Institution:	**Loughborough University**
Unit of Assessment:	**C16 Architecture, Built Environment and Planning**
Title of case study:	**Revolutionising design planning and management**

1. Summary of the impact (indicative maximum 100 words)

Between 1992 and 2002, Loughborough University invented an award-winning approach to planning complex, highly interdependent development projects. Since 2008 the Analytical Design Planning Technique (ADePT) method has resulted in:

1. A sustainable spin-out business (Adept Management Ltd) employing 10 staff with a £6.2 million turnover, providing ADePT services to the majority of the UK's top construction contractors - the business is run by four ex-researchers who were integral to the development of ADePT at Loughborough University;
2. Formation of an Adept Management Ltd technology arm in 2008 providing a state-of-the-art commercial design planning software package incorporating enhancements to the method;
3. Establishment of a US office in 2009 and growth in the number of international clients in Europe, the US, the Middle East and Africa; and as a result
4. Application on projects valuing £11 billion since 2008, with higher levels of cost and time certainty, fewer delays and less waste due to improved design management.

2. Underpinning research (indicative maximum 500 words)

In the early 1990s Professor Simon Austin (1984-present) and Professor Andrew Baldwin (1989-2003, 2007-2011) identified a major problem with design planning and management on complex construction projects: inadequate methods were creating significant delays and costly rework in most projects **[G1]**. Research suggested that over 40% of design was late and more than 35% over-budget. Such projects often involve many thousands of activities and the interfaces between them – typically information exchanges – often number tens of thousands. Company or geographic boundaries increase the complexity and inevitable rework. This is often overlooked when planning design due to the lack of a method of analysis (hamstrung by all software being based on the Critical Path Method, which cannot deal with iteration). The potential efficiency benefits are significant given that design organisations typically estimate levels of rework at 20-40%.

In response the academics, primarily assisted by PhD students Andrew Newton and Paul Waskett, developed ADePT, the **A**nalytical **De**sign **P**lanning **T**echnique, a novel approach to mapping and optimising iterative design processes, analogous to, but a fundamental advancement upon, the sequential critical path method. Its four steps involve (Figure 1): modelling the process as tasks and information flows; finding optimum sequences that minimise iteration; creating a design schedule and integrating the design schedule with the construction/manufacturing schedule; and monitoring and controlling design activity against the plan.

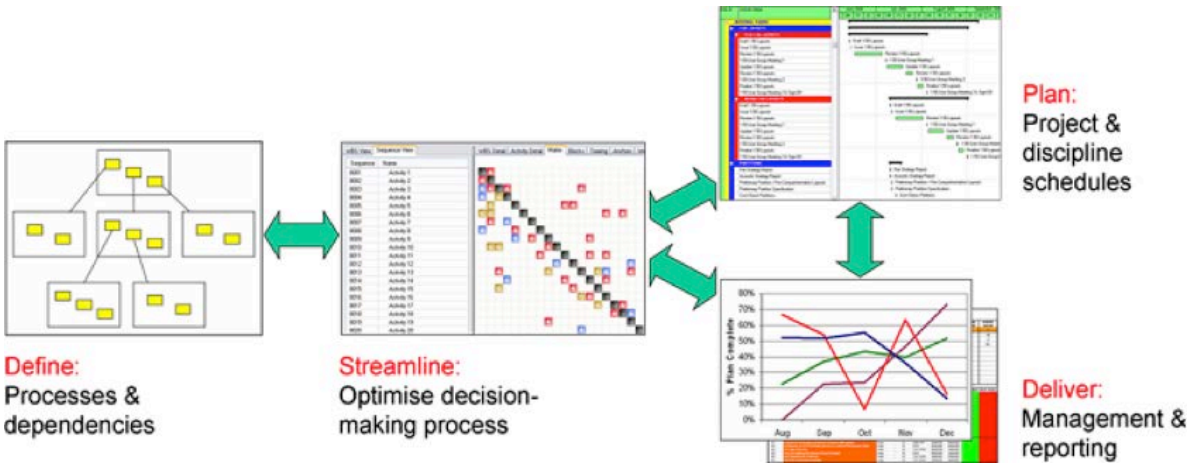

Figure 1: Overview of the ADePT method

ADePT enables shared decision-making within a multi-disciplinary team to agree design compromises, reduce risk, create a sophisticated design plan integrated with construction/manufacturing and hence enable measurable and auditable control of any complex project, such as those faced in engineering industries.

