# PROJECT SUSTAINABILITY MANAGEMENT and TECHNOLOGY

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## INTRODUCTION

The concept of "sustainability" is being used in just about every facet of life and the meaning is controlled by the user and the context in which it is used. Therefore it is best that we provide our definition of the term for this discussion.

**Sustainability:** from the verb to sustain meaning: to hold up; to bear; to support; to provide for; to maintain; to sanction; to keep going; to keep up; to prolong; to support the life of. (Chambers Concise Dictionary)

Concepts such as sustainability are defined by the majority of the people involved and based on the environment within which the term is applied. The generic definition of sustainability (above) does not mention ecology and yet today, most would consider it in terms of climate change, recycling and pollution among other, relevant topics. It should also be noted that the definition does not use terms such as forever, permanent or eternity. Here we attend to three main focuses of sustainability;

- The ecological implications of managing resources and waste.

- Supporting the multiple needs of an organisation undertaking an operation remote from its normal source of support, (often used in the context of an army in the battlefield). This could be viewed as the interaction of the system with the other elements of the operational environment. The macro aspects.

- Support of a specific project outcome from first operational use until its disposal. The micro aspects.

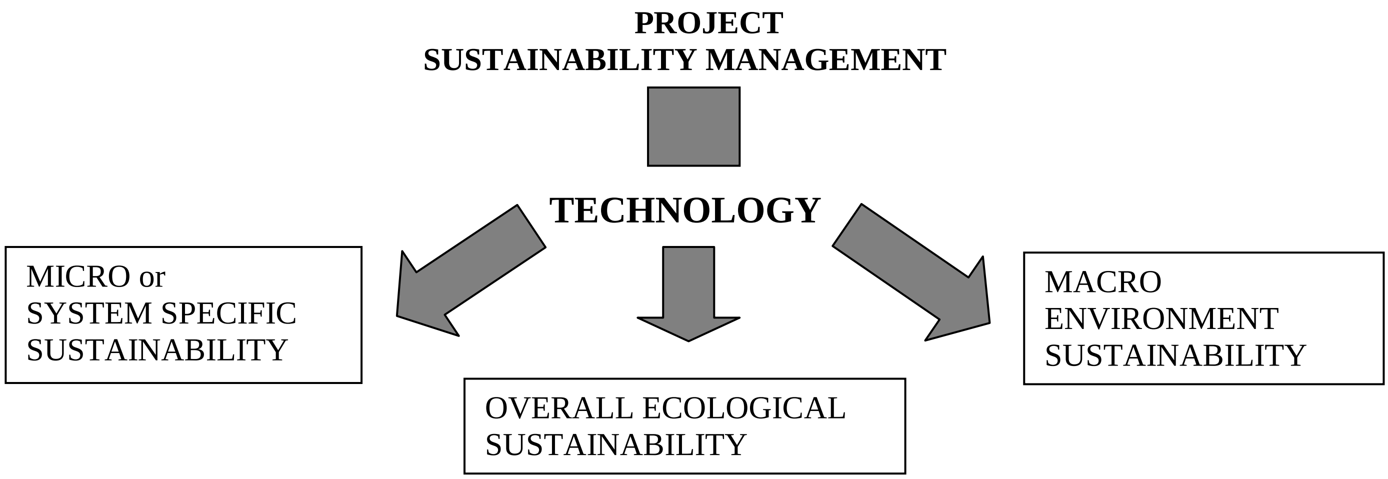


**Figure 1. Project sustainability management**

Sustainability management will involve consideration and management of the broader sustainability issues involved in undertaking any project, as well as the sustainment of the finished project outcomes for the balance of its' life cycle. Project management is about managing the sustainability of that project. If it is not sustainable, the viability of the project / program is jeopardised. Key to effectively managing is data and information on the status of the project. Technology has developed to the point that real time information is available for the Project Manager to base their decisions on.

This discussion concerns the three elements as described above and the impact of Technology on the management of these elements. This paper is essentially conceptual in nature and does not rest on a foundation of quantitative data although the authors intend to extend research in this direction through the study of applications in the mining industry.

