Annual Report
2019

UNISIM Group

Research in
Reservoir Simulation and Management

Center for Petroleum Studies
School of Mechanical Engineering
University of Campinas
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1. INTRODUCTION

UNISIM was created in 1996, dedicated to research in numerical simulation and management of petroleum fields. The group is part of the Energy Department, Division of Petroleum Engineering (Scholl of Mechanical Engineering) and Center for Petroleum Studies (CEPETRO), University of Campinas (UNICAMP). More information about the group is available at: http://www.unisim.cepetro.unicamp.br.

1.1. Mission

The mission of UNISIM is to promote innovative research, development and training of human resources in the area of numerical simulation and management of petroleum reservoirs.

1.2. Objectives

The main technical objectives of the group are:

- Increase the reliability of studies and methodologies that employ the numerical simulation of reservoirs;
- Improve the decision making process in oil and gas production;
- Develop techniques to increase research’s efficiency by the management of multiple simulations;
- Integrate reservoir simulation with reservoir engineering, geosciences, production engineering economics, among others; and
- Develop research on subjects related to the needs of the E&P industry.

1.3. Research Lines

The research developed by the group includes the main activities related to the decision analysis process focused on the development and management of oil fields using reservoir simulation.

The main research lines of the group are:

- Integration with reservoir characterization
  The objective of this line is the representation of rock and fluid properties in simulators, including the treatment of uncertainties, upscaling, estimation of the value of information, the integration with 4D seismic and building of benchmark cases.
- Simulation techniques
  This line is dedicated to the construction of simulation models aiming their reliability for the study of oil production process, including techniques to speed up the process such as fast objective function estimators (FOFE) such as proxies and emulators.
• **Data Assimilation**
  The main focus is the development of techniques to reduce uncertainties through dynamic data to improve quality of production forecast. Probabilistic approaches and real time processes are included in this line.

• **Decision analysis**
  The key objective of this line is the decision-making process for development and management of oil fields, addressing optimization of exploitation, selection of strategies under uncertainty, risk analysis, smart fields, flexibility and robustness value and integration with production systems. Long-term production optimization and integration with short-term data driven processes is also one topic of interest as preparation to digital field management.

• **Applications**
  The methodologies developed by the group are tested mainly in pre-salt carbonate reservoirs, heavy oil reservoirs, naturally and hydraulically fractured reservoirs, mature fields, multi-reservoir simulations, WAG processes and polymer injection. The group has several benchmarks for specific applications.

• **Auxiliary techniques**
  This line includes optimization methods, parallel computing, integration with economic evaluation (including different tax schemes in Brazil) and modeling of production systems.

1.4. **Knowledge Transfer**

UNISIM aims to transfer to the society and to the oil industry the knowledge obtained from its research in the form of publications such as articles, theses, dissertations, UNISIM ON-LINE (periodical publication with the research results), and computational software in which the methodological solutions generated by the group are available.

In 2013, it was launched the UNISIM-I project, which has some benchmark projects for comparative studies (http://www.unisim.cepetro.unicamp.br/unisim-i). In the original version, we generated the reference case (UNISIM-I), a comparative case for reservoir development (UNISIM-I-D) and a case to test history matching procedures (UNISIM-I-H). UNISIM-I-M was created in 2016 to represent a reservoir in a management phase.

The UNISIM-II project, representing a benchmark case of a carbonate reservoir, was created in 2016 and it will be available in 2017 and updated in 2018.

The group also develops tools integrated to the main current commercial simulators. In 2019, several software registration were made: SEPIA, MERO, WAHOO, IDLHC and CORAL.
1.4.1. Software Registration

- **SEPIA 2019.4**
  Date: 16/Jul/2019
  Location: Instituto Nacional de Propriedade Industrial (INPI)
  Authors: Denis José Schiozer; Talita Cristina Tomaz Alves; Carlos Gustavo Moratori; Antonio Alberto de Souza dos Santos; Célio Maschio; Alessandra Davolio Gomes; João Carlos von Hohendorff Filho; Paulo Soares Drumond; Luís Otavio Mendes da Silva