ADePT was developed in three phases through a series of government- and industry-funded research projects at Loughborough University between 1992 and 2002:

- **Phase 1** (1993-1996) identified the design management problem as an outcome of an SERC project **[G2]** and found a new approach to planning complex iterative processes, the basic technique being invented in Andrew Newton's doctoral research, supervised by Austin (1992-95). This showed that a robust process model of design tasks and their information flows could be analysed by a dependency structure matrix to predict the coordination challenges experienced on projects **[R1]**.
- **Phase 2** (1996-1999) explored ADePT's scalability, viability and suitability in various design stages, using case studies of construction and engineering projects, to produce robust integrated design plans. It was undertaken through two EPSRC grants **[G3, G4]** and Austin's PhD students Paul Waskett **[R2]**, Tarek Hassan **[R3]**, John Steele **[R4]** and Martin Pendlebury.
- **Phase 3** (1998-2001) refined the technique in collaborative design chains through EPSRC/DTI projects, which included collaboration with the University of California, Berkeley. This resulted in DePlan **[R5]**, in which ADePT was integrated with control techniques to improve the active management of design activities against the improved plans, and hence achieve the benefits. This research also produced a handbook for practitioners through the ICE's publishing arm **[R6]** as well as a complimentary values/value management approach (VALiD) later licensed to Adept Management Ltd.

By 2001, this body of Loughborough University research had developed and tested the ADePT method to give the industrial research collaborators the confidence that it could be applied robustly in industry settings and the belief that the method could be encapsulated in commercially viable software. There was also growing evidence that other sectors involving complex, multi-disciplinary projects faced challenges on a similar scale to construction; more significantly the ADePT approach was equally suited creating further opportunities for exploitation and impact.

3. References to the research (indicative maximum of six references)

ADePT-related research has been reported in 15 peer-reviewed journals since 1988, including the 5 journal papers cited below to evidence the quality of the underlying research.

R1 Austin, S., Baldwin, A. and Newton, A. (1996) "A data flow model to plan and manage the building design process", *Journal of Engineering Design*, 7(1), pp. 3-25. DOI: 10.1080/09544829608907924 [impact factor 0.928; 83 citations]

R2 Austin, S., Baldwin, A., Li, B. and Waskett, P. (2000) "Analytical Design Planning Technique (ADePT): a dependency structure matrix tool to schedule the building design process", *Construction Management and Economics,* 18(2), pp. 173-182. DOI: 10.1080/014461900370807 [SCImago Journal Rank 0.64; 111 citations]

R3 Baldwin, A. N., Austin, S. A., Hassan, T. M., and Thorpe, A. (1999) "Modelling information flow during the conceptual and schematic stages of building design", *Construction Management and Economics*, 17(2), pp. 155-167. DOI: 10.1080/014461999371655 [SCImago Journal Rank 0.64; 64 citations]

R4 Austin, S., Steele, J., Macmillan, S., Kirby, P. and Spence, R. (2001) "Mapping the conceptual design activity of interdisciplinary teams", *Design Studies*, 22(3), pp. 211-232. DOI: 10.1016/S0142-694X(00)00026-0 [impact factor 0.969 (5 year 1.481); 79 citations]

R5 Choo, H., Hammond, J., Tommelein, I., Austin, S. and Ballard, G. (2004) "DePlan: A tool for integrated design management", *Automation in Construction*, 13(3), pp. 313-326. DOI: 10.1016/j.autcon.2003.09.012 [impact factor 1.500 (5 year 1.702); 52 citations]