## Fusion of Project Management, Systems Engineering and Integrated Communications Technology

Project Management has evolved over the years, pushed forward by "Waves of Innovation" (Weaver, 2008) [Refer to **Figure 2** below] from an "Art" dependent upon the Project Manager's (PM) ability and skill for determining the outcome of a project to the current structured approach that increases the probability of repeatable successful outcomes.

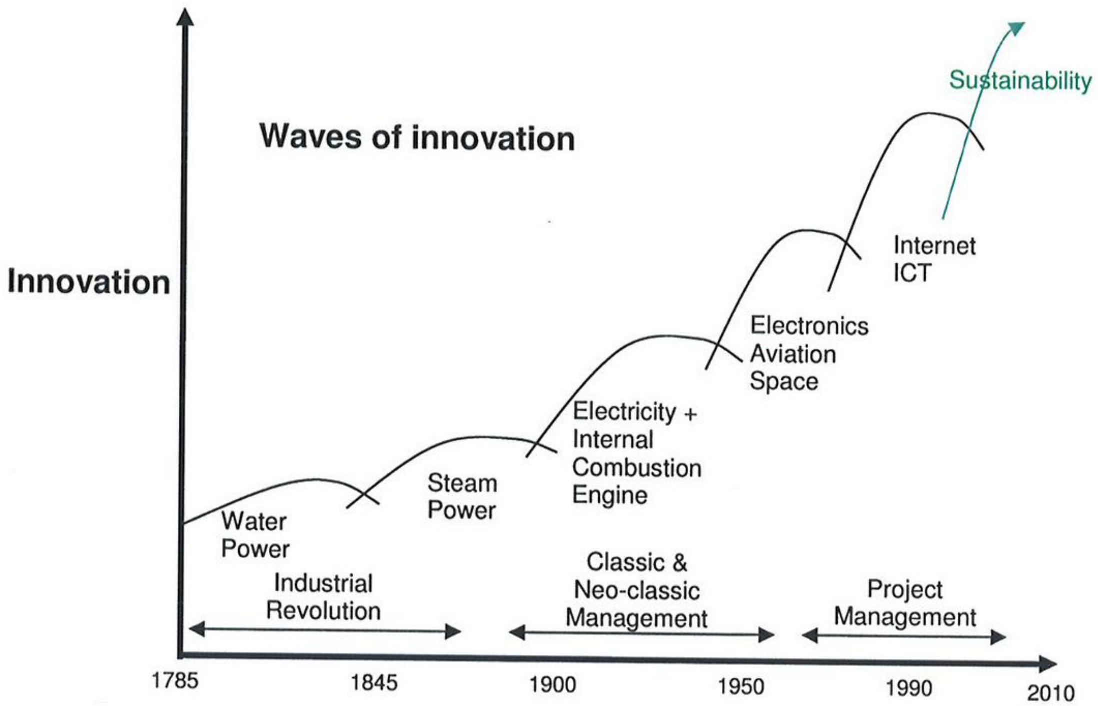


**Figure 2 Waves of Innovation**, Source: Weaver, P., (2007), The Origins of Modern Project Management.

Logistics has travelled a similar path to the present and emerging, synchronous, data-based process it is evolved into.

The Integrated Logistics area, within the *Requirements* element of Systems Engineering, has arguably the biggest impact on overall project lifecycle cost. The project logistics adage "Design for Support; Support the Design" (Galloway, 1996) has been around since at least the 1970s and yet a large percentage of undertakings do not consider this fundamental of sustainability.  Recent examples drawn from various Australian Defence Force acquisition programs highlighted in the main-stream media serve as cases in point.

While operational capabilities are the drivers behind the development of a project, neglect of any of the three elements of sustainability (system, environmental and ecological) will mean that those capabilities cannot be maintained in an effective and/or economical manner.  Information is the webbing that both the P M and the Systems Engineer (SE) rely on.  That information has traditionally been acquired ex post, so that the PM had to anticipate normal operational needs and premature failures.  Changes in Integrated Communications (ICT) concepts and advances in sensor technology have created an availability of real-time data to feed into, and thereby fuse, these activities.

