IfM Distributed Information and Automation Laboratory

UNIVERSITY OF CAMBRIDGE

DIAL Quarterly: The KT-Box project, Robots & automation for eco-efficiency

Welcome from Professor Duncan McFarlane

You will have noted various references in the past few newsletters to an "Innovative Knowledge Centre in Smart Construction and Infrastructure". A bit of a mouthful – for the moment it is simply the IKC. The programme is a joint activity across the engineering department, computer laboratory, business school and architecture department here at Cambridge and with more than 20 collaborators from the construction industry. DIAL and the IFM generally are involved in this programme to pursue a number of research themes which take our work in the industrial supply chain into the construction and infrastructure management domain.

1. Reconfigurability of construction systems – assess the potential for new infrastructure to "futureproof" by using standardised building blocks that are able to be readily redeployed during or after construction.
2. Value of infrastructural sensing – providing a link between emerging infrastructural sensing systems (for example crack detection, vibration analysis, load monitoring) and their impact on the management and use of infrastructure.
3. Real-time building automation – examining options for developing information systems for integrating many information and automation functions in large buildings and infrastructure.

Beyond this, there are further opportunities within the IFM for deploying manufacturing and service optimisation tools in the construction sector. The IKC formally began on 1st April and first months are devoted to an industry-wide analysis of trends and development requirements.

DIAL research to create industrial services tool box

DIAL is leading a consortium of six academic institutions to exploit research into service and support engineering. The group has been awarded £2.2m to help develop tools to transfer knowledge and aid the deployment of these research outputs to UK industry. The project - known as KT-Box, builds on the centre's work as a founding participant in the BAE Systems and EPSRC funded project S4T – Support Service Solutions: Strategy and Transition. This project examined key aspects for businesses making the change from supplying complex engineering products, such as aircraft, to contracting to

Recent Research Publications

Tomasella, M., McFarlane, D.C. Thorne, A.J (2011)
Do Auto-ID technologies enhance airport processes servicing Passengers with Reduced Mobility? (Accepted by EurOMA)
In 2006, the European Parliament and Council adopted a new regulation (No. 1107/2006) that considerably improved the rights of Passengers with Reduced Mobility (PRMs), when travelling by air. The regulation states that these passengers may never be refused transportation on the grounds of their disabilities. Airport authorities are given the full responsibility to provide any needed assistance and fund the services by levying charges on airlines. This paper reports on the work carried out so far and details the first results obtained in a case study at a major UK airport which examined how RFID can improve PRM operations.

Tomasella, M. and Parlikad, A. K. (2010)
Through-Life Management of Engineering Assets, Published by WCEAM 2010
Effective through-life management of physical (engineering) assets is essential for any asset-intensive organisation to reach and maintain sustainable levels of growth and value creation. The asset life cycle starts when the organisation decides to acquire (purchase/lease) an asset to deliver products/service to meet

guarantee the availability of such aircraft to the end user.

Support Service Solutions: Strategy and Transition Information and its management have formed the focus of key research at DIAL. This has led to the successful proposals to develop three tools through the KT-Box programme, they are:

Through Life Service Information The tool provides a method of assessing information needed for service operations. This tool, exploitable via a training package and workshops, may be used for the development of new services, the rectification of troubled services or to inform or improve existing tools and processes within service-providing organisations. The tool enables:

• reduced risk to the organisation through minimised information gaps
• reduced time from service request to implementation through use of established process
• reduced service development cost via application of a focussed process
• improved contract performance and heightened customer satisfaction through better matching of the customer's expectation of the service outcome (agreed SLAs/KPIs) and the (critical) information availability.

Information Quality Risk Assessment Poor information quality (IQ) creates major risks for decision making, and these risks need to be identified, measured and mitigated. In particular, the tool will focus on the asset management function of an organisation aimed at identifying the risks associated with the management of physical assets, and the impact of information quality on these risks. It will aim to:

• Help organisations assess their IQ to identify critical IQ problems
• Quantify the risk posed by these problems on the ability to manage their physical assets.

Disruption Management Organisations, in many cases, have an array of tools which are aimed at improving standard planned operations. However, service operations frequently suffer from disruption, and therefore, the Disruption Management Tool seeks to help organisations to deal with unplanned disturbances within their systems. The tool can be used to help service-providing organisations to evaluate their current ability to handle disturbances affecting service performance and to gain a clear understanding of the organisation's performance relative to its goals.

