DIAL Quarterly – April 2014: Collaboration with YH Global China, GS1 Industry and Standards Event, Futureproofing of Asset Management Workshop, MET projects 2014, Future Airport Operations Workshop and more

Introduction from Professor Duncan McFarlane:
Welcome to the DIAL Spring Newsletter for 2014

As we approach DIAL's 20th birthday in 2015 it is interesting to see that some of the concepts we have worked on for a long time are still as applicable in the 2010s as they were in 1990s. In our work with three different manufacturers in the last year we have been examining methods for improving production flexibility and ability to respond to disruptions. Resilience in manufacturing and the supply chain is more important today than it was 20 years ago. Also, our work with distributed AI which began – for us - with so-called holonic manufacturing in production now finds purchase in areas such as logistics, repair and asset management. In the latter area, an article in this newsletter introduces the notion of intelligent infrastructural assets as a means of ensuring a smarter, more coordinated approach to managing / repairing / upgrading infrastructure. Something that might perhaps help address the age old challenge of digging up our streets – time after time – as new services are added …..

As is usual for this time of year you will start to see new faces popping up in DIAL as we bolster our ranks with a flurry of Master's students who year after year provide excellent support to our research programmes. There are also major changes currently underway in DIAL's automation lab – something that Laboratory Manager Alan Thorne will report on in more detail in a future issue.

Meet DIAL's new Research Associates:

Dr Alena Puchkova joined DIAL in March 2014. She is working on research topics related to the DisTAL project.

Alena graduated in 2009 from the Faculty of Computational Mathematics and Cybernetics, Lomonosov Moscow State University (MSU), Russia, with a degree in applied mathematics and computer science. She received her PhD in 2013 from the Department of Optimal Control, MSU. The title of her PhD thesis is "Nonlinear Optimal Control Models in Biological Systems".

Her thesis investigated optimal strategies for fishery harvesting models with state constraint and microbial growth optimisation.

Dr Puchkova has international and industrial research experience, having worked as a research and technical associate with Norilsk Nickel Australia in Perth, Australia where she worked on modelling and understanding the parameter space which affects nickel price movements on a global scale. Alena also spent three months as an academic visitor at the University of Western Australia and at the Curtin University in Australia. Previously Alena worked as a research assistant at the International Institute for Applied Systems Analysis (IIASA) in Vienna, Austria where she worked on developing data-driven probabilistic models for predicting economic recessions and models for optimising infrastructure applied to land-use in developed countries.

Dr Jumyung Um joined DIAL in February 2014 as a research associate. He is developing a system architecture that tracks individual items on the shop floor for the concept of Disruption-Tolerant Automated Lean Factories (DisTAL), which is the goal of the project funded by The Boeing Company.

He received his PhD in industrial engineering from POSTECH, South Korea, and was a research associate at EPFL in Switzerland, where he worked on EU FP7 projects. He has extensive experience in industrial projects involving Airbus, Jaguar, Fiat, Posco and machine tool builders. He completed research on the development of Eco-Advisor software for manufacturing processes and on the implementation of Smart Factory using RFID, RTLS and sensor networks. Jumyung also participated in writing the ISO standard for the machine tool data model (described by ISO TC184/SC1/WG7) focusing on general machine tools and additive manufacturing. Jumyung's research interests are Intelligent product-driven manufacturing systems, Holonic manufacturing systems, Ontology reasoning and context-awareness, Sustainable manufacturing, High-power laser welding and others.

Meet DIAL's Visitor:

Roxana Hossu is a Masters student at the Faculty of Automatic Control and Computers, at Politehnica University of Bucharest.

Roxana joined DIAL in February 2014 as a visiting student for a period of 4 months and is working on the DisTAL project.

Roxana received her Bachelor's Degree at Politehnica University of Bucharest after developing her graduation thesis at Polytech' Lille, Université Sciences et Technologies Lille 1, France during a 4 month Erasmus Internship.

Her research interests include: multi-agent systems, intelligent products and product-driven manufacturing control and holonic manufacturing systems.

Future Event: Airport Operations 2025

Airport operations continue to be stretched with increasing aircraft numbers and a need to provide ever changing tailored services. With lean operational service providers and capacity-constrained airports all battling to meet critical on-time performance measures, operational processes have become critically sensitive to unexpected delays and disruptions.

