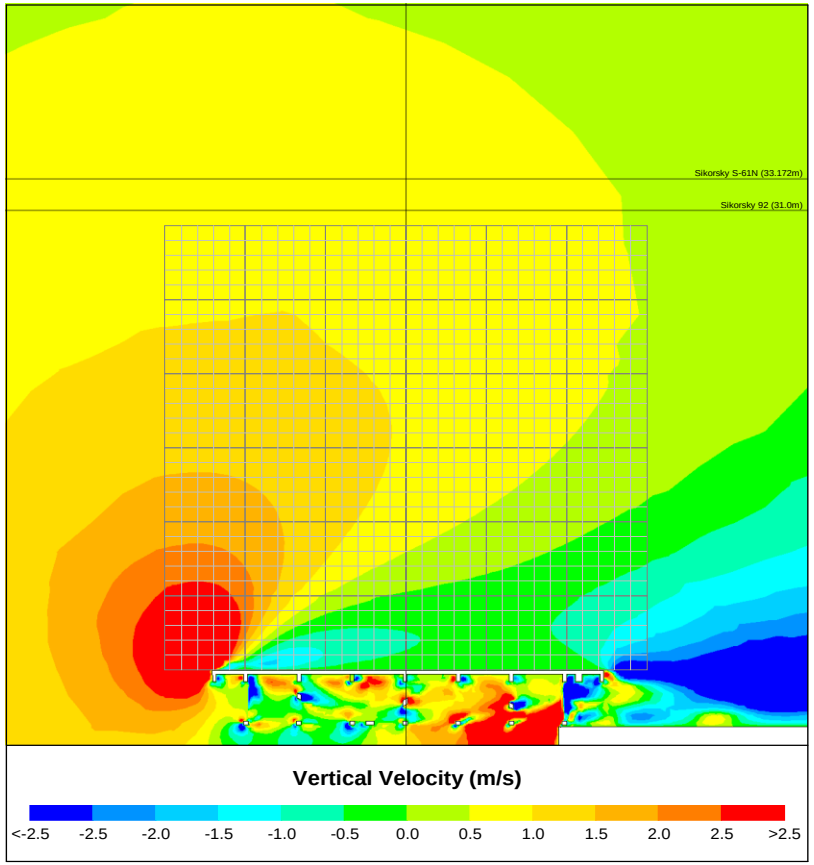
- Atmospheric dispersion



Initial applications

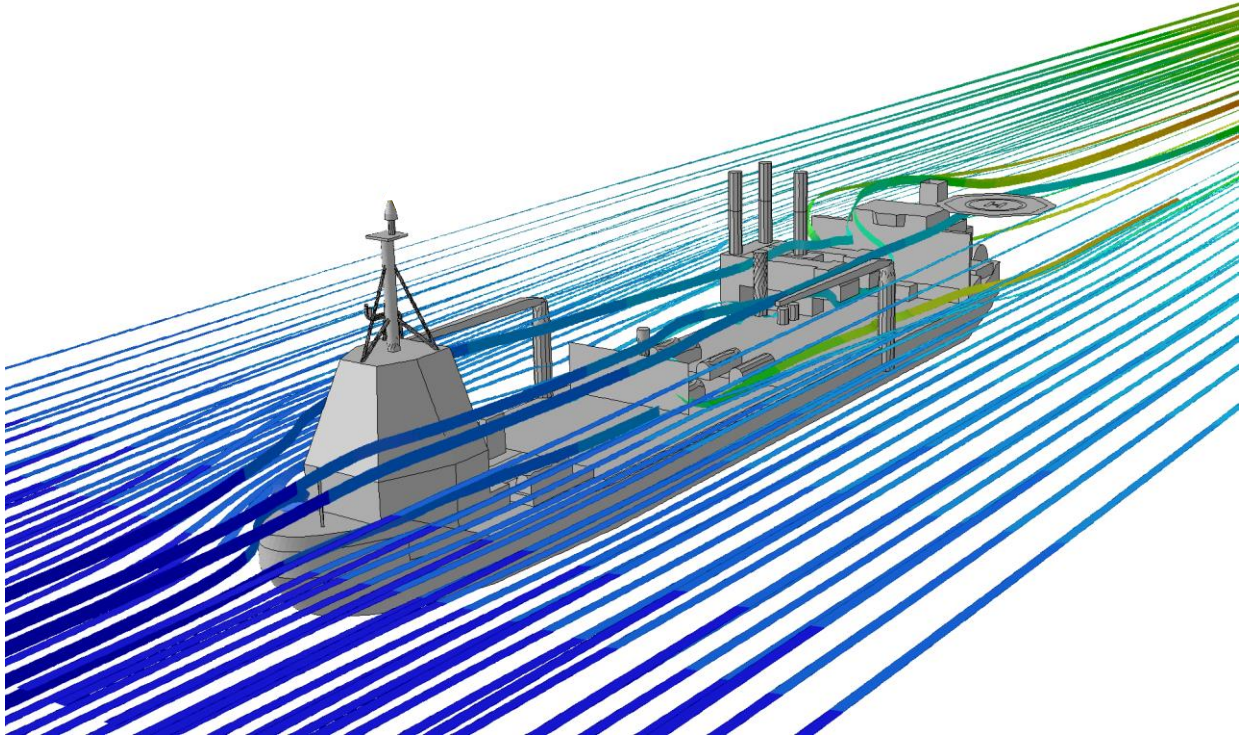
- Helideck turbulence

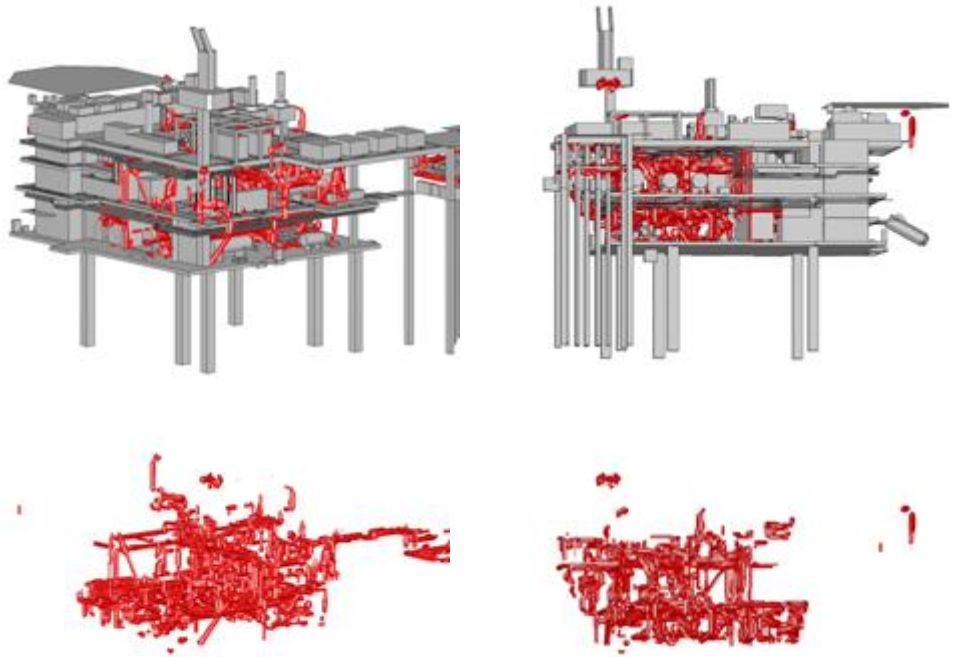




Initial applications

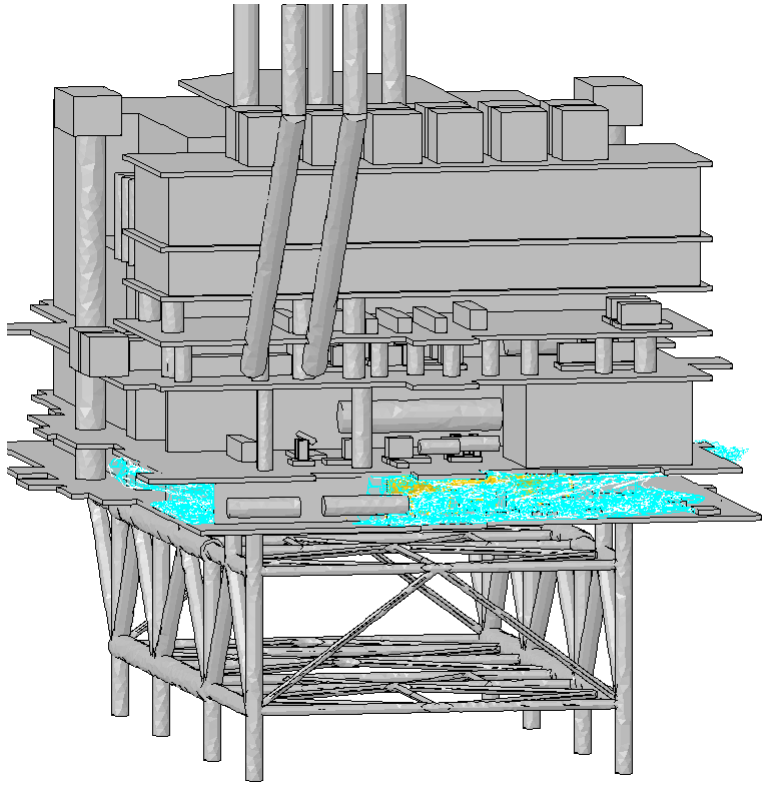
- Natural ventilation

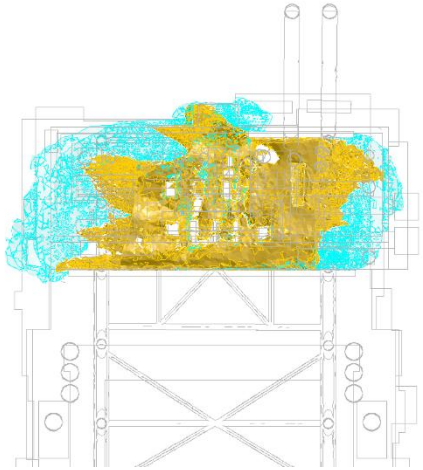


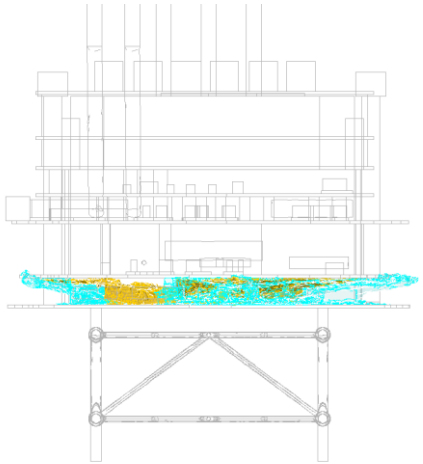


