

Preparing for take-off



Raven on the runway: next generation, low cost, truly autonomous airborne surveillance

Autonomous systems project gets underway

The Autonomous Systems Technology Related Airborne Evaluation and Assessment programme (ASTRAEA) is a major £32m investment combining the forces of a consortium of industrial, academic and SME partners to open up the airspace to UAVs and allow their routine use in segregated and non segregated airspace. This will allow UAVs to perform tasks currently undertaken by manned vehicles but more safely, cheaply and efficiently and, in the process, will create new opportunities for business.

The ASTRAEA demonstration programme is a major feature of the Aerospace Innovation and Growth Team (AeIGT) initiative. It complements work in the military domain and cooperates closely with regulators and authorities as well as European and International programmes. Close links with many of the other Aerospace Innovation Networks and Aerospace Technology Validation Programmes, whose technology is required to enable safe autonomous flight, are also being developed.

BAE Systems Military Air Solutions are leading the Prognostics and Health Management Technology Development (T7) sub-theme. This sub-theme will establish an integrated approach to the development of a UAV Contingency Management capability that will in turn enable autonomous UAVs to determine and manage their health and adapt their behaviour accordingly. Clearly, to achieve this the autonomous vehicle needs to acquire the fault detection and decision-making traits of the human pilot. The main requirements are to embody improvements in system hazard and reliability assessment, with a specific focus upon real-time airframe and vehicle system diagnostic and prognostic issues, and the implementation of machine intelligence in contingency management.

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The focus of this work is to deliver a demonstration of this capability, through a

ASTRAEA FACTSHEET

- **Industrial partners:**
Agent Oriented Software, BAE Systems, EADS, Flight Refuelling, QinetiQ, Rolls-Royce and Thales UK.
- **Academic partners:**
Loughborough University, University of Leicester, University of Wales Aberystwyth, University of Bristol, Cranfield University, Imperial College London, Lancaster University, the University of York, and the University of Sheffield.
- **The three-year, £32M programme has been built around three main themes:**
 - technology development and maturation;
 - regulatory process development;
 - systems integration and flight demonstration.

Delivering a Future Capability through Systems Engineering



Although R&T Conferences have been hosted regularly by the SEIC, this was the first to be open to any participants and attendees.

The SEIC hosted a highly successful two-day Research and Technology (R&T) conference addressing future capability and how, through systems engineering, companies such as BAE Systems will be better placed to deliver it. The conference, sponsored by the Systems Engineering Council (SyEC) of BAE Systems was also the first for NECTISE; The Network Enabled Capability Through Innovative Systems Engineering programme.

With over 170 registrations, this year's theme attracted top level presentations from government, industry and academia addressing issues relating to collaborative approaches for capability provision and solutions for supportability. The conference also provided a forum for researchers to present their respective developments in novel approaches to architectures and system representation within the context of capability delivery.

As a keynote presenter at the conference, the Head of Science and Industry in HM Treasury, Caroline Barr, provided a view on how the university sector benefits the UK economy and should, therefore, be more engaged with industry in formulating the research agenda. On a similar note, senior Programme Leader for the Defence Science and Technology Laboratory (DSTL), David Oxenham, articulated the challenges facing

research for engineering the military capabilities required for the 21st century.

In addition to the presentations and the networking opportunities enabled by this event, the conference also offered a platform for academic and industrial researchers involved in systems engineering related programmes to demonstrate some of their work, tools and results impacting this theme of future capability. Although R&T Conferences have been hosted regularly by the SEIC, this was the first to be open to any participants and attendees.. This transition to a wider audience reflects the importance of systems engineering and how, according to Dr Andrew Bradley (Chairman of the Systems Engineering Council for BAE Systems) "It is clear to most people now, that without systems engineering know-how and skills we will be unable to meet challenges thrown at us by advances in technology and increased demands for coherent, affordable, through-life capability; and this is true not just in the defence domain but in all aspects of modern life".

For full details of the conference, including papers and speakers, see <http://www.seic-loughborough.com/conference>



representative end-to-end system design and development process; from system hazard and reliability analysis, through to the instantiation of an experimental Contingency Response mechanism. Planned activities include:

- developing the vehicle Prognostic Health Management (PHM) requirements,
- employing Smart Structures and Structural Health Management capabilities,
- integrating the PHM technologies,
- integrating this with the Synthetic Environment and
- exploiting the simulation and systems engineering capabilities, both within Military Air Solutions and at the SEIC.

Those most challenging aspects of this work programme will further develop and employ innovative approaches to Hazard Identification, FMEA generation, Fault Diagnostic methodologies, and the real-time application of Fault Tree Analysis in Contingency Management.

ASTRAEA will lay the foundations for opening up UK airspace, looking at the technology and regulatory approvals needed to prepare for the safe operation of unmanned systems without the need for restrictive, specialised or non-routine conditions of operation.

For further information, contact Dr John Pearson (j.t.pearson@lboro.ac.uk)



NECTISE is a collaborative research programme between academia and industry in the UK and is led by BAE Systems with the support of the Engineering and Physical Sciences Research Council (EPSRC). The programme involves researchers representing 10 universities from across the UK and is aimed at addressing the capability-based acquisition environment in which the delivered capability is network enabled.