The University of Cambridge conducts pioneering research into Airport Operations by examining

operational and environmental benefits that can be achieved through process improvement techniques traditionally used in the manufacturing sector as well as improvements that can be gained through data sharing and Auto-ID technologies.

With airports starting to adopt networked airport information services such as Collaborative Decision Making (CDM), the Distributed Information and Automation Lab (DIAL) at the University of Cambridge would like to explore what airport operations services should provide in 2025.

The DIAL research group and Boeing will be running a free one day workshop on Thursday 15 May 2014 to discuss the latest developments in this area and hold structured workshops to capture current issues and future requirements in the airport space.

DIAL's collaborator - Yue Hai Global Logistics (YH Global)

YH Global Logistics is an innovation-oriented modern logistics company with global vision. With over 520 million GBP total assets, YH Global has 39 warehouses, 16 subsidiaries, 30 operating offices and outlets all over mainland China.

With forward-looking ideas and new modes of operation, the company has successfully integrated a variety of resources nationally and abroad. It has built a safe and efficiently integrated supply chain platform, established a good strategic partnership with many multinational companies and domestic well-known enterprises. These boosted the rapid growth in transportation and distribution, international freight forwarding, import and export agents, Vander Managed Inventory (VMI) warehousing, distribution execution, supply chain finance, supply chain solutions and all other business lines and services.

As the first to use the 'integrated supply chain management model', YH Global has developed into one of the largest supply chain service provider in mainland China. In November 2010, the company was awarded the 'China Logistics Outstanding Enterprise' from the China Federation of Logistics and Purchasing; then in January 2011, they won the award for the Largest Business in 'Shenzhen Logistics and Supply Chain Enterprise League', and later in December 2011, they won the '2011 China Logistics Innovative Enterprises' award from the China Federation of Logistics and Purchasing.

YH Global's 'Integrated supply chain model' is not only the leading logistics industry in mainland China, but it has also become a new industry model, called the 'YH Model'. In September 2009, Chinese ministries visited the company and put a


premium on the 'Yue Hai Model', and agreed that the model represents the future direction of China's modern logistics industry.

YH Global places a great importance on the use of cutting edge technologies in the logistics field. To date, the company has independently developed its own Supply Chain Information System, Warehouse Management System and Vender Management System, etc.

In the next three years the company will complete the warehouse bases construction in East, South, Central, North, Southwest, Northwest, Northeast

and Central Plains, namely the Eight Major Bases, with a total construction area over one million square meters. With the formation of the Eight Major Bases and the company's overseas operations, YH Global is running into a new development stage.
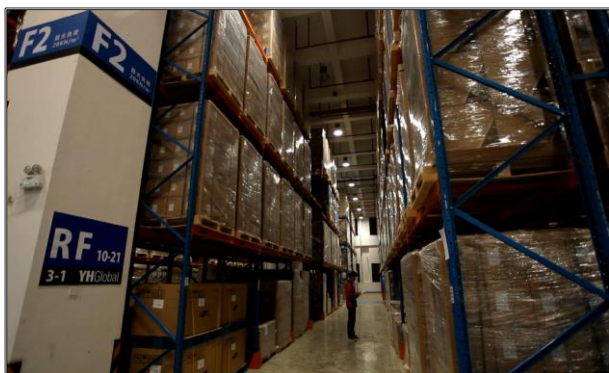
In the next few months, DIAL will kick off a new project funded by YH Global which will look into the IT architectures for logistics integrations.

Intelligent Infrastructural Assets?

At a recent Institute of Civil Engineering meeting on Infrastructure Asset Management I was asked to provide a view on what asset intelligence might mean in an infrastructural context. In conjunction with colleagues Prof Kenichi Soga a geotechnical engineer and Dr Ajith Parlikad who heads our asset management programme, we began by noting that with the ever increasing number of infrastructural assets, the uncertainty about their life span and the conditions they might face and the declining availability of funds for maintenance and upkeep, asset management in the future will need to:
•   Involve low cost, easy to maintain sensing, data gathering & management
•   Prioritise all assets within a single integrated portfolio
•   Examine value of the use of the asset in conjunction with cost of maintaining
•   Be robust to future ownership, usage changes
A conclusion from this was that today's centralised coordination of assets by asset owners or third party facility managers is particularly challenging.

Following on from some previous work in logistics and spare parts management, we then began to explore what it might take to empower an asset to "take care of itself' as indicated in the cartoon below. Ironically this talk was given on the same day as the government announced new measures to allow an individual to manage his or her own pension funds rather than the government.