If you have any interest in these tools either from trialing prototypes or testing fully developed versions, then please get in touch as opportunities to participate are always welcome. Contact us

Role of control systems in energy efficiency

Recent government figures show UK industry consumes around 100TWh of electricity per year, accounting for around 33% of the UK's total electricity production, ***writes Karl Walker***, Marketing Manager for Automation products at Omron Electronics Ltd. The majority of this demand (around 64%) is down to electric motors. There

the requirements of the market. Currently, these decisions are made from a price perspective, and increasingly from a through-life cost perspective. However, frequently changing and highly uncertain market requirements, it is essential to ensure not only that the initial configuration would meet the current requirements, but to be able to reconfigure the assets as market requirements evolve over time. However, this need for reconfiguration and its impact on through-life costing is not accounted for today. This paper takes a first step towards addressing this problem, and presents a modelling approach for incorporating reconfiguration issues in making optimised asset acquisition decisions.

McFarlane, D. and Cuthbert R. (2011)
Modelling Information Requirements in Complex Engineering Services, Submitted to CII special issue on "Product-Service System Engineering: From Theory to Industrial Application".
Within this paper we look at the role of information in the provision of Complex Engineering Services. The need for effective and appropriate information can be critical to the design and delivery of such services and, hence, establishing an accurate and comprehensive set of information requirements is the first step towards specifying an appropriate information system. With a backdrop of little work, in the service domain, on the formalisation or modelling of information requirements, this paper:

- develops criteria for selecting an appropriate model to represent service information requirements
- selects and develops a modelling approach in line with these criteria
- provides a practical procedure for examining

are estimated to be around 10m units in operation throughout the UK, with a combined capacity of 70GW and a collective annual running cost of more than £3bn. Breaking this down, a 90kW motor may cost up to £30,000 per year to run, with a 110kW motor consuming around £1m worth of electricity over its typical 20 year working life. The vast majority of these motors will have been 'sized' for peak load conditions, typically running at full speed. For pump and fan applications, the laws of affinity tell us that by reducing a motor's speed you reduce power absorption, a 20% speed reduction will result in power absorption reducing by almost half. Yet it is estimated around 90% of motors used in industry have no form of variable speed control, despite schemes such as The Carbon Trust's "Enhanced Capital Allowance" making these measures financially attractive. Omron works to develop solutions that monitor and log energy usage and utilise process control systems to identify areas of wastage helping to rationalise energy consumption. For example modern programmable control systems (PCS) now mean scheduled production patterns from Enterprise Resource Planning (ERP) systems, can be downloaded to the PCS, allowing the control system to make intelligent decisions about resource requirements in real-time for any part of a process. It gives the ability to turn off systems in areas of a factory which are not being utilised. However, the responsibility for energy-efficient factories shouldn't be the sole responsibility of the end users; it is up to the original equipment manufacturers (OEMs) to play their part. In the automotive or white goods industries, operational efficiency is as important a selling point as the performance of the product itself. Many industrial machinery builders often do not consider the environmental impact of their equipment during the design phase; 'right sizing' of motor and transmission systems, the inclusion of variable speed drives by default, greater intelligence in the control software to make operational decisions, and the 'exposure' of energy consumption data, will be the first steps towards building more energy efficient factories.

- Omron is one of several companies working with DIAL in examining the role automation can play in achieving greater energy effieciency in manufacturing.

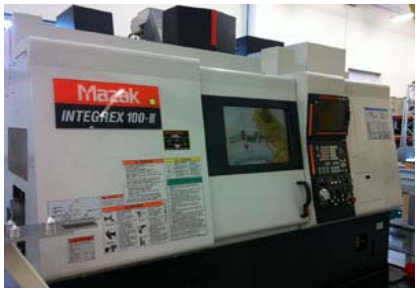
Bots are back: Integrated Automation Lab in action

Since the IfM moved to it's new home on the West Cambridge site, a lot of effort has been put in by the DIAL team to recommission the IfM's integrated automation laboratory. We now have a new layout and, more importantly, new cutting-edge resources, such as a MAZAK machining centre, a new FANUC anthropomorphic robot and 3 modular OMRON PLCs (Programmable Logic Controllers), which together went on to complete the previously existing 4 FANUC robots, the automated

service information requirements using this modelling approach
- illustrates the use of this procedure with an industrial example.

