

Minutes: Building the Nuclear Island
Thursday 17th March 2011, 10:00 – 16:00
Royal Academy of Engineering, 3 Carlton House Terrace, London, SW1Y 5DG

1. Welcome to the Royal Academy of Engineering, Hal Igarashi (RAE)

Welcome from Hal Igarashi, introducing the programme for the day. 36 delegates registered and 30 were present in the room at the start of the event.

Hal Igarashi provided a review of how we have reached this point in the Nuclear Island project. The first call for HE STEM projects went out in May 2010, with a focus on innovation, research and enabling. The bid originated from Cogent and Imperial, with the concept of "How the nuclear island will establish partnership between industry and HEI to tackle the critical future workforce needs of nuclear new build?". This provided the research and scene setting for a subsequent, high value bid. Hal rose how the RAE could assist HEIs to align their educational product to industry needs through this programme, enhancing the student learning experience and promoting collaboration between HEIs, FEIs and employers and the embedding and transfer of effective practice.

The Nuclear Island project was unique in that it is cross-STEM initiative and an overall UK perspective. Physics, chemistry, maths and engineering are all involved in nuclear engineering and it is not just a regional solution: this made for very strong points in its favour.

Developing the Constructionarium capability for nuclear new build: these points are to be produced in the pilot phase: broadly determine the scope for the HE curriculum development, have a body of evidence to be taken forward and looked at funding.

From pilot project to large scale project is a step change. We last met in November and after that last consultation meeting, Hal took proposition to the HE STEM board that the programme should go to a further phase. Given that the project addresses so many HE STEM programme objectives, it was easy to argue the case for additional funding, but the funding source was not obvious as this cross-stem scheme didn't fit the funding pots exactly. In January 2011, the funding issues had been discussed and resolved, with a bid from Cogent and Imperial, finally approved.

This project has attracted one of the largest grants. Regional grants cover over £60k of the £95k funding. The remainder funding is from HE STEM central funds. Hal regards this as an exciting project.

Thanks go to Caroline Sudworth, Alison Ahearn, Clive Smith and Robin Holdsworth from Constructionarium Ltd. Regional directors; Michael Grove, the National HE STEM director at the University of Birmingham, who guaranteed the remaining funds for the project.

2. Nuclear Island Programme Update, Caroline Sudworth (Cogent)

Caroline Sudworth thanked Hal for his welcome and his continued support to the programme. Caroline thanked the National HE STEM programme for identifying with the high value of the initiative, and the extra funding is great news – exactly what is needed to change this into a "Building" project with outputs. With the 15months limit in time (as HE STEM programme has a sunset clause), this brought forward concepts for discussion today, and is a real opportunity to get regional partners, HE, FE and employers involved across the regions. We have 95k for project management, paying for a project manager to run the programme, across the country and mesh with all the regions, write curriculum, talk to employers. RAE will also be monitoring the project and mentoring it as well.

As part of the programme, the curriculum will be developed for a pilot a Constructionarium, with the project transferring the information and lessons learned to other partners. There is an opportunity to interact with the other STEM subject areas, including chemistry, physics and maths, and a real opportunity to develop and embed the skills sets into programmes, in particular, Mechanical and Electrical Engineering, Materials science and Chemical Engineering. This is a real opportunity to deliver a multidisciplinary agenda, starting with civils with a view to having a clear output at the end.

David Willets mentioned Nuclear Constructionarium at the Guardian HE conference yesterday: so our aims and objectives have significant and high profile buy-in.

Student fees are a concern, and may impact on the programme, but we are pushing for support as part of the high cost subject review and growth areas. Caroline is talking about high cost subjects and getting employer support: Caroline talking to BIS and others about this being a “high cost” subject.