**Loughborough University (lead)
University of Bath
University of Cambridge
Cranfield University
University of Leicester
University of Leeds
University of Manchester
Queen's University Belfast
University of Strathclyde
University of York**

Integrating experimental systems using IMS

Professor Shaun Yang spent six months in the SEIC on a secondment sponsored by the Royal Academy of Engineering. Here's what he had to say about the experience.

I originally graduated as a process control engineer and worked in various universities before becoming a professor at Loughborough. As I had had no previous opportunity to work in industry, my knowledge of industrial practice came from student placement visits and collaborative academic research projects with industrial partners. So you can understand how much I appreciated this opportunity. During the six months I visited two BAE Systems' sites: the Advanced Technology Centre (ATC) in Filton and Military Air Solutions (MAS) in Warton, which was not only fascinating and insightful, but also gave me the chance to talk to their engineers about nano-sensor technology and risk assessment.

What did you set out to do at the SEIC?

Primarily, to gain knowledge about current working practices and state-of-the-art software and experimental systems used in systems engineering. But we also hoped the secondment would strengthen and extend collaboration between the SEIC and industrial partners in support of future research proposals and projects. A third aim was to identify projects for MSc students and industrially relevant materials and case studies for Loughborough University (LU) teaching modules. Practically, and working as a team member in the SEIC, we planned to integrate three existing experimental systems: a fuel rig (the Advanced Diagnostic Test Facility or ADTF) controlled by a local computer system, a mobile robotics rig (ConSERT - consisting of six mobile robots and a blimp), and a synthetic environment lab.

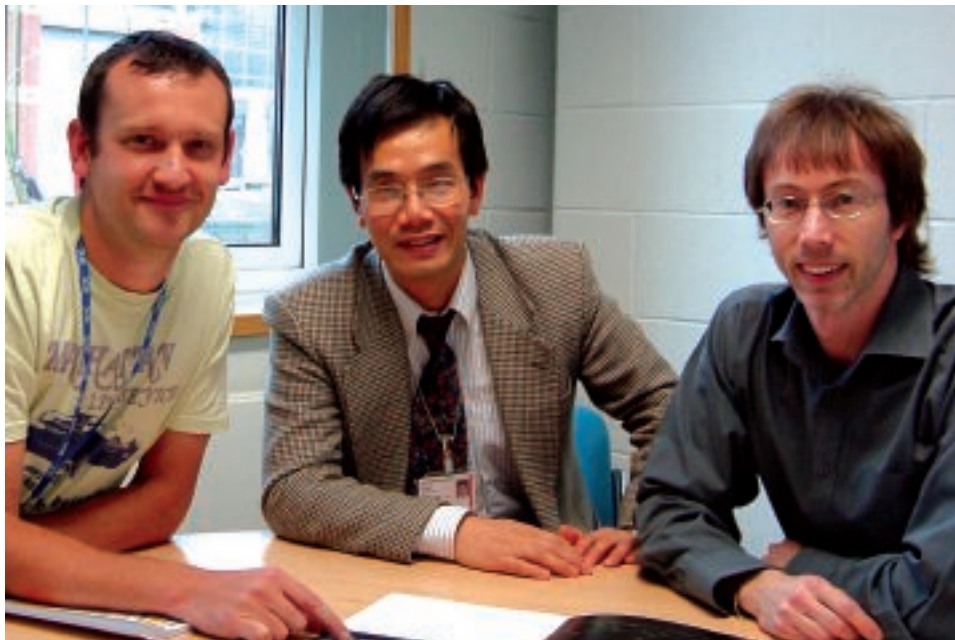
How did you go about that?

We used Labview Internet Toolkit supported by various software technologies including SQL, Java Applet and Web-server to remotely control the ADTF and we put three levels of security control into operation: administrator level with the highest authority, normal user level with no access to the refuel pump and valves, and anonymous (guest) level which observes the system and has no control at all.

When we'd finished, the ADTF could be remotely and safely operated through the public internet, the overall integrated system performance and interaction in pre-defined fault situations could be demonstrated and we had secured the environment from malicious attack over public networks. Now we've created it, this solution provides a basis for future integration of a fourth rig to demonstrate IMS distributed system management concepts.

So, your project was successful then?

We believe so. I, my students and the SEIC staff



(Left - Right) Dr Tony Martin, Professor Shaun Yang and Dr Alan Grigg get down to details.

together managed to get the three experimental rigs to communicate with each other via a generic communication system.

To get it all working, we had to incorporate a data oriented IMS (Integrated Modular System) Virtual Channel (VC) communication protocol. The VC protocol needed to be implemented over a hybrid wired and wireless network connecting the three rigs.

Did you learn anything yourself?

