SimBest

Simulation & Modelling Best Practise

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Gap Analysis

Academia & Industry Perspectives

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Gap Analysis
Introduction

The use of Numerical Simulation in Industry has significantly increased over the last 30 years due to:

- the availability of affordable computer power
- enhancement of simulation techniques & accuracy improvement

In this session, we will look at the gap between the current trend in academic research activities and industrial requirements

This session has 3 objectives:

- to discuss these gaps identified through the interview process
- to confirm findings using Q&A session
- to identify potential means to close these gaps

Gap Analysis
Uncertainty Quantification

In this section, we will look into the application of UQ for the assessment and quantification of uncertainty on physically-derived models.

Sources of uncertainty include (not are not limited to):

- measurement error in data
- modelling errors
- uncertain tuning parameters
- uncertain boundary conditions
- manufacturing tolerance
- the inability to run the model for arbitrary inputs

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Uncertainty Quantification

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Academia:

- The field of UQ is quite new and is evolving
- UK has strong mathematical & statistical capability
- Main research areas are:
  - the combination of big data and UQ
  - high-dimensional model responses
  - probabilistic / meta modelling / data analytics
  - optimisation under uncertainty

Industry:

- Very limited or no UQ applications in most companies
- Most companies UQ understanding is limited to sensitivity analysis & parametric studies
- Some R&D activities in Aero
- Limited applications mainly due to H&S regulation; e.g. Nuclear sector

Cross business platforms are being set-up to exchange data (e.g. KTN SIG)

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Materials Modelling

In this section, we will look into the application of simulation techniques as a means of predicting and interpreting mechanical, physical, chemical, optical and electronic properties in the discovery of new materials and the optimisation of existing ones.

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Materials Modeling

Academia:

- Research is heading towards the prediction of new materials which are designed to have better properties than the known materials
- The UK is regarded internationally as a world leader in atomistic simulation and methodology for electronic structure

Industry:

- Material modelling shows strong variation across sectors
  - Impressive applications in Process and Electronic (IPR) sectors
  - Very limited applications in other sectors
- Companies rely on the data obtained from academic institutes and commercial companies

No well established cross business platform to exchange data

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Optimisation

In this section, we will investigate the use of optimisation processes.

Industry has been using optimisation for product & process development but traditionally this has been a “manual” process.

However, here we will focus on “automated algorithm driven” applications

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Optimisation

Academia:

- Believes mature technologies exist in these areas
- Research moved to advanced modelling activities (HPC capabilities)
  - multi-objective Kriging
  - robust design / optimisation with uncertainties

Industry:

- Mostly manual optimisation
  - the use of automated optimisation is limited to a few international companies
- Parametric design optimisation is the most common applications
  - adjoint optimisation is becoming more common
- Mainly commercial tools applications
  - Limited in-house tools, no significant open-source tool usage

  (Commercial tools are commonly using open-source tools e.g. Dakota, JMetal)

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Optimisation

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Barriers:

- Time / Cost
- Tool Integration & automation not easy
- Industry wants incremental development – no risk taking !
- Limited availability of “end to end” products
- Number of variables of variables
  - Academia uses < 10 variables
  - Industry requires effective algorithms for hundreds of variables

Well established cross business platforms to exchange data
e.g. NAFEMS OWG, ERCOFTAC SIG

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Optimisation

What is the level of maturity of the optimisation algorithms to be used by Industry in day-to-day applications?

Vote 1 to 5

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Optimisation

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What are the barriers to the greater use of optimisation in Industry?

Choose your top 3 in order of significance

1. Don't know
2. Software cost
3. Hardware
4. Automation
5. Understanding of techniques

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Coupled & Multi-Physic Modeling

In this section, we will look into the application of simulation techniques as a means of predicting interaction between different physics by means of coupled simulation.

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Coupled & Multi-Physic Modeling

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Academia:

- Research moved to complex areas
  - Quantum mechanics
  - Corrosion
  - Plasma Physics
  - Electro-Magnetic

Industry:

- Mostly limited to Fluid-Structure Interaction (mostly manual link), Conjugate HT & Thermo-mechanical (particularly in energy, aviation & electronics)
- New Area: FSI using Smoothed-particle hydrodynamics (limited applications)

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Coupled & Multi-Physic Modeling

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Barriers:

- Tool integration & data transfer between tools & processes
- Stability (solver & coupling)
- Computational time
- Memory requirement
- Differences in time scales between different physics
- Validation

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Multi-scale Modeling

In this section, we will look into the application of multi-scale simulation techniques.

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Multi-scale Modeling

Academia:

- Quantum mechanics
- Composite materials
- Plasma physics
- Electro-magnetic

Industry:

- Showing strong variation between sectors
- Most common applications are:
  - 1-D ⇔ 3D calculations
  - Simple FE/correlation ⇔ full FE
- Advanced applications in:
  - Aero (composites)
  - Process (from molecular level up to process plant scale)

Barriers:

- Tool integration & automation, software & hardware capabilities

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Multi-scale & Multi-Physics Modeling

What are the barriers to the greater use of Multi-Scale & Multi-Physics simulation in Industry?

