



**FRANCIELE BRAGA MACHADO TULLIO
LUCIO MAURO BRAGA MACHADO
(ORGANIZADORES)**

**AMPLIAÇÃO E
APROFUNDAMENTO
DE CONHECIMENTOS NAS
ÁREAS DAS ENGENHARIAS**



**FRANCIELE BRAGA MACHADO TULLIO
LUCIO MAURO BRAGA MACHADO
(ORGANIZADORES)**

**AMPLIAÇÃO E
APROFUNDAMENTO
DE CONHECIMENTOS NAS
ÁREAS DAS ENGENHARIAS**

2020 by Atena Editora

Copyright © Atena Editora

Copyright do Texto © 2020 Os autores

Copyright da Edição © 2020 Atena Editora

Editora Chefe: Profª Drª Antonella Carvalho de Oliveira

Diagramação: Natália Sandrini de Azevedo

Edição de Arte: Lorena Prestes

Revisão: Os Autores



Todo o conteúdo deste livro está licenciado sob uma Licença de Atribuição *Creative Commons*. Atribuição 4.0 Internacional (CC BY 4.0).

O conteúdo dos artigos e seus dados em sua forma, correção e confiabilidade são de responsabilidade exclusiva dos autores. Permitido o download da obra e o compartilhamento desde que sejam atribuídos créditos aos autores, mas sem a possibilidade de alterá-la de nenhuma forma ou utilizá-la para fins comerciais.

Conselho Editorial

Ciências Humanas e Sociais Aplicadas

Profª Drª Adriana Demite Stephani – Universidade Federal do Tocantins

Prof. Dr. Álvaro Augusto de Borba Barreto – Universidade Federal de Pelotas

Prof. Dr. Alexandre Jose Schumacher – Instituto Federal de Educação, Ciência e Tecnologia de Mato Grosso

Profª Drª Angeli Rose do Nascimento – Universidade Federal do Estado do Rio de Janeiro

Prof. Dr. Antonio Carlos Frasson – Universidade Tecnológica Federal do Paraná

Prof. Dr. Antonio Gasparetto Júnior – Instituto Federal do Sudeste de Minas Gerais

Prof. Dr. Antonio Isidro-Filho – Universidade de Brasília

Prof. Dr. Carlos Antonio de Souza Moraes – Universidade Federal Fluminense

Prof. Dr. Constantino Ribeiro de Oliveira Junior – Universidade Estadual de Ponta Grossa

Profª Drª Cristina Gaio – Universidade de Lisboa

Profª Drª Denise Rocha – Universidade Federal do Ceará

Prof. Dr. Deyvison de Lima Oliveira – Universidade Federal de Rondônia

Prof. Dr. Edvaldo Antunes de Farias – Universidade Estácio de Sá

Prof. Dr. Eloi Martins Senhora – Universidade Federal de Roraima

Prof. Dr. Fabiano Tadeu Grazioli – Universidade Regional Integrada do Alto Uruguai e das Missões

Prof. Dr. Gilmei Fleck – Universidade Estadual do Oeste do Paraná

Profª Drª Ivone Goulart Lopes – Istituto Internazionale delle Figlie de Maria Ausiliatrice

Prof. Dr. Julio Candido de Meirelles Junior – Universidade Federal Fluminense

Profª Drª Keyla Christina Almeida Portela – Instituto Federal de Educação, Ciência e Tecnologia de Mato Grosso

Profª Drª Lina Maria Gonçalves – Universidade Federal do Tocantins

Profª Drª Natiéli Piovesan – Instituto Federal do Rio Grande do Norte

Prof. Dr. Marcelo Pereira da Silva – Universidade Federal do Maranhão

Profª Drª Miranilde Oliveira Neves – Instituto de Educação, Ciência e Tecnologia do Pará

Profª Drª Paola Andressa Scortegagna – Universidade Estadual de Ponta Grossa

Profª Drª Rita de Cássia da Silva Oliveira – Universidade Estadual de Ponta Grossa

Profª Drª Sandra Regina Gardacho Pietrobon – Universidade Estadual do Centro-Oeste

Profª Drª Sheila Marta Carregosa Rocha – Universidade do Estado da Bahia

Prof. Dr. Rui Maia Diamantino – Universidade Salvador

Prof. Dr. Urandi João Rodrigues Junior – Universidade Federal do Oeste do Pará

Profª Drª Vanessa Bordin Viera – Universidade Federal de Campina Grande

Prof. Dr. William Cleber Domingues Silva – Universidade Federal Rural do Rio de Janeiro

Prof. Dr. Willian Douglas Guilherme – Universidade Federal do Tocantins

Ciências Agrárias e Multidisciplinar

Prof. Dr. Alexandre Igor Azevedo Pereira – Instituto Federal Goiano

Prof. Dr. Antonio Pasqualetto – Pontifícia Universidade Católica de Goiás

Profª Drª Daiane Garabeli Trojan – Universidade Norte do Paraná

Profª Drª Diocléa Almeida Seabra Silva – Universidade Federal Rural da Amazônia
Prof. Dr. Écio Souza Diniz – Universidade Federal de Viçosa
Prof. Dr. Fábio Steiner – Universidade Estadual de Mato Grosso do Sul
Prof. Dr. Fágner Cavalcante Patrocínio dos Santos – Universidade Federal do Ceará
Profª Drª Girlene Santos de Souza – Universidade Federal do Recôncavo da Bahia
Prof. Dr. Júlio César Ribeiro – Universidade Federal Rural do Rio de Janeiro
Profª Drª Lina Raquel Santos Araújo – Universidade Estadual do Ceará
Prof. Dr. Pedro Manuel Villa – Universidade Federal de Viçosa
Profª Drª Raissa Rachel Salustriano da Silva Matos – Universidade Federal do Maranhão
Prof. Dr. Ronilson Freitas de Souza – Universidade do Estado do Pará
Profª Drª Talita de Santos Matos – Universidade Federal Rural do Rio de Janeiro
Prof. Dr. Tiago da Silva Teófilo – Universidade Federal Rural do Semi-Árido
Prof. Dr. Valdemar Antonio Paffaro Junior – Universidade Federal de Alfenas