3. Nuclear Island: Lessons Learned, Clive Smith (Cogent)

Clive Smith presented the lessons learnt from the previous events: detailing the needs from employers and the suggestions raised by the HE and FE providers for the future direction of the project. Clive stated there was a real want for the programme to proceed from all parties, with many of the benefits from the existing Civil Engineering projects being transferred, but with the nuclear behaviours and expectations taking centre stage: a reversal to the teaching of safety and quality, rather than completing to reduced costs and standards. The opportunity to integrate and increase the Mechanical and Electrical Engineering was also discussed at the previous events, with a need to determine a programme that would incorporate similar behaviours into the programme.

With a need for 1000 people to support the current programme today, this would mean that approximately 400 graduates per annum and 1000 technicians across the STEM footprint would be required, so the need to integrate university provision with wider further education would be welcome as part of the programme.

In addition, the University of Lancaster “Nuclear Lessons Learned” report emphasises the need for the people factor to be taken into account. Events in Japan this week shows us that having the right human reaction to an engineering crisis is key. The focus for Nuclear Island takes all of the inherent benefits of construction and adds additional learning outcomes.

The programme will pilot in summer 2011, with the integration of civil, mechanical and electrical engineering in a step wise manner, and the design of the nuclear island project will cover these issues, noting the critical safety nature of the structure, including the importance of cooling water connections an aseismic design.

4. Workshop 1: Delivering the Nuclear Civil Engineering Programmes, Robin Holdsworth (Constructionarium), Alison Ahearn (Imperial College London), and Ruth Hopgood-Oates, Expedition Engineering

Following the first round of events, a number of small meetings with employers and designers have taken place in order to develop a draft concept for the Nuclear Island Civil programme. This initial design was presented to the audience by Ruth of Expedition Engineering for wider discussion. As the students won't spend all their time constructing, so we have to think about doing it a little differently, embedding the behaviours required for safety and quality. If we consider the central reactor design, there needs to be a water cooling system around the reactor vessel that can be tested for leakages, or perhaps a seismic base is critical, as we have learned from events in Japan.

Discussion regarding the water reservoir inlet took place, with delegates questioning the need to perform or construct inlets and outlets. This was as yet undecided, and discussion continued around whether students would be able to connect systems that are pre-made or leave it to the students to make the connection themselves. The design stipulates steel piles, and questions were raise regarding the installation of these prior

to site preparation. It was suggested that the steel piles be installed, with the students completing the pile caps. Based on this design, the base, the outer and inner box are to be made by students with a domed roof to add complexity. The audience was acutely aware that it won't look as aesthetically pleasing as the Gherkin so the domed roof adds in some interest, complexity and shape. But the other priorities such as quality and behaviours are to be addressed.

Lawrence Coates from the University of Birmingham considered the amount of time that students may have not constructing, but organising and waiting on safety and quality compliance checks. There was discussion around the need for a preassembly section, for functional and parallel tasking, which would replicate the facilities of a real site. This would enable the challenge of project management of transporting sections without altering the component constructed, to get it from preassembly yard to the actual site.

The nature of student support offered from Constructionarium? Robin Holdsworth detailed the support offered by the team, including the HEI and Contractor agreements for student support throughout the full week on site. Every project requires a contractor to embed engineering practice on site; in this case, the project would need an additional specialist contractor for nuclear on site for this particular project, whilst other Constructionarium projects do not. The nuclear project will be one of 5 projects being built at Norfolk during the pilot week.

Details of the proposed cooling quality check were also discussed. The water flow is not only the cooling analogy but a test for the structure to ensure quality by not leaking (mustn't leak radiation but we test it with water). The students only have one opportunity to get it right in a crisis: it must be fit for purpose. No "bodging" allowed.

In terms of project management, the students are expected to undertake full project management from the start of the programme. The contractor acts as the client (and the project demander/management but the students are the "contractor trying to meet the client brief, and to conform to the management regime that the client wants"). The contractor goes over the risk and method statements and writing in the week before going on site.

The issue of concrete quality and control was raised – perhaps the students would be asked to build using certain specifications, which could be checked on delivery. In addition, there could also be testing of the concrete on site, perhaps with a slump test.

The design is a pilot phase, and may have to be lengthened or simplified – the pilot phase will provide the project with an opportunity to test the concept, and begin to look at bringing in scenarios that will challenge the students.

