LEAN STRATEGIC ASSET MANAGEMENT: Integrating Value, Flow and Capacity Provision in the UK Health Sector

Grant Mills[1], Sameedha Mahadkar[2], Andrew D.F. Price[3] and Steve Wright[4]

ABSTRACT

Purpose: The English National Health Service is facing a huge financial and capacity crisis. There is a major need for new thinking in meeting expanding healthcare demand while controlling rising costs, improving quality and raising productivity. Lean thinking will be central to achieving success; however, a broader interpretation of asset value is necessary.

Methodology: This paper is based on a health specific literature review of the existing evidence that *inter alia* supports the use of Lean thinking in infrastructure re-design, reconfiguration, space rationalisation and clinical productivity. There is some reflection on the significant underpinnings of Lean Manufacture, but this has been limited since it has been well documented by others since Womack *et al.,* (1990) and the Toyota Production System (TPS). It also reports on a workshop with academic and industry professionals and outlines a potential future direction for Lean healthcare asset related research and development.

Findings: This paper highlights the need for a whole system integrated approach to delivering value over various healthcare care scales through lean asset management.

Implications: Incentivising the alignment of national and local healthcare stakeholders around value will maximise the use of scarce capital resources.

KEY WORDS

Assets, Lean, Infrastructure, Healthcare, Value

CONTEXT TO LEAN IN HEALTHCARE

There are a number of UK organisations that support Lean thinking within clinical settings. The Lean Enterprise Academy (2011), defines the process as one where *"customer value is created by the actions of lots of different people across many departments and organisations. Linking these together into a seamless end-to-end process or value stream"* to streamline flow, eliminate non-value creating steps, and aligning flow with demand. Similar organisations such as Lean Healthcare West (2011), the NHS Institute for Innovation and Improvement (2011) and Westwood *et al.*, (2007) however have paid little attention to estates and infrastructures issues.

Lean can be applied to different assets to achieve various outcomes. The application of value (through approaches and tools) used within Lean is often too narrowly conceived

[1] Research Associate, Department of Civil and Building Engineering, Loughborough University, LE11 3TU, UK. G.R.mills@lboro.ac.uk

[2] Research Assistant, Department of Civil and Building Engineering, Loughborough University, LE11 3TU, UK. S.Mahadkar@lboro.ac.uk.

[3] Professor and HaCIRIC Co-Director, Department of Civil and Building Engineering, Loughborough University, LE11 3TU, UK. A.D.F.Price@lboro.ac.uk.

[4] Executive Director, European Centre for Health Assets and Architecture, Churchilllaan 11, 3527 GV Utrecht, Netherlands. steve.wright@echaa.eu

(around flow, capacity and waste). This paper argues for a wider Lean approach, and defines themes and work streams that need to coincide to support decision makers involved in whole-system strategic asset management (from service planning, through design and into operation).

Although the foundations of Lean and Lean healthcare in the UK arguably originate with Jones and Mitchell (2006) and Womack *et al.*, (1990), it is the NHS Institute for Innovation and Improvement (2011) that provides the most explicit definition of Lean and value in the UK healthcare system today. For them, the aim of Lean is to improve the quality of patient care, improve safety and eliminate delays, while it further supports reduced length of stay while using no more resources. The NHS Institute for Innovation and Improvement (2011) states that *"Lean is basically about getting the right things to the right place, at the right time, in the right quantities, while minimising waste and being flexible and open to change"*. This definition is interesting as the "*right thing*", "*right place*", "*right quantity*" are in part asset-based decisions on the setting and access of care. However, far too often these concerns are overlooked as clinical innovation and technology are considered more important.

