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**Lean and Low Environmental Impact Manufacturing**

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**Abstract**

There is an assumption that Lean means Green because Lean means doing more with less and this is also taken to mean less energy used, less raw materials consumed and less toxic waste produced. Yet the evidence to support this is mostly anecdotal and the causal link is unproven. As a result it poses the question:

*Are the operational practices of Lean manufacturing more environmentally sustainable than traditional mass, or batch, manufacturing?*

Resolution of this question is of interest to academics in the operations management and sustainability arena; as well as to business managers designing sustainable operations and to policy advisors advising industry on “Best Practice” in the light of environmental concerns.

The paper examines the concept that Lean manufacturing secures both economic and environmental sustainability for the long-term growth and prosperity of the organisation by improving productivity whilst minimising the environmental impact of its activities.

*Key words: Lean Manufacturing, Sustainability, Environmental Impact*

## **Introduction**

Our outlook is changing on how we engage ourselves with the resources that are available and how we are to react to the expectations and needs of a global market. It is now critical to encourage sustainable business practices and help companies “green” their products and services through such means as: mapping environmental footprints, rethinking resource extraction, use and recycling, sustainable re-design of products, analysis of supply-chains and human resources. Businesses are being held accountable for the use of resources, design, manufacture, storage, use and disposal of goods which sit at the centre of the complex relationship between the three pillars of sustainability, namely, the economy, the society and the environment at large.

In the past two decades the three components have been considered in isolation without taking into account the interdependency between them. In this paper, the literature around Lean and Green is reviewed. The purpose is to explore the contribution of lean manufacturing to low environmental impact manufacturing. This will form the building blocks required for developing a large-scale study that will inform businesses and policy makers in creating a sustainable manufacturing future.

## **Background Literature**

There has been a concern that improving environmental and social performance would undermine the economic sustainability of an organisation and that many businesses could not afford the costs of meeting their environmental and social responsibilities (Florida, 1996). However, there are examples where improving environmental performance has improved the company’s profits (Porter and van der Linde, 1995, Hart, 1995, Corbett and Klaasen, 2006) and, further, that companies with higher environmental performance achieve higher stock market returns (Klaasen and McLaughlin, 1996, Derwall, 2005). According, to the website

for EMAS, the Environmental Management and Audit Scheme, *“Minimising the amount of waste that is produced, reducing energy consumption and making more efficient use of resources can all lead to financial cost savings, in addition to helping to protect and enhance the environment”* ([www.emas.org.uk](http://www.emas.org.uk)) whilst the Stern Review Report (2006 p. 302) concluded that *“Climate change policy can help to root out existing inefficiencies. At the company level, implementing climate policies can draw attention to money-saving opportunities. At the economy-wide level, climate change policy can be a lever for reforming inefficient processes”* and cited several organisations who have made economic savings through waste elimination and process improvements as part of their environmental programme (Stern Report, 2006 p.307). These statements and conclusions suggest that taking a Lean approach to waste elimination has considerable potential for environmental and economic sustainability, although Magness (2007) argues that this might be industry and time specific.

Until recently Lean manufacturing and the application of Lean thinking has concentrated on the economic and some of the social aspects of sustainability. However, the essence of Lean is to produce more with less, this implies that Lean thinking organizations use less non-renewable resources in the form of raw materials and energy. This concept can be extended to determine whether Lean thinking can be applied to producing less pollution and emissions and whether Lean manufacturers are therefore more eco-friendly than traditional manufacturers. In 1993 Maxwell, Rothenburg and Schenk posed the question *“Does Lean Mean Green?”* and suggested that there was a relationship between Lean production and innovative environmental practices. David Wallace (1995) in a report for the Royal Institute of International Affairs and concluded that the pursuit of continuous improvement, i.e. *kaizen*, created substantial opportunities for pollution prevention and waste and emissions reduction. Florida (1996) took up these themes and examined the relationship between

advanced production processes and innovative approaches to environmentally conscious manufacturing. In this study he questioned the argument that there is a trade-off between industrial and environmental performance and his findings were that plants that practice green design are also those that are involved in advanced manufacturing. However, the link between Lean and green has been implicit rather than explicit and it is not clear whether the application of Lean thinking leads to better environmental performance or whether organizations that are open to tackling environmental concerns are also more open to innovative manufacturing processes. Much of the research relies on anecdotal evidence and empirical results linking Lean production and environmental performance are sparse (King and Lennox, 2001). Further, the causal link between Lean and green is unproven and, in some cases it is contradictory. For example the research by Rothenburg et al. (2001) suggested that volatile organic compounds (VOC) emissions may well be higher in Lean plants as Lean managers resist the large abatement equipment required to reduce emissions.

Lean and Green literature often tends to look at clustering of organizations that are a) environmentally conscious at a practical, strategic and financial level; and b) organisations who adopt manufacturing 'best practice', including Lean and agile. They conclude that 'best practice' organisations are greener (Florida, 1996; King et al., 2001). This is a very valid approach and is a precursor to Llenim thinking, informing the researchers of macro-level survey results. However, the existing literature has gaps in that it cannot prove cause and effect that 'best practice' is greener. This is shown by Rothenberg et al. (2001) where the survey results did not significantly support the hypothesis that Lean is greener, and it was only interview data that supported the relationship between Lean management and environmental management practices. So there maybe deeper, underlying cultural reasons where companies that adopt 'best practice' are more responsive to change. These companies may have higher levels of organisational learning with deeper understanding of the benefits,

both financial and social, of environmental consciousness and are therefore more likely to embark on quality and environmental and management systems (ISO 9000:2001 and ISO 14001).

Recently the US Environment Protection Agency (EPA) has been developing this theme and reported some key findings: Lean produces an operational and cultural environment that is highly conducive to waste minimization and pollution prevention and that Lean can be leveraged to produce even more environmental improvement. However, they recognise that some regulatory 'friction' can be encountered when applying Lean to environmentally-sensitive processes. Further, they suggest that environmental agencies have a window of opportunity, while companies are embarking on Lean initiatives and investments, to collaborate with Lean promoters to further improve the environmental benefits associated with Lean ([www.epa.gov/lean](http://www.epa.gov/lean)).

As Lean evolves and new manufacturing paradigms that go beyond Lean emerge, there will inevitably be an environmental sustainability element. Projects, such as this one, will have the potential to inform industry of the environmental impacts and constraints that might help drive new paradigms and models.

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