The issue of assessment was raised – do students finish the project, or do they stick to nuclear standards and condemn inadequate work? Discussion around this is needed, as all parties wanted to raise the profile of the nuclear industry, and challenge students appropriately, rather than "incomplete" projects.

Clive Smith reported back on a number of issues highlighted from his group. The main concern was that the design wasn't quite true to form – a nuclear plant has 2 features – a steel containment building liner and intensive rebar. However, the important part for development is the behaviour around the construction, so it was important to keep the design challenging enough.

The group felt that a pre-brief was essential, and must include Quality Assurance and Nuclear Safety Processes above that already offered for construction safety. It was thought that the input of MSc students will greatly assist this for the pilot stage who could potentially add value acting as the Nuclear Inspectors/QA officers.

It was thought the design could be simplified if a steel container could be used, with the students concentration on the cast rebar concrete around it (in quarters or half casts), domed lid (with sighting hole) on top of inner container – sighting hole for leak check. These constructed to one side and then slid into the outer square concrete box. 4th wall raised into place once the inner cylinders in place. It was also suggested that the

students plumb in water pipes as final commissioning /QA check for water tightness. This could be 3 teams (inner cinder, domed top, outer box) and all come together to get inner cylinder in place. This requires integrated planning for elements to come together, challenging the project management of the pilot.

The need for a new gravity reservoir was questioned intensively, when other solutions such as a pumped water supply to/from the lagoon may be more appropriate. However, the design must remain suitably challenging and large enough scale for compatibility with other projects on-site. 4x4 meters outer box is okay, but it must be simple enough to allow the nuclear lessons (safety culture, behaviours and QA) to be embedded.

It was thought that the seismic slab would over complicate the pilot – a simple concrete foundation provided would work, but the need for seismic justification (and all extreme condition safety justification) must be covered in the pre-brief. This is currently very topical following the events at Fukushima. However, if the centre cylinder is a provided (a large domestic hot water cylinder was suggested) then a reinforced base slab could be incorporated into the design and the plumbing in of connections added to tasks. While base slab is drying the outer walls – with rebar- and casting of cylinder lid take place. This injects realism of water in RPV while still having rebar feature and should be simple enough allow completion of project while bringing out the Nuclear Lessons.

Nuclear Lessons should include:

- Project specification with high Quality Assurance (QA) requirements;
- Established Hold Points for QA and Compliance checks – including Concrete tests (certainly Slump Tests for comparison to QA Spec);
- Students to complete QA documentation (aligned to Hold Points).

5. Workshop 2: Resolving the Funding Issues, Robin Holdsworth (Constructionarium) and Caroline Sudworth (Cogent)

Caroline Sudworth introduced the HE STEM funding that has now been awarded, despite the future of HE funding being uncertain. This particular time is quite challenging in this respect, but to move forward, we must start as we mean to go on. The Government and HEIs are now working against a climate of tuition fee changes, and it is widely thought that employers will be asked to look at supporting the key skills for industries through schemes such as this. In addition, STEM subjects are high cost subjects, so there remains some slight protection as against social sciences but there is still a need for employer input. The programme also demands wider integrated STEM developments to meet holistic needs of the nuclear industry, and will incorporate engagement from across the STEM sector, but will initially concentrate on civil engineering, moving to Mechanical and Electrical Engineering, and bring in chemistry/chemical engineering, physics and mathematical models.

The funding is large for the HE STEM Programme, but will not go far: the programme needs employers to participate. There is a cost for site development so that we can rub the programme, which is approximately valued at £80k (essentially to put the reservoir and fenced off areas into place). This is above and beyond the HE STEM funding, which will concentrate on project management, developing HE/FE and employer partnerships, and developing the module for students, for academic staff CPD and for wider employer engagement. Support in kind or in cash is essential.