Seven types of waste were identified by Taiichi Ohno (1988), the mastermind of the Toyota Production System: Correction (Defects); Waiting; Transportation; Over-processing; Inventory; Motion; and Overproduction (Womack *et al.*, 1990). However, the concept of value is far less well defined and there appears to be no tools to make broad value assessments. Westwood *et al*., (2007) uses Ohno's concepts and further explains *"...any activity which improves the patient's health, well being and experience"* and its identification is operationalised through value stream mapping, which exposes waste by identifying the components of the patient journey which add value to their care. The "5S" model to improve the visibility of value is also used to: Sort, Set in order, Sweep & Shine, Standardise and Sustain; however, value is not directly defined, beyond waste minimisation in the clinical process. Such aspects are cited as patient flow, patients treated faster, best use of capacity, cost savings, waste reduced, shorter waiting times, reduced length of stay, increased productivity, more patients treated, safer more reliable services, standardised procedures and equipment, and improved staff morale. The NHS Confederation, the Lean Enterprise Academy (2011) and the NHS Institute for Innovation and Improvement (2011) support value stream mapping. Equally though, it is not explicit about what value is or how it is defined. One of the key principles outlined by Jones and Mitchell (2006) is staff involvement, and that has three core principles: one of which is no redundancies as a result of Lean exercises, a principle that would be difficult to achieve in today's climate.

DEFINITION OF TERMS: VALUE, FLOW AND CAPACITY

Before starting to review existing Lean approaches, it is important to be clear about the language being used. This paper primarily explores the use of three terms across various levels of strategic asset management: *capacity* (the utilisation and a measure of the maximum possible output of a process or system); *flow* (movement of people and logistics of other infrastructure assets along a process or around a system); and *value* (the multi-stakeholder and multi-attribute whole life assessment of outcomes and their relative trade-off relationship to inputs). Value is a more overarching assessment than capacity and flow, and as such will be used as an encapsulating term. This paper argues that many current approaches to Lean in healthcare cite the importance of value, but often adopt tools and approaches that fall short of making broad outcomes assessments (beyond objective and measurable capacity, flow and waste). Figure 1 starts to pull apart these competing views of value, and demonstrates the need for a new broader interpretation that includes an emergent and iterative process of stakeholder engagement, which goes beyond standard approaches and integrates unique

stakeholder views into the asset planning and design process. Value assessment in asset management needs to be both objective (quantified, engineered and measurable) and subjective (qualified with stakeholder judgments of what is good or worthwhile). It is the process of stakeholder engagement that must manage the interplay between these two views of value[5] and apply project management approaches to coordinate between competing powers and interests (Mills *et al.*, 2009). Furthermore, the ongoing engagement of stakeholders in the design process creates a learning culture, and ensures that products do not become outdated and (if innovation and change are applied) past mistakes are not replicated.

