



DIAL Quarterly January 2014: Infrastructure Futureproofing workshop, New developments in the DIAL lab, Interventionist order-picking approach in warehousing and more.

Introduction from Professor Duncan McFarlane:

To Futureproof or Not To Futureproof



Planning for the future has been upper most in our minds in the last few weeks here. Internally, in DIAL we have had a series of meetings on future research directions and simultaneously

the IfM is running an open meeting next week to discuss future developments. Also, as part of our involvement in the Centre for Smart Infrastructure and Construction, we ran the first of a series of workshops on Futureproofing of Infrastructural Assets last week. This workshop is written up later in this newsletter but I will mention a few interesting threads arising from the meeting which apply broadly to industrial operations or systems:

1. To futureproof or not to futureproof? It seems obvious that some consideration of the future is beneficial. Yet a key differentiation exists between considering future needs and choosing to take actions today in support of these needs. Sometimes the most value-effect preparation might in fact be to do nothing!

2. Does a vision for the future help? A single vision for the future can unduly orient any preparations around a situation that might not be realised. Perhaps more helpful is the consideration of multiple possible scenarios. Many companies have enough issues to worry about today and cannot find space to prepare for the future.

3. Prepare for events or changes or both? It is important to differentiate in futureproofing between the need to build resilience for unexpected or uncontrollable events that can impact on the system and the need to plan for adaptability and capacity shifts in response to planned changes.

And finally a working definition which describes futureproofing of industrial systems.

“The process of making provision today for future developments, needs or events that impact on particular industrial system through related planning, design, production or asset management processes.”



DIAL's new visitor Lin Tang

Lin Tang joined DIAL in November 2013 as a visiting student for six months under the supervision of Alan Thorne and Duncan McFarlane. He is currently

working on the DisTAL project (Disruption Tolerant Automated Lean Factories) which is funded by the Boeing company. This project focuses on improving the resilience of manufacturing automation in the face of operational disruptions. Prior to this, Lin received his BEng degree in the Department of Industrial Engineering, Mechanics Science and Engineering from Huazhong University of Science and Technology (HUST) in 2009. After completing his BEng degree, Lin joined the Department of Industrial Engineering at the Tsinghua University where he is pursuing a PhD degree. Lin's research mainly focuses on RFID enabled manufacturing, which includes optimization of RFID network, RFID data processing and RFID application design in manufacturing.

Interventionist order-picking approach in warehousing

Wenrong Lu, DIAL's 2nd year PhD student, shares his research in intelligent warehousing. During the last year, several third party logistics companies suggested that the key for improving the efficiency of order-picking operations in warehousing is the ability to face disruptions, such as changes in orders, delays in transportations etc. Under such requirements, we envisioned that if distributed intelligence could be embedded into the operations in warehousing, we may have a chance to significantly enhance the flexibility of operations which can then lead to the improvement of the overall efficiency.

Due to the stochastic nature of disruptions, only partial information is available regarding their nature. Therefore a global optimal solution to the dynamic problem is not feasible. Hence, an alternative objective is to minimise the order completion time each time a disruption occurs. Although this does not guarantee the calculation of a global optimum, it can lead to schedules that take into account the disruptions. We named this method an 'interventionist strategy'.

Therefore, we need to enable each picker to regenerate his picking-list when a disruption occurs. To start with, we have developed an algorithm which allows pickers, regardless of their current locations, to generate an optimal route every time when a new order arrives.



Warehouse of YH Global that provides data for simulations

To determine the advantages, we have implemented the algorithm using Matlab and linked the outputs into a simulation environment which is created using Netlogo, an agent-based modelling platform. The first results revealed that our proposed solution can reduce the order completion time by 45% on average, compare to a static strategy with optimal routing algorithm. They also showed that the algorithm outperforms the interventionist strategy with heuristic method up to 15%.

In the next phase, we will develop strategies for utilising this algorithm, which will further improve the performance. Also we will study how to implement this algorithm for multiple pickers in a warehouse, which may involve intensive multi-agent studies.