Robin Holdsworth introduced the costs associated with the week on site:

1. Contractors' cost for typical triangle role with a university is £20k for a week on site. In addition, there is a need for at least one senior person, a project manager and two trades' people to be present. For nuclear, that will be supplemented with external inspectors (Clive Smith is working on getting NII involved in this project).
2. Cost to the students: the Constructionarium accommodation is £55 per night including 3 meals. £300 for the week. Transport to get up there. And introduced a £150 per student. Sustainability of Constructionarium. Makes the costs of £500 per student.

3. Higher Education commitment includes staff time for organise and run the teaching beforehand. Typically takes 3 days to look after the students. In addition, HE staff are to be on site for the full week also.

In addition, the project requires time and input from industry to help develop the curriculum, and employer participants should include a day for preparation, which would include Health and Safety, risk assessment, method statement writing, project costings, programme writing/GANTT charts with the staff and students. For the nuclear pilot plant, we hope that a specialist contractor involved in nuclear industry will go to the university and participate in the training day.

Students often leave out time for tasks like fixing steel for columns, and don't time it into the task, adding interest when the project slips from the planned timescale. Contractors often pick these issues up, and can suggest project plans to incorporate these additional timings and the like.

The audience requested to see the site, and Robin provided an aerial view of the site, showing the existing main lakes, with the plan to develop a new reservoir for the nuclear project. There is also an additional need for a pre-assembly and storage area to be levelled and concreted for all weathers. There is no new site compound, but more huts and project offices have already been put in. The project teams tend to give someone the administration and they are off over in the cabins. Site power source is generators. Long term plan to develop the site but it would cost a lot of money: £20k to put a cable into the site. As the site is to be set up as nuclear site licensed, fencing for this site would be required to stop people entering from alternative sites, and as additional security checks for students, helping ensure the nuclear safety aspects of the programme. There is also a potential to utilise the site passport concept – ensuring that students carry the relevant paperwork to enter the site, or re-sit the safety video.

The team asked if there was an appetite from industry to do this, and to help support the upfront costs. There is an opportunity to change the way we deliver the Constructionarium? Do you think it will benefit you? Cheaper if we all chip in a little bit. How to do it? And want to take it to other sites in the UK.

There is a real opportunity to review set-up costs. The audience questioned the need to complete the construction of a new reservoir. In the case of the overall funding, there was more of an appetite to pool the funding than have one organisation carry the full cost. All happy to provide a resource across different disciplines; organisations can benefit from own internal training systems. Capital cost investment is the difficulty. Programmes will get funding but not capital on this scale.

Joint sponsorship from a variety of companies and from the supply chain: we could add benefit by talking to the supply chain.

Undergraduate training was very welcome, but the industry partners could also see a real benefit for their own training needs, enhancing the programme for their own employees and enabling the supply chain to join in. It was noted that this was a real opportunity, especially as the facilities are there all year round. A graduate scheme would suit the use of it for a company, especially as it is available in July and August and September in good weather as the universities are on vacation.

From HE perspective, there is an opportunity for 5 additional universities to trial it in spring 2012, on a region by region basis – and it is open to first come, first served, prior to it becoming an openly available programme, with potential other regional hubs. This year long project will allow issues to be polished out prior to portfolio release. If universities choose the nuclear project, we'd like to engage specialists in that area.

In terms of expansion, there is already industry support for the concept from EDF Energy who is investing in the southwest region, for the first reactor site at Hinkley. It was noted that subcontractors who support the Bircham project would be looked on well in future, if the programme was supported and utilised. This additional project would run to the Southwest and run concurrently with Hinkley C construction. Nuclear Island as a live test laboratory!

Industries also see critical skills gaps around steel fixers, concreters, who work traditionally to tolerance of 10mm and now have to work to 1mm tolerance. There is a real need for an educated, trained and productive workforce that makes money, and so you need to put in the investment. The long-term relationship with Constructionarium is important. The trial at Bircham Newton is essential to development in the SW region, and the rest of the nuclear industry needs to support and partner up on this programme.

It was agreed that costs could be reviewed with industry for the pilot phase. Caroline Sudworth suggested as review of capital costs with Constructionarium, and to present costs appropriately, and if there were a share option, or if industry could commit resource to the programme, such as PPE, concrete, plant and tools etc.