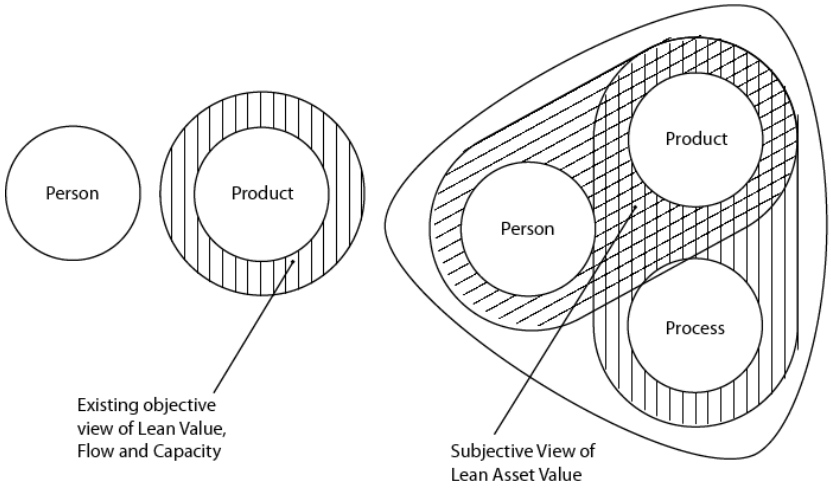

Figure 1: Objective and Subjective View of Lean Asset Value

LEAN HEALTHCARE ASSETS

Healthcare is a complex system comprising care services, estates and transport infrastructure assets. Developments in care settings and medical technologies are changing the scale, scope and distribution needs for infrastructures, so what is required is a robust and dynamic approach to investment planning and appraisal. This paper proposes "Lean Strategic Asset Management" as a way to assess the real value of assets[6]. Although the underlying principles of existing healthcare service planning, asset planning, and facilities and operations management are intended to deliver 'optimum' and efficient estate (providing good 'value'), these are not explicitly based on principles of Lean (Arts, 2004). Many tools have been engineered to address this 'waste' within the healthcare system, but as such there is no single well-integrated Lean solution. There is a need for a framework that can: address the inadequacies of the various tools; provide valuable guidance to planners; and that can be developed into a comprehensive asset-planning tool. Price (2007) and May and Price (2009) were perhaps the first to coin the term "Lean Assets"; however, their work refers to the operation of assets only. This paper looks to extend the consideration of Lean assets back through construction and design into investment planning and service reconfiguration.

[5] The discussion of objective and subjective views of value are part of an ongoing discussions in construction management, starting with Green (1995), and Connaughton and Green (1996) through Thomson *et al.* (2003a), Thomson *et al.* (2003b) and Thyssen *et al.* (Thyssen, Emmitt et al. 2010) to its adoption into lean construction (Rooke, Sapountzis et al. 2010).

[6] For the purpose of this research when we refer to assets, we mean tangible fixed assets like buildings and equipments.

LEAN CLINICAL PROCESSES

A Lean clinical process is the organisation of people and equipment within care models and care pathways that are efficient, effective and deliver value, while concurrently aiming to reduce waste. Clinical processes must be designed to address some need, prevalence or market demand. The Lean Enterprise Academy (2011) is very explicit about the role that Lean can play in delivering change within the NHS environment that: *"demand for health services is effectively infinite, demand for health services is volatile and unpredictable"* and *"there is not (and might never be) enough capacity to keep up with the scale and/or variability of demand. So we have to ration services, and this rationing takes the form of queues"* (p.17). What is not clear is how the built environment can respond and scale to changes in flow and capacity, nor how strategic asset management tools can support dynamic healthcare organisation and flex to accommodate reorganisation.

In the past, hospitals have often been designed around specialties and departments rather than patients (Hillman, 1999, Rechel *et al.*, 2009). However, today there is a greater recognition that patients who share complex conditions and syndromes should be treated together. According to Rechel *et al.*, (2009), one of the key challenges is getting processes to flow across organisational boundaries, and hence there is a need to understand the whole setting of a care pathway and how integration across the spectrum of care can be achieved. Often construction providers are presented with a client brief and business case that may prohibit or constrict this flow; however, they may often lack expertise in how to respond, or feel unable to influence operational and clinical decision making. According to Rechel *et al.*, (2009) principles of manufacturing can be applied in healthcare to different condition types and they identify two broad types of work flow. The first involves continuous flow processes, characterised by linear production lines and systematisation, for example uncomplicated elective surgery for cataracts, breast lump diagnostics, rectal bleeding and hip replacement. The Coxa joint-replacement hospital in Finland is an example of a care organisation structured for maximum efficiency in dealing with such conditions. The second approach is more uniquely individualised around the patient, and the authors provide the example of diagnostic and treatment of acute and chronic diseases such as cancer and AIDS. They suggest that these diagnoses are best treated in batches, where a team is engaged in the process of care throughout the patient's journey. The problem with the batch process according to them is that in some cases, these very often delay smooth flow and are often used even when not necessary clinically. These problems may seem outside of the role of strategic asset management; however, if correct asset decisions are to be made on the scale, scope and distribution of services across healthcare buildings, both clinical and estates providers must support one another in reaching an optimum value solution. According to Ben-Tovim *et al.*, (2008) and as a rule of thumb, 80 percent of hospital cases follow standard pathways, while 20 percent of patients require individualised and batch management. This provides a justification for particular Lean building organisations around the patients' acuity.