Ciências Biológicas e da Saúde

Prof. Dr. André Ribeiro da Silva – Universidade de Brasília
Profª Drª Anelise Levay Murari – Universidade Federal de Pelotas
Prof. Dr. Benedito Rodrigues da Silva Neto – Universidade Federal de Goiás
Prof. Dr. Edson da Silva – Universidade Federal dos Vales do Jequitinhonha e Mucuri
Profª Drª Eleuza Rodrigues Machado – Faculdade Anhanguera de Brasília
Profª Drª Elane Schwinden Prudêncio – Universidade Federal de Santa Catarina
Prof. Dr. Ferlando Lima Santos – Universidade Federal do Recôncavo da Bahia
Prof. Dr. Fernando José Guedes da Silva Júnior – Universidade Federal do Piauí
Profª Drª Gabriela Vieira do Amaral – Universidade de Vassouras
Prof. Dr. Gianfábio Pimentel Franco – Universidade Federal de Santa Maria
Profª Drª Iara Lúcia Tescarollo – Universidade São Francisco
Prof. Dr. Igor Luiz Vieira de Lima Santos – Universidade Federal de Campina Grande
Prof. Dr. José Max Barbosa de Oliveira Junior – Universidade Federal do Oeste do Pará
Profª Drª Magnólia de Araújo Campos – Universidade Federal de Campina Grande
Profª Drª Mylena Andréa Oliveira Torres – Universidade Ceuma
Profª Drª Natiéli Piovesan – Instituto Federaci do Rio Grande do Norte
Prof. Dr. Paulo Inada – Universidade Estadual de Maringá
Profª Drª Renata Mendes de Freitas – Universidade Federal de Juiz de Fora
Profª Drª Vanessa Lima Gonçalves – Universidade Estadual de Ponta Grossa
Profª Drª Vanessa Bordin Viera – Universidade Federal de Campina Grande

Ciências Exatas e da Terra e Engenharias

Prof. Dr. Adélio Alcino Sampaio Castro Machado – Universidade do Porto
Prof. Dr. Alexandre Leite dos Santos Silva – Universidade Federal do Piauí
Prof. Dr. Carlos Eduardo Sanches de Andrade – Universidade Federal de Goiás
Profª Drª Carmen Lúcia Voigt – Universidade Norte do Paraná
Prof. Dr. Eloi Rufato Junior – Universidade Tecnológica Federal do Paraná
Prof. Dr. Fabrício Menezes Ramos – Instituto Federal do Pará
Prof. Dr. Juliano Carlo Rufino de Freitas – Universidade Federal de Campina Grande
Profª Drª Luciana do Nascimento Mendes – Instituto Federal de Educação, Ciência e Tecnologia do Rio Grande do Norte
Prof. Dr. Marcelo Marques – Universidade Estadual de Maringá
Profª Drª Neiva Maria de Almeida – Universidade Federal da Paraíba
Profª Drª Natiéli Piovesan – Instituto Federal do Rio Grande do Norte
Prof. Dr. Takeshy Tachizawa – Faculdade de Campo Limpo Paulista

Conselho Técnico Científico

Prof. Me. Abrãao Carvalho Nogueira – Universidade Federal do Espírito Santo
Prof. Me. Adalberto Zorzo – Centro Estadual de Educação Tecnológica Paula Souza
Prof. Dr. Adaylson Wagner Sousa de Vasconcelos – Ordem dos Advogados do Brasil/Seccional Paraíba
Prof. Me. André Flávio Gonçalves Silva – Universidade Federal do Maranhão

Profª Drª Andreza Lopes – Instituto de Pesquisa e Desenvolvimento Acadêmico
 Profª Drª Andrezza Miguel da Silva – Universidade Estadual do Sudoeste da Bahia
 Prof. Dr. Antonio Hot Pereira de Faria – Polícia Militar de Minas Gerais
 Profª Ma. Bianca Camargo Martins – UniCesumar
 Profª Ma. Carolina Shimomura Nanya – Universidade Federal de São Carlos
 Prof. Me. Carlos Antônio dos Santos – Universidade Federal Rural do Rio de Janeiro
 Prof. Ma. Cláudia de Araújo Marques – Faculdade de Música do Espírito Santo
 Prof. Me. Daniel da Silva Miranda – Universidade Federal do Pará
 Profª Ma. Dayane de Melo Barros – Universidade Federal de Pernambuco
 Prof. Me. Douglas Santos Mezacas -Universidade Estadual de Goiás
 Prof. Dr. Edwaldo Costa – Marinha do Brasil
 Prof. Me. Eliel Constantino da Silva – Universidade Estadual Paulista Júlio de Mesquita
 Profª Ma. Fabiana Coelho Couto Rocha Corrêa – Centro Universitário Estácio Juiz de Fora
 Prof. Me. Felipe da Costa Negrão – Universidade Federal do Amazonas
 Profª Drª Germana Ponce de Leon Ramírez – Centro Universitário Adventista de São Paulo
 Prof. Me. Gevair Campos – Instituto Mineiro de Agropecuária
 Prof. Me. Guilherme Renato Gomes – Universidade Norte do Paraná
 Profª Ma. Jaqueline Oliveira Rezende – Universidade Federal de Uberlândia
 Prof. Me. Javier Antonio Albornoz – University of Miami and Miami Dade College
 Profª Ma. Jéssica Verger Nardeli – Universidade Estadual Paulista Júlio de Mesquita Filho
 Prof. Me. José Luiz Leonardo de Araujo Pimenta – Instituto Nacional de Investigación Agropecuaria Uruguay
 Prof. Me. José Messias Ribeiro Júnior – Instituto Federal de Educação Tecnológica de Pernambuco
 Profª Ma. Juliana Thaisa Rodrigues Pacheco – Universidade Estadual de Ponta Grossa
 Prof. Me. Leonardo Tullio – Universidade Estadual de Ponta Grossa
 Profª Ma. Lilian Coelho de Freitas – Instituto Federal do Pará
 Profª Ma. Liliani Aparecida Sereno Fontes de Medeiros – Consórcio CEDERJ
 Profª Drª Lívia do Carmo Silva – Universidade Federal de Goiás
 Prof. Me. Luis Henrique Almeida Castro – Universidade Federal da Grande Dourados
 Prof. Dr. Luan Vinicius Bernardelli – Universidade Estadual de Maringá
 Profª Ma. Marileila Marques Toledo – Universidade Federal dos Vales do Jequitinhonha e Mucuri
 Prof. Me. Rafael Henrique Silva – Hospital Universitário da Universidade Federal da Grande Dourados
 Profª Ma. Renata Luciane Polsaque Young Blood – UniSecal
 Profª Ma. Solange Aparecida de Souza Monteiro – Instituto Federal de São Paulo
 Prof. Me. Tallys Newton Fernandes de Matos – Faculdade Regional Jaguaribana
 Prof. Dr. Welleson Feitosa Gazel – Universidade Paulista

