Multi-Level Innovation for Sustainable Product Development: The Case Study of an Electronic Product for Earthmoving Equipment

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Innovation to improve the eco-efficiency of products and services is often thought to take place at four levels: product improvement, product redesign, function innovation and system innovation (Brezet, 1997). As these levels have differing scopes and are not necessarily dependent on one another, it is possible for an organisation to innovate across all levels simultaneously. By managing the links between levels, stricter social and environmental performance criteria can be phased into each successive product/service generation, helping to minimise implementation costs.

This paper will present a framework for organising product/service innovation for sustainable development that brings together the lower three levels. At the highest level (function innovation), the graphical scenario-building technique Scenario Network Mapping (List, 2005) is used to explore and chart possible future developments for the product or service's current market. The scenarios take a long-term (20 year) perspective and are constructed through dialogue with key stakeholders. New product/service concepts can then be "tested" against these scenarios for robustness (i.e., performance under multiple scenarios) and adaptability. Once one or more concepts are selected, product and technology roadmaps are drawn up to plan the development of the product/service and the different social and environmental benchmarks that should be met generation-by-generation. At the lower levels (product improvement and product redesign), techniques such as life cycle assessment, eco-design and material blacklists are used to optimise the current product/service and comply with relevant legislation.

The framework will be illustrated using the case study of Loadrite, an electronic weighing system installed in earthmoving machines (e.g., wheeled loaders) to measure the weight of material in the machine's bucket in real-time. This product is manufactured by Actronic Technologies, a New Zealand-based Small to Medium-sized Enterprise (SME), and exported to approximately 30 countries. Loadrite is used in a range of industries, most commonly construction aggregates. As a result, Scenario Network Maps have been developed for earthmoving equipment in the global construction aggregates industry until the year 2030. As these maps consist of cause-and-effect chains, it is possible to examine each link in the chain and assess how different technologies and business models would perform in the "scenario world" at that time. In this case study, the fit of different equipment types (e.g., conveyor belts), underlying technologies (e.g., fuel sensors) and business models (e.g., selling products as a service) will be examined alongside their implications for Loadrite products.

This paper will also discuss a parallel track of innovation focusing on the redesign of existing products. This started with a review of existing and potential environmental product policy in Loadrite's 30 markets. It then led to three separate projects: (1) the staggered phase-out of potentially hazardous chemicals/ materials using material grey- and black-lists; (2) reducing environmental "hot spots" using streamlined life cycle assessment and eco-design; and (3) field studies to investigate potential for improving the energy-efficiency of customers' operations.

While this framework has been tested in only one case study, it should be applicable to other product/ service developers, particularly SMEs in industrial sectors where development cycles are relatively slow.

References

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