Indeed! IMS was a new concept to me and I am now considering using it as part of my future teaching on networks and distributed systems at LU. The IMS concept is different from object-oriented concepts: it deals with software and hardware and the scale of the modules in the IMS might be as big as an individual system. It's got so much potential! The IMS VC communication protocol gives you seamless, platform independent communication between applications even if they

...a basis for future integration of a fourth rig to demonstrate IMS distributed system management concepts.

are implemented by different tools and programming languages (including LabView, MatLab, C and C++) and running on different rigs and in different labs or locations. The rigs can also incorporate different software operating systems: some use Linux and some, Windows.

The VC protocol is part of a much bigger IMS open

systems approach to the construction of systems from a set of standard hardware and software building blocks or modules, each of which has well-defined interfaces and internal behaviour. The modular building blocks make integration of the target system easy and facilitate the re-use of hardware and software between different sub-systems and different projects across the land, sea, air and space domains.

With the synthetic environment rig, this provides a way to visualise the degraded behaviour of a system, for example after injecting a fault. Unfortunately, we only had time to implement a simple model - including a model of an airship (blimp) programmed in Matlab/Simulink - but a more complete system model could easily be developed in the synthetic environment in the future.

We installed the solution in the SEIC labs and gave a demonstration to Dr Imren Markes, who was my Industrial Secondment Scheme manager from the Royal Academy of Engineering when she visited in February. My technical report describing the overall approach and implementation, set against the original technical objectives is available to anyone who is interested.

To get a copy of the report or for further information, contact: Professor Shaun Yang (s.h.yang@lboro.ac.uk) or Alan Grigg (a.grigg@lboro.ac.uk, alan.grigg@baesystems.com)

In the news

The SEIC hosted a visit by the Director of the Centre for Performance Excellence (CfPE), Margaret Helsabeck. The visit enabled the CfPE and the SEIC to assess areas of common interest and potential collaboration. The SEIC's activities on organisational systems engineering initiated the first step towards such an engagement.

The SEAS DTC has now completed the assessment of responses to the Year 3 Call for Proposals. Planning is underway for the second Annual Conference in July. For more details see <http://www.seasdtc.co.uk/>

Presentations on selected SEIC activities in relation to INCOSE and the CEMMNT project were invited by Loughborough University for visitors from Thales Aerospace (Simon Watts, Chief Scientist and Vice-President of Research, Paul Davies, Head of Innovations and Jean Chazelas, Head of University Collaboration)

The SEIC, through Loughborough University, submitted an Expression of Interest (£1.7M) to host the East Midlands Transport Technologies Innovation Network (INET). The proposal is based on the strong partnership with the Midlands Aerospace Alliance (MAA) and if successful would create a lean but capable management framework, with both organisations bringing industry and research institution perspectives, and both bringing direct experience and a strong record in both transport technologies and innovation and knowledge transfer.

The iFestival (the largest collective celebration of innovation in the East Midlands region) was officially launched on the 15th of February 2007 at the Sir Denis Rooke building of the SEIC. The event was headlined by *emda*'s Executive Director of Business Services, Mike Carr, and runs until 17th May 2007. The CEMMNT Launch on 2nd May forms part of this regional celebration agenda and features a key note speech by the Chief Executive of *emda*, Jeff Moore.

The event celebrates "regional" innovation in general and the launch of the Centre of Excellence in Metrology for Micro and Nano Technologies (CEMMNT) in particular.

Members of the SEIC attended the leading international Conference on Systems Engineering Research, CSER, hosted at Stevens Institute (New York). Attendance figures for 2007 were about 200, of which about half are academic staff and doctoral students.

If you or your company are interested in getting involved or would like any more information on any of these topics, contact Ayman El-Fatraty, Customer Manager, (a.el-fatraty@lboro.ac.uk)

Business Events

Business Support Hub

The SEIC has hosted two principal events in the past few months. The first was a Communications Discovery Day which introduced the work of the Communications Research Division of Loughborough University's Electronic and Electrical Engineering Department to a number of academics and industrialists.

The second was a meeting of the INCOSE Midlands SysML/ UML Practitioners' Group at which Mike Gould of BAE Systems, Land Systems gave a presentation on 'A practical introduction to UML for System Designers'. Mike also proposed a number of ways in which the UML model information could be used in an integrated manner to support other development activities.

The meeting also discussed the use of SysML/ UML in business applications. This raised a lot of interest and will therefore form the main topic of discussion at the next meeting. The Association of Proposal Management Professionals (APMP) systems engineering working group will also provide input to this meeting. This group is attempting to address the question of how systems engineering methods can be applied in their domain of expertise.

In May, we welcome both National Instruments, who will be holding their Military Aerospace Solutions Conference at the SEIC and the INCOSE Rail Interest Group, who will discuss 'Systems Engineering and Tram projects' at their event.



For further information, please contact Ken Astley (tel: 01509 635208 or e-mail: k.r.astley@lboro.ac.uk) or, for the May events, see the SEIC web-site for registration details.

FEEDBACK

Please email your feedback, news and views to seic@lboro.ac.uk. Edited by Ayman El-Fatraty and Amanda Pearce. Copyright SEIC*. All Rights reserved. Spring 2007

FUTURE ISSUES

- Building a helicopter simulator
- CEMMNT launch