The standard pathways are increasingly treated in different care settings and beyond the confines of the hospital; work on describing the importance of the regional distribution and scaling of care has been cited elsewhere by the authors. According to Rechel *et al.*, (2009), the *"...assumption is that queuing in the...health system is solely due to a lack of capacity (in terms of beds, facilities, diagnostics, nurses or doctors) to meet demand"*; however, this is not true. Rather, it is system configuration that has the largest impact, and Lean process improvement aims to unlock this (Rechel, *et al.* 2009). Mills *et al.*, (2010) cite the importance of the concept of scalability as a desirable property of an infrastructure system, network or process whereby assets can be adapted by adding resources and growing or shrinking

capacity while concurrently improving quality and performance – which is critical against a kaleidoscope of changing care settings and providers. Lean does not address the whole value equation (or complex and divergent perspectives of it). Nor does thinking about Lean design systems incorporate principles of flexibility and changeability.

Caution is needed in interpreting the applicability of Lean. The system was classically developed in a manufacturing context, as a considerable development beyond assembly line and process technologies. It is not easy to extend this to a services sector context, where the product is highly perishable and the interaction between consumer and provider is more personal. Furthermore, Lean has been most used where the raw material (physical resources and components etc.) are precisely and infinitely replicable: but healthcare is not like this. If the car industry is the metaphor for Lean, then most healthcare is closer to a garage repair shop than a car assembly plant; old and imperfect bodies are fitted with new parts.

While this notion establishes some differences between Lean in manufacturing and healthcare, many of the core concepts inherent in Lean focus on the needs of the final consumer, reduction of waste including time loss etc. do remain valid. The differences do imply, however, that directly applying Lean to services development and assets will require attention to the: triage and selection systems, response systems which flip patients between the two broad types of processes; and flexibility in handling variable workload flows across the two sorts of processes.

Overall, the consideration of Lean within clinical process planning and design is concentrated on “Flow”. What it lacks is a broader assessment of value against various stakeholders, multi-attribute and whole life views of an asset's value. The following section moves from planning for flow across settings and between care pathway activities to the definition of appropriate spatial capacity.

LEAN SPACE

Healthcare is provided within a complex, multi-specialist and multi-acuity setting. As such, patients must flow between spaces (moved through, for example, discharge, referral, step-up, step-down, direct urgent access, and transfer) to receive diagnostics, treatment and ongoing support. Given this complexity, duplication in both services and space is highly likely. Lean space and operations require a whole system approach to understanding and organising around "*value*". One of the biggest causes of bottlenecks in hospitals is the desire of semi-autonomous departments to optimise their own patient throughput without considering how this impacts on other departments Rechel *et al.*, (2009), with centralised diagnostic and imaging facilities such as CT often causing bottlenecks (Elkhuizen *et al.*, 2007). This demonstrates the need for a whole-system approach to Lean asset management, which looks beyond single sub-processes and bottlenecks, but addresses Lean across the whole nested healthcare system, with spaces designed around care processes, in turn around care models and again in turn around patient and market demands.

Lean space is the architectural response to the business case in the form of buildings, departments, wards, rooms and equipment to meet the present and future demands of the healthcare service, and to facilitate rather than constrain clinical care processes and the delivery of health gain. The design of Lean spaces will include the definition of capacity and service activities and procedures. The definition of Lean space must also consider departmental adjacencies to make processes more efficient and enhance the value of working practice and staff and patient behaviours.

The implementation of lean at a spatial planning and design scale can learn significant lessons from value stream mapping[7]. This incorporates the flow of many different artefacts (such as goods, drugs, waste and information) and people (patients, staff and visitors). With regards to the latter flow type, one solution has been to separate different flows so they do not interface with each other; another has been the treatment of them within discrete zones and hierarchies of acuity. Different organisations vary in their contribution to enabling or constraining flow. Rechel *et al.*, (2009) cite other authors and describe the growing use of separation between emergency, elective, outpatient and inpatient care; the grouping of patients with shared medical needs. The separation of support roles (back of office – staff and goods) and front of office care delivery (patients and carers) can often be based on the level of dependency or acuity rather than body systems and disease groups. At the scale of room design, there is an emerging trend within American and many other national systems, for hospitals to build "acuity-adaptable" single rooms as part of an impetus to promote patient-centred care. Such a room allows it to change seamlessly from a relatively intensive care (if not full ICU) to rehabilitation (Chaudhury *et al.*, 2005). Such a Lean approach will almost certainly deliver value to patients and carers, with a principal benefit being the reduction of medical errors implicit in patient transfers. However, the impacts of such room types on other forms of flow are less well understood within the "evidence based design" literature.