This fusion can be identified as Smart Logistics (SLog) and covers various names such as Autonomic Logistics (AL) used by Lockheed Martin, Inc., Sense and Respond Logistics (S&RL) associated with the U.S. military and Health and Usage Monitoring Systems (HUMS) with the National Aeronautics and Space Administration (NASA) and the Defence Science and Technology Organisation (DSTO).  Terms such as Preventative Maintenance (PM) are giving way to Predictive Maintenance (PDM), Condition Based Maintenance (CBM+) and Prognostics and Health Monitoring.

The common element in all of these systems, and the reason they represent a change from previous methods, is that they incorporate the availability of real-time data from every aspect of the project.  Data generated by normal operational usage, health of critical components, identification of failures in key system parts and the status of the supply chain, are all available synchronously.

## Current Applications

Autonomic is taken from human physiology and refers to the autonomic nervous system which controls bodily functions, such as breatheing or heart beats, which occur without us having to think about them. (Hingst & Gunter, 2008) Therefore, an AL system is designed to function without having to be "told" to act. (Hingst & Gunter, 2008) The AL system we are using here supports the F-35 Joint Strike Fighter (JSF).  The main elements of this system are the sensors embedded in the system (JSF), embracing Prognostics & Health Monitoring (P&HM), the information system (ALIS) that links the aircraft to the Lockheed Martin facility in the U.S.A. as well as the supporting intermediate elements in the supply chain in between.

Autonomic Logistics is employed in the mining industry in Australia by heavy equipment vendors such as Caterpillar as a component of CBM+. Data collected from sensors embedded in major components of the equipment are downloaded into an information system every time the vehicle comes within range of a receiving device.  Tom Albanese, CEO of Rio Tinto provided his vision to the Science and Technology in Society (STS) Forum in Kyoto, Japan;

*Rio Tinto has developed its vision for the mine of the future.*

*In surface mining, excavators and draglines will do much of their operational thinking for themselves.  Driverless trucks will ferry their loads around the mine, automatically reporting to the workshop as maintenance falls due or faults are predicted.*

*In the processing plant, sensors will make constant fine adjustments to win more metal from the ever varying stream of ore, using less energy, water and time.*

*Operators can be located in an urban mission centre a couple thousand kilometres away, running the mine "hands off", scrutinising functions in minute detail from an avalanche of data, and adjusting the workings ever closer to the technical limits.*

*In this vision we still see open pit mines, with the largest trucks in the world, but with no drivers. This could be with us within three to five years if we push hard.* (Albanese, 2007 p 3)

QANTAS has invested in the Airbus AIRTRAC system via their acquisition of the A380. This system provides a link between the airframe and a dedicated support facility staffed with specialist engineers available 365 days a year. (Thomas, 2007)

*The A380's onboard software monitors every system and instantly sends an email to AIRTRAC if any anomaly is spotted. The instant the email is received, the required part is ordered so it's ready for the arrival of the A380.* (Thomas, 2007)

QANTAS's application of AL through the AIRTRAC system focuses on the temporal concentration of the various elements required for the performance of a maintenance event (ME), (the required component, technicians, specialist equipment and tools, hanger space, airframe and necessary consumables).

In the building and construction arena, plant equipment such as elevators and air conditioning units have the capability monitor their usage, operational conditional serviceability and health and transmit that to a central point, either onsite or remotely. Radio Frequency Identification (RFID) devices are being embedded into pre-stressed concrete pillars and beams. These memory devices contain information that verify the manufacturing data as well as assisting in the correct delivery. If the RFIDs are connected to stress sensors, they could be used to audit integrity of a building after an event such as an earthquake or explosive blast.

The automobile industry has incorporated the concept of electronic data collection and diagnostics but mostly the methods employed require the vehicle be taken to a maintenance location, external test equipment is then attached in-house and the data downloaded and analysed. Automatic remote analysis or self diagnosis is limited to special applications such as BMW's monitoring of wheel bearings and devices that monitor tire pressure and wirelessly notify the driver/owner. In the United States, certain vehicles come with the 'On Star' system that incorporates Global Positioning Systems and satellite communication so that a remote site can interact with the operator anywhere in the country and provide local information, some aspects of vehicle status or direct maintenance or emergency vehicles accurately.