Zied M. Ouertani, Jasser Al-Kassab, Andy Neely, Giovanni Schiuma (accepted by EurOMA) Visualization of service performance information: insights for management decisions
In the age of information overload, a critical dimension of Performance Measurement Systems (PMSs) is the visualisation and reporting of performance measures. Although great attention has been paid in the management literature on the design and management of PMSs, there is still a lack of clear understanding on how to define and implement visualisation and reporting approaches that can better inform management decisions. The importance of information visualisation is a topic that has been largely addressed in many disciplines, fundamentally highlighting that human cognitive performance can be enhanced by means of appropriate visualisation of data and information. Indeed the way information is displayed strongly affects the capacity of employing, deploying and exploiting data in order to support cognitive processes from knowledge transfer and sharing to knowledge extraction and creation. In this paper we provide a better understanding of information visualization and discuss its role and functions to visualize and report performance to support management decisions. Based on a case example of a major European apparel retailer, which implemented Radio Frequency

conveyor system and the HF and UHF RFID (Radio Frequency Identification) systems. The lab is used every year for teaching undergraduates (see image) in manufacturing and management on how to develop and operate an automated production system that is fully integrated, from metal cutting of single product components all the way down to product assembly, testing and packaging. Secondly, the lab is used as a test-bed to develop cutting-edge research in areas such as reconfigurable manufacturing, holonic manufacturing, agent-based manufacturing, distributed control and intelligent products and assets. DIAL is planning to organize new demo events exploiting the full functionality of the automation lab in the near future. Check out the forthcoming issues of the DIAL Quarterly for more updates.



Meet the team: Maurizio Tomasella

Maurizio joined DIAL and the Auto-ID Lab in January 2009, after having completed a PhD on Reconfigurable Manufacturing Systems at Politecnico di Milano (Italy). His PhD Thesis presented a novel methodology to optimally change the physical layout and composition (numbers and types of machines) of a manufacturing system, as the technical specifications for the products to be manufactured change over time. Since joining DIAL, Maurizio has continued working on reconfigurability of industrial systems and processes. Currently, he is developing a quantitative tool set to help airport managers in the long-term reconfiguration of their airports' infrastructure, capabilities and capacity. At the same time, he has been investigating on the operational benefits that Auto-ID technologies such as RFID (Radio Frequency Identification) or RTLS (Real Time Location Systems) would bring to diverse airport processes, ranging from the management of multiple aircraft turnarounds to the delivery of services to PRMs (Passengers with Reduced Mobility). Aside from researching on reconfigurability, Maurizio has been deeply involved in DIAL research on asset management and maintenance decision making. In particular, he is interested in developing novel models that support condition-based maintenance and inspection decisions in sectors such as utilities, transport and oil and gas.

Dial-up some student profiles

Raj Srinivasan is researching a PhD on the Impact of information availability on maintenance decisions. The work focuses on understanding the value of condition monitoring and inspection information supporting maintenance decisions. It considers the quantitative impact of information on maintenance decisions such as when to inspect and whether to replace or repair. The problem is modelled as a sequential decision process to understand the value of information over time. It will explore what will be the optimal cost and the quality of condition monitoring information that will enable optimal maintenance decisions.

Identification (RFID) technology in its supply chain as well as in its store, we illustrate how the retailer manages his operations using new methods of data capture and performance visualization to eventually make decisions that impact on performance.

Upcoming Events:

Launch of the Innovation and Knowledge Centre on Smart Infrastructure 12th May 2011

Innovation and Knowledge Centre for Smart Infrastructure and Construction Industrial Launch Event – This invitation only event will launch this £17 million 5 year programme laying out plans for near and longer term, industrial involvement and academic direction. For more information on this event and the IKC please contact Ellen Mumford, the centre administrator on em502@cam.ac.uk.