**Dados Internacionais de Catalogação na Publicação (CIP)
(eDOC BRASIL, Belo Horizonte/MG)**

A526 Ampliação e aprofundamento de conhecimentos nas áreas das engenharias [recurso eletrônico] / Organizadores Franciele Braga Machado Tullio, Lucio Mauro Braga Machado. – Ponta Grossa, PR: Atena, 2020.

Formato: PDF

Requisitos de sistema: Adobe Acrobat Reader

Modo de acesso: World Wide Web

Inclui bibliografia

ISBN 978-65-86002-74-4

DOI 10.22533/at.ed.744200804

1. Engenharia – Pesquisa – Brasil. 2. Inovações tecnológicas. 3. Tecnologia. I. Tullio, Franciele Braga Machado. II. Machado, Lucio Mauro Braga.

CDD 620

Elaborado por Maurício Amormino Júnior | CRB6/2422

Atena Editora

Ponta Grossa – Paraná - Brasil

www.atenaeditora.com.br

APRESENTAÇÃO

Em “Ampliação e Aprofundamento de Conhecimentos nas Áreas das Engenharias” vocês encontrarão dezenove capítulos que demonstram que as fronteiras nas engenharias continuam sendo ampliadas.

A engenharia aeroespacial brasileira vem realizando muitos estudos para a melhoria nos processos de construção de satélites e temos nesta obra quatro capítulos demonstrando isso.

Na engenharia elétrica e na computação temos quatro capítulos demonstrando empenho no aprofundamento de pesquisas envolvendo temas atuais.

A engenharia de materiais e a engenharia química trazem quatro capítulos com pesquisas na produção de novos materiais e produção de medicamentos.

Pesquisas na engenharia de produção temos três capítulos que demonstram o empenho na análise de qualidade da produção industrial.

Os demais capítulos apresentam boas pesquisas em engenharia civil, engenharia mecânica e engenharia agrícola.

Boa leitura!

Franciele Braga Machado Tullio

Lucio Mauro Braga Machado

SUMÁRIO

CAPÍTULO 1	1
AVALIAÇÃO DA PRONTIDÃO DA ORGANIZAÇÃO DE AIT DE SATÉLITES ARTIFICIAIS PARA O ATENDIMENTO DE REQUISITOS DE SEUS STAKEHOLDERS	
Isomar Lima da Silva Andreia Fátima Sorice Genaro José Wagner da Silva Elaine de Souza Ferreira de Paula Bruno da Silva Muro	
DOI 10.22533/at.ed.7442008041	
CAPÍTULO 2	13
EMPREGO DOS PARÂMETROS DE LAMINAÇÃO PARA OTIMIZAÇÃO DE PAINÉIS REFORÇADOS EM COMPÓSITOS SUBMETIDOS A CARGAS COMPRESSIVAS	
Hélio de Assis Pegado Laura Tameirão Sampaio Rodrigues	
DOI 10.22533/at.ed.7442008042	
CAPÍTULO 3	30
AN OVERVIEW OF THE BFO - BASIC FORMAL ONTOLOGY - AND ITS APPLICABILITY FOR SATELLITE SYSTEMS	
Adolfo Americano Brandão Geilson Loureiro	
DOI 10.22533/at.ed.7442008043	
CAPÍTULO 4	39
COLETA DE REQUISITOS DO SUBSISTEMA BAZOOKA CANSAT UTILIZADO NO SEGUNDO CUBEDESIGN	
Daniel Alessander Nono Anderson Luis Barbosa Bruno Carneiro Junqueira André Ferreira Teixeira Aline Castilho Rodrigues	
DOI 10.22533/at.ed.7442008044	
CAPÍTULO 5	47
CENTRAIS HIDROcinÉTICAS COMO MEIO PARA A REESTRUTURAÇÃO DEMOCRÁTICA DO SETOR ELÉTRICO	
Luiza Fortes Miranda Geraldo Lucio Tiago Filho	
DOI 10.22533/at.ed.7442008045	
CAPÍTULO 6	60
DE KAOS PARA SYSML NA MODELAGEM DE SISTEMAS EMBARCADOS: UMA REVISÃO DA LITERATURA	
Timóteo Gomes da Silva Fernanda Maria Ribeiro de Alencar Aêda Monalizza Cunha de Sousa Brito	
DOI 10.22533/at.ed.7442008046	