We extended the notion of a self-aware asset used in work with Boeing in the 2000s, to propose a definition and set of characteristics for an intelligent infrastructural asset:

A self-contained infrastructural element linked to its own monitoring, diagnostic and maintenance strategy and with the ability to guide, influence or direct its own use, use, maintenance & support.


To do this, the intelligent infrastructural asset needs:

1.   Identity: An independently constructed/fabricated element of known properties and unique identity.
2. State Awareness: An awareness through sensing or inspection of its own state [location, depgradation, strain etc]
3. Communication: An ability to communicate information relating to identity and state when integrated into larger systems.
4. Data Management: An ability to collect / store / retrieve data associated with the elements identity, properties and state as required.
5. Language: An ability to interpret and communicate information relating to rules, instructions and preferences associated with the use of the element in its environment.

6. Decision [support]: An ability to influence decisions that are made with regard to the assets or collection of the assets.

7. Value system: A means of evaluating cost & benefit in terms of service provided by the asset and services received

In simple terms this means that any information associated with an asset is tightly "bound" to the asset it represents [and not to the owner, user, operator etc]. In this way, the asset has a virtual counterpart holding data and also rules, guidelines and via this virtual counterpart it can trigger new decisions/actions as required.
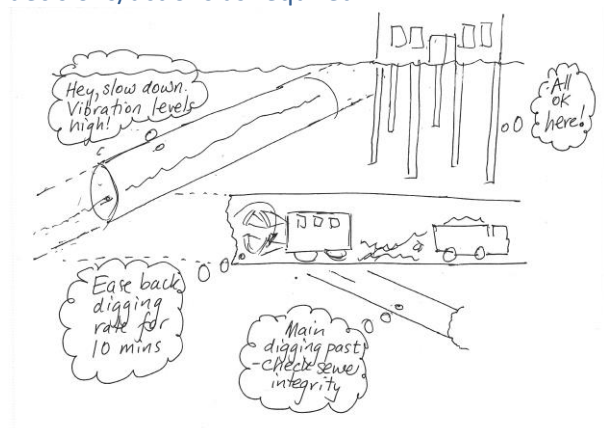
Within the Centre for Smart Infrastructure and Construction a significant amount of groundwork is underway to develop some of the characteristics identified above. The centre, with over fifty sponsors from construction and infrastructural organisations addresses infrastructural challenges on three levels: city level, asset level and sensor level. Research focussed on assets ranges from development of new distributed, low energy, low maintenance sensing systems, to better ways of managing and visualising asset data, to methods for computing asset value over its life to futureproofing strategies for ensuring a future needs and environment changes are accounted for in the assets management plan. Much of this work is tied in with global work on Asset Management standards [e.g. ISO 55000], UK government work on Building Information Modelling [BIM] and Infrastructure UK's initiatives on Resilient Infrastructure. More to the point, these research initiatives directly underpin the development of a smarter, more self-sustaining infrastructural environment both in the construction phase and during the assets operating life.

The presentation can be found at: http://www.ifm.eng.cam.ac.uk/uploads/Research/DIAL/Resources/Presentations/Institute_of_Civil_Engineering_presentation.pdf

Duncan McFarlane

GS1 Industry and Standards Event

Mark Harrison and Vaggelis Giannikas attended the GS1 Industry and Standards Event in Atlanta during the week of 24-28th March 2014. This is a twice-yearly event where the various technical work groups at GS1 meet for face-to-face meetings to make progress on the development of open standards for sharing information within supply chains, in addition to the progress made in weekly conference calls. At this event, we participated in the launch meeting of a new GS1 technical work group called 'GTIN+ on the Web', which is looking at ways that machine-interpretable structured data about products and product offerings can be embedded as Linked Open Data within web pages, so that this can be extracted by software including search engines, smartphone applications, etc. The initial benefit to end-users is the prospect of improved search engine listings for products, such as Google Rich Snippets (which typically feature a picture of the product, a description and key characteristics as well as information about sales offers for that product). Beyond that, we expect that this work will provide the foundation for a range of new information services about products, such as smartphone applications (apps) that can be used to help consumers find the products that best match their needs, e.g. warning them if a scanned product is incompatible with their dietary requirements and suggesting an alternative product - or even assisting them with finding a particular product when they are travelling in a foreign country where they do not speak the local language and are unfamiliar with the local brands and local retailers; such an app could help them find an equivalent product and provide a map and direction to a local retailer that sells the product and even provide an image of the product and an in-store map.