Typical operating costs for the week could be approximately £10k per week plus staff time to run the event for the nuclear contractor who acts as a Constructionarium partner. The issue of getting the right students to you was asked – industry requested they were keen for students who are interested in nuclear engineering.

Industry is interested in investing in this type of learning process: there are opportunities for us to understand and appreciate by bringing in staff to assist the nuclear process. It is critical to have the pilot project and set the scene. How do we collectively fund that pilot project?

THE TIME FRAME for the June 2011 pilot is critical – the site needs to be prepared, starting the week after Easter, as concrete to develop the site can only be delivered after this time.

Industry participants questioned the need to see a break down of tasks and costs. It was suggested that by working on this programme together, costs would cost down, and in kind donations could be used. There is a need for this task list with costing. Employers will then be asked to donate a task

6. Workshop 3: Beyond Civils: Developing the STEM programmes, Steve Franklin (ECITB)

Steve Franklin from the ECITB began by providing his background in Aeronautical engineering at Loughborough University, which contained a week's work experience in his degree – with that week being extremely valuable. Steve then opened up the role of ECITB – they are not a sector skills council because our workforce is quite small, but they have a similar role in developing qualifications, and represent approximately 450 companies. However, they are able to raise a training levy income from employers. Companies are either in scope or out of scope. The role that ECITB welcomes is interdisciplinary engineering, such as process build characteristics for the nuclear worksite, and for the off site fabrication of products for the nuclear industry, where products are built and tested to nuclear code.

In the wider scope of this programme, ECITB have available a rig that could be utilised to help develop the Mechanical and Electrical Engineering aspects of training, where there is a real physical structure than can be used. This is currently used as part of the NE training association at Stockton. It comprises a large steel frame with floors at each level so that pipes and wires can be fitted and fixed. There is a standard kit of parts, that can be used, rather than students fabricating big pipes and the like, but it also helps students understand the logistics of fitting and lifting.

This project presents a challenge, and a potential for the programme to involve technicians right through to postgraduates. There is potential to segregate a containment area, where pipes and wiring run, perhaps to a mounted pressure vessel in that containment area (use a tank or household water tank. Put a heater inside and so you have to deal with hot water coming out).

To build the structure for practice, apprentices could be used, reducing build cost. Steve raised the question of what might make this a nuclear programme. Could it be nuclear installation, nuclear standards and procedures, simply using the right labels for things! Close employer involvement to make the connection to and link between simulation and reality. There are other structures around amongst the training providers, but these rigs are useful and flexible.

There is a smaller indoor rig option, which could be much closer to a process model. ECITB looks after Sellafield, and they have process simulator which has pressure vessels as part of it. If you work on smaller scale inside, you can look at different bit of the system. This would help develop control room operators: Instrumentation for the system can be linked to a control room. If you use a process simulator, you could put in the disasters. Extend a process simulator to other disciplines to get them involved.

What needs to be done to help undergraduates work in multi-skilled environment? What operations can we safely consistently supervise? Welding? Working at heights? Do we need a long rig on the ground if we cannot teach at height? What could be added change to broaden the use of chemistry, engineering, physics and maths etc? June is 12 weeks away so we mustn't get distracted from June pilot.

Discussion around this concept was welcomed with employers seeing the value in this, with the funding for project focussed on HE, so there is a need to use this as the starting point, but again it is versatile and can expand to CPD in future. The programme has 15 months to deliver for HE initially and then look at other modes. There is a problem with HE funding in future, but employers urged the need to press on as the power stations need to be up and running, and students will demand more from HE as a whole in future. The novelty of bringing the sector together with a coordinating programme for universities is a very good structure.

Caroline Sudworth then read out the quote from the Guardian HE conference

DAVID WILLETTS quotes: Accreditation is not the only valid approach. For example, I'm delighted a project involving HE, FE, industry and professional bodies has just secured funding from the National STEM HE programme to embed nuclear power-related skills in degree courses at English and Welsh institutions. These are skills of singular importance – as we've sadly witnessed over the past several days.