CAPÍTULO 7	68
INTERNET OF THINGS NA ENGENHARIA BIOMÉDICA	
Tatiana Pereira Filgueiras	
Pedro Bertemes Filho	
DOI 10.22533/at.ed.7442008047	
CAPÍTULO 8	77
AVALIAÇÃO DE TOPOLOGIAS DE FONTES DE CORRENTE EM BIOIMPEDÂNCIA ELÉTRICA	
David William Cordeiro Marcondes	
Pedro Bertemes Filho	
DOI 10.22533/at.ed.7442008048	
CAPÍTULO 9	97
OBTENÇÃO DE BIODIESEL POR MEIO DA TRANSESTERIFICAÇÃO DO ÓLEO DE SOJA UTILIZANDO CATALISADOR DE KOH/Al ₂ O ₃ EM DIFERENTES COMPOSIÇÕES	
Laís Wanderley Simões	
Normanda Lino de Freitas	
Joelda Dantas	
Elvia Leal	
Julyanne Rodrigues de Medeiros Pontes	
Pollyana Caetano Ribeiro Fernandes	
DOI 10.22533/at.ed.7442008049	
CAPÍTULO 10	113
CARACTERIZAÇÃO MECÂNICA DE FILMES HÍBRIDOS PRODUZIDOS POR AMIDO DE MILHO E QUITOSANA	
Francielle Cristine Pereira Gonçalves	
Kilton Renan Alves Pereira	
Rodrigo Dias Assis Saldanha	
Simone Cristina Freitas de Carvalho	
Vitor Rodrigo de Melo e Melo	
Kristy Emanuel Silva Fontes	
Richelly Nayhene de Lima	
Magda Jordana Fernandes	
Elano Costa Silva	
Thaynon Brendon Pinto Noronha	
Liliane Ferreira Araújo de Almada	
Paulo Henrique Araújo Peixôto	
DOI 10.22533/at.ed.74420080410	
CAPÍTULO 11	125
SYNTHESIS AND STRUCTURAL CHARACTERIZATION OF SODIUM DODECYL SULFATE (DDS) MODIFIED LAYERED DOUBLE HYDROXIDE (HDL) AS MATRIX FOR DRUG RELEASE	
Amanda Damasceno Leão	
Mônica Felts de La Rocca	
José Lamartine Soares Sobrinho	
DOI 10.22533/at.ed.74420080411	
CAPÍTULO 12	134
THIN PLATE SPLINE INTERPOLATION METHOD APPLICATION TO PREDICT THE SUNFLOWER OIL INCORPORATION IN POLY (ACRYLIC ACID)-STARCH FILMS	
Talita Goulart da Silva	
Débora Baptista Pereira	
Vinícius Guedes Gobbi	

Layla Ferraz Aquino
Thassio Brandão Cubiça
Matheus Santos Cunha
Tiago dos Santos Mendonça
Sandra Cristina Dantas
Roberta Helena Mendonça

DOI 10.22533/at.ed.74420080412

CAPÍTULO 13 152

GESTÃO ESTRATÉGICA PARA O DESENVOLVIMENTO DE PROJETOS NA EMPRESA DE MANUTENÇÃO JL AUTOMAÇÃO INDUSTRIAL

Francely Cativo Bentes
David Barbosa de Alencar
Marden Eufrasio dos santos

DOI 10.22533/at.ed.74420080413

CAPÍTULO 14 162

OTIMIZAÇÃO DOS INSPETORES ELETRÔNICOS NA PRODUÇÃO DE TAMPAS METÁLICAS NO POLO INDUSTRIAL DE MANAUS

Elisabete Albuquerque de Souza
David Barbosa de Alencar
Marden Eufrasio dos Santos

DOI 10.22533/at.ed.74420080414

CAPÍTULO 15 174

CONTROLE DE QUALIDADE DOS BLOCOS CERÂMICOS DE VEDAÇÃO DE SEIS E OITO FUROS DAS OLARIAS DO AMAPÁ

Daniel Santos Barbosa
Adler Gabriel Alves Pereira
Orivaldo de Azevedo Souza Junior
Ruan Fabrício Gonçalves Moraes
Paulo Victor Prazeres Sacramento

DOI 10.22533/at.ed.74420080415

CAPÍTULO 16 190

REAPROVEITAMENTO DE TOPSOIL COMO MEDIDA DE RECUPERAÇÃO DE ÁREAS DEGRADADAS

José Roberto Moreira Ribeiro Gonçalves
Fabiano Battemarco da Silva Martins
Ronaldo Machado Correia

DOI 10.22533/at.ed.74420080416

CAPÍTULO 17 199

AVALIAÇÃO DE OBRAS DE ARTE ESPECIAIS: COMPARAÇÃO ENTRE A NBR 9452/2019 E O MÉTODO ESLOVENO

Ana Carolina Virmond Portela Giovannetti

DOI 10.22533/at.ed.74420080417

CAPÍTULO 18 208

DIMENSIONAMENTO DA POTÊNCIA MÍNIMA EXIGIDA DO ACIONAMENTO PRINCIPAL DE TRANSPORTADORES DE CORREIA

José Joelson de Melo Santiago
Carlos Cássio de Alcântara
Daniel Nicolau Lima Alves