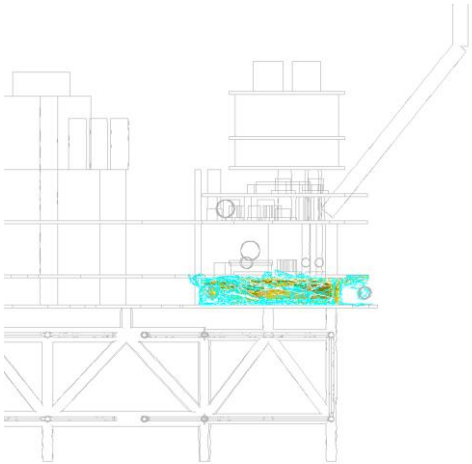
Initial applications

- Fire and smoke transport



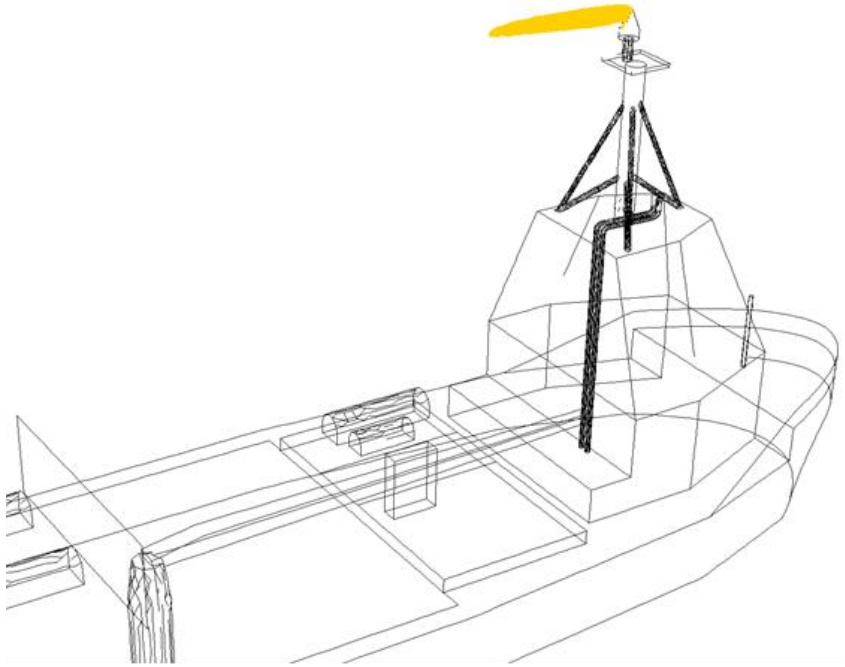




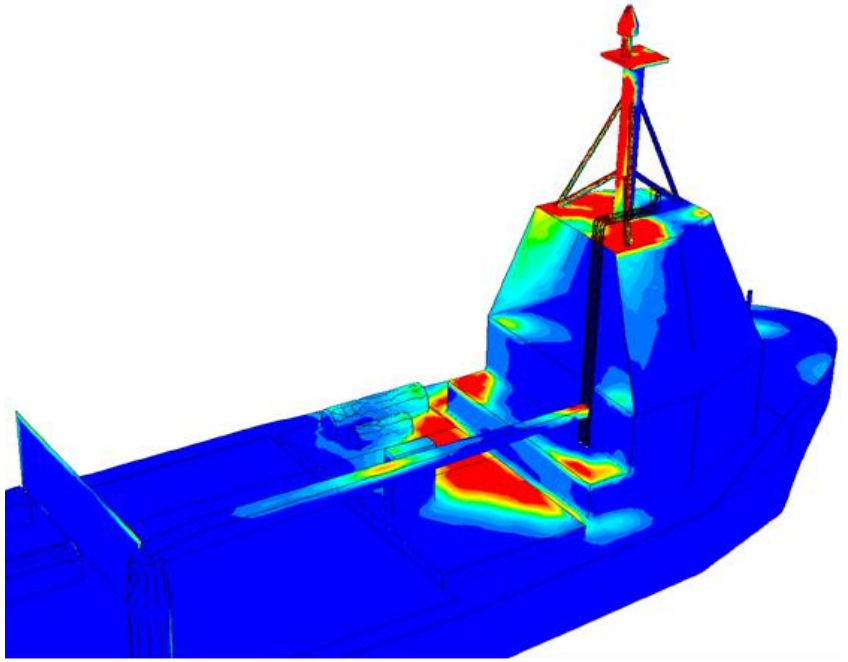


Initial applications

- Flaring and radiation



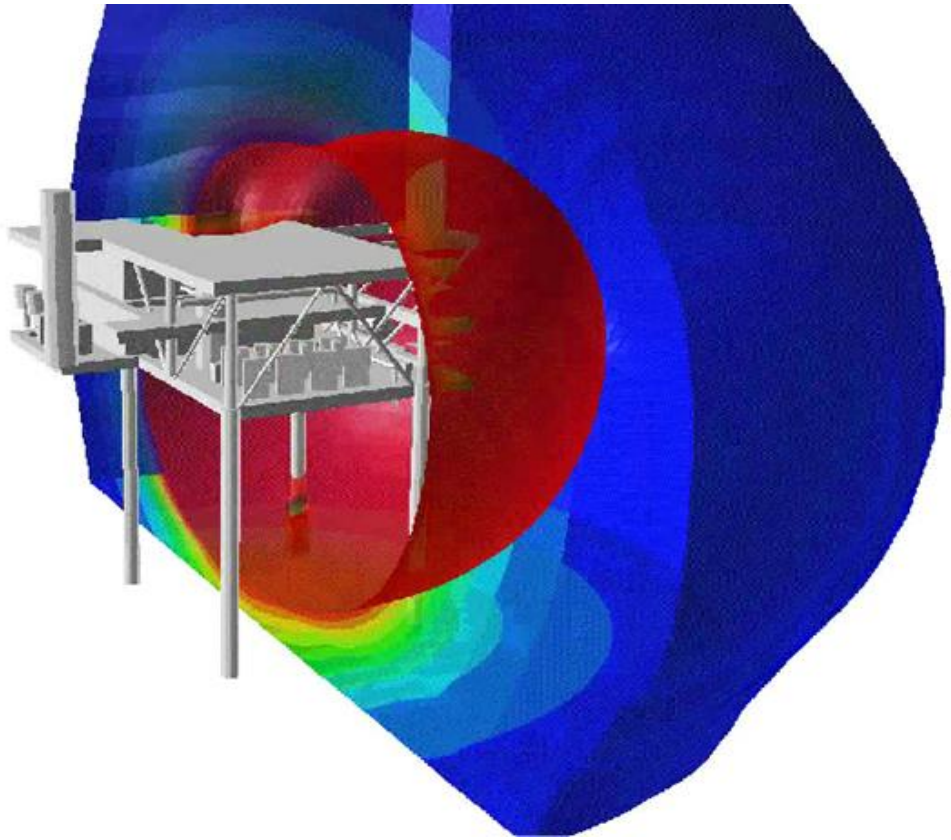
Envelope of combustion zone

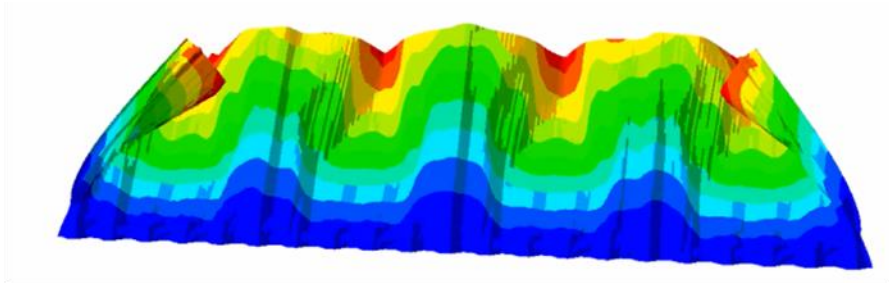


