

# CRA Connect

Keeping you up to date with  
CRA's services and sectors

Welcome to the spring edition of CRA Connect. In this edition, Ashraf El-Shanawany, one of our Principal Consultants, provides a view of the latest news of CRA's Advanced Risk Analytics (ARA) business, and selected highlights of CRA news from across all business areas. This edition includes:

- Advanced Risk Analytics
- Significance of R&D efforts
- Supporting graduate & post-graduate studies
- Quantifying Expert Judgement
- HVAC & Sustainability

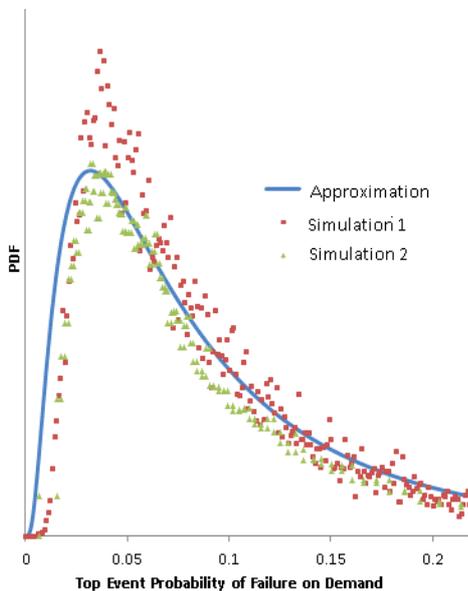
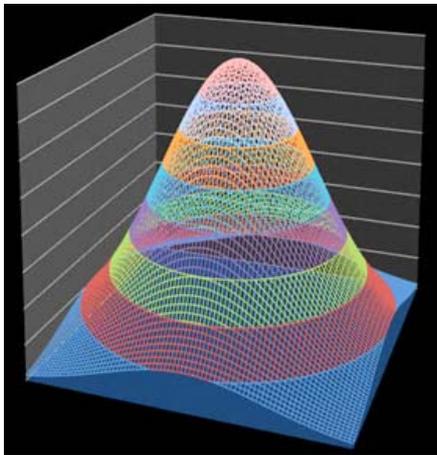
*Jasbir Sidhu*



**Imperial College  
London**

I have recently completed my doctoral thesis on uncertainty quantification in PSA. In my thesis I developed a new method of estimating fault tree uncertainty distributions in closed form and explained methods for interpreting uncertainty results. My work advances PSA uncertainty analysis methods and can improve the way in which uncertainty information is used in industry. I am currently publishing papers on my doctoral work, and the work from my thesis will be made available to interested parties shortly. **My new challenge is heading up the Advanced Risk Analytics (ARA) arm of CRA's business.** An outline of the activities and objectives of ARA is presented below.

**Ashraf El-Shanawany**  
Principal Consultant



## ARA – Advanced Risk Analytics

### Services

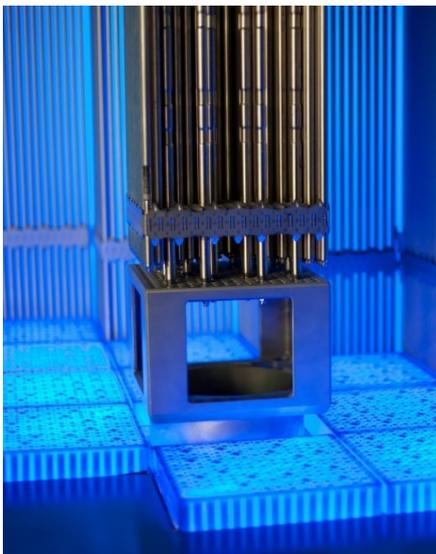
ARA is the application of statistical and data science methods to risk and safety problems. The particular focus is on tailoring the theoretical methods to our clients' practical needs. Our capabilities include:



### Keeping CRA at the cutting edge of risk analysis techniques: R&D

We are committed to deepening our knowledge and ability in existing risk analysis methods. A key principle of ARA is to do smarter risk analysis rather than more risk analysis. This is key to ensure that the analyses being performed are the right ones and help to ensure maximum value for money. To achieve this necessitates that we keep abreast of new methods, software developments, developing in-house tools as well as carrying out targeted research. **The research is shared with clients, and is part of our wider mission to help advance the state of knowledge within the safety industry at large.** Examples of recent work include developing Bayesian parameter estimation methods, uncertainty analysis methods, seismic PSA analysis and database tools to allow more efficient use of risk models.