Jackson de Brito Simões

DOI 10.22533/at.ed.74420080418

CAPÍTULO 19 220

CONSTRUÇÃO, INSTRUMENTAÇÃO E CARACTERIZAÇÃO DE UM TÚNEL DE VENTO DIDÁTICO DE CIRCUITO FECHADO

Lucas Ramos e Silva

Guilherme de Souza Papini

Rafael Alves Boutros

Romero Moreira Silva

Wender Gonçalves dos Santos

DOI 10.22533/at.ed.74420080419

SOBRE OS ORGANIZADORES..... 236

ÍNDICE REMISSIVO 237

AN OVERVIEW OF THE BFO - BASIC FORMAL ONTOLOGY - AND ITS APPLICABILITY FOR SATELLITE SYSTEMS

Data de aceite: 27/03/2020

Data de submissão: 03/01/2020

Adolfo Americano Brandão

INPE – Instituto Nacional de Pesquisas Espaciais,
Engenharia e Gerenciamento de Sistemas
Espaciais – CSE
São José dos Campos – SP
<http://lattes.cnpq.br/9801309621464289>

Geilson Loureiro

INPE – Instituto Nacional de Pesquisas Espaciais,
Engenharia e Gerenciamento de Sistemas
Espaciais – CSE
São José dos Campos – SP
<http://lattes.cnpq.br/7824447045520901>

ABSTRACT: This work aims to present an overview of the top-level ontology BFO - Basic Formal Ontology - and its applicability for Satellite Systems. As an upper level ontology, the BFO was designed to be extended, providing the basis for the specification of detailed representational artifacts about scientific information domains. These aspects and the challenges of satellite systems complexity and large size compose a suitable scenario for the creation of a specialized dialect to improve efficiency and accuracy when modeling such

systems. By analyzing BFO based ontologies in other disciplines and existing satellite models it is possible to describe an application for satellite systems, which can provide a foundation for the creation of a concrete ontology to be applied on satellite modeling.

KEYWORDS: Ontology; Knowledge-based engineering; Complex systems; Model based systems engineering; Satellite systems.

VISÃO GERAL DA BFO – BASIC FORMAL ONTOLOGY – E SUA APLICABILIDADE PARA SISTEMAS DE SATÉLITE

RESUMO: Este trabalho tem por objetivo apresentar uma visão geral da ontologia de topo BFO - Basic Formal Ontology – e sua aplicabilidade para sistemas de satélite. Como uma ontologia de topo, a BFO foi projetada para ser estendida, fornecendo a base para a especificação de artefatos detalhados de representação em domínios informacionais científicos. Tais aspectos e os desafios da complexidade inerente a sistemas de satélite compõem um cenário adequado para a criação de um dialeto especializado para melhorar a eficiência e acurácia na modelagem desse tipo de sistema. Através da análise de ontologias baseadas na BFO em outras disciplinas e

modelos de satélites é possível descrever uma aplicação para sistemas de satélite, o que possibilita a criação de uma ontologia concreta para ser aplicada na modelagem de satélites.

PALAVRAS-CHAVE: Ontologia; Engenharia baseada em conhecimento; Sistemas complexos; Engenharia de sistemas baseada em modelos; Sistemas de satélite.

1 | INTRODUCTION

An ontology is a representational artifact composed of a taxonomy, concepts and relations between them, concerning an informational or scientific domain. Therefore, it formalizes knowledge about a specific subject and is studied nowadays by information systems, knowledge management and knowledge-based engineering disciplines.

One purpose of ontologies is to allow consistent sharing, interchanging, collaboration, reuse and continued knowledge development among scientific communities regardless of location, language and socio-cultural aspects, mainly by computational resources. This goal can only be achieved if knowledge is structured according to a formal, common computer-based dialect.

As observed by many scientists in many disciplines, as society evolves, also do the problems. Increasing demand for solving more complex problems require more advanced techniques and tools. According to [Warwick 2016],

It did not seem to matter as much in the heydays of the 1950's and 60's, when programs with technically unachievable goals were launched and canceled with astonishing regularity. But today shareholders and taxpayers, as well as customers, demand accountability, and program performance has become a crucial issue.

For those ever-growing complexity problems, it is needed that computers are empowered with common means in order to share, reuse and expand knowledge. As stated by [Liu et al. 2005],

The task of computing is seamlessly carried out in a variety of physical embodiments. There is no single multi-purpose or dedicated machine that can manage to accomplish a job of this nature. The key to success ... lies in a large-scale deployment of computational agents capable of autonomously making their localized decisions and achieving their collective goals.

This is only achievable if disparate computers communicate efficiently among each other. This is one of the purposes of ontologies. One specific kind of ontology, upper level, or top-level ontology allows two ontologies to be accurately related to one another. They do not specify an information domain, but rather lay down the common structure needed to relate and extend specific domain ontologies, being a tool for integrating and sharing knowledge.

On the satellite systems perspective, why is it needed an ontology? Letting

aside the knowledge sharing and scientific development aspect, the very nature of complex systems is to be called to answer this question: Intricateness, size, variety, among others [Macau 2002]. According to [Skarka 2007],

Scientific literature shows that 80% of design engineers activities is related to repetitive, routine tasks, while the remaining 20% on innovative tasks.

A reason to use ontologies for product development is that it can encapsulate much information in a single concept, providing standard practices and reuse, enabling engineers to engineer more, instead of repeating manual, error prone work. When a problem is solved, or an error is corrected, it can be automatically propagated by the use of an ontology. This can reduce costs and improve quality, which is another very compelling reason.

At this point of our research there could not be found a single ontology related to designing and modeling satellites on the system level. This is why we think that creating such ontology would be an important contribution and is the subject of an ongoing work, mentioned in section 5.