- **MERO versão 2019.3.0**
  Date: 16/Jul/2019
  Location: Instituto Nacional de Propriedade Industrial (INPI)
  Authors: Rafael Jurado Neto; Denis José Schiozer; Alessandra Davolio Gomes; João Carlos von Hohendorff Filho; Paulo Soares Drumond; Raphael Veronesi Bastos; Cristina Célia Barros Cavalcante; Derek Brito Vasconcelos; Daniel Lopes de Carvalho; Célio Maschio; Talita Cristina Tomaz Alves; Antonio Alberto De Souza Dos Santos; Ana Teresa Ferreira da Silva Gaspar; Vinicius Eduardo Botechia; Luis Otavio Mendes da Silva

- **WAHOO**
  Date: 16/Jul/2019
  Location: Instituto Nacional de Propriedade Industrial (INPI)
  Authors: Denis José Schiozer; João Carlos von Hohendorff Filho; Derek Brito Vasconcelos

- **IDLHC**
  Date: 16/Jul/2019
  Location: Instituto Nacional de Propriedade Industrial (INPI)
  Authors: Denis José Schiozer; João Carlos von Hohendorff Filho; Célio Maschio

- **CORAL**
  Date: 23/Jul/2019
  Location: Instituto Nacional de Propriedade Industrial (INPI)
  Authors: Denis José Schiozer; João Carlos von Hohendorff Filho
2. ORGANIZATION AND STRUCTURE

The collaborators of 2019 are listed below:

2.1. Coordination and Administration

- Prof. PhD. Denis José Schiozer – general coordination
- Guilherme Roberto Tonin – Administrative support
- Renato Corsani – Financial support

2.2. UNICAMP Collaborators (Faculty and Researchers)

- PhD. Alessandra Davolio Gomes – Center for Petroleum Studies (CEPETRO)
- Prof. PhD. Alexandre Campane Vidal – Geosciences Institute (IG)
- Prof. PhD. Anderson de Rezende Rocha – Institute of Computing (IC)
- Prof. PhD. André Ricardo Fioravanti – School of Mechanical Engineering (FEM)
- Prof. PhD. Celmar Guimarães da Silva – School of Technology (FT)
- Prof. M.S. Euclides José Bonet – Center for Petroleum Studies (CEPETRO)
- Prof. PhD. Guilherme Daniel Avansi – School of Mechanical Engineering (FEM)
- Prof. PhD. Guillerme Palermo Coelho – School of Technology (FT)
- Prof. PhD. João Roberto Bertini Junior – School of Technology (FT)
- Prof. PhD. Julio Cesar dos Reis – Institute of Computing (IC)
- Prof. PhD. Luís Augusto Angelotti Meira – School of Technology (FT)
- Prof. PhD. Marcelo Souza de Castro – School of Mechanical Engineering (FEM)

2.3. Research

- M.S. Alexandre de Lima
- PhD. Abouzar Mirzaei Paiaman
- Antonio Alberto S. Santos
- PhD. Ana Teresa F. S. Gaspar
- PhD. Carla Janaina Ferreira
- PhD. Carlos Eduardo A. G. Barreto
- PhD. Célio Maschio
- M.S. Felipe Bruno Mesquita da Silva
- PhD. Gonçalo Soares de Oliveira
- PhD. Helena Finardi A. Scanavini
- PhD. Husham Awadelssied Ali Elbaloula
- PhD. Igor Ricardo de S. Victorino
- M.S. João Carlos von Hohendorff
- M.S. Luís Carlos Oliveira Pires
- PhD. Lucas Soares Monte-Mor
- PhD. Luciana Maria da Silva
- PhD. Maiara Moreira Gonçalves
- PhD. Manuel Gomes Correia
- PhD. Marcelo Ferreira Zampieri
- M.S. Marcelo Lopes
- Ph.D. Masoud Maleki
- Ph.D. Rashid Sher Muhammad
- Rúbya Santana Mota
- PhD. Samuel Ferreira de Mello
- PhD. Susana Margarida G. Santos
- M.S. Vinicius de Souza Rios
- PhD. Vinicius Eduardo Botechia

2.4. Technology

- Carlos Gustavo Moratori
- M.S. Cristina C. B. Cavalcante
- Daniel Lopes de Carvalho
- Derek Brito Vasconcelos
- Luis Otavio Mendes da Silva
- Paulo Soares Drumond
- Pedro Alan Tapia Ramos
- Rafael Jurado Neto
- Raphael Veronesi Bastos
- Sérgio Ferreira Batista Filho
- Talita Cristina Tomaz Alves
- Thiago Della Coletta Feliciano
2.5. Students