Given the situation described, an overarching system of Lean strategic asset management (to ensure that healthcare facilities are suitable both in today's climate and for the future) is critical. Existing standards such as Health Building Notes (HBN) and tools such as Activity Data Base (ADB) have contributed significantly to the provision of standardised, lower cost and quicker procurement when compared to other countries such as Sweden (Lindahl *et al.*, 2010). However, the impact of standards on design and clinical excellence is not known (Phiri *et al.*, 2009). Standards and standardised approaches run the risk of becoming outdated, so must sit alongside stakeholder customisation processes. This section has shown that value, flow and capacity provide a common language for Lean strategic asset management that can be used to deliver optimum infrastructures.

METHOD

This paper draws on a workshop that invited industrialists to join with academics in describing the future direction for Lean healthcare. It describes some of the overall findings of this work in the context of the literature on Lean healthcare planning and design, and describes the need for a future research roadmap to integrate different disciplines' views of Lean, particularly the translation of architectural and construction views into clinical and organisational views. In order to capture data on the various different views of Lean, 32 participants (14 practitioners and 18 academics) with expertise in three areas were grouped into 3-hour workshop sessions. These working groups were asked: what is being done in Lean healthcare, and further afield? What are the problems with existing approaches? What is the future for Lean healthcare? and what are the priorities for future research and who will benefit?

The findings were analysed using a matrix to highlight similarities and differences between the asset planning, space and construction expert disciplinary discussions.

[7] A lean manufacturing technique that can be applied to most value chains, which originating at Toyota, that is used to analyze and design the flow of materials and information required to bring a product or service to a consumer.

DATA AND FINDINGS

The columns in Tables 1 and 2 contain a summary of the issues raised by each of three expert academic and practitioner work groups on Lean assets, Lean space and Lean construction, when asked about existing directions and possible/desirable futures.

Table 1: Existing Directions and Problems

Lean Assets	Lean Space	Lean Construction
• Productivity of operating theatres/wards • Excessive and underused assets • Culture and language misconceptions • Need for a whole-system / whole pathway view • Need for a whole-life view of the asset • Missed opportunities to introduce new disruptive technologies • Lack of balance between stakeholder views • Lack of understanding about adaptability / flexibility • Lack of skills / competencies	• Cynicism and scepticism • Lack of consistency / sharing • No early user / constructor involvement	• Designing flexible buildings • Offsite construction and modular construction • Complexity in commissioning of M&E services / oft landings • 3D Visualisation and Lean tool applications (fish bone diagramming) • Difficulties in standardisation • People flow during refurbishment • Uncertainties in the construction process • Open plan nature of healthcare buildings

Table 2: Future Applications of Lean

Lean Assets	Lean Space	Lean Construction
• Determine the most efficient distribution and modality of new remote technologies • Application of Lean to understand capacity across changing settings of care • Cultural change, collaboration and branding • RFID[8]-Radio-frequency identification • Improvements in asset management • Evaluation of Lean as a tool • Understanding the evidence around the optimum delivery of quality / value and cost effectiveness • Better understanding of no new build options • New dynamic approaches to modelling and simulation • New approaches to adaptability and flexibility	• Hotel modules • Better stakeholder management / engagement • Collaboration / sharing information • Cultural Integration and change / creative thinking / incentive • Practical evidence of Lean benefits and sacrifices / particularly on single rooms and patient journeys • Better benchmark data • Clear language and framework / take out the jargon	• Understanding the impact of medical technologies on building designs • Improving probability of change • Integrating project delivery • Productivity improvement studies • Integration of Lean, BIM[9] (Building Information Modelling) and sustainability simulation • Designing flexible buildings / and the adaptability of building components and equipment • Facilitation around 24 x 7 operations of healthcare facilities • Understanding building performance and ventilation trends and their impact on building design and refurbishment • Improvements in Lean commissioning and soft landings

This cross-workshop data matrix showed that there are common threads between the different disciplines concerning Lean applications and futures. These include the need for: better cultural change and clearer language of Lean implementation across disciplines; improved adaptability and flexibility in asset planning, space design and construction; access to whole-system/whole value evidence; and improved approaches to flow simulation modelling and tool integration to achieve a value balance across the whole life or service plan of a building. What is most interesting is the lack of planning and design-orientated

[8] RFID is a technology that uses communication via radio waves to exchange data between a reader and an electronic tag attached to an object, for the purpose of identification and tracking.