2 | METHODOLOGY

We executed an extensive, but not exhaustive literature examination on several published papers related to the subject matter in question, to determine whether this work is relevant in terms of scientific contribution. Material produced for an ongoing bibliometrics [McBurney and Novak 2002] work for my master's degree has been used, in which keyword searches followed by paper analysis were performed. This procedure is being carried on by executing a set of steps, described below:

1. Mainly IEEE and Engineering Village were searched at this point of the research;
2. Objective keywords regarding ontologies, systems engineering, space systems and satellite engineering were used;
3. Time frame was set from beginning of all publications at each database;
4. Title and abstract were defined as the search attributes;
5. Papers were filtered according to most relevant titles;
6. Filtered papers were filtered again according to most relevant abstracts;
7. Filtered papers were selected based on the most relevant contents;
8. Article was written based on selected papers and author experience.

3 | RESULTS AND DISCUSSION

Some Considerations About Ontologies

Ontologies represent things that exist, things that are. In this prism, they can be used to represent any physical thing in the world, any domain of information including complex systems, engineering systems and satellite systems. The most popular areas we could identify in which ontologies are vastly used are biology, medicine, pharmacology, chemistry and computer science. BFO was used in the design of a large list of industry ontologies, which can be found in [Arp et al. 2015]. In engineering in general and specifically in aerospace engineering, there are very few ontologies compared to other sciences.

After researching most popular scientific sources, very few ontology research works related to aerospace engineering and even less for satellite development were found. Among those works we can mention a few: [Arvor et al. 2019], a research which focuses on the capacity of ontologies to represent both symbolic and numeric knowledge, to reason based on cognitive semantics and to share knowledge on the interpretation of remote sensing images; [Cox et al. 2016], an ontology to characterize space objects according to a variety of parameters including their identifiers, design specifications, components, subsystems, capabilities, vulnerabilities, origins, missions, orbital elements, patterns of life, processes, operational statuses, and associated persons, organizations, or nations; [Malin and Throop 2007], a paper which paper describes a set of taxonomies for interpreting descriptions of aerospace entities, functions, properties and problems; [Blasch 2015], a paper which explores the concepts of ontologies for applications to aerospace avionics as motivated by the NextGen and Single European Sky ATM Research (SESAR) standards and [Verhagen and Curran 2011], a paper about the development of an ontology for the aerospace composite manufacturing domain.

BFO Overview

BFO was created as a result of experience and practice. It has evolved from the Gene Ontology - GO [Ashburner et al. 2000], which has the purpose of representing the gene scientific domain. It was developed during years of research and practice, making it a very broad, general ontology, capable of representing all kinds of concepts. The most basic concepts of BFO are Universals and Particulars. Those can be easily understood by applying an analogy to computer programming languages variables and its types. For example, A numeric variable with value 10 is of the type number. In this case, number is the Universal and 10 is the Particular. These concepts define types and instances, which are among the most important concepts for designing ontologies, together with relations between them.

BFO Entities

BFO presents many concrete elements (entities and relations) which allow to define a precise communication language and semantic for any domain, including satellite systems, which comprise our object of study. BFO, as all ontologies, is composed of a hierarchy of concepts, but following the single inheritance rule, where the elements are described from top down, increasing the level of detail and decreasing the level of generality, inheriting the characteristics of only one upper element. Lower elements are specializations of upper elements. Except by the top-most element, all elements in BFO have one more general concrete type. This hierarchical inheritance principle is fundamental to ontological languages based on a top-level ontology because they are designed by extending the definition and characterization of the base concepts and defining possible relations between the new extension concepts. Figure 2 summarizes the entities defined by BFO 2.0 in [Ruttenberg 2019], and the element hierarchy.

BFO Relations

BFO defines two main kinds of relations: 1) Universal-Universal relations: relations between two universals and 2) Spatial and Temporal relations: treatment of location and adjacency and temporal aspects of relations. Table 4 provides the relations defined by [Arp et al. 2015] in the BFO.

BFO Applicability to Satellite Systems

According to [Arp et al. 2015], BFO is an upper-level ontology developed to support integration of data obtained through scientific research. In this sense, it can support the integration of the disparate disciplines involved in a satellite design project, because diverse teams and sets of knowledge are required in order to be composed as a whole. For that to be achieved, models of different nature must have a mechanism of vocabulary synchronism and integration. This BFO integration feature is made clear by [Arp et al. 2015]:

BFO is deliberately designed to be very small, in order that it should be able to represent in consistent fashion those upper-level categories common to domain ontologies developed by scientists in different fields ... BFO assists domain ontologists by providing a common top-level structure to support the interoperability of the multiple domain ontologies created in its terms.

It can be noticed in Figure 2 and Table 4 the diversity and generality of the terms comprising the BFO entities and relations. This makes possible to reach the objective of being a tool to construct languages and representational artifacts to be applied in any field of science, including satellite systems modeling.

Structure and Behavior

A top-level ontology, such as BFO, provides the base concepts, is very general and capable of scaling down to more specific areas while making it possible to maintain the structure and logic of all things to be represented. Also, it is by nature carefully designed to be extended. It brings concepts for things that are (Continuants), things that occur (Occurrents), going down to a certain level of generality, after which the concepts must be specific to the domain in question; By defining Continuants and Occurrents, it covers both static (structure) and dynamic (behavior) aspects of satellite design concepts such as its physical constituent parts and its behavior function flows.

Element Detailment

Many elements in BFO can be used to detail parts of a satellite system, including Quality, Disposition, Function, Specifically Dependent Continuant, Generically Dependent Continuant, among others. Those can provide a means to formalize fine grained details which can be further reused and shared among projects. Also, other information modeling ontologies can be applied to represent very precise modeling constructs, including standard and complex systems of engineering units. By formalizing qualities or attributes, it becomes possible to ensure only pertinent qualifiable elements can be qualified with specific information.