Already the GS1 community has developed detailed data models and product classification

systems for describing products and this new work group is working on ways to enable retailers and manufacturers to make some of this information openly available on the web if they choose to do so. Already a major UK retailer and a major global food manufacturer have expressed strong interest in this initiative and we are working closely with them to help them to adopt this technology in a practical way. This standardisation work also has relevance to our research on intelligent products because it will help to make it much easier for products to describe their characteristics and requirements using open web-accessible protocols such as HTTP and standardized vocabularies. We are also working to ensure that this way of accessing rich structured data via the web can work with the next generation of product barcodes that are expected to be web-enabled.

More data about this work is available at http://www.autoidlabs.org.uk/GS1Digital

We also provided technical leadership in the GS1 technical work group on Event Based Traceability, which is developing a new architecture component (Checking Services) to automatically collect upstream traceability data and analyse it (via a number of configurable tests) to check for any gaps or inconsistencies that might indicate where a counterfeit product is being inserted into a supply chain, since the traceability information for an inserted product will generally not be traceable all the way back to the original manufacturer. We made some significant progress on the design of the standardised interfaces for Checking Services and that work is still ongoing and under further development. We expect that this work will be applicable to pharmaceutical traceability initiatives in Brazil, the USA and Europe, as well as traceability in other industry sectors, such as food.

In addition, we also presented a research update at the Auto-ID Labs breakfast briefing, which was well attended.

Mark also participated in the GS1 Architecture Group meeting at the end of the week, which included a discussion about the benefits and challenges of serialisation / unique identification.

Mark Harrison & Vaggelis Giannikas

MET (Manufacturing and Engineering Tripos) Projects 2014

Nick Roope - Agile production control systems
There is an ever growing demand to provide production systems that can be quickly reconfigured to cater for product variation and line disruptions. A significant challenge to achieving this is having control systems / architectures that have this inherent capability embedded within their design, allowing reconfiguration changes to be carried out quickly and at low cost. This project will investigate the feasibility and challenges in implementing such a system, in the context of Boeing's industrial resilience requirements, by examining the boundary of PC's running high level strategic production software and PLC's running low level, fail-safe, equipment code. The project will also examine the capability of PLC infrastructure to merge the boundary between high level and low level production control.

The project will be sponsored by Boeing & Omron Electronics. Boeing & the Cambridge research team are providing future production requirements that control systems should achieve. Omron Electronics will provide support on the latest technologies that are being developed to meet these needs.

Ollie Burgess - Design for Repair
Repair has become an increasingly forgotten art; items that historically were mended are treated as disposable in today's society. In most cases, the cost and effort associated with diagnosing and remedying faults means repair is an unattractive option. This is especially apparent for household appliances, where a simple fault typically leads to immediate replacement and disposal of the old appliance. This short product lifecycle places a significant burden on material and energy use during manufacture.

This project aims to analyse the current state of Design for Repair, working closely with Dyson,

Bosch and John Lewis, to identify critical areas for improvement, to enable the future repair of household appliances. This will culminate in a set of Design for Repair guidelines to be critically assessed by the industrial partners.

Oskar Kelliher – Educating Production Engineers

There is an ever-growing demand to educate and update production engineers with the skills required to develop and reconfigure production control systems. The hardware used in systems today such as PLC's are very powerful, having high levels of functionality that allow them to integrate and control many processes across the shop floor. This increased functionality and underlying connectivity into business systems can provide enormous benefits to organisations as well as potential failure points, impacting wide scale operations. Having clearly defined methods and tools for developing or modifying these systems is critical.

This project will identify the skills required by production engineers in producing and maintaining production control systems. It will examine methods and guidelines that can be used by production engineers in developing and reconfiguring systems. A training test bed will be developed as part of the project, demonstrating the findings of the above.
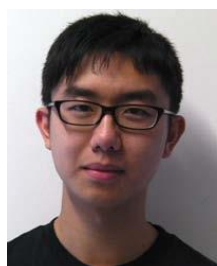
Matthew Lee – Aircraft pre-departure scheduling in Stansted Airport

Manchester Airport Group (MAG) is looking to implement Airport Collective Decision Making (CDM) mechanism in Manchester & Stansted airports to improve efficiencies in operations, as a part of Eurocontrol's Single European Sky initiatives. In particular, MAG seeks to understand factors affecting operation predictability when scheduling aircraft before departure through this project.

