
Preface

The decision to invest in *oil field development* is an extremely complex problem, even in the absence of uncertainty, due to the great number of technological alternatives that may be used, to the dynamic complexity of oil reservoirs - which involves multiphase flows (oil, gas and water) in porous media with phase change, and to the complicated *combinatorial optimization* problem of choosing the *optimal oil well network*, that is, choosing the number and types of wells (horizontal, vertical, directional, multilateral) required for draining oil from a field with a view to maximizing its economic value.

This problem becomes even more difficult when *technical uncertainty* and *economic uncertainty* are considered. The former are uncertainties regarding the existence, volume and quality of a reservoir and may encourage an *investment in information* before the field is developed, in order to reduce these uncertainties and thus optimize the heavy investments required for developing the reservoir. The economic or market uncertainties are associated with the general movements of the economy, such as oil prices, gas demand, exchange rates, etc., and may lead decision-makers to defer investments and wait for better market conditions. Choosing the *optimal investment moment* under uncertainty is a complex problem which traditionally involves dynamic programming tools and other techniques that are used by the real options theory. In addition, consideration should be given to development alternatives that include an *expansion option* and already ensure (at a certain cost) that the expansion of production will be facilitated if favorable scenarios occur in the future.

The present book is a result of about 4 years of research in this area through a partnership between the Applied Computational Intelligence Laboratory (ICA) of the Department of Electrical Engineering at PUC-Rio, and Petrobras, through its R&D (research and development) program called PRAVAP (Advanced Oil Recovery Program), which is linked to its research center (CENPES). The book makes use of computational intelligence techniques, especially *genetic algorithms*, *genetic programming*, *neural networks*, *fuzzy logic* and *neuro-fuzzy* systems for purposes of solving this investment under uncertainty problem. These techniques are combined with modern finance theory, particularly with the *real options theory*, also known as the investment under uncertainty theory, in such a way as to provide practical as well as

theoretically rigorous solutions. This partnership, through which countless master's and doctoral theses were produced at PUC-Rio and computational methodologies and programs were developed for Petrobras, has been summarized in this original and comprehensive work, now available to a wider audience of researchers and interested readers.

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