Past Event: Infrastructure Futureproofing workshop

The Infrastructure Futureproofing workshop was held at the Institute for Manufacturing on 23rd January 2014. The workshop was organised by Dr Tariq Masood, Dr Jennifer Schooling and Prof Duncan McFarlane. This workshop was organised as a part of the Futureproofing of infrastructure project which is being run by the Centre for Smart

Infrastructure and Construction (CSIC). The aim was to gather together people involved in infrastructure development, management and ownership with expertise in aspects of futureproofing. The workshop was composed of presentations and breakout sessions.

Firstly, Prof Duncan McFarlane introduced the DIAL/CSIC infrastructure futureproofing project. He explained futureproofing dimensions as i) resilience to unexpected / uncontrollable events and circumstances; and ii) capability to adapt or respond to changing needs, uses and capacities.

The first speaker was **Will McBain from Arup**, who spoke on futureproofing infrastructure from flooding-related disruptive events. He talked about the cost and impact of the 2007 floods to the UK economy, specially looking at critical infrastructure which was valued at £674 million.

Kate Avery from Network Rail presented on climate change adaptation and rail. She presented challenges faced by Network Rail as having large asset portfolio with new and legacy assets, climate and weather impacts, wider system challenges, and resilience and recovery.

Andrew Ellis from Heathrow spoke on futureproofing of Heathrow infrastructure. Andrew presented about the Heathrow Masterplan to meet 2030 demand forecast. The master planning includes runway, stand and terminal capacities, surface access and infrastructure e.g. heating, cooling, power, aircraft fuel systems, drainage, communication & IT and baggage.

The last presenter, **Jon May from Lend Lease**, illustrated some of the futureproofing challenges, and took the participants through the Elephant and Castle regeneration project. He also presented E&C Masterplan of Lend Lease, which is based on creating a community of long-term residents and building flexibility into the design to adapt spaces and technology as needs change.

Parts of the workshop were two breakout sessions facilitated by Jennifer Schooling. During these sessions, the participants

discussed and tried to find answers to the following broad questions: futureproofing terminology and examples (what does futureproofing mean and current industry best practice and examples), and building a business case for futureproofing of existing and new infrastructure.

The aim of the workshop was to identify key terminology and issues in futureproofing. It also provided industrial perspectives on why and how to futureproof infrastructure.

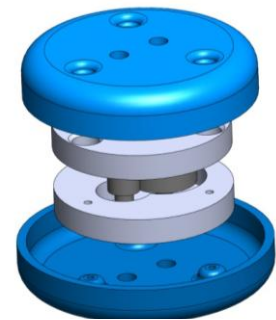
The second infrastructure futureproofing workshop will be held in Cambridge in April 2014. This will draw together construction engineers, asset managers, and facilities managers etc. to discuss current practices and how futureproofing might be best used within them.

For further information, please contact the conference organiser, Dr Tariq Masood (tm487@cam.ac.uk).

New developments in the DIAL lab

The DIAL Automation Laboratory is currently going through an update that will take place over the next six months, providing an industrial strength test bed environment for both DIAL's industrial research projects and other core research topics ongoing within the group.

This is currently being driven by the need to provide a test bed for the Disruption Tolerant Automated Lean Factories project (DISTAL) that is being sponsored by Boeing. The project has recently completed an industrial review of operations at Boeing's Interiors Responsibility



Gearbox Demonstrator

Center (IRC) in Seattle and is now moving forward into its research phase.

The proposed lab development will allow the DIAL research group to propose and evaluate new production control concepts. These control concepts should allow for customised and reconfigurable production requirements as well as catering for every day production disruptions (problems).

Central to the lab development is a production process that has the capability to produce parts with high levels of variability in quality dependent on process parameters prior to parts passing through to a multi-stage assembly process. The initial product to be produced on the system is a small gear box made from vacuum formed plastic components. The vacuum forming process can be used to produce parts with different quality defects depending on process parameters used, such as plastic temperature and forming time. These defects will have a significant effect on subsequent assembly processes, introducing disruptions to the production process.



DIAL Automation Lab

The lab development will allow a number of current research topics under investigation to be extended and tested in a semi-industrial environment.