[9] BIM is the process of generating and managing building data during its life cycle, utilising three-dimensional, real-time, dynamic building modeling software to increase productivity in building design and construction.

directions, problems and futures, and the lack of consideration of value as determined around the patient.

FRAMEWORK FOR INTEGRATED LEAN STRATEGIC ASSET MANAGEMENT

The application of Lean principles can help healthcare providers streamline services to accommodate increased patient volumes. This paper proposes "Strategic Asset Management" as the bridge between service design, construction projects and operated assets. However, there are no magic bullets that translate and integrate health services with health estates assets and infrastructures. Lean teams (representing multi-disciplinary supply chains) must work together to develop whole system solutions to value, flow and Lean, and will need to use a range of portfolio and project management tools to do so, for example: scenario planning, modelling and simulation, evidence-based planning and design, culture and change management, standards and standardisation, and stakeholder and user customisation.

The most fundamental questions for Lean in today's NHS context is: what are the scale, scope and distribution of services and assets, and how can scalability be achieved? Once answered, healthcare planners must then consider: what is the value and evidence that supports reconfiguration, and how can effective and efficient flow be facilitated for various stakeholders and specialist clinical patient conditions? What is clear is that "mass customisation" systems must be put in place to deal with the smooth and systematic conditions which form the majority of care cases, while more advanced and individualised assets (that are combined in clinical, estates and access infrastructures) must deal with more complex cases. With the more complex cases, Lean space and clinical process design may be less effective in major service reconfiguration, as typified by today's cancer, trauma and paediatrics networks. Lean strategic asset management must move from an objective view of value, capacity and flow to a broader approach to integrating different views of value into the asset planning and design process that has to include an assessment of value against various stakeholder multi-attributes and whole life views of Lean across a whole nested healthcare system.

CONCLUSIONS

The effective planning and management of health service assets is essential. This can be achieved by the systematic management of all decision-making processes taken throughout the physical asset's whole life. This paper has responded to the economic need to achieve more efficient and effective healthcare infrastructure asset reconfiguration and change. What is clear is that Lean could be a significant tool and has the potential to deliver integration. Lean still has a strong currency within the sector; however, it is being applied in isolated knowledge pockets with no integrated view of how Lean clinical processes, Lean assets and Lean space and operational design can be applied together in a whole system and multi-disciplinary Lean approach.

Further work is needed by construction industry practitioners and researchers to develop new integrated Lean project and asset management approaches that can be used by construction industry supply chains and healthcare planners and approaches.

REFERENCES

Arts, J. (2004) *Lean Thinking and Strategic Asset Management*, Available online at http://www.ebizq.net/topics/scm/features/5443.html?page=1 [accessed on 24/1/ 2011].

Ben-Tovim, D. I., Dougherty, M. L., O'Connell, T. J. & McGrath, K. M. (2008) "Patient journeys: the process of clinical redesign." *MJA* **188**: 14-17.

Chaudhury, H., Mahmood, A. & Valente, M. (2005) "Advantages and Disadvantages of Single-Versus Multiple-Occupancy Rooms in Acute Care Environments: A Review and Analysis of the Literature." *Environment and Behavior* **37**: 760-86.

Connaughton, J. N. & Green, S. D. (1996) "*Value Management in Construction: A Client's Guide*." ***Special Publication 192***: -.

Elkhuizen, S. G., van Sambeek, J. R. C., Hans, E. W., Krabbendam, K. & Bakker, P. J. M. (2007) "Applying the variety reduction principle to management of ancillary services." *Health Care Management Review* **32**: 37-45.

Green, S. D. (1995) "A Metaphorical Analysis of Client Organisation and the Briefing Process." *Construction Management and Economics* **14**: 155-164.