The project will begin with collecting operational data to assess the time taken in turnaround and taxi out under different conditions. Effects of disruptions, such as passenger no-show and taxiway in use by other aircraft will also be assessed.

Once these factors are understood, computer models will be constructed to simulate the effects of the factors identified. The simulation will stop short of attempting to sequence the aircraft movements, due to the short timeframe of the project.

The logic from Stansted will then be brought over in context to Manchester Airport, with a much more complex taxiway and stand configuration. From these analyses, a list of requirements can be drawn out and used to compare various commercial CDM solutions and their applicability to Manchester & Stansted.

Past Event: "Futureproofing in Asset Management" Workshop

As part of our collaboration with the Centre for Smart Infrastructure and Construction (CSIC), a second workshop around the theme of Infrastructure Futureproofing was held at the Institute for Manufacturing on 2nd April. The scope of the workshop encompassed value and integration of futureproofing into asset management practice. This addressed both the ability of infrastructure to be resilient to unexpected or uncontrollable events, e.g. those associated with climate change, and also the ability to adapt to required changes in structure and/or operations of the infrastructure in the future, e.g. expansion of capacity, change in usage mode or volumes.

CSIC director Jennifer Schooling presenting

The workshop gathered together senior advisors, directors, heads and lead engineers responsible for

asset management, facilities management, government policies, built environment foresight and strategies to discuss current practices and how future proofing might be best used within them. Delegates from London Underground, Costain, UCL, IBM, Crossrail, John Dora Consulting, Heathrow, Cementation Skanska, CIRIA, Network Rail, Arup, Highways Agency, Atkins, Halcrow/CH2M, Infrastructure UK and CSIC attended the workshop.

The workshop aimed to:
- Capture value / relevance of future-proofing in asset management.
- Determine challenges of future-proofing in whole-life asset management approaches.
- Consider appropriate methods/frameworks of future-proofing in asset management.
- Capture means of integrating future-proofing into asset management practice.

Workshop attendees outside IfM

The workshop activities will result in a White Paper on Infrastructure Futureproofing.
The workshop was organised by Dr Tariq Masood, Dr Jennifer Schooling and Professor Duncan McFarlane as part of CSIC's collaborative project on Infrastructure Futureproofing. Details of the project and workshops are available at: http://www-smartinfrastructure.eng.cam.ac.uk. For further details, please contact Dr Tariq Masood (tm487@cam.ac.uk).

Recent Research Publications

Woodall, P., Oberhofer, M. and Borek, A., A Classification of Data Quality Assessment and Improvement Methods. International Journal of Information Quality, in press.

Masood, T, Erkoyuncu, J A, Roy, R, Harrison, A (2014): Integrating design attributes, knowledge and uncertainty in aerospace sector. CIRP Journal of Manufacturing Science and Technology, Vol 7, Issue 2, pp 83–96. http://dx.doi.org/10.1016/j.cirpj.2014.02.001

Recent DIAL Seminars

"EU Horizon 2020 Funding", Vaggelis Giannikas, 6th February 2014, 14:00 – 15:00, IfM, Seminar Room 2
"Research proposals process", Petra Kasmanova, 27th February 2014, 14:00 – 15:00, IfM, Seminar Room 3
"Smart Factory. How to realize it?", Jumyung Um, 06 March 2014, 14:00-15:00, IfM, Seminar Room 3
"Holonic Control and Intelligent Products", Roxana Hossu, 20 March 2014, 14:00-15:00, IfM Seminar Room 2
"Management of Energy Systems", Mohsen Jafari (Rutgers University), 27th March 2014, 14:00 - 15:00, IfM, Seminar Room 2

Upcoming DIAL Seminars

"Aladdin project current progress", Phil Woodall & Mark Harrison, 9th May 2014, 14:00 – 15:00, IfM, Seminar Room 3

Title to be confirmed, Azman Aziz, 15th May 2014, 14:00 – 15:00, IfM, Seminar Room 2

"Inclination analysis can yield early-warning signals of economic recessions", Alena Puchkova, 22nd May 2014, 14:00 – 15:00, IfM, Seminar Room 3

If you are interested in anything that has been featured in the newsletter or would like further information about DIAL, then please do not hesitate to contact us on dial-enquiries@eng.cam.ac.uk or call Petra Kasmanova on +44 (0)1223 764306.