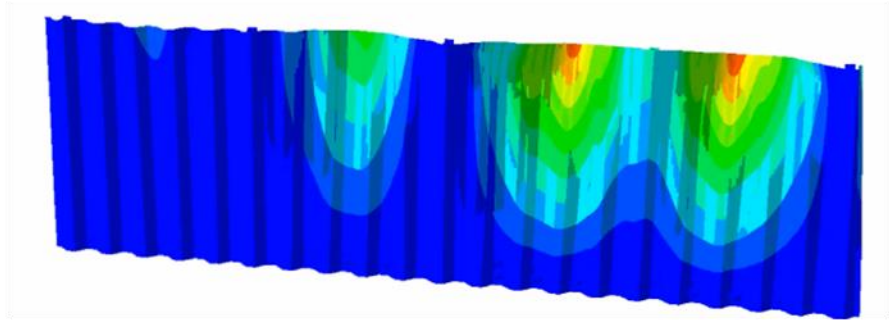
Incident radiation

Initial applications

- Explosion modelling







Initial applications

- Atmospheric dispersion
- Helideck turbulence
- Natural ventilation
- Fire and smoke transport
- Flaring and radiation modelling

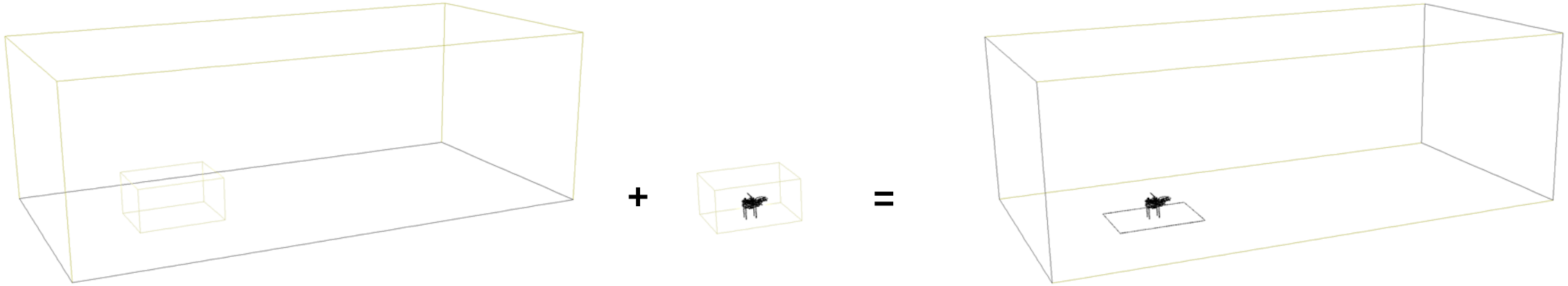
General purpose CFD code, driven by scripts and user-defined code