PhD Students

- Alexandre de Lima
- Ashish Kumar Loomba
- Bruno Albiero Pazetti
- Cinthia Kelly Quispe Cerna
- Conrado Rizzo Freschi
- Daiane Rossi Rosa Lessa
- Daniel Rodrigues dos Santos
- Evângela Patricia Alves da Silva
- Forlan La Rosa Almeida
- Gilson Moura Silva Neto
- Gonçalo Soares de Oliveira
- Helena Nandi Formentin
- João Carlos von Hohendorff Filho
- Juliana Maia Carvalho dos Santos
- Leonardo Alencar de Oliveira
- Luís Augusto Nagasaki Costa
- Luís Otávio Mendes da Silva
- Oscar Julián Peña Piraneque
- Pablo Julián Rodríguez
- Pedro Carlos Xavier de Moraes
- Randerson de Araújo Lemos
- Robison Quintana Saalfeld
- Rodrigo Gonçalves Vaz
- Shahram Danaei
- Sharon Andreina Rolón Soler
- Seyed Kourosh Mahjour
- Victor Augusto Kolhs Cattani
- Victor de Souza Rios
- William Chalub Cruz

Master Students

- Diêgo Moreira Fontes
- Fernanda Gois Alves Pereira
- Fernanda Gramorelli
- Fernanda Gusson Roscito
- Geltom Luís Vieira Junior
- Guilherme Nunes Lopes
- Henrique Treptow Weinberger
- Isabela Magalhães Oliveira
- Jéssica Moreira Lima
- João Henrique Lima do Nascimento
- Leticia Siqueira dos Santos
- Nathaly Alice Moreno Ayala
- Otávio Freitas Neves
- Vinicius Pereira Casanova Campos

Undergraduate Students

- Gabriel Marchiori
- Gabriel Shen Baldon
- Henrique Hungari Rodrigues
- Mariana Marafon Fabricio

Other Students

- Luã Monteiro Guimarães – PhD Student
  Instituto Superior Técnico (IST) Lisbon, Portugal
3. PROJECTS

The 2019 projects with external funding are presented below:

3.1. Industry Projects

   Effective: 09/2014 – 03/2020  
   Sponsor: Shell

2. Optimization and Integration of Reservoir Simulation and Production Facilities.  
   Effective: 10/2014 – 10/2019  
   Sponsor: Enervi Simulation

3. Methodologies to increase the reliability in reservoir simulation models – Focus on Carbonate Reservoirs and Offshore Mature Fields.  
   Effective: 02/2016 – 02/2020  
   Sponsor: Petrobras

4. Methodologies for Oilfield Development and Management through Reservoir Simulation.  
   Effective: 02/2016 – 02/2020  
   Sponsor: Petrobras

5. Methodologies for Oilfield Development - Focus in Integration with Production Systems.  
   Effective: 12/2016 – 11/2020  
   Sponsor: Petrobras

   Effective: 12/2017 – 12/2021  
   Sponsor: Shell

7. Integration of Reservoir Simulation and 4D Seismic Data – Phase 2.  
   Effective: 12/2017 – 12/2021  
   Sponsor: Shell

   Effective: 04/2018 – 04/2022  
   Sponsor: Petrobras / Shell / Total / CNPC / CNOOC

   Effective: 12/2018 – 11/2023  
   Sponsor: Equinor and FAPESP

10. Artificial Intelligence Applied to High-Fidelity Models Upscaling.  
    Effective: 06/2019 – 05/2021  
    Sponsor: Repsol-Sinopec

    Effective: 07/2019 – 07/2024  
    Sponsor: Shell
3.2. Scholarships

1. Análise do Valor da Informação em Processos de Tomada de Decisão nos Campos de Petróleo.  
   Effective: 03/2017 - 02/2019  
   Sponsor: CAPES – Masters Scholarship (Letícia Siqueira dos Santos)

2. Integração do Sistema de Produção com Reservatório no Campo de Libra.  
   Effective: 08/2017 - 07/2021  
   Sponsor: CAPES – PhD Scholarship (Rodrigo Gonçalves Vaz)

3. Aplicação de Alternativas de Controle e Otimização na Integração de Sistemas de Produção no Gerenciamento de Campos de Petróleo.  
   Effective: 08/2017 - 07/2019  
   Sponsor: CAPES – Masters Scholarship (Otávio Freitas Neves)

4. Machine Learning aplicado a otimização das Variáveis de Projeto e Controle em Campos Sujeitos a Injeção WAG.  
   Effective: 03/2018 - 02/2022  
   Sponsor: CAPES – PhD Scholarship (Daniel Rodrigues dos Santos)

