Preface

In the field of intelligent manufacturing, there is a definitive need for methodologies for holonic systems (HMS), based on software engineering principles, which assist the system designer in every development step and provide clear, unambiguous analysis and design guidelines. We believe that methodologies from multi-agent technology (MAS) are good candidates for modeling HMS. Some reasons for this are: the similarities between the holonic and agent approaches, the wide use of agents as the implementation tool for holonic systems, and the availability of complete multi-agent system methodologies. Nevertheless, there are some extensions we have to add to a MAS methodology to be able to model the HMS requirements in a proper way: holon recursive structure, systems abstraction levels, HMS specific guidelines and a mixed top-down and bottom-up approach for analysis and design steps.

In this book we propose an abstract agent notion as a modeling artifact for autonomous entities with recursive structures. The abstract agent extends the traditional definition of an agent adding a structural perspective to the agent concept: "... *an abstract agent can be an agent; or it can be a MAS made up of abstract agents* ...". The abstract agent is an attempt to unify the concepts of holons and agents and to simplify and close the gap between holons and agents in analysis and design steps. This will make it easer to translate modeling products, obtained from methodologies for HMS, into coding elements for the implementation of the holonic system.

This book presents ANEMONA, a MAS methodology for HMS analysis and design based on the abstract agent notion and on the HMS requirements. ANEMONA defines a mixed top-down and bottom-up development process, and provides specific HMS guidelines to assist the designer in identifying and implementing holons. In our approach the HMS is specified dividing it into more specific aspects that form different *views* of the system: agent model, organizational model, interaction model, environment model and task/goal model. The way in which the views (models) are defined is inspired by the INGENIAS methodology. The extensions we have made to the INGENIAS metamodels deal with the addition of the abstract agent notion, the redefinition of some relations to conform with the new modeling entities, the dependencies between them and real-time modeling issues from the RT-Message methodology.

The development process of ANEMONA tries to provide the HMS designer with clear, HMS-specific modeling guidelines, and complete development phases for the HMS life cycle. The first stage, *system requirements analysis* and the second stage *holons identification and specification* define the analysis phase of our approach. The aim of the analysis phase is to provide high-level HMS specifications from the problem *requirements*, which are specified by the *client/user* and that can be updated at any development stage. The analysis adopts a top-down recursive approach. One advantage of a recursive analysis is that its results, i.e., the *analysis models*, provide a set of elementary elements and assembling rules. The next step in the development process is the *holon design* stage, which is a bottom-up process to produce the *system architecture* from the *analysis models* of the previous stage. The aim of the *holons implementation* stage is to produce an *executable code* for the *setup and configuration* stage. Finally, maintenances functions are executed at the *operation and maintenance* stage.

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