- Explosion modelling

Niche explosion-specific CFD code

Initial applications

- Common feature – interaction with incident wind



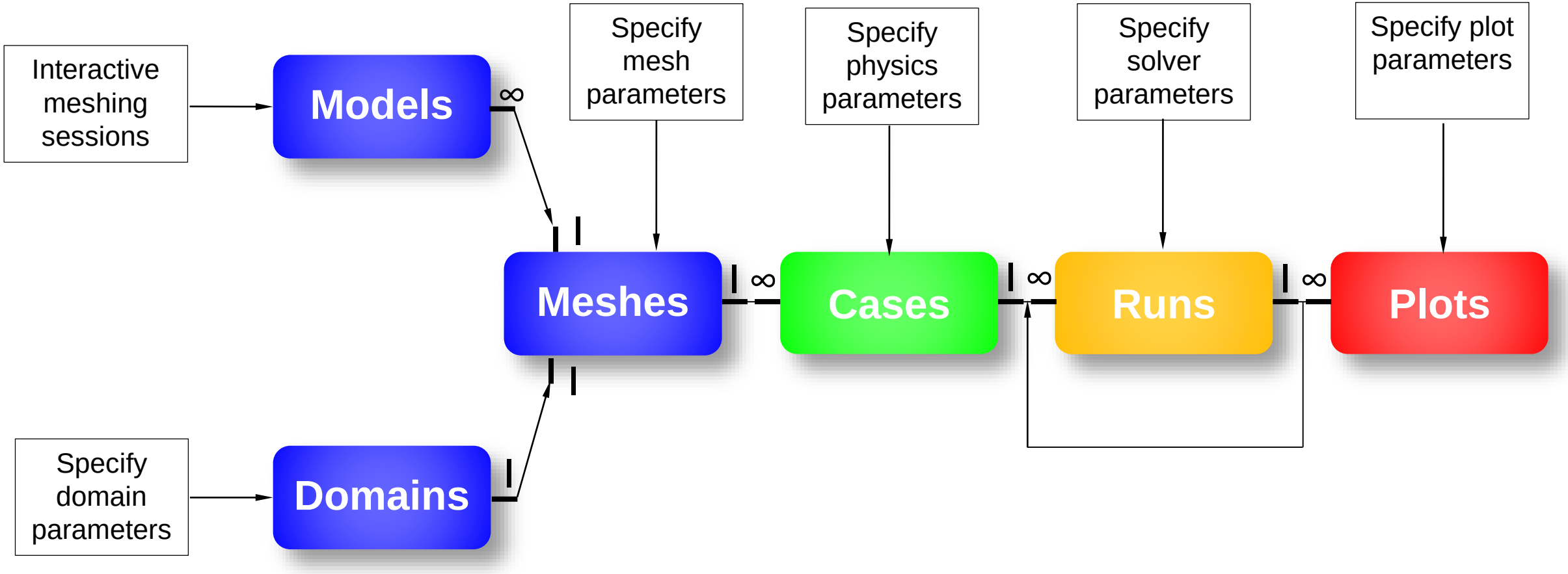
Domain object

Model object

Mesh object

Initial applications

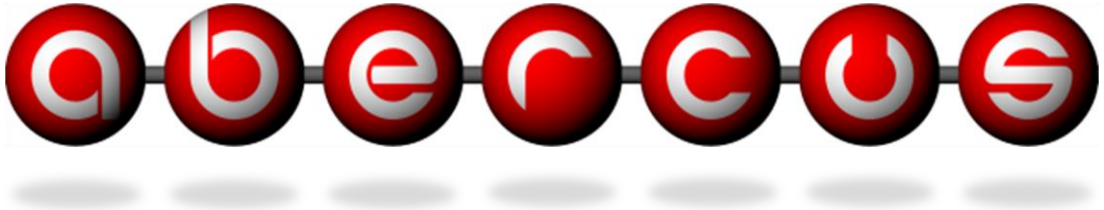
- JET object structure



Initial applications

- JET object structure
- Two distinct types of object
  - interactive sessions – objects constructed manually through an interactive session with a third-party software (model object)
  - non-interactive background processes – objects constructed through a non-interactive, automated scripted background process (domain, mesh, case, run and plot objects)

Initial applications

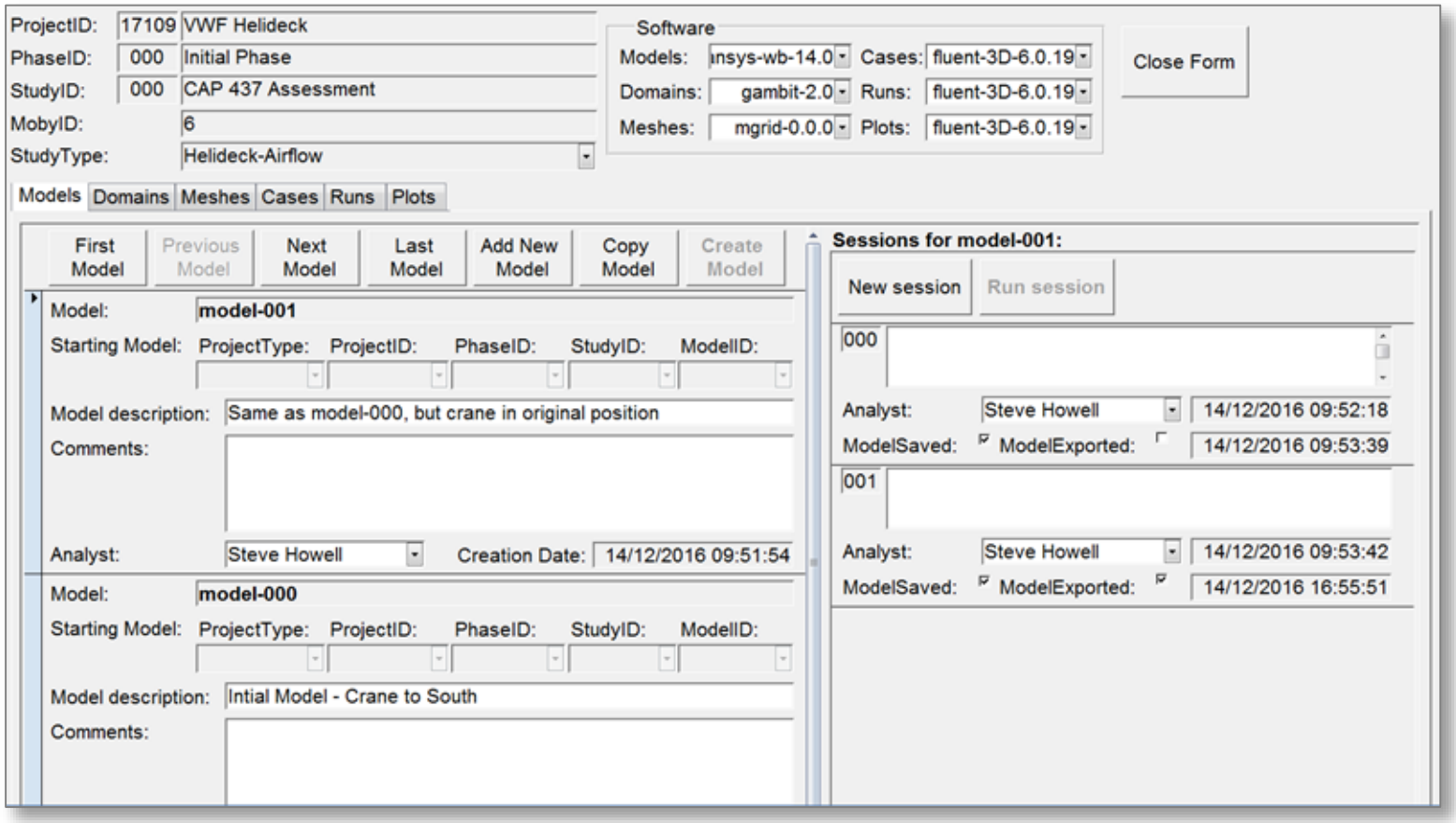


JET – job execution tool

(This animation does not work in the .pdf version of this presentation – please visit http://www.abercus.com/News_20170612.aspx to download a powerpoint show with a working animation)