Choose your top 3 in order of significance

1. Don't know
2. Software cost
3. Hardware
4. Automation
5. Understanding of techniques

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HPC

In this section, we will look into the use of High Performance Computing for simulation in Industry and Academia.

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HPC

Academia:

- Very significant increase in usage
- Essential
- Using national capabilities

Industry:

- Very limited usage of national HPC centers
- Mostly internal resource usage

Barrier:

- License Cost / Inflexible licensing system
- Cyber Security
- Connection / data transfer difficulties
- Post processing

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HPC

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What are the barriers for Industry to use HPC facilities?

Choose your top 3 in order of significance

1. Don't know
2. License cost / Inflexible licensing system
3. Hardware cost
4. Cyber Security
5. Connection / data transfer difficulties
6. Post processing

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Simulation Data Management

Misunderstanding in the definition for Simulation Data Management process

- Academia (and software vendors) refer to “fully automated global system”
- Most companies use locally managed manual process for data management e.g. storing data on external hard disks but assume that they have “efficient” data management process

Barriers :

- Cost
- Data transfer
- Cyber security
- Storage

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Simulation Process

In this section, we will look into the use of Simulation Process and Data Management in Industry and Academia.

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Simulation Process

- Academia concentrates on “individual calculations” and tries to obtain a perfect result
- By contrast, it is essential for industry to run sets of calculations which require a strong integration & automation process
- Academia assumes that some methodologies are mature and available but these are still not easily available to industry
- There seems to be no big initiative to improve the linkage between tools or moving towards a standard data format

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Simulation Process

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What is most important to you when performing simulation?

Choose in order of significance

1. **Cost / Time**
2. **Accuracy**
3. **Stability**
4. **Ease of use**

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Communication

- Communication between the Industry and Academia is conducted by technical specialist
- There is no permanent platform for “industry decision makers” and “academic leaders”
- There is a need for a platform where academia can present their capabilities to industries senior managers

Gap Analysis
Communication

BUSINESS-UNIVERSITY INTERACTIONS FOR RESEARCH AND INNOVATION: AN ICARG SWOT ANALYSIS

STRENGTHS

- New ideas and innovations of all kinds – not bounded by industry mind-set
- Networks and knowledge of international, cutting edge research
- Highly specialised research and test facilities
- Excellent teams of researchers, constantly being refreshed with new talent
- Growing levels of experience of working with business and understanding of the potential benefits
- Specialist consultancy to complement the research work
- Wider benefits and new contacts can arise from engagement
- World-class researchers can be interested in business-relevant problems, and help to solve them, if they are attracted by the scientific challenge – this is a win-win
- In addition to core strengths at 'technology readiness levels (TRLs) 1-3', there is growing competence at higher TRLs

WEAKNESSES

- Academics are largely 'free agents'; if there are problems don't expect to 'go to their boss' to sort it out
- Not all academics collaborate well with industry – some just want to go in their own direction
- Some academics may be unfamiliar with business timeframes and market focus
- Experienced researchers are often busy with teaching and other commitments, while junior research staff and students may lack depth or breadth of expertise and tend to have high turnover
- Resource may not be 'on-tap' and they may have to recruit for specific pieces of research
- University capability and excellence is scattered and not easy to spot – and universities compete with each other, so some are reluctant to recognise that a rival may be a better place to go

OPPORTUNITIES

- Universities are being encouraged to demonstrate impact from their research — and incentives for academics to work with business are growing
- Possibility of gaining the benefits of funding from Research Councils, Innovate UK, and others, specifically for industry-university collaboration
- Opportunity to influence the direction and agenda of future research programmes
- University links to other industries, allowing research consortia to be created
- Ability to spot and recruit the brightest young talent
- Joint publication by academic and industry researchers can raise the profile and reputation of the business
- Research-related links can offer scope to build wider engagement, for example in raising the skills and qualifications of the existing workforce

THREATS, RISKS AND HAZARDS

- Negotiation of collaboration agreements can cause delays and add to business costs – which have to be written off if agreement is not reached
- Academics want to publish something from their research (it's what they are judged on) – and may sometimes be unfamiliar with commercial approaches to IP
- A university will work with the whole industry, including, potentially, your competitors – though competence in operating 'Chinese walls' is growing
- Universities (naturally) want to make money out of what they invent
- A proper contract MUST be in place to control these risks

http://news.cbi.org.uk/reports/best-of-both-worlds/best-of-both-worlds-pdf/

Gap Analysis
Communication

What are the main barriers which prevent better interaction between Industry and Academia?

Choose your top 3 in order of significance

1. Don't know
2. Difficulties in finding correct contacts
3. Intellectual Property Rights
4. Funding
5. Conflict of interest (practical result vs publication)
6. Lead time / time-scale
7. Industrialisation of tools & processes

Breakout Sessions

then return to this room