There are also the career decisions taken by STEM students. In truth, there is no "STEM pipeline" as graduates in STEM subjects are free to choose what they do with their careers. Insofar as there's a STEM pipeline at all, it's leaky. But STEM students in their final undergraduate year do need an opportunity to consider STEM jobs, and this is where the recruitment system may not be working – according to our recent "STEM graduates in non-STEM jobs" report.

There is a real emphasis here on embedding career attractiveness and employability. Barbara Smith of AMEC says we have to make sure we attract the right people. Supply chains are easier to tap into in a clear sector like nuclear.

7. Workshop 4: Forming Partnerships for Delivery, Caroline Sudworth (Cogent)

Following earlier discussion the agenda was revisited to discuss the costing and design of the programme. The costs were presented as:

Item	Cost (£k)
Design package	25*
Permanent works at Bircham Newton	25*
Materials	10
Disposal of waste and demolition	2.5
Plant Operations	1
Plant and Small Tools	5
Contractor	6
Contingency	6.5
TOTAL (*Capital Costs)	£80k

The capital costs are setting up costs and site preparation ready for the design, which has a cost in developing with Expedition Engineering. Other costs are to operate and re-run the pilot. Costs can be reduced if there are donations in kind for materials such as concrete, tools, plant, PPE and even steel (tanks).

The pilot would enforce a £61,500 cost to design and get to the point of running the site if this design were to stand. However, pump options might not require another lagoon building, thus reducing costs.

The funding gained to date was also questions – Caroline explained the full use of the HE STEM finding which is to include a project manager (Caroline) for 3 days per week, plus travel, with HE/FE partners being offered a small grant to engage in the curriculum development and delivery of it.

There remains a need to identify HE/FE partners across the region – volunteers were then requested to cooperate. Regional breakdown as it stands at the end of the meeting is:

Region	Representation from:	Specialism
South East	Imperial College London	Project Lead, Civil and Nuclear Engineering
South West	Bridgwater College; Plymouth; perhaps Bath University and Exeter.	Nuclear and Civil Engineering
North West	Manchester University	Dalton Nuclear Institute: Full STEM capacity
North East	Possibly Leeds or Sheffield (TBC)	
Central	University of Birmingham	Nuclear and Civil Engineering
Wales	Glyndwr University; Coleg Menai	Nuclear Engineering

The question remains on how to engage industry. Caroline requested that if there was willingness, people should deal direct with Caroline and Clive in the first instance, and we are ready to move forward.

8. Meeting Summary, Caroline Sudworth (Cogent)

The meeting was summarised by Caroline from Cogent, who outlined the pilot programme:

- To run the pilot in June: look for volunteer employer to pilot it (one or two employers)
- Follow on pilot with regional partners is in spring 2012. Iron out issues in the meantime and trial it in the spring.
- Development work before June 2011 includes the designer job being done.
- Caroline to initiate an employer meeting with the designer.
- Design by the end of April to employers to make sure we haven't overlooked anything.
- Then produce the project packs for the students.
- DEADLINES: First deadline end of April, mid May have finished the design. Then the pack. Then the industry partners have time to arrange to go to imperial to have input for that project (June 2011).

Opportunity, once pilot gone through, for the facility to be used again for CPD for engineers, contractors, rehearsals for processes, and such training is not constrained to term time or one week slot.

Rolls Royce question: do I have to give you a letter of intent by when – Caroline requested any supporting materials immediately if possible.

Finally, Robin repeated that one of the great aspects of Bircham Newton is the blanket planning permission to build anything on their site: Bridgwater currently has to get people to build structures and planning permission.

If anyone wants to see Constructionarium in action, there are 4 universities going through (200 students each week). Liverpool and Northumbria (Sunday 3rd April to 8th April); Salford and U East London (10th April) and Birmingham (2nd May). If you want to be engaged, leave your card.

9. Meeting Close