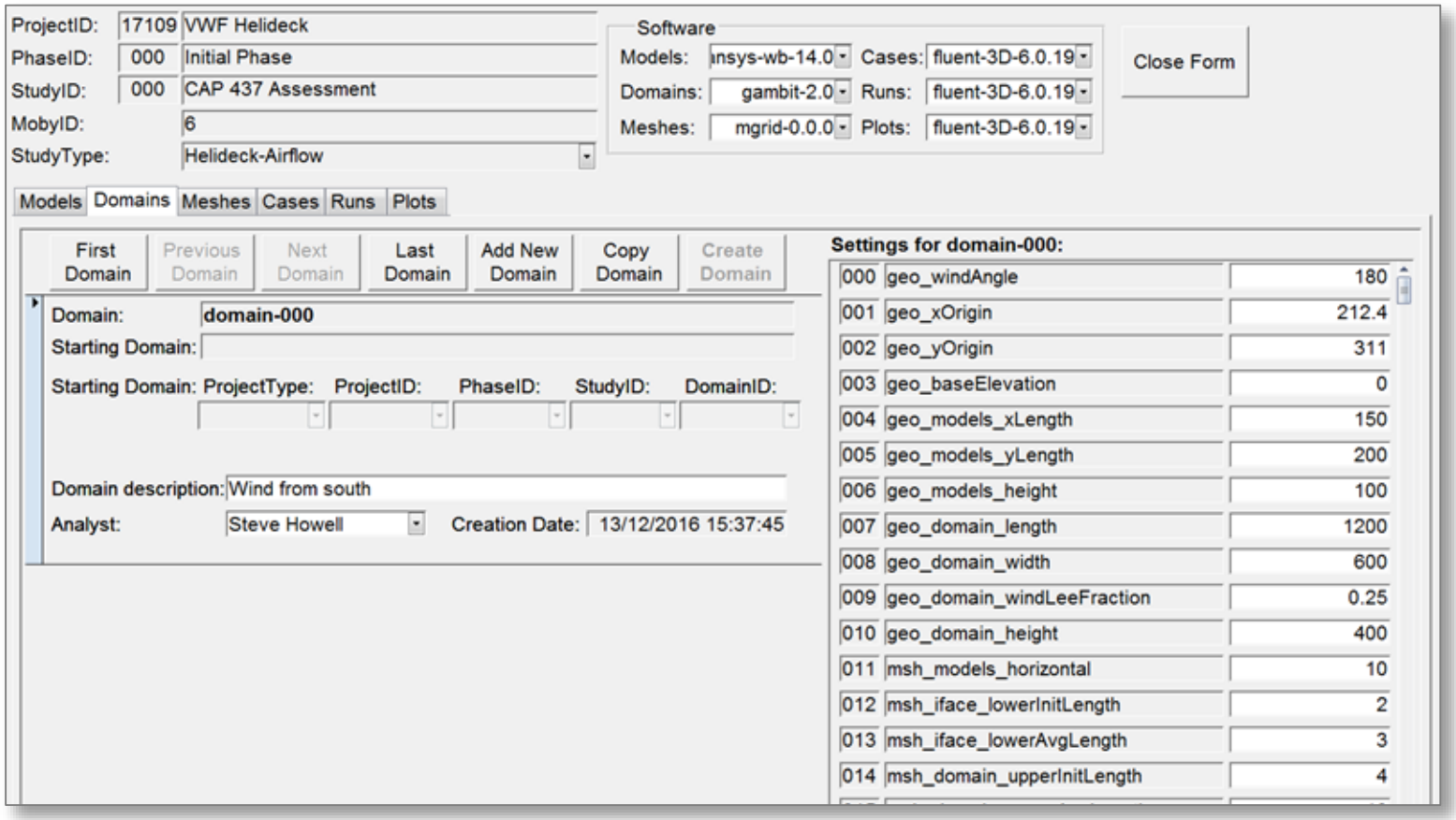
Initial applications

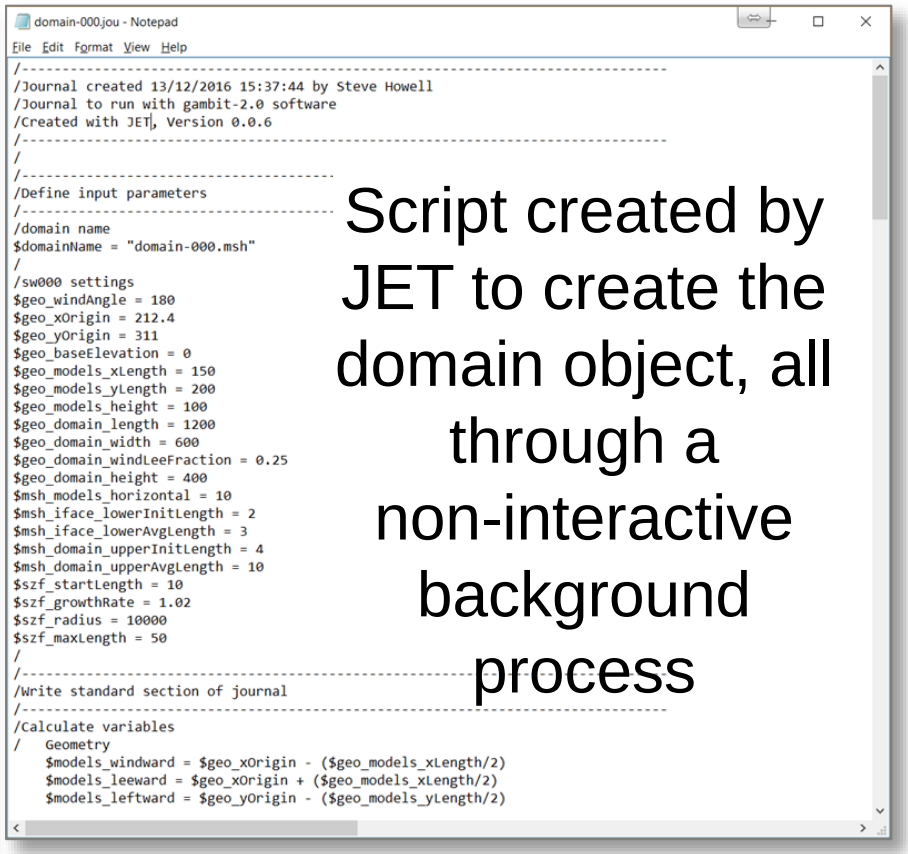
- JET objects – models (interactive sessions)



Initial applications

- JET objects – domains (non-interactive process)