Component Track and Trace concepts will be extended to include part-specific production process parameters and quality information. This will integrate auto-ID technologies used to track parts and assets through the production process as well as process control information and quality control sensor information.

Resilient manufacturing concepts will be developed to cater for production disruptions, both in terms of logistics and part quality

issues. This work will also examine the balance between lean and resilient operations and how this can be altered dynamically to cope with disruptions.

Customised production capabilities will be examined using intelligent product concepts, effectively allowing individual products to request an optimal production sequence to meet their needs. New distributed control architectures will be developed and evaluated for reconfigurable and disruption tolerant production systems.

One of the key aspects of our research is to ensure that systems and people have the correct information to allow them to make effective decisions. We will be exploring the effectiveness of new technologies in visualisation techniques, such as Google Glass.

Many of the hardware changes for the lab development are currently under-way and architecture and software developments are on-going within research projects. DIAL would like to thank Lab Sponsors, Omron Electronics, Fanuc Europe, Mazak, SMC Pneumatics and RedBite, who are supporting us in these developments.

EU Research Fellowship for Vaggelis Giannikas



Vaggelis Giannikas, a 4th year PhD student in DIAL, received a Research Fellowship under the Marie Curie framework of the European Union. Vaggelis will be an Early Stage Researcher in the RELATE Initial Training Network, the trans-european research network on engineering and provisioning of service-based cloud applications. As a RELATE fellow, Vaggelis will work under the supervision of the European Projects Department of SingularLogic, one of the leading software and integrated IT solutions group in Greece.

During this fellowship, Vaggelis will look at distributed intelligence techniques supporting IoT applications in cloud-based systems, especially in the context of operations management and logistics. It will also be further investigated how the distributed intelligence control module can be integrated as part of a cloud platform, consisting possibly of both cloud and mobile infrastructure parts. As a member of the European Projects Department, Vaggelis will also receive training on the preparation of research proposals for EU programmes as well as on the organisation and management of EU projects.

Recent Research Publications

Borek, A., Parlikad, A.K., Woodall, P.W., Tomasella, M. "A risk-based model for quantifying the impact of information quality," Computers in Industry, 2014. DOI: 10.1016/j.compind.2013.12.004.

Dheedan, A., Parlikad, A.K., "Towards an intelligent fault-diagnosis technique informed by model-based failure data", 19th IFAC World Congress, 24th - 29th August 2014, Cape Town, South Africa.

Recent DIAL Seminars

"Manufacturing and Information management research at Loughborough University", Prof Tom Jackson (Loughborough University), 29th October 2013, 14:00 – 15:00, IfM, Seminar Room 3

"Optimising Maintenance of Multi-Component Systems with Continuous State Degradation Interactions", Nipat Rasmekomen, 31st October, 14:00 – 15:00, IfM, Seminar Room 2

"Interoperability on the Internet of Things", Pilgrim Beart (1248 Ltd, AlertMe.com Ltd), 7th

November, 14:00 – 15:00, IfM, Seminar Room 3

"Systematic Literature Review & Academic Literature Review – ways how to cheat the system", Phil Woodall, 15th November, 16:00 – 17:00, IfM, Seminar Room 3

"Condition-Based Maintenance Model for Complex Assets with Fault Propagation" Zhenglin Liang, 21st November, 14:00 – 15:00, IfM, Seminar Room 2

"Condition monitoring for infrastructure assets: Building the business case", Phil Catton, 12th December 2013, 14:00 – 15:00, IfM, Lecture Theatre 1

"Auto ID lab activities", Mark Harrison, 22nd January 2013, 15:00 – 12:00, IfM, Seminar Room 2

"Research Areas and new ideas for proposals", Duncan McFarlane, 30th January 2014, 14:15 – 15:15, IfM, Seminar Room 3

Upcoming 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

"Management of Energy Systems", Mohsen Jafari (Rutgers University), 27th March 2014, 14:00 - 15:00, IfM, Seminar Room 2

"Asset Management", Ajith Parlikad, 17th April 2014, 14:00 - 15:00, IfM, Seminar Room 2

"Fault Diagnosis", Amer Dheedan, 24th April 2014, 14:00 - 15:00, IfM, Seminar Room 2

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.