OMRON Food Technology Event

19th May 2011
IfM
Aimed at decision-makers in the food industry, specifically end users. DIAL and Omron will provide industry specific information regarding the role of automation in food processing and the benefits this can bring, as well as the current trends in the market. For more information or if you would like to attend this event please contact Sarah Hofsten on sb555@cam.ac.uk

Workshop on Business Intelligence / Business Objects, June 20 – 24

SAP University Alliance Community and the Institute for Manufacturing of Cambridge University are organising a 1-week course on Business Intelligence / Business Objects, This event will be preceded by a 2 hour Q&A with David Keane – SAP Global VP of Competitive Intelligence.
For further details please contact Dr Zied M. Ouertani

Sahil Shah is a 4th year undergraduate on the Manufacturing Engineering Tripos. For his MET2 six week project (beginning in May 2011) he is working with Dr. Maurizio Tomasella and Prof. Duncan McFarlane on investigating the reconfigurability of airport operations. The project forms part of a larger DIAL research theme on airport operations collaborating with various stakeholders including the Manchester Airport Group. His previous experience includes a feasibility study at Mercedes-Benz High Performance Engines that led decisions about implementing certain component traceability techniques. In 2008 he also completed a placement at Martin-Baker Aircraft Company Ltd working in the design team for the Joint Strike Fighter ejector seat unit.

Ikechukwu Ofodu is currently studying for an Mphil degree in Industrial Systems Manufacturing and Management. He has a B.Sc. in Chemical Engineering from the University of Lagos, Nigeria. He is being supervised by Prof. Duncan McFarlane in a research project with the DIAL group involving the use of information and automation to reduce energy consumption in manufacturing operations.

Nicolas Rubir is a final year student at Supelec (French "grande école" in sciences of information, energy and systems) in Paris. With an agreement between Cambridge University and Supelec, he joined the IFM as a student of the Mphil ISMM. He is currently doing his 3 months dissertation in the DIAL research group with Prof Duncan McFarlane about the "value of sensing in construction."

Ahmed Kadri joined DIAL at the IfM as a student visitor from France working on the project "Value of Sensing". The focus of his project is to help companies and provide them with a useful sensing strategy tool box where they can find the different techniques and approaches to measure the value of information. He will work with an industrial partner in the field of aeronautics to test and validate the tool box and also highlight the choice of the source of information and the cost of information.

Clelia Zattoni joined the IfM as a Visiting Student and will work with DIAL until November. Clelia is here to develop her Laurea thesis under the supervision of Dr Maurizio Tomasella. The purpose of her work is to investigate the reconfigurability of complex industrial systems and to study quantitative methods. In particular the work focuses on the reconfiguration of airport operations, as required by the recent trends in the air transportation industry and legislation.

Ulrich Saiger is doing an MPhil in Industrial Systems, Manufacturing and Management (ISMM) at the IfM. His dissertation is about the Hybrid Approach to assessing data quality which is a project he is working on in the DIAL Research Group. The Hybrid Approach was developed by Dr. Philip Woodall and Dr. Ajith Kumar

EurOMA 2011

The 18th International Annual EurOMA Conference will return to Cambridge from 3 – 6 July 2011. The conference will be hosted by the IfM and the Judge Business School. EurOMA conferences have a long standing tradition of critical discussion and drive for quality research in an open and friendly atmosphere Click here for further details

DIAL Seminars – list of talks

Maintenance optimisation of complex engineering assets

Nipat Rasmekomen, DIAL, IfM, University of Cambridge.
Monday 23 May 2pm-3pm
Seminar 2, IfM.

The Value of Intelligent Products in Supply Chain Management

Vaggelis Giannikas, DIAL, IfM,
Thursday 9 June, 2pm-3pm.

Value creation in closed loop supply chains and the role of information management

Erwin van der Laan, Professor at Erasmus University Rotterdam School of Management.
Thursday 16 June 10am-11am
Seminar room 1, Institute for Manufacturing, Cambridge.
For more information on the DIAL seminar series please click here

DIAL is jointly organising the 2011 Asset Management Conference with the IET. This conference brings together people from leading asset management organisations and leading academic researchers to disseminate the latest developments in asset management research and practice. This year, the conference invites paper submissions and will publish selected papers in the official conference proceedings. For further details and information on key dates please see the conference website

Parlikad. Ulrich's objective is to identify how the Hybrid Approach can be extended to account for any dependencies, precedence and required ordering between the activities described by the approach.

Burcu Bora is also a student on the IfM's MPhil ISMM (Industrial Systems, Manufacturing and Management). Previously she has studied mathematics and management, completing two bachelor degrees in Worcester Polytechnic Institute in the United States. Burcu joined DIAL to work on her thesis conducting a research on role of visualisation in decision making focusing on how visualisation software is utilized within the process. She will be working with Dr. Zied Ouertani in the DIAL Research Group until June 2011.