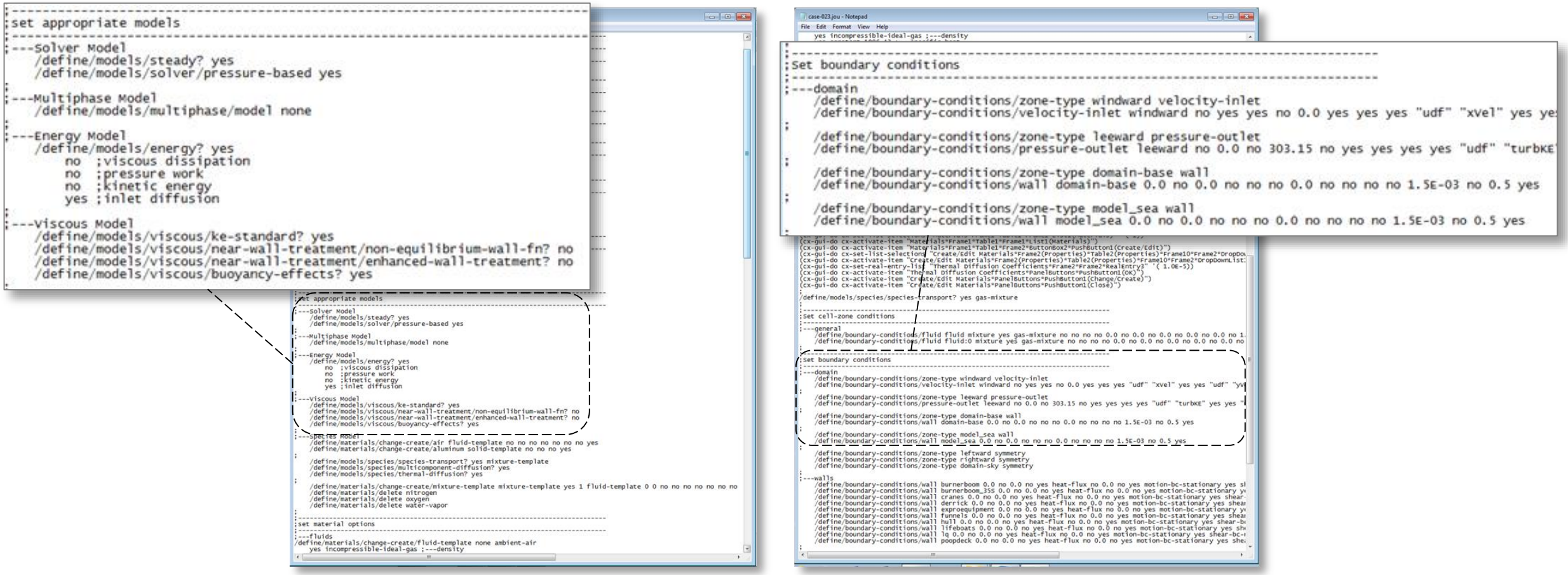




Script created by JET to create the domain object, all through a non-interactive background process

