Chapter 12
Transforming eMaintenance into iMaintenance with Mobile Communications Technologies and Handheld Devices

Nalin Sharda
Victoria University, Australia

ABSTRACT
iMaintenance stands for integrated, intelligent and immediate maintenance; which can be made possible by integrating various maintenance functions, and connecting these to handheld devices, such as an iPhone, using mobile communication technologies. The main innovation required for developing iMaintenance systems is to integrate the disparate systems and capabilities developed under the current eMaintenance models, and to make these immediately accessible by ubiquitous and intelligent computing technologies—such as Digital Ecosystems and Cloud Computing—connected via wireless networks and handheld devices such as the iPhone. A Digital Ecosystem is a computer-based system that can evolve with the system that it monitors and controls, and can be embedded in the system’s components, thereby providing the ability to integrate new functionality without any downtime. Cloud Computing can provide access to additional software services that are not available in the local Digital Ecosystem. This chapter will show how these computing paradigms can provide mobile computing and communication facilities required to create novel iMaintenance systems.

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INTRODUCTION AND HISTORICAL PERSPECTIVE

Maintenance is an essential aspect of any system; because, without the required maintenance the system’s performance can deteriorate; and this is at the lower end of the consequence spectrum, while on the higher end of the consequence spectrum, the system can fail catastrophically.

Early Maintenance Methods

“Prior to the Industrial Revolution, generally held to have begun in England in about 1750, maintenance consisted of individual craftsmen such as carpenters, smiths, coopers, wheelwrights, masons, etc. repairing the buildings, primitive machines and vehicles of the day” (Sherwin, 2000). In those days failures were repaired primarily by making a new part, or repairing the old one. As there was no concept of ‘remove-and-replace’ spare parts, these repairs took a long time. Most early manufactured systems were made to last as long as possible through repair oriented maintenance.

A case in point is Lord Nelson’s flagship HMS Victory, which was 40 years old in 1805, when it took part in the battle of Trafalgar. It was kept either in active service or in reserve until 1860, and then as a hulk until 1922. Towards the end, almost all of its original structure would have been replaced. Such a maintenance policy was economically viable in those days, because skilled labour was cheap as compared to the value of the system components (Sherwin, 2000).

However, in the modern world the cost of labour often exceeds that of the system components; therefore, one of the main objectives of the current maintenance strategies is to reduce the Mean Time ‘Taken to Repair’ (MTTR). This is achieved by using fast diagnostic techniques and ‘remove-and-replace’ spare parts. The concept of preventive maintenance has also become commonplace to reduce the Mean Time Between Failures (MTBF).

Diagnosis and Repair

In 1785 Thomas Jefferson noted that musket parts could be interchangeable, if made accurately enough; this led to the idea of ‘remove-and-replace’ spare parts. Good quality maintenance however, still requires skilled craftsmen; presently, such craftsmen are either rare or too expensive in the well-to-do countries. Consequently maintenance, particularly of items that require high level of skills, is becoming a problem (Sherwin, 2000).

“Shortages of competent repairers and their consequent higher wages have affected maintenance policy and subsequently the design of industrial, commercial, and especially domestic machinery” (Sherwin, 2000). Simple household systems such as toasters are treated as throwaway items in rich counties, but are repaired in less well-to-do countries. This has also changed the fundamental design philosophy behind goods such as motor cars. A car that has longer MTBF and lower MTTR is preferred even at a higher cost. Much of this improvement (in MTBF and MTTR) is achieved by introducing electronics and computer technology under the bonnet of the car for faster diagnostics. However, older, and simpler designs can be used where the cost of repair by skilled craftsmen is still affordable (Sherwin, 2000).

Preventive Maintenance

Preventive maintenance models are used to avoid unpredicted system breakdown, and thus, loss of production. One of the methods for selecting the frequency of preventive maintenance and the choice of parts to be replaced is based on historical data. Usually such preventive maintenance schemes are time-based, and do not consider the current health of the product. Such schemes are inefficient and cost more to a customer (Lee, et al., 2006). An improvement over such time-based preventive maintenance methods is degradation analysis, which measures the changes in physi-