“Never abandon a theory that explains something until you have a theory that explains more”

John McCarthy

Introduction to Embedded Automation

1.1 Introduction

This book has resulted from ongoing research by a group of enthusiastic people within both Defence Science and Technology Organisation (DSTO) and Knowledge-Based Intelligent Information and Engineering Systems (KES) Centre during work on automation and Artificial Intelligence (AI). Our effort has enabled the formation of teams that combine the skills of both human and machine (electronic) members. This book proposes a general, conceptual framework for the development of automation in human-machine environments that will allow such teams to work effectively and efficiently. This chapter introduces the subject and the main challenges which developers have to face. The method of approach in developing this conceptual framework will be described with an outline of original contributions. An overview of the structure of the book and its chapters is also presented.

1.2 Challenges

The book provides a viable mechanism to enable agents to auto-negotiate a communications channel, using self-organising techniques to establish trust via negotiation in order to share the system workload or maintain a balanced and efficient application. The use of multi-agent teams is also becoming entrenched in applications that require significant Human Computer Interface (HCI). In the Air domain a hierarchy of agents could be used to coordinate and control a team of Unmanned Aerial Vehicle (UAV) or coordinate a squadron of aircraft during a mission. Agents in the form of an adaptive HCI may be used to assist in improving the efficiency of
team-based applications. Hence, the Defence community is very interested in the progress of this research and its possible uses within their equipment.

Therefore this study will:

- Identify the architecture and implementation of Multi-Agent System (MAS) that could be used to improve coordination and control using the Trust, Negotiation, Communication (TNC) concepts;
- Identify the properties required to negotiate a trusted role as a team member capable of being controlled or coordinated from a variety of sources; and
- Examine the adaptable nature of agent teams, to dynamically reconfigure their capability and solve problems.

### 1.3 Approach

This book is intended for an audience of scientists, students, researchers and application engineers who are interested in the analysis, design and development of automation applications in complex adaptive environments. The main contribution of this book is the definition of a coherent, conceptual agency framework for automation and a clear articulation of generic steps to be taken in this process. These steps are:

**Definition of Boundaries:** The basis of the framework will be the introduction of automation (machine-assistant) into the traditional environment where the human is ultimately responsible for all activities. A classical system engineering approach will be used to identify the boundaries, interfaces and tasks to be shared by human and machine. The nature of the relationship between adaptation and automation will also be characterised.

**Task Classification:** The classification of tasks can be allocated to either the human or machine. Two main schemes for task classification will be used, based on the interface and the level of control required. These are not mutually exclusive, but each should be capable of dynamic interaction and able to self organize in a coherent manner to adapt within the environment.

**Task Management and Coordination:** The use of automated coordination and collaboration to achieve the successful completion of tasks is a requirement introduced by automation. This provides a mechanism for MAS to supervise and cooperate on tasks to establish the extended trust and adaptability of the agent system during evolution.

### 1.4 Outline of Book

The introduction reflects the problem domain, its challenges and the method of approach used to develop in order to examine the requirements to extend the self