3	9.65%	248.36	4.58	85.36	74.36	96.3	40.28%	236.3
8	2.38%	988.24	8.36	44.55	89.33	22.3	61.4	4.25%
	1.20%	545.32	5.36	78.76	7.35	24.3	81.85%	2
	9.33%	282.80	2.17	83.88	80.25	132.10	1.20%	
	6.35%	256.36	2.78	56.39	74.36	245.3	9.33%	
	4.25%	375.69	9.56	24.35	45.23	82.5	6.35%	
	5.36%	248.36	4.58	85.36	95.36	61.4	4.25%	
	8.35%	896.33	3.54	32.23	5.33	3.35	5.33%	
		896.33	7.63	44.45	2.55	6.35	8.35%	
	2.56%	323.24	2.33	42.36	56.35	234.6		
	1.23%	236.58	6.35	78.96	24.36	96.3		
	69%	596.33	7.98	33.33	72.65	25.3		



## Risk Analysis Techniques Applied

We have demonstrated experience of applying risk expertise in numerous sectors, including nuclear, rail, defence and the financial sector. CRA is now expanding and applying its skills in new sectors which we believe could strongly benefit from the rigor of the risk analysis used in the nuclear sector, a prime example being the health industry.

## Bespoke training

Training new members of staff forms a vital part of CRA's long term strategy, and I will be developing CRA's ARA internal training further. In addition to internal training, **CRA offers clients bespoke training courses across the spectrum of reliability engineering topics.** Courses offered include fault tree analysis, event tree analysis, data analysis, reliability models and human reliability analysis.

## Universities engagement

**We have a long track record of university engagement.** This commitment has several strands including:

- Supporting students, education and placements:
  - CRA has provided support for two doctoral programmes at Imperial College. I was one of those doctoral students, researching uncertainty analysis, and the other is Lavinia Raganelli who is currently researching seismic PSA methods.
  - CRA is supporting Andrew Wright to do a part time MSc at Loughborough University in Ergonomics with Human Factors.
  - For many years CRA has mentored NTEC MSc students with their summer dissertations.
  - CRA supports BSc Mech Eng students at Imperial College with their final year projects.
  - CRA regularly provides short placements for school and university students.
- Collaborative projects
  - CRA has recently collaborated in assessing Small Modular Reactor (SMR) designs with academics at Imperial College.
- Giving industry lectures as part of university courses.

**Maintaining good links with academia is essential to the wider industry to ensure that industrial practices are kept up to date and effective.**



## Quantifying Expert Judgement

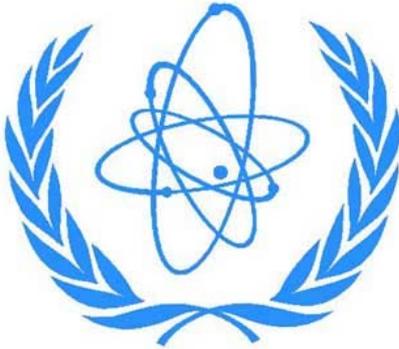
In January 2016 CRA successfully trialed an internship process with University of Warwick chemistry graduate, Francesca Brandford-Adams. Her internship was on methods of quantifying expert judgment. During her internship Francesca produced a detailed protocol for Structured Expert Judgment which evaluated current work in the field, under my guidance. Quantification of the opinions of experts has many important applications, especially in safety where the observed failures may be very sparse. **These methods enhance both the credibility and accuracy of risk models, and hence impact on risk informed decision making.** The process was trialed using real data collected from in-house workshops. We are now producing a paper for the European Safety and Reliability (ESREL) 2016 Conference in Glasgow in September. I'm pleased to say that Francesca has now joined the CRA team as a graduate consultant. Welcome Francesca!