5. Representação de Reservatório Carbonático Carstificado em Simulação Numérica.  
   Effective: 03/2018 - 02/2022  
   Sponsor: CAPES – PhD Scholarship (Pedro Carlos Xavier de Moraes)

6. Representação de Heterogeneidades Críticas e Influência no Desenvolvimento de Campos.  
   Effective: 03/2018 - 02/2022  
   Sponsor: CNPq – PhD Scholarship (Víctor Augusto Kolhs Cattani)

7. Representação de Heterogeneidades Críticas e Influência no Desenvolvimento de Campos.  
   Effective: 03/2018 - 02/2020  
   Sponsor: CNPq – Master Scholarship (Isabela Magalhães Oliveira)

8. Bayesian History Matching For Reservoir Uncertainty Reduction.  
   Effective: 06/2018 - 12/2019  
   Sponsor: CNPq – PhD Scholarship (Helena Nandi Formentin)

   Effective: 08/2018 - 07/2022  
   Sponsor: CAPES – PhD Scholarship (Oscar Julian Peña Piraneque)

10. Otimização de Estratégia de Produção Guiado por Modelos Representativos.  
    Effective: 08/2018 - 07/2022  
    Sponsor: CAPES – PhD Scholarship (Luís Otávio Mendes da Silva)

11. Metodología de Ótimização Híbrida Aplicada ao Processo de Ajuste de Histórico.  
    Effective: 08/2018 - 02/2022  
    Sponsor: CNPq – PhD Scholarship (William Chalub Cruz)

    Effective: 03/2019 - 02/2021  
    Sponsor: CNPq – Master Scholarship (Vinicius Pereira Casanova Campos)
13. Avaliação de Alternativas de Infill Drilling em um Campo de Petróleo Desenvolvido com Base em Informações de Sísmica 4D.
   Effective: 04/2019 - 02/2021
   Sponsor: CAPES – Master Scholarship (Gelton Luís Vieira Júnior)

   Effective: 03/2019 - 02/2023
   Sponsor: CAPES – PhD Scholarship (Randerson Araújo de Lemos)

15. Representação de Heterogeneidades Críticas em Simulação de Reservatórios Carbonáticos.
    Effective: 03/2019 - 02/2023
    Sponsor: CAPES – PhD Scholarship (Conrado Rizzo Freschi)

16. Caracterização de Fluido e Simulação da Injeção Alternada de CO2 e Água para Reservatórios Carbonáticos com Características do Pré-Sal Molháveis a Óleo.
    Effective: 08/2019 - 07/2021
    Sponsor: CAPES – Master Scholarship (Diêgo Moreira Fontes)

17. Técnicas de Otimização Aplicadas ao Processo de Tomada de Decisão com Poços Inteligentes em Reservatórios de Carbonato.
    Effective: 08/2019 - 07/2021
    Sponsor: FAPESP – Master Scholarship (Guilherme Nunes Lopes)

18. Metodologia de Seleção de Estratégia de Produção Sob Incertezas através do Gerenciamento de Longo e Curto Prazo.
    Effective: 08/2019 - 07/2021
    Sponsor: CAPES – Master Scholarship (Jéssica Monteiro Lima)

    Effective: 10/2019 - 09/2021
    Sponsor: FAPESP – Postdoctoral Scholarship (Abouzar Mirzaei Paiaman)

    Effective: 10/2019 - 09/2020
    Sponsor: FAPESP – Undergraduate Scholarship (Gabriel Shen Baldon)

21. Uso de Modelos Rápidos na Previsão de Produção de um Campo de Petróleo.
    Effective: 10/2019 - 07/2023
    Sponsor: CAPES – PhD Scholarship (Sharon Andreina Rolón Soler)
4. COURSES, LECTURES, REGISTERS AND PUBLICATIONS

4.1. Courses

- **CORAL Software Introduction**
  Date: 03-04/Apr/2019
  Location: CENPES, Petrobras, Rio de Janeiro
  Instructor: João Carlos von Hohendorff Filho

- **CORAL Advanced**
  Date: 05-06/Nov/2019
  Location: Center for Petroleum Studies (CEPETRO)
  Instructor: João Carlos von Hohendorff Filho

4.2. Lectures

- **Formação Profissional para Gerenciamento de Campos de Petrôleo**
  Date: 24/Sep/2019
  Event: VI SPE Meeting
  Location: School of Mechanical Engineering (FEM)
  Lecturer: Denis José Schiozer