Subsystems Interfaces

Many constructs from BFO target the relationship among parts which can be further refined. Site, Spatial Region, Continuant Fiat Boundary are entity examples. From the relations side, all the relations from BFO can be used directly or refined to represent interfaces at any level in a satellite system, such as adjacent to, has participant, and others. By designing semantic language rules, roles in an interface interaction can be validated in order to fulfill their responsibilities by providing only valid information, energy or matter, at a conceptual level.

Risks and Failures

Failure Modes and Effects Analysis is a very powerful tool to identify actions to mitigate possible failures and should be carried out for all aerospace systems. [Ebrahimipour et al. 2010] proposes an approach to use an ontology to carry on FMEA activities in such a way its results can be shared and reused among projects. According to [Ebrahimipour et al. 2010],

The information stored in risk assessment tools is in the form of textual natural language descriptions that limit computer-based extraction of knowledge for the

reuse of the FMEA analysis in other designs or during plant operation. To overcome the limitations of text-based descriptions, FMEA ontology has been proposed that provides a basic set of standard concepts and terms.

The FMEA ontology shows an example of application of an ontology for complex systems and can be a reference to develop risk management concepts in a BFO based satellite systems ontology. Aspects of a satellite project which can be modeled and designed by conforming to a formal ontology can be many more than those mentioned in this section. The ones covered by this work are part of a preliminary study to provide a starting point for a deeper research to be carried out in our ongoing work, mentioned in section 5.

4 | CONCLUSION

In our experience, disparate and informal notations and inconsistent sets of vocabulary are applied to create isolated and disintegrated models. Even when standard languages are used, modeling environments still lack syntactic and semantic verification throughout the miscellaneous models, which can cause misunderstandings, increasing the time needed for comprehension at each development stage and many issues can arise.

An ontology defines a standard clear semantic, language and vocabulary needed for a precise communication among teams involved in any scientific research or product development. A top-level ontology helps to enforce the correctness and robustness of such artifacts and its constructs. Being based on the same top-level ontology, different sets of terms can be integrated in a consistent fashion allowing more effective collaboration and reuse.

Broad adoption in many domains has proven BFO to be a powerful tool to accomplish successfully effectiveness and accuracy in many projects. Its general terms and coverage of all base concepts and distinctive characteristic aspects about things that can exist in the real world are concluded to make BFO a relevant candidate for any domain.

It can be clearly perceived by reading BFO summary table provided in the discussion section, it provides enough terms to represent all material things, processes, compositions, relations, and so on, required in all systems. Even more abstract concepts as boundaries, spaces, regions, among others, can be formally defined by using BFO as a top ontology.

As for satellite systems, the lack of ontologies at the system level is a clear opportunity for the proposition of such an artifact. Being BFO one of the most robust, mature and popular top-level ontologies available, we conclude it has the characteristics which may be needed to bring to the satellite engineering teams

environment a change game tool.

5 | ONGOING WORK

”An Ontology for Satellite Systems” is an ongoing work for my master’s degree at INPE. It is being made of a deep research of ontologies in general, specific ontologies related to space and satellite systems, bibliometrics research and literature review and it is planned to be concluded by 2020.

This paper [Brandão and Loureiro 2019] was originally published at the WETE X - 10º Workshop em Engenharia e Tecnologia Espaciais, held at INPE – Instituto Nacional de Pesquisas Espaciais, São José dos Campos, SP, on 7, 8 and 9 of august, 2019 [Rodrigues et al 2019].

ACKNOWLEDGMENTS

Dr. Geilson Loureiro, my dear mentor.

REFERENCES

Arp, R., Smith, B., and Spear, A. D. (2015). **Building Ontologies with Basic Formal Ontology**. The MIT Press.

Arvor, D., Belgiu, M., Falomir, Z., Mougnot, I., and Durieux, L. (2019). **Ontologies to interpret remote sensing images: why do we need them?** *GIScience & Remote Sensing*, 56(6):911–939.

Ashburner, M., Ball, C. A., Blake, J. A., Botstein, D., Butler, H., Cherry, J. M., Davis, A. P., Dolinski, K., Dwight, S. S., Eppig, J. T., Harris, M. A., Hill, D. P., Issel-Tarver, L., Kasarskis, A., Lewis, S., Matese, J. C., Richardson, J. E., Ringwald, M., Rubin, G. M., and Sherlock, G. (2000). **Gene ontology: tool for the unification of biology**. *Nature Genetics*, 25(1):25–29.

Blasch, E. (2015). **Ontologies for nextgen avionics systems**. In 2015 IEEE/AIAA 34th Digital Avionics Systems Conference (DASC), pages 3B5–1–3B5–13.

Brandão, A. A.; Loureiro, G. **An overview of the BFO - Basic Formal Ontology - and its applicability to satellite systems**. In: WORKSHOP EM ENGENHARIA E TECNOLOGIA ESPACIAIS, 10. (WETE), 2019, São José dos Campos. Anais... São José dos Campos: INPE, 2019. On-line. ISSN 2177-3114. IBI: <8JMKD3MGPDW34R/3TTALCH>. Disponível em: <<http://urlib.net/rep/8JMKD3MGPDW34R/3TTALCH>>.

Cox, A. P., Nebelecky, C. K., Rudnicki, R., Tagliaferri, W. A., Crassidis, J. L., and Smith, B. (2016). **The space object ontology**. In 2016 19th International Conference on Information Fusion (FUSION), pages 146–153.

Ebrahimipour, V., Rezaie, K., and Shokravi, S. (2010). **An ontology approach to support FMEA studies**. *Expert Syst. Appl.*, 37(1):671–677.