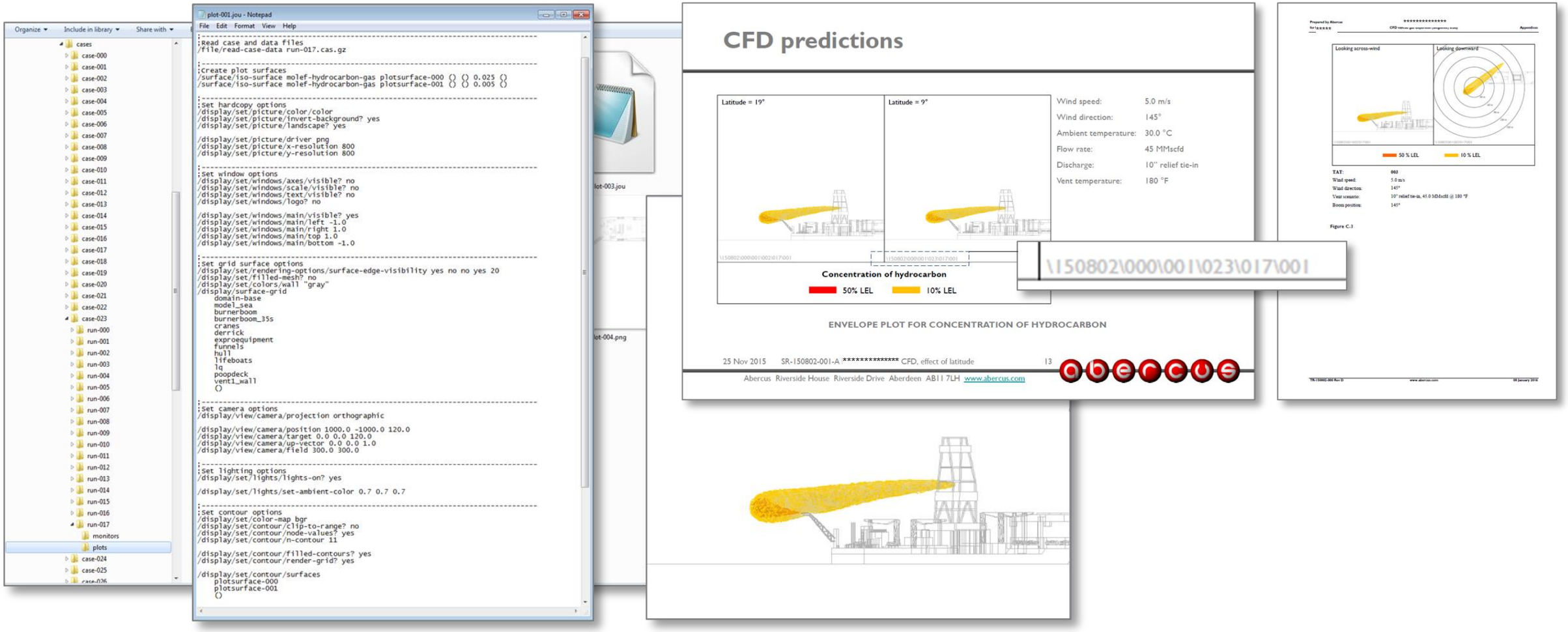
Initial applications

- JET objects – cases



Initial applications

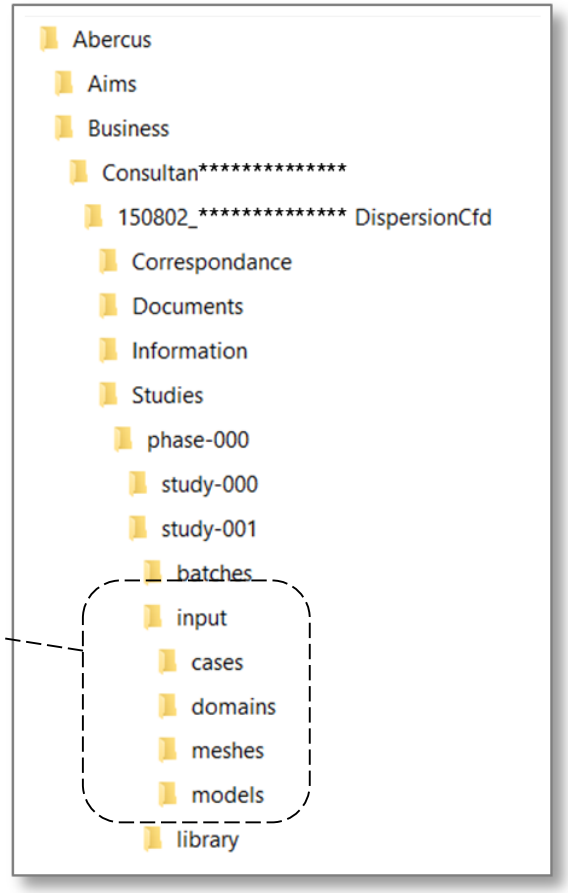
- JET objects – plots

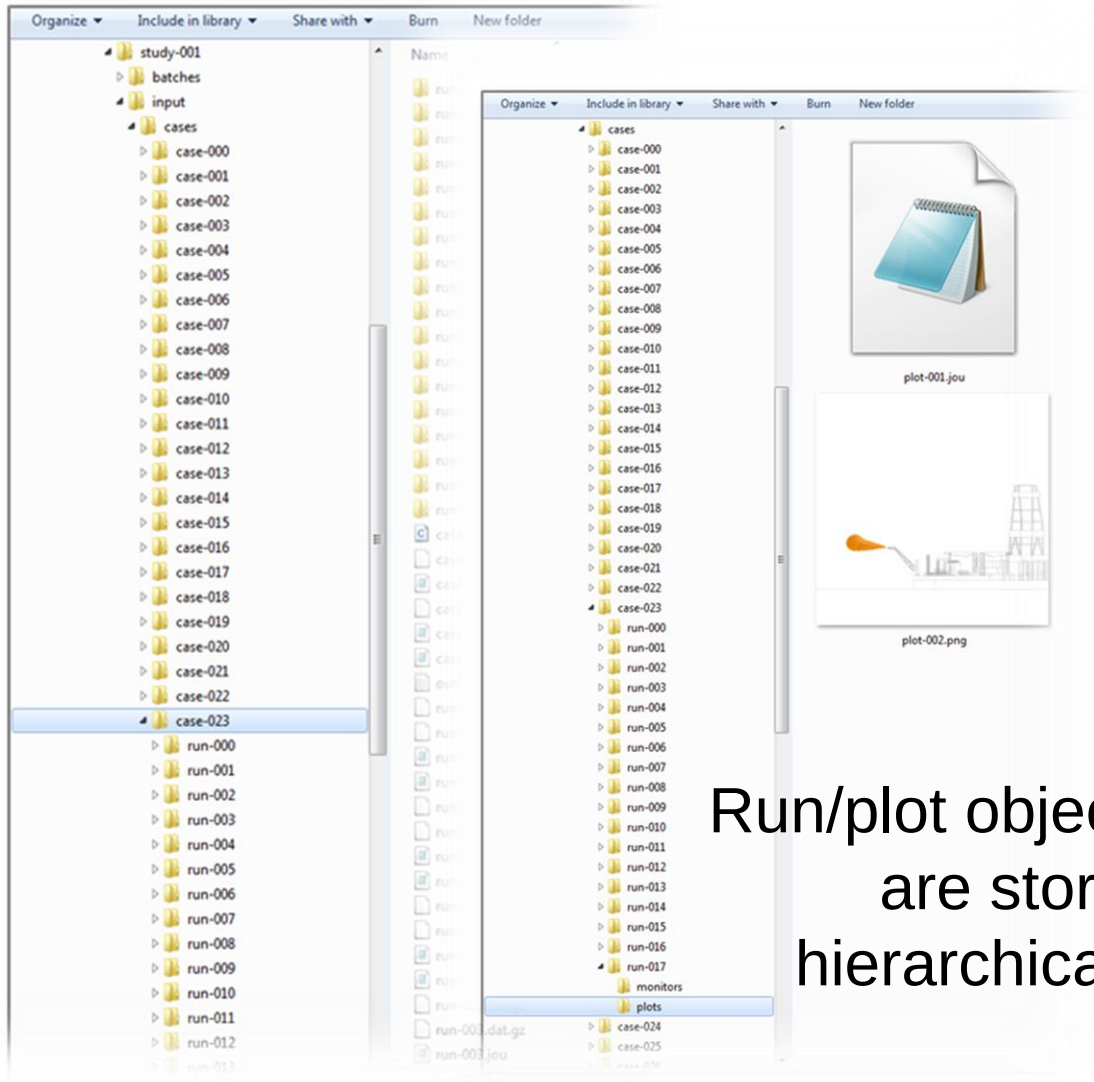


Initial applications

- JET file structure

The folder structure is automatically created by JET – models, domains, meshes and cases are organised at the top level within the study folder



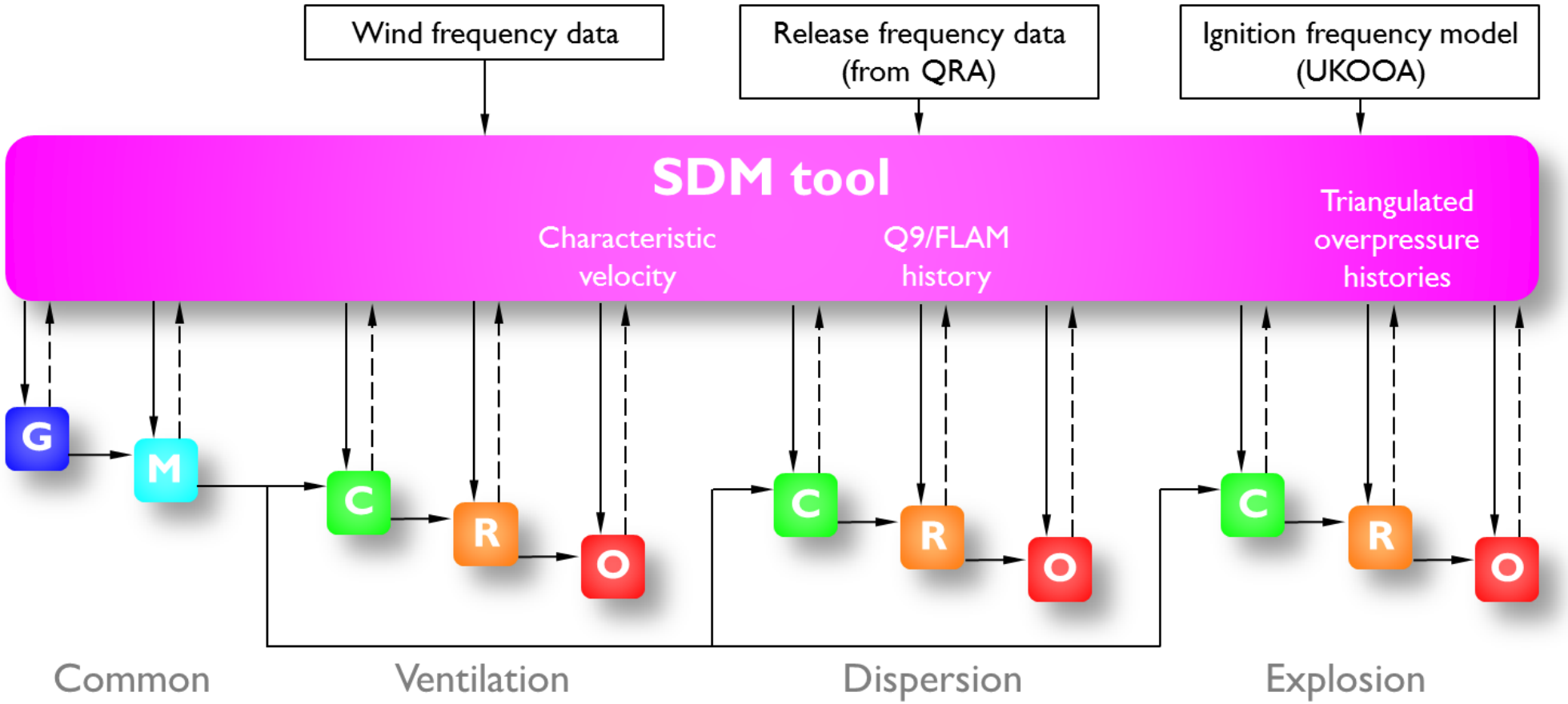


Run/plot objects are stored hierarchically

Limitations of the original JET tool

- Workflows are hard-coded into JET
- Templates for the solution sequence are not readily created
- The object structure is fixed