4.3. Articles – Journals


### 4.4. Articles – Congress


14. HOHENDORFF FILHO, J. C. V.; SCHIOZER, D. J. Methodology to Accelerate Explicit Integration between Reservoir and Production System Simulators, CILAMCE, 11-14 November, Natal, Brazil, 2019.
UNISIM ON-LINE


5. COMPLETED ACADEMIC WORKS AND AWARDS

5.1. Master

GRAMORELLI, Fernanda. Gerenciamento Integrado de Múltiplos Reservatórios Sujeitos a Restrições Operacionais e de Escoamento, PETROBRAS (Advisor: Denis José Schiozer).

NASCIMENTO, João Henrique Lima do. Dynamics of Uncertainties in Petroleum Reservoirs, ANP (Advisor: Denis José Schiozer).

5.2. Awards

MALEKI, Masoud. First place in CEPETRO AWARD 2018 – Category PhD. CEPETRO, UNICAMP.

SCHIOZER, Denis José. Academic Recognition Award “Zeferino Vaz” – UNICAMP.

Finalist of the ANP Technological Innovation Award 2019 - Category I: Desenvolvimento e Gerenciamento de Campos de Petróleo por meio da Simulação Numérica de Reservatórios – Rede SIGER. ANP (Agência Nacional do Petróleo).

ANP Technological Innovation Award 2019, Rio de Janeiro, Brazil
6. PUBLICATIONS AND PROJECTS

The figures below show the evolution of UNISIM publications over the years and external funding considering all support from 1996 to 2024.

6.1. Publications

6.2. External Funding

UNISIM - 1996 to 2024
(Total - R$ 110 millions)
7. PRODUCTS

Computational applications are also developed in UNISIM aiming to help professionals involved with reservoir engineering activities. The main applications are listed below:

**SEPIA**
A software for graphical analysis and support tools to assist the user in decision making.

**MERO**
A framework built with plug-ins designed to assist the users in some key reservoir areas such as: exploitation strategy, risk and uncertainty analysis, history matching, optimization, representative models, economic analysis, among others.

**PSGR**
The PSGR (Reservoir Simulation and Management Portal) was developed aiming to create a repository with up-to-date information on oil reservoir simulation and related subjects.

**Site UNISIM**
The UNISIM web page was developed aiming to share information about the UNISIM group, such as research lines, publications, software applications, among others.
8. ADDRESS, OPPORTUNITIES AND PARTNERSHIPS

8.1. Address
UNISIM/CEPETRO/UNICAMP
Cora Coralina Street, 350, Campinas, São Paulo, Zip Code: 13083-970
PO Box: 6052 – Phone: +55 19 3521-1220 – http://www.unisim.cepetro.unicamp.br/

8.2. Opportunities

*Academic: information about graduate courses at the Petroleum Science and Engineering program:*

Phone: +55 19 3521-3344

*Research: opportunities for researchers:*

- If you are interested in developing research in any of the UNISIM action fields, send your updated CV to: rh-unisim@cepetro.unicamp.br

8.3. Partners

- **UNICAMP (Project Partnership)**
  - Geological Modeling of Reservoir – MGR
  - Laboratory of Methods Miscible Recovery – LMMR
  - Laboratory Oil Reservoirs – LABORE
  - Reasoning for Complex Data - RECOD

- **Brazilian Universities (Petrobras Research Networks SIGER)**
  - Federal University of Pernambuco – UFPE
  - State University of Northern of Rio de Janeiro – UENF
  - Federal University of Rio de Janeiro – UFRJ
  - Rio de Janeiro State University – UERJ
  - Federal University of Santa Catarina – UFSC
  - Pontifical Catholic University of Rio de Janeiro – PUC-RJ

- **Brazilian Universities**
  - São Paulo University – USP
  - Federal University of Pelotas – UFPel

- **International Partners**
  - Durham University – UK
  - Institut Français du Pétrole – France
  - Texas A&M University – USA
  - Instituto Superior Técnico – Portugal
  - Norwegian Research Centre (NORCE) – Norway
  - University of Bergen – Norway
  - University of Wyoming – USA
9. SPONSORS

BR Petrobras
Shell
Equinor
Energi Simulation
Capes
Repsol Sinopec Brasil
FapESP
PRH
ANP
CNPq
Total
Pre-sal Petróleo
CNOOC
CNPC