## So Much Hot Air: Reliability of Heating Ventilation and Air Conditioning (HVAC)

A vast amount of heat is generated by large IT systems. For some high hazard operations HVAC is a safety critical function necessary to avoid equipment overheating and potential plant shutdown. Similarly, for data centres HVAC is a business critical function.

CRA created a fully integrated Risk Model to predict the availability of the HVAC and this data was compared to the client's target. **This gave the client a very clear indication of the potential issues that failure of the HVAC raises for the facility and enabled them to make informed cost-effective decisions.**





**Jasbir Sidhu, CEO, CRA**

**In June Jasbir Sidhu, CRA's CEO, will be working in Vienna with the IAEA to develop international guidance on complementary safety analysis in light of the Fukushima accident.** This has a number of strands which are normally considered to be beyond design basis, including guidelines for multi-unit PSAs, consideration of longer mission times in accident sequences, combinations of hazards, the complexity of human interactions including potential obstacles caused by the accident conditions, and the use of alternative systems or mobile components for accident mitigation.

Jasbir will also provide input at the Asia Nuclear Business Platform 2016, a three day event in Hong Kong in May.



In April, Jasbir attended the Iranian Trade Conference in London. The event was chaired by Lord Price the Minister for Trade and Investment and attended by many including Lord Lamont, Chairman of the British Iranian Chamber of Commerce. International expansion is an exciting prospect for CRA.



**Ring the Bell!** CRA's Rail System Safety is pleased to announce that it has won a contract to provide bid support to an international rail consortium seeking to establish an operation in the Middle East; it will do this as Lead Expert in all issues related to Rail Safety, Risk Management and Health & Safety Management. Exciting times for Ruairí and the rail team.



## Events

**Mathematics Employers' Forum.** On 23<sup>rd</sup> February 2016, Abigail Sleightholme, a mathematics graduate and consultant from CRA's Warrington office, attended the fifth annual Institute of Mathematics & Its Applications Employers' Forum, 'Motivating and Rewarding Chartership' at the Defence Academy. The aim of the event was to share best practice in the use of mathematics in industry and academia. The event also featured discussions on the value that professional mathematicians bring to industry. **The greatest value from professional mathematicians was thought to come from being able to translate between abstract concepts and real world problems.**

**Safety Critical Systems Club.** On April 14<sup>th</sup> Hugh Stephenson, CRA's PSA Lead & Principal Consultant, and I attended our first meeting of the Safety Critical Systems Club. The topic was the use of service history and field data in support of safety justifications for software and C&I components. Reliability assessment of software and smart instruments is notoriously difficult, and the issue is becoming increasingly important as the number of systems with COTS (commercial off the shelf) "smart" components built into them proliferates. As their use increases, so too does their importance to risk model predictions. **CRA will be researching this area further in order to improve the level of realism in our risk models.**

**EDF PSA Technical Forum.** Hugh and I attended the EDF PSA Technical Forum Meeting on 19<sup>th</sup> April. The meeting covered PSA related technical news including software issues and the introduction of a new PSA wiki. **PSA users are encouraged to use and contribute to the EDF wiki as a living community project to enhance accessibility of PSA information.** I gave a presentation at the meeting about the value of uncertainty analysis in PSA; I chose the topic whether uncertainty analysis has value engenders a wide variety of opinions from complete agreement to deep scepticism.



**The Safety and Reliability Society (SaRS) provides a valuable forum for cross-industry discussion of safety and reliability**, of which CRA Risk Analysis is an Affiliate Organisation. I have recently joined the SaRS London Branch Committee as a representative for the nuclear sector, and I hope to increase the number of SaRS members from the nuclear industry.