Hillman, K. (1999) "The Changing Role of Acute-care Hospitals." *Medical Journal of Australia* **170**: 325-328.

Jones, D. & Mitchell, A. (2006) *Lean thinking for the NHS*, London, Lean Enterprise Academy UK.

Lean Enterprise Academy (2011) *Lean Enterprise Academy*, Available online at http://www.leanuk.org/default.htm [accessed on March 2011].

Lean Healthcare West (2011) *Lean Healthcare West: Lean Implementation Design for Healthcare*, Available online at http://www.leanhealthcarewest.com/ [accessed on 1/12/ 2010].

Lindahl, G., Phiri, M., Mills, G., Fröst, P., Strid, M. & Price, A. D. F. (2010) "Quality Innovation and Evidence in Healthcare Physical Environments in England and Sweden - Establishing a Collaborative Roadmap", *HaCIRIC10 Better Health through Better Infrastructure*, 22-24 September, Edinburgh, Scotland.

May, D. & Price, I. (2009) "A revised approach to performance measurement for health-care estates." *Health Services Management Research* **22**: 151-157.

Mills, G. R., Price, A. D. F., Mahadkar, S., Sengonzi, R. N. & Cavill, S. (2009) "Who Or What Really Counts In Stakeholder Value Management: How Can Stakeholder Weighting Be Used In Strategic Asset Management", *HaCIRIC International Conference, Improving Healthcare Infrastructure through Innovation*, April 2009, Brighton, UK.

Mills, G. R., Price, A., Astley, P., Mahadkar, S. & Jun, L. (2010) "Open Building for a Kaleidoscope of Care: A New Conceptual Approach to Open Scenario Planning", *Open and Sustainable Building, 16th International Conference on Open and Sustainable Building*, Labein, Technalia.

NHS Institute for Innovation and Improvement (2011) *Lean Simulation Suitcase*, Available online at http://www.institute.nhs.uk/index.php?option=com_joomcart&Itemid=194&main_page=product_info&cPath=71&products_id=740 [accessed on March 2011].

Ohno, T. (1988) *Toyota Production System: Beyond Large-Scale Production*, Productivity Press.

Phiri, M., Mills, G., Price, A. D. F. & Austin, S. A. (2009) Evidence Based Learning Environments HaCIRIC Research Project. *ESPRC Funded Proposal.* Sheffield and Loughborough University Collaboration.

Price, I. (2007) "Lean Assets: New Language for New Workplaces." *California Management Review* **49, Winter**: 102-118.

Rechel, R., Wright, S., Edwards, N., Dowdeswell, B. & McKee, M. (2009) *Investing in Hospitals of the Future,* Denmark, European Observatory on Health Systems and Policies.

Rooke, J. A., Sapountzis, S., Koskela, L. J., Codinhoto, R. & Kagioglou, M. (2010) "Lean Knowledge Management: The Problem with Value", *Proceedings IGLC-18, July*, Technion, Haifa, Israel.

Thomson, D. S., Austin, S. A., Devine-Wright, H. & Mills, G. R. (2003a) "Managing Value and Quality in Design." *Building Research & Information* **31**: 334-345.

Thomson, D. S., Austin, S. A., Mills, G. R. & Devine-Wright, H. (2003b) "Addressing the Subjective View of Value Delivery", *Proceedings of Cobra '03 Conference*, 1-2 September, University of Wolverhampton, Priorslee Hall, Telford, UK.

Thyssen, M. H., Emmitt, S., Bonke, S. & Kirk-Christoffersen, A. (2010) "Facilitating Client Value Creation in the Conceptual Design Phase of Construction Projects: A Workshop Approach." *Architectural Engineering and Design Management* **6**: 18-30.

Westwood, N., James-Moore, M. & Cooke, M. (2007) *Going lean in the NHS: How lean thinking will enable the NHS to get more out of the same resources,* Warwick, Warwick University.

Womack, J. P., Jones, D. T. & Roos, D. (1990) *The Machine That Changed the World,* London, Simon & Schuster Ltd; New edition.