## Impact

The automotive example allows for a review of the potential changes that technology within project sustainment offers. Included is a pictorial of technology applied to the sustainment of the common automobile. [Refer to **Figure 3.** below]

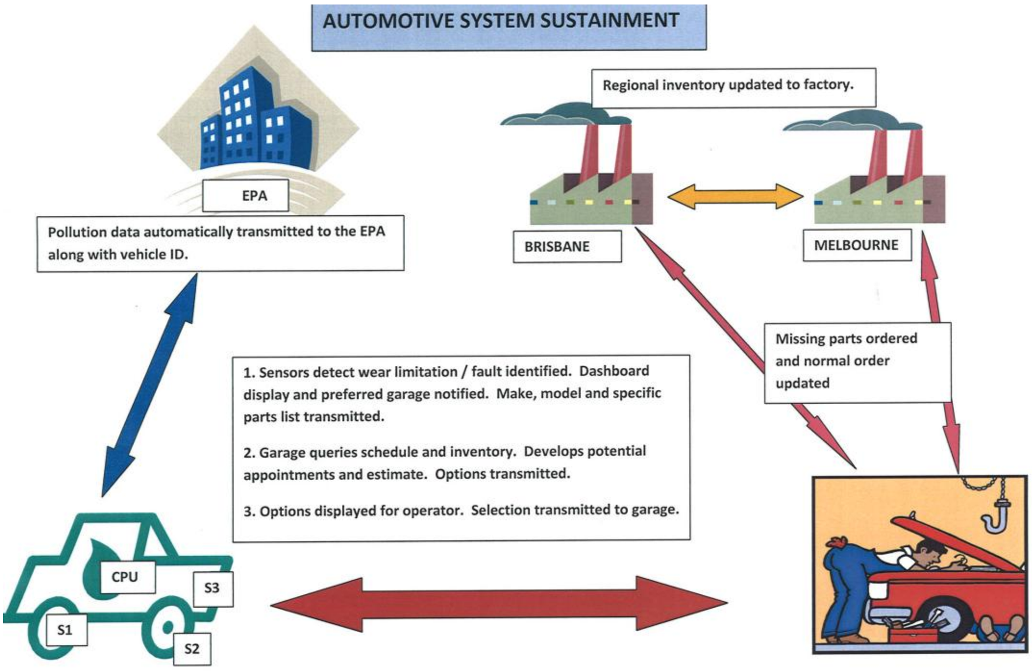


Figure 3. Automotive Example

All of the technology depicted is currently available. What is missing is the ability of the various systems to inter-link. As discussed previously, the ICT connectivity (ability to communicate, not necessarily commonality) of the entire system, from platform to user back through the supply chain to the manufacturer / supplier, along with prognostics, is what sets AL and S&RL apart from previous methodologies. This has been called the 'Factory to Foxhole to Factory continuum of logistic support' (Hingst & Gunter, 2008).

Various impacts can be seen in the auto visualisation (**Figure 3**). The first is CBM+ has been introduced. The operator has the information available to decide the criticality of the situation, when the repair can be done to optimise operations and who will do the repairs. This capability is also known as Local Operations Analysis Decisions (LOADS) (Hingst & Gunter, 2008). The next major impact is the optimisation of inventory, not just at the local garage, but throughout the system back to the lean manufacturer.

What are the overall impacts? Qualitatively we can discuss how systems be optimally operated and maintained through technology and sustainment management / design. But what are the actual savings? The information available is limited to estimates and measured impacts on some elements of existing systems. A well known quantitative estimate of the impact on the overall sustainment of a system has been provided by the Lockheed Martin Corporation (LMC) for their F-35 Advanced JSF. LMC estimates a 20 % reduction in the operations / logistics costs over the life cycle due to the application of AL (Mansfield, 2006).