R6 Austin, S., Baldwin, A., Hammond, J., Murray, M., Root, D., Thomson, D. and Thorpe, A. (2001) *Design Chains – a handbook for Integrated Collaborative Design*, Thomas Telford, London, 231pp, ISBN 978-0727730398 [43 citations]

Grants

G1 Austin, Baldwin and Thorpe, *Cost control in design and build & HVAC computer simulation*, SERC/DTI/IDC Ltd (Teaching Company), Jan 1988 – Dec 1990, £266,000

G2 Austin, Baldwin and Thorpe, *Improving information transfer within a design & build environment by modelling and simulation*, SERC/Industry, Mar 1993 – Mar 1996, £88,863 + £63,200 industry

G3 Austin and Baldwin, *Design methodology and tools for detailed building design management*, IMI/EPSRC/DoE/Industry, June 1996 – Sept 1998, £105,828 + £105,828 industry

G4 Austin and Baldwin, *ADePT Technology Transfer Project*, EPSRC/Industry (grant), Jan 1999 – Dec 1999, £45,339 + £69,850 industry

G5 Austin, Baldwin and Thorpe, *Integrated Collaborative Design*, IMI/EPSRC/DETR/Industry, Oct 1998 – July 2001, £427,117 + £465,104 industry

G6 Austin, Baldwin and Thorpe, *ICD: RAIS for Process and Value Management*, EPSRC (grant), Jan 2000 – June 2001, £55,156 + £33,705 industry

G7 Austin, Baldwin and Thorpe, *ICD: RAIS for Integrating and Streamlining the Supply Chain*, EPSRC (grant), July 2000 – June 2001, £31,910 + £14,364 industry

4. Details of the impact (indicative maximum 750 words)

The ADePT method attracted widespread interest from its launch at the Institution of Civil Engineers in 1999, with 130 senior industrialists attending an evening meeting to learn about 'An Innovative Approach to Design Management'. This coincided with an industry awaking to the challenge of design management and ADePT won the DETR Quality in Construction innovation award with AMEC. Such was the response that Professor Austin and four of his ex-researchers (Andrew Newton, Paul Waskett, John Steele and Jamie Hammond) set up a university spin-out company Adept Management Ltd (AML) in 2001 largely with 'Business Angel' funding and personal investment. The ADePT method was patented and licensed to a third party software developer, and AML provide a combination of consultancy, software and training services to many leading clients, contractors and consultants.

In 2008 the company made strategic decisions to open an international office and to develop its own software through a technology business financed from retained profits and a second tranche of private investment. The following four impacts of the underpinning research have occurred in the REF period.

1. Sustainable spin-out company

The underpinning research **[R1-R6]** has contributed directly to the growth of Adept Management Ltd [www.adeptmanagement.com, **C1**]. The knowhow and IP (patent and process models) together with staffing by Simon Austin and his four ex-researchers have created a sustained business success (despite the global economic downturn) generating £6.75 million in turnover (2008-2012) **[C2]** with 10 employees; the ADePT approach remains at the heart of the company's business model **[C3]**, as do the four ex-researchers who have remained at the helm of the company.

Reach and significance are evidenced by ADePT being adopted by many top companies **[C4]** in the construction sector (e.g. seven of the contractors rated the UK's top 10 by turnover in the annual league table published by *Building Magazine* in July 2012), including Balfour Beatty, Skanska and Carillion **[C5]**. One Head of Design described how: "*We have been so impressed with the methodology, we have bought software licenses and are training design managers/co-ordinators to manage the process in-house*". The technique has also been adopted by design and project management consultancies (e.g. Arup, Atkins, Capita Symonds, Ryder) and property developers (e.g. Westfield, Dart Realty Ltd). The construction sectors impacted include healthcare, education, commercial offices, residential, highways, bridges, rail and energy **[C6]**.