Limitations of the original JET tool



Object structure for a probabilistic explosion assessment

Limitations of the original JET tool

- Workflows are hard-coded into JET
- Templates for the solution sequence are not readily created
- The object structure is fixed
- Remote access?

Drivers for a new SDM tool

- Expand capability
- Improve flexibility and agility for a wider range of application areas
- Allow access from anywhere via a web browser
- There are several successful implementations of SDM using either in-house custom tools or through the use of commercial codes
- The cost of commercial SDM software is a major barrier for small companies such as Abercus.

Recent experience with openSPDM

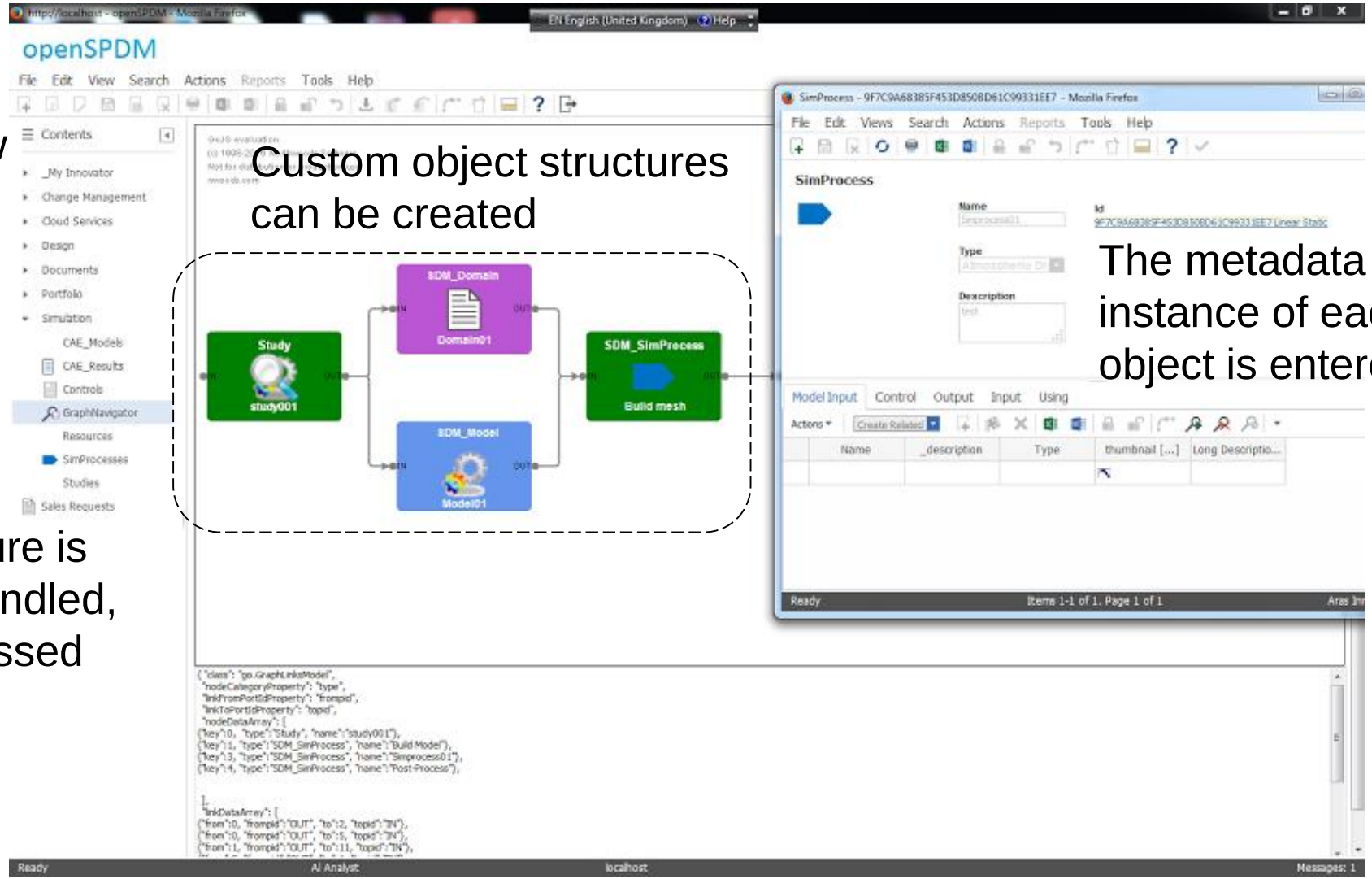
- openSPDM was brought to Abercus' attention by theSDMconsultancy at the 2016 NAFEMS UK conference
- openSPDM is an extension of the open source ARAS PLM platform for SPDM, and is based upon the Microsoft solution stack of Windows Server, Internet Information Services (IIS), SQL Server and .NET.

Recent experience with openSPDM

- openSPDM allows the *rapid* development of simulation workflows through drag-and-drop functionality, whilst the construction of the associated database structure is automatically handled in the background
- Abercus has been supporting some developments that specifically focus on simulation – a workflow display module that enables users and managers to access any process step or data item used at any stage of a particular simulation workflow.

Recent experience with openSPDM

This is all done in a browser window



The metadata describing each instance of each workflow object is entered via forms

The underlying database structure is automatically handled, but can be accessed

Recent experience with openSPDM

- Abercus has been working to replicate its existing workflow for atmospheric dispersion using openSPDM
- Existing VB code from JET has been re-used to replicate similar tasks in openSPDM
- Crucially, openSPDM allows custom object structures to be rapidly generated, which allows the workflows to break from the restricted fixed structure implemented in the original version of JET – our atmospheric dispersion example does still conform to this workflow, but it is no longer a requirement of the SDM tool.

The way forward?

- openSPDM is a powerful tool, but is not necessarily that easy to use at first
  - there is a lot to learn
  - is this appropriate for companies that may use the tool infrequently
- openSPDM would benefit from a library of worked examples/tutorials.

The way forward?

- Abercus has re-started the development of JET
- Over the last year, having had the opportunity to use openSPDM, some of our original ideas in 2002 are not too dissimilar to the methodology captured in openSPDM
- At that time we did not have the conviction to implement them within the original tool
- Now, confident in the knowledge that some of our early ideas were at least sensible, Abercus has a renewed appetite to capture some of this functionality within JET.

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