To put this into perspective, when acquiring a new system, a general rule used to estimate the life cycle costs is that the initial acquisition of the system in question accounts for one third of whole of life costs. Logistics and Operational costs make up the other two thirds. An example is the Australian JSF program. A 100 aircraft buy is prefered. Using a per aircraft cost of US$50 million, this would amount to a US$5 billion purchase. Using the general rule above, support / operating costs would equate to US$10 billion for a whole of program cost of US$15 billion. A 20 % reduction in the operations / logistics costs over the program life cycle, due to the application of AL, equates to a US$2 Billion savings for the Australian JSF program. (Hingst & Gunter 2007)

Minimal data is available as the savings arising from the application of sustainment technology on a system level. Therefore, two examples are presented using RFIDs as sensors since these are some of the most simplistic devices and yet it shows how even these can generate savings through their tactical application.

Example one is a liquid propane supplier in Malaysia has automated gas cylinder filling and tracking by putting RFIDs on the cylinders. Bar codes tended to be damaged and weren't reliable. Information concerning each cylinder, which must be identified, weighed and checked prior to filling took an average of 30 seconds. The RFID system takes two seconds to complete the same checks, a savings of 28 seconds per cylinder. When that time saving is extrapolated across a small plant which processes 700 cylinders an hour, a time saving of 43.5 hours of labour, to a large plant filling 3,600 cylinders per hour, (224 hours of labour per eight hour shift), without human interaction compared with the previously used bar code scan, the savings become significant. (Burnell, 2008a)

In example two NASA has put RFID tags on tools, equipment and other assets used at Kennedy Space Flight Center in support of the International Space Station. Before each launch all items have to be located and accounted for. The Real Time Location System (RTLS) does that instantaneously. Previously, a crew of 23 had to do a "walkdown" of the launch site with a further 90 people on standby for the two and a half hours it took to ensure that the shuttle was clear to launch.(Burnell, 2008b).

## Ecological Element

In the automotive example we have mentioned the possibility of monitoring a systems' impact on the environment whether direct pollution, the use of resources or wastage. It should also be noted in **Figure 3** that the ecological impact of the reduction of resources (materials, energy and human), as well as the reduced pollutants due to the vehicle operating optimally, have the potential to be evaluated. In fact, the vehicle can monitor its pollution, petrol and oil consumption and automatically transmit this to an Environmental Protection Agency (note that this application of the technology has not yet been implemented). This could be used to track excessive individual polluters or as a database for the agency to predict future overall pollution generated by the end user including the location and temporal point at which the event occurs. This would present obvious challenges for legislators to mandate data collection from private individuals' use of fossil fuels, none the least of which would be the need to respond to privacy concerns. Contending with these issues though, is outside of the scope of this paper.

Again, Mr. Albanese of Rio Tinto in the Kyoto forum stated:

*Since about 2000, Rio Tinto and many of its peers have recognised that the best way to reconcile wealth creation with environmental and community concerns is to relate our activities to the concept of sustainable development.* (Albanese, 2007 p 3)

With the introduction of the ISO 14000 (Environmental Management Systems) family of standards and the requirements within the ISO 14040 section for Life Cycle Assessment (LCA) a structured approach to determining the ecological impact has been formalised. The LCA requires extensive data accumulation over a protracted period (approximately 1 year). Obviously remote sensing is an obvious solution that reduces human interaction, and thereby labour costs, as well as the potential for errors and inaccuracies.

Project managers need to be knowledgeable of the ecological footprint their system creates and must be able to contain that impact within limits acceptable to the various stakeholders. Real time data is the basis for the effective decisions to provide the greatest possibility of maintaining those boundaries.

## CONCLUSION

It is our contention that Project / Program Management, Systems Engineering and Integrated Communications Technology are undergoing a process of fusion enabled by technology. The availability of a wide variety of sensors, advances in computing power and communications technology, as well as changes in the concepts of how systems should interact have changed the way systems sustainment is being managed.

There are apparent, significant financial, environmental and labour reductions in cost offered through the ability to monitor, and make informed decisions, based on data aggregated from the operation key equipment and infrastructure components. Examples reviewed in this paper examine applications of technology in the military and civilian spheres, from advanced weapons platforms to the aviation and mining industries. A challenge is identified for the further extension of technology to enhance our understanding of the environmental impacts of consumption of fossil fuels as energy sources.

PMs, whether they are involved in the design and development or manage an operational system, must become knowledgeable of the capabilities (and limitations) of these changes in order to manage the project sustainment at an optimal level.

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