The reach has extended beyond construction to other sectors such as manufacturing, ship building and aerospace, including organisations such as Dart, BAE Systems, Rolls-Royce and Boeing. The significance is underlined by ADePT winning a BAE Chairman's award in 2010 for shipbuilding work (on the Type 26 frigate). Since, 2008 ADePT has been used on 94 commissions (60 individual projects), 81 of which were from repeat customers. For instance, Skanska has used

ADePT on eleven occasions, John Sisk, ten times and Costain, nine times. As one client explained "*A recommendation was given that ADePT should be used on all future suitable projects, both in the pre-tender stage and also during the project itself*" **[C6]**.

2. New technology business and products

Adept Management has invested over £1.1 million to develop the ADePT Design Software Suite, launched in 2008. In doing so, it made the transition from a service provider to also a technology provider. By becoming partners of Microsoft and Oracle, the 'Builder' software interfaces directly with conventional scheduling software used globally for project management and specifically construction/manufacturing phase planning, enabling integrated design and construction planning, as conceived by the research **[R2]**. The 'Manager' software encapsulates the planning and control functions first described as DePlan **[R5]**, critical to maximising the benefits of the method. Sales of software licences (including support and training) totalling £540,000 **[C2]** have been made, including non-construction businesses such as Boeing and BAE Systems. Adept Management also delivered bespoke training courses on the ADePT approach to companies such as Balfour Beatty, Morgan Sindall, Kier, BAE Systems, CDM Smith in Boston MA, RQ Construction in San Diego, BNIM architects in Kansas City and the Westfield Group **[C3]**.

3. US Office and international clients

Adept Management established an office in California in 2009 (trading as AML Technologies) to expand into the lucrative North American market. ADePT has been used on £11 billion worth of projects since 2008, in countries including the UK, US, Australia, Cayman Islands, Sweden, Nigeria, Saudi Arabia, the United Arab Emirates and Morocco (evidencing reach). Examples of significant projects include the King Abdulaziz International Airport development in Jeddah, the New Karolinska Hospital in Stockholm and Westfield Stratford City Development in London **[C4]**.

4. More efficient projects through better design management

The research team have run 14 three-day "Managing the design process" training courses (since 2008) on the ADePT approach on behalf of Thomas Telford Training, to over 150 delegates from companies including Transport for London, Qatar Petroleum, Anglian Water Services, Toyota and BP further evidencing reach **[C7]**. The ADePT approach is also taught at various UK universities, including Reading, Northumbria and Coventry.

Feedback from users of ADePT has highlighted its positive impact on the planning and management of design on complex projects. The impact was described in terms of improvements to the design process and project outcomes. Users of ADePT explained how the technique had resulted in *"appropriate resource allocation*", "*lower design costs*" and "*less problems on site*". Using ADePT had enabled them to "*minimise reiteration*", "*reduce the risk*", "*avoid delays*", "*see how the design team is performing*" and "*demonstrate rapidly and scientifically [to clients] the impact of variations and their late decisions*". ADePT was considered to be "*much quicker than the traditional way of planning design*" and consequently "*saved me time and money*" and "*made the whole design and construction process much more transparent*". In terms of project outcomes, these process improvements were seen to have resulted in "*increased time certainty*" and "*improved cost certainties*" **[C6]**.

5. Sources to corroborate the impact (indicative maximum of 10 references)

The following sources of corroboration can be made available at request.

C1 Adept Management Ltd website, www.adeptmanagement.com (describes services offered and sectors served)

C2 Adept Management Ltd annual company accounts

C3 Interview with a Director of Adept Management Ltd

C4 Adept Management Ltd client list (which differentiates ADePT work from other consultancy)

C5 Building Magazine's list of "Top 75 Contractors 2012", 27 July 2012 (http://bit.ly/H0egD3)

C6 Client testimonials supplied by Adept Management Ltd

C7 Delegate lists sourced from Thomas Telford Training Ltd