Ruairí Kennedy, CRA's Principal Consultant for Rail System Safety, was delighted to accept an invitation to speak at the SaRS North West Branch event on 14<sup>th</sup> January 2016, which was also sponsored by CRA. Ruairí's talk was titled 'Safety Risk in the Operational Railway – Improving Worksite Protection' and there followed some healthy discussion regarding the use of near miss data in the study of signalling control system and human reliability.

Mia Bennet, CRA's Safety Case lead and Principal Consultant, took part in a Question Time panel for SaRS in Warrington on 3<sup>rd</sup> March. As one of four experts on the panel, she responded to questions related to safety and risk in a number of industries with a predominantly nuclear focus. The audience was receptive to the interesting debates that ensued.

**If you wish to contribute to any of SaRS' national events and regional branches, please get in touch with me or Elinor Davies, the Membership, Events & Press Co-ordinator at SaRS: [elinor.davies@sars.org.uk](mailto:elinor.davies@sars.org.uk) or 0161 393 8411.**

**Women in Nuclear conference.** Mia was joined by Lavinia Raganelli in attending the Women in Nuclear conference in London on 2<sup>nd</sup> February, arranged by the Nuclear Institute. There were many interesting talks, notably an inspirational talk from Adrienne Kelbie, the new Chief Executive of the ONR. **CRA are leading the way as an equal opportunity employer, blind to colour, age, gender, religion and disability.**



## Cyber Security

### CRA Certification by Cyber Essentials

**With the increasing prevalence of cyber crime, CRA is continually looking to improve the way we protect our IT systems and our clients' data.** CRA is delighted to announce that its Cyber Essentials registration has been approved and certification granted as of 25<sup>th</sup> January 2016. Cyber Essentials is a UK government-led scheme designed to encourage organisations to adopt good practice in information security. To gain Cyber Essentials certification, companies must examine their security controls in the areas of firewalls, security configuration, access control, malware protection and patch management. **Gaining this certification is part of CRA's ongoing commitment to our customers, constantly looking to improve the services we offer.**

### Humans in cyber security – the weakest link

Andrew Wright, Consultant at CRA, is currently pursuing a MSc in Ergonomics with Human Factors. Andrew has an interest in cyber security and has recently published an article discussing the human element of cyber security. The article explores how the biggest vulnerabilities of a system are not necessarily found within hardware or software, but rather with the people who use it. It notes that more than 95% of cyber security breaches are due to human error, and more than half of all security attacks are caused by individuals who had insider access to organisations' IT systems. Detection technology and security packages, no matter how sophisticated, will always be limited by this human factor. Andrew is working with a team of other CRA consultants to develop CRA's cyber security offering, including the importance of Human Factors in securing an organisation against external threats.



**Imperial College  
London**



### Our Current Support for Students

CRA is supporting Stella Toh, an undergraduate at Imperial College to complete her final year project. **The project is to conduct sensitivity studies on level 3 PSA for a proposed SMR design, examining the effects of differing radiological inventories on the predicted consequences.** Different options for counter measures are also being assessed including distribution of Iodine tablets, sheltering and evacuation.

CRA is supporting Shunsuke Yamamura, a MSc statistics student at the University of Sheffield. **Shunsuke's project is analysing the effects of using differing Bayesian models on reliability parameter estimates.**

CRA has a long standing relationship with NTEC, and has supported student MSc projects for several years. In the summer of 2016 CRA will be supporting two NTEC MSc students with their dissertations. **The students will be analysing the effects of maintenance on estimates of the probability of common cause failures, and in particular will consider how output from online risk monitors could be affected.** The students will be mentored by Garth Rowlands in our Warrington office.

### CRA 7<sup>th</sup> Annual Risk Forum

Every year CRA holds a risk forum to discuss all aspects of probabilistic risk analysis and human factors. **The 2016 forum will be held on 5<sup>th</sup> and 6<sup>th</sup> October 2016 in Stratford upon Avon, and the theme of the forum is: 'To Automate or Not to Automate'.** The prestigious speakers will include industry leading specialists from the fields of nuclear, rail, aviation and academia. The attendance cost is waived for students and retirees. Contact me if you would like further any information about this year's forum. To reserve a place at this year's forum please contact Ruth Mantle: M: 01372 860847, E: [rmantle@crarisk.com](mailto:rmantle@crarisk.com)



## Our People

CRA has a very talented team of risk professionals with many years of cumulative experience. A few members of the team are introduced below.

