



Outcomes from Inclusive Innovation: Industrial and Academic Research Collaboration

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RESEARCH AREA

Software Systems and Services

Designing automated solutions for enterprise systems

Chief Scientist: Vinay Kulkarni

Dr Souvik Barat
Dr Sreedhar Reddy

TCS Research and Innovation

Prof. Balbir Barn Prof. Tony Clark (2011-2016)

Middlesex University

Prof. Tony Clark

Aston University

Preconditions: Strategy, Resources, Research Led



A Middlesex University Campus in Delhi, India

How to enhance local reputation

Moving from a network of recruitment offices to a campus

The importance of connections with the IT industry in India

Building high-end connections and collaborations

A whistle-stop tour of India's leading IT research labs

Risk and sufficient investment

Research led

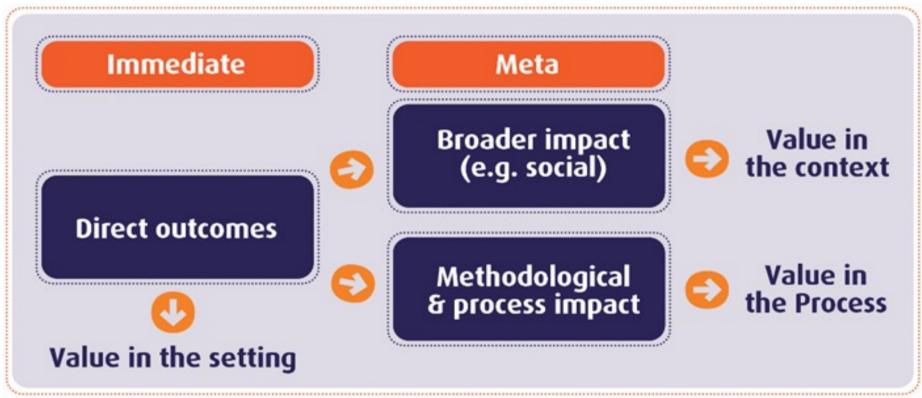
Potential value to labs



Research Strategy: Inclusive Innovation

 How we describe our approach to research today at Middlesex (Our 2030 Strategy).

Figure one —Levels of Impact



But practiced 10 years ago!

Research Led Serendipity

- Reputation building in India
- Targeting of the top ranked Software Engineering conference in India
- Delegates include most of India's IT research labs
- Research aligned with TCS Innovation – the Model driven Organisation

RESEARCH AREA

Software Systems and Services

Designing automated solutions for enterprise systems

LEAP: A Precise Lightweight Framework for Enterprise Architecture

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ABSTRACT

This paper proposes LEAP, a simple framework for Enterprise Architecture (EA) that views an organization as an engine that executes in terms of hierarchically decomposed communicating components. The approach allows all aspects of the architecture to be precisely defined using standard modelling notations. Given that the approach is simple and precisely defined it can form the basis for a wide range of EA analysis techniques including simulation, compliance and consistency checking. The paper defines the LEAP framework and shows that it can be used to represent the key features of ArchiMate whilst containing fewer orthogonal concepts. We also show that the precision of LEAP, achieved through the use of OCL, can be used to verify both the claims made for inter-layer relationships in EA models and for extensions to ArchiMate.

Categories and Subject Descriptors

H.4 [Information Systems Applications]: Miscellaneous;C.0 [Computer Systems Organization]: Systems Architectures

General Terms

Modelling

Leywords

Enterprise Architecture, Model Driven Architecture

1. INTRODUCTION

Enterprise Architecture (EA) aims to provide a holistic view of a business from the business drivers through to their implementation using information systems. The leading technologies for EA provide diagram-based models for expressing architectures, however the diagrams are not based on a precise semantics and therefore can become difficult to manage when, inevitably, EA models become large and complex.

Key features of EA technologies are that they provide different views of an organization and that they link the business motivators (goals) to their realization in technology. Model driven approaches can help to add precision to EA by using models to link various views and by defining semantics for the modelling languages. This paper reviews EA in section 2 including a leading EA technology (ArchiMate in section 2.2) and one of its proposed extensions (section 2.3). The key problem we address is one of precision in EA technologies (section 2.4). Our contribution is the definition in section 3 of a precise modelling language for EA, called LEAP (where precision is achieved through the use of the formal constraint notation OCL) that can be mapped directly to leading EA technologies. LEAP is used in section 4 to develop and analvse part of an architecture for a university. The proposed extension to ArchiMate involves adding business goals and we show in section 5 how these can expressed and formally analysed in LEAP.

2. AN OVERVIEW OF EA

Enterprise Architecture (EA) aims to capture the essentials of a business, its IT and its evolution, and to support analysis of this information: 'fit is! a coherent whole of principles, methods, and models that are used in the design and realisation of an enterprise's organizational structure, business processes, information systems and infrastructure.' [17]

A key objective of EA is being able to provide a holistic understanding of all aspects of a business, connecting the business drivers and the surrounding business environment, through the business processes, organizational units, roles and responsibilities, to the underlying IT systems that the business relies on. In addition to presenting a coherent explanation of the what, why and how of a business, EA aims to support specific types of business analysis including [8, 19, 18, 4, 13]: alignment between business functions and IT systems; business change describing the current state of a business (as-is) and a desired state of a business (to-be); maintenance the de-installation and disposal, upgrading, procurement and integration of systems including the prioritization of maintenance needs: quality by managing and determin-

Operationalising Inclusive Innovation

Proposition Development

Operationalisation Research and Beyond

Outcomes

Two week sabbaticals

—Value in setting

 Regular Workshops/Tutorials/Research papers at ACM/IEEE Indian Software Engineering Conference

—Value in context

- Technology development, Experimentation and Research Publications (TRL-5)
- PhD Supervision at Middlesex

—Value in process

(Direct) Outcomes

Proposition Development

Operationalisation Research and Beyond

Outcomes



- Ongoing collaborative research leading to 30+ publications since 2013 at leading international conferences.
- An Agent based programming platform and environment (ESL)
- A research roadmap for Digital Twin Research
- TwinX™ product at TCS based on ESL.
- Impact Case Study for REF 2021 at MDX and ASTON.
- Establishment of London Digital Twin Research Centre

Digital Twin: At the Faculty of Science & Technology at MDX

- 2019 The faculty established the London Digital Twin Research Centre.
- Inter-departmental collaboration between Design Engineering & Mathematics and Dept of Computer Science and now with Natural Sciences.
- Showcases several several externally funded research projects.
- Regular business facing events (2020, 2021)
- 7 Doctoral students, 2 Research Fellows.
- 25+ research publications.
- Digital Twin projects in multiple domains.
- → Industry 4.0 Automation; (Infra)Structure Health Monitoring, Architectural Heritage, Connected Curriculum and Enterprise / Organisation modelling/ simulation



Impacts reported in REF2021:

Vietnam Ministry of Transport: £1.5M in savings

TCS Global IT Services: TwinX software product.

Lessons learnt

- Focus on collaboration not competition. Seek long term relationships. Identify a grand challenge for your area that requires industry-academic collaboration
- Recognise that risk requires some investment.
- Align with university strategy (not just the high-level bingo words).
- Recognise that high quality collaborations are possible in all our universities.
- The move to bigger pots of research funding allocation is stopping creativity and risk taking. Funding councils are focusing investment in "safe" institutions.
- EPC Role? Help to dismantle the old adage



"NOBODY EVER GOT FIRED FOR BUYING IBM" Finance and CIO Finance and CIO