Meet the robots - family fun at science festival

Visitors to this year's IfM science Festival event had a new attraction to entertain and educate - DIAL's robot lab. Around 1,500 people attended the Manufacturing Zone event.

The robot demo was split into two parts. First, each of the 5 FANUC robots introduced themselves to the audience by name and showcased their capabilities, ranging from quick pick-and-place operations to welding of car parts. The kids had fun when they were asked to scream out loud so that the robots could move faster. The second part of the demo highlighted how the automation equipment in the lab, including the robots, 3 OMRON PLCs (Programmable Logic Controllers), RFID (Radio Frequency Identification) systems and the automated conveyor system, has been integrated to produce our test-bed IfM gear boxes. In the current implementation, the robots are programmed to fully assemble, test and pack away the gear boxes, thus showing the full production cycle of the gear box. RFID information on the status of completion of each gear box in the plant is used to assign production tasks to each robot in real time. Overall the day was a great success, the demos ran smoothly and the specially printed "I met a robot today" stickers were well received.

- DIAL would like to thank Karl Walker and Justin Baker for their help and ongoing support of PLC equipment used in the demonstrations. We would also like to thank John Rainer from Fanuc Robotics for demonstrating the M-1IA high-speed parallel link assembly robot.

Opportunities for participation

Special Thanks

DIAL would like to record its gratitude to Kane International for the loan of emission gas test equipment in support of its Green Airports work under its Airport Operations Programme. See the last DIAL quarterly for a picture of this great kit in action.

Case studies in Maintenance of Complex Engineering Assets

Nipat Rasmekomen, a doctoral student at DIAL is looking to carry out a number of case studies on the maintenance of complex engineering assets, such as automated integrated production lines, trains, marine propulsion systems etc. Benefits of taking part would include a report on how failure or degradation of some parts of the asset can cause problems that need additional maintenance for the subsystems or for the overall plant. The report will provide maintenance process maps and recommendation for improvements. If you would like to participate or would like more information, please contact Nipat Rasmekomen at nr324@cam.ac.uk.

Information System Performance for Complex Engineering Services

Opportunities for participating in the area of information system (IS) performance for Complex Engineering Services will enable organisations to benefit from:

- a full appraisal of information requirements (IR) for service delivery
- an assessment of the IS capability against the IRs
- the provision of a "contract information capability metric".

Organisations moving towards service provision take on new roles and responsibilities requiring new information to support the contracts. Information capability is based around systems not designed for service-based businesses. This work will enable the assessment of IS capability against the service delivery IRs. More information is available from Rachel Cuthbert at rc443@cam.ac.uk.

Energy Efficiency and Automation

Work is being carried out to develop a tool that assesses opportunities for reducing energy consumption in manufacturing operations using information and automation. As part of the tool development process, the researcher needs to talk to automation and manufacturing companies. Benefits of participation are:
For Automation vendors: Access to a tool that can be used in any manufacturing plant to assess profitable opportunities to use automation products to reduce energy consumption in manufacturing plants.
For manufacturing companies: A chance to cut their energy bills and carbon emissions with investments that will have high returns and quick payback.
Interviews and case studies are expected to run from the last week in April to the third week in May. If you would like to participate or would like more information, please contact Ike Ofodu at ivo20@cam.ac.uk.

The Value of Sensing in Construction

Evaluating the value of sensing in construction particularly the role of sensors in maintenance strategy. Work on assessing and validating the model is underway but help is sought from construction and infrastructure maintenance companies. Benefits of participation are:
For construction companies: to know if a specific monitoring system would be worth installing on the infrastructure in terms of cost (repair+monitoring/inspection+failure) The maintenance companies: to optimise the maintenance strategy with and without sensors so as to reduce costs during the life cycle of the infrastructure. Interviews and case studies are expected to run from the 18th April to the 18th May. If you would like to participate or would like more information, please contact Nicolas Rubir at nr334@cam.ac.uk.

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 the DIAL business manager Andy Shaw on +44 (0) 1223 760361.

To subscribe you or a colleague to the DIAL quarterly newsletter, please visit www.ifm.eng.cam.ac.uk/newzapp.html

Institute for Manufacturing
Department of Engineering, Alan Reece Building, 17 Charles Babbage Road, Cambridge, CB3 0FS, UK

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