### Charles Shepherd

Charles has about forty years of experience as a safety analyst, a regulator of nuclear facilities and a consultant in carrying out fault studies and Probabilistic Safety Analysis. As a regulator, he has been involved in the assessment of the safety cases for all types of nuclear facilities including nuclear power plants, nuclear fuel reprocessing facilities, research reactors and defence facilities. He was project manager for the licensing of the Pressurised Water Reactor at Sizewell B and for the regulatory review of the Fully Developed Safety Cases for Sellafield and he has also worked on the periodic safety reviews of the operating Magnox reactors and Advanced Gas-cooled Reactors. He established the methodologies for the assessments of public and worker risk that were carried out for the upgrading of the UK defence facilities at Devonport and Aldermaston, and reviewed the analyses produced by the licensees. As a consultant, he has provided services on probabilistic safety analysis, fault studies, Human Reliability Analysis and availability analysis both for the nuclear industry and for conventional facilities. Charles has been integral in work to develop the methods and the data to be used to model Common Cause Failure in future updates of the PSAs for the AGRs. He has worked extensively as a consultant for the International Atomic Energy Agency in the updating of their Nuclear Safety Standards, providing training through the IAEA training programmes and is currently working on the review of new nuclear power plant designs. He has recently completed the review of a new Korean design of advanced PWR and a new Russian design of VVER and has just started a review of two new Chinese designs of PWRs. He has also acted as the UK representative on the OECD Nuclear Energy Agency Working Group on Risk and the EC Nuclear Regulators' Working Group.



### **Garth Rowlands**

Garth originally started his working career in final salary pensions. In 2010 he decided on a career change and completed an NTEC masters in nuclear science and technology. Garth subsequently joined CRA. Since that time Garth has gained a range of PSA experience and in particular has become very knowledgeable in the area of estimating common cause failure probability.



### **James Cooke**

James graduated from Imperial College London in 2010 with an MEng in Chemical with Nuclear Engineering. James worked for EDF Nuclear New Build for two years before joining CRA in 2013. James has a particular for passion for coding and relational databases. James is currently seconded to Sofinel in France.



### **Abigail Sleightholme**

Abi graduated from the University of Sheffield in 2012 with a BSc (Hons) in Mathematics. Upon completion of her undergraduate degree, Abi gained an MSc in Mathematics with Distinction before joining CRA as a graduate in 2013. Abi has been working on PSA models for operating nuclear power stations and on nuclear new build projects.



### **Anthony Bell**

Anthony Bell was appointed Business Development Co-ordinator at the end of 2015. Anthony is experienced in developing relationships in industry and had been supporting the role for 18 months prior to his new appointment. Anthony's dynamism and enthusiasm make him well equipped to step into the role, enabling business development activities both internally and externally. Anthony is the first point of contact for general business development and sales enquiries:

M: 07984 070 099

E: [abell@crarisk.com](mailto:abell@crarisk.com)



### Looking forward

CRA is well-known and well-respected for its expertise in quantitative risk analysis. We have a proven track record of delivering projects on time and within budget, providing a cost-effective service and developing great relationships.

CRA works with numerous partners, including industry, academia and professional bodies, and we are building further relationships as we grow. ARA is an expansion of the range of offerings historically offered by CRA. We work closely with our clients to identify the most efficient approach to their particular questions. An inevitable side benefit of our approach is that we are developing the next generation of risk analysis methods as we work.

I hope you have found this newsletter useful and that it provides you with further clarity on CRA's business. In particular I hope that the work of ARA and our plans for the future are of interest. For further information or to discuss any opportunities arising, please contact me:

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