Liu, J., Jin, X., and Tsui, K. C. (2005). **Autonomy Oriented Computing - From Problem Solving to Complex Systems Modeling**. Springer.

Macau, E. E. N. (2002). **Sistemas complexos e complexidade**. In Anais... Congresso Temático de Dinâmica, Controle e Aplicações, 1. (DINCOM).

Malin, J. T. and Throop, D. R. (2007). **Basic concepts and distinctions for an aerospace ontology of functions, entities and problems**. In 2007 IEEE Aerospace Conference, pages 1–18.

McBurney, M. K. and Novak, P. L. (2002). **What is bibliometrics and why should you care?** In Proceedings. IEEE International Professional Communication Conference, pages 108–114.

Rodrigues, I. P.; Rodrigues, A. C. ; Barbosa, A. L. ; Junqueira, B. C. ; Batista, C. L. G. ; Mateus, D. A. C. ; Blanco, G. C. ; Lima, J. S. S. ; Leonardo, J. M. P. ; Munhoz, M. G. C. ; Silva Júnior, M. W. ; Tenório, P. I. G. ; Pereira, Y. M. D. . **Anais do 10º Workshop em Engenharia e Tecnologia Espaciais**. 2019.

Ruttenberg, A. (2019). **Basic formal ontology (BFO)**.

Skarka, W. (2007). **Application of Moka methodology in generative model creation using Catia**. Engineering Applications of Artificial Intelligence, 20(5):677 – 690. Soft Computing Applications.

Verhagen, W. J. C. and Curran, R. (2011). **Ontological modelling of the aerospace composite manufacturing domain**. In ISPE CE.

Warwick, G. (2016). **Problems aerospace still has to solve**.

<http://www.inpe.br/wete/2019/>

ÍNDICE REMISSIVO

A

AIT 1, 2, 3, 4, 5, 8, 9, 10, 11

Alumina 97, 98, 99, 101, 102, 103, 105, 107, 108, 109, 110, 111, 112

Áreas Degradadas 190, 192, 193, 194, 195, 196, 197, 198

B

Biocompatible Polymers 135

Biodegradáveis 114, 115

Biodiesel 97, 98, 99, 100, 101, 104, 110, 111, 112

C

Camada fértil do solo 190, 194

CanSat 39, 40, 43, 44, 45

Catalisadores Impregnados 98, 105, 106, 108

Cerâmica 102, 174, 175, 176, 177, 178, 188, 189

Controle de qualidade 174, 177, 178, 184, 188

D

Democracia energética 47, 51, 52

Desenvolvimento 15, 47, 52, 53, 54, 55, 56, 58, 60, 61, 63, 64, 67, 75, 98, 102, 111, 112, 114, 120, 122, 152, 164, 178, 190, 191, 192, 193, 194, 196, 197, 236

E

Embalagens 114, 115, 122

Engenharia baseada em conhecimento 31

Engenharia Biomédica 68, 70, 72, 74

Engenharia de Sistema 39

Espectroscopia de bioimpedância elétrica 77, 78, 81, 83, 88, 93

Estradas 190, 200

F

ferramentas da qualidade 152, 153, 156, 162

Filmes 113, 114, 115, 116, 117, 118, 119, 120, 121, 122

Flambagem 13, 15, 18, 20, 21, 24, 27, 28

Fonte de corrente Howland 77, 89

Fonte não linear 77

G

Gestões estratégicas 152

I

Inspetores Eletrônicos 162, 163, 168, 169, 171, 172, 173

K

KAOS 60, 61, 62, 63, 64, 65, 66, 67

M

Modeling 30, 32, 34, 35, 36, 37, 44, 60, 61, 64, 66, 67, 111, 135, 136, 139

N

NASTRAN 13, 15, 16, 19, 20, 21, 22, 25, 26, 27, 28, 29

O

Olaria 174, 175, 182, 183, 184, 185, 186, 187

Ontologia 30, 31

Otimização 13, 15, 16, 18, 20, 21, 22, 23, 24, 25, 27, 28, 29, 91, 94, 162

P

PDCA 153, 154, 155, 158, 159, 162, 163, 164, 166, 173

Planejamento 55, 67, 114, 116, 117, 118, 152, 153, 155, 158, 164, 177, 178

Polymeric Films 134, 135

Processos 1, 63, 69, 102, 105, 117, 120, 157, 158, 160, 162, 163, 164, 165, 173, 178, 190, 192, 193, 196, 209

Projeto 1, 13, 15, 16, 17, 18, 19, 25, 61, 62, 70, 71, 74, 103, 152, 156, 177, 191, 192, 207, 208, 209, 219, 235

Prontidão 1

R

Reaproveitamento 190, 192, 194, 195, 196

Rede de Petri 60, 64

Requisitos 1, 39, 60, 61, 62, 63, 65, 67, 68, 70, 74, 75, 79, 90, 178, 179, 188, 189

Rodovias 190, 191, 194

S

Saúde 53, 68, 70, 71, 74, 75

Sistemas Complexos 31, 38, 60, 62
Sistemas de satélite 30, 31
Sistemas Embarcados 60, 61, 63, 64, 65, 67
Stakeholders 1, 2, 3, 4, 5, 8, 11, 12, 39, 40, 41, 43, 44, 45
SysML 60, 61, 62, 63, 64, 65, 66, 67

T

Tecnologia 37, 38, 47, 48, 49, 50, 56, 58, 68, 69, 74, 128, 134, 174, 175, 189, 190, 208, 236
Tecnologia hidrocínética 47, 48, 49, 56
Tissue engineering 135, 144, 145
Topsoil 190, 191, 192, 193, 194, 195, 196, 197, 198
transição energética 47, 55, 58
Transição energética 48
Transport phenomena 134, 135

 **Atena**
Editora

2 0 2 0