

25<sup>th</sup> ABCM International Congress of Mechanical Engineering  
October 20-25, 2019, Uberlândia, MG, Brazil

## MODELING OF NAVAL PROPULSION – APPROACH BASED ON HYBRID SYSTEMS

Vinícius Novicki Obadowski  
Thalles Andrade Estrela Batista  
Paulo Eigi Miyagi

Escola Politécnica da Universidade de São Paulo  
obadowski@usp.br, thalles.batista@usp.br and pemiagi@usp.br

**Abstract.** *This paper proposes a model for a full electric naval propulsion system using object-oriented differential predicate transition Petri nets (OO-DPT). This approach encompasses discrete events characteristics as well as the continuous values. To formulate this model, it was adopted the Production Flow Schema methodology in order to describe the system behavior and its main components and equipment. And after, using OO-DPT Petri Nets, a hybrid systems approach, it is possible to build a comprehensive model.*

**Keywords:** *naval propulsion, hybrid systems, Petri Nets, Objected-oriented Differential Predicate Transition Petri Nets*

### 1. INTRODUCTION

The shipbuilding design

### 2. NAVAL PROPULSION DESCRIPTION

To write something here.

### 3. MODEL

To write something here.

### 4. RESULTS

To write something here too.

The purpose of these instructions is to serve as a guide for formatting the extended abstracts to be submitted to the XXV COBEM.

The proceedings of the XXV COBEM will be published in Adobe™ PDF format.

The extended abstracts **MUST** be formatted strictly according to these instructions. The present file can be used as a template for  $\text{\LaTeX}$  users. Also, it could be used as a formatting guide to users of other text processing software.

The extended abstract should have a maximum of 4 pages, including tables and figures.

### 5. TEXT FORMAT

The extended abstracts should be written in English, typed in A4 size pages, using font Times New Roman, size 10, except for the title, authors affiliation, abstract and keywords, for which particular formatting instructions are indicated above. Single space between lines is to be used throughout the text.

The text block that contains the title, the authors' names and affiliation, the abstract and the keywords must be indented 0.1 cm from the left margin and marked by a leftmost black line border of width 2 1/4 pt.

The first page must have a top margin of 3 cm and all the other margins (left, right and bottom) must have 2 cm. All the other pages must be set with all margins equal to 2 cm.

**PAGES SHOULD NOT BE NUMBERED**

The body of the text must be justified. The first line of each paragraph must be indented by 0.5 cm. Sufficient information must be provided directly in the text, or by reference to widely available published work. Footnotes should be avoided.

All the symbols and notation must be defined in the text. Physical quantities must be expressed in the SI (metric) units. Mathematical symbols appearing in the text must be typed in italic style.

Bibliographic references should be cited in the text by giving the last name of the author(s) and the year of publication,

according to the following examples: “In a recent work (Miyagi, 1996). . .” or “Recently, Xinglong and Guo (2011). . .”. In the case of three or more authors, the form “(Sivčev *et al.*, 2018)” should be used. Two or more references having the same authors and publication year must be distinguished by appending “a”, “b”, etc., to the year of publication. For example: “In papers (Xinglong and Guo, 2011) and (Xinglong and Guo, 2011). . .”.

Acceptable references include journal articles Villani (2004), numbered papers, dissertations and theses (Machado *et al.*, 2011), published conference proceedings, preprints from conferences, books (Miyagi, 1996) and submitted articles (if the journal is identified).

References should be listed at the end of the extended abstract according to instructions provided in Section 4.

## 5.1 Section titles and subtitles

The section titles and subtitles must be aligned at left, typed with Times New Roman, size 10, bold style font. They must be numbered using Arabic numerals separated by points. No more than 3 sublevels should be used. One single line must be included above and bellow each section title/subtitle.

## 5.2 Mathematical equations

The mathematical equations must be indented by 0.5 cm from the left margin. They must be typed using Times New Roman, italic, size 10 pt. font. Arabic numerals must be used as equation numbers, enclosed between parentheses, right-aligned, as shown in the examples below. Equations should be referred to either as “Eq. (1)” in the middle of a phrase or as “Equation (1)” in the beginning of a sentence. Matrix and vector quantities can be indicated either by brackets and braces, as in Eq. (1), or in bold style, as in Eq. (2). Symbols used in the equations must be defined immediately before or after their first appearance.

One single line must be included above and bellow each equation.

$$[M]\{\ddot{x}\} + [C]\{\dot{x}(t)\} + [K]\{x(t)\} = f(t) \quad (1)$$

$$\mathbf{M}\ddot{\mathbf{x}}(t) + \mathbf{C}\dot{\mathbf{x}}(t) + \mathbf{K}\mathbf{x}(t) = \mathbf{f}(t) \quad (2)$$

## 5.3 Figures and tables

Figures and tables should be placed in the text as close as possible to the point they are first mentioned and must be numbered consecutively in arabic numerals. Figures must be referred to either as “Fig. 1” in the middle of a phrase or as “Figure 1” in the beginning of a sentence. The figures themselves as well as their captions must be centered in the breadth-wise direction. The captions of the figures should not be longer than 3 lines.

The legend for the data symbols as well as the labels for each curve should be included into the figure. Lettering should be large enough for ease reading. All units must be expressed in the S.I. (metric) system.

One blank line must be left before and after each figure.

Color figures and high-quality photographs can be included in the extended abstract. To reduce the file size and preserve the graphic resolution, figures must be saved into GIF (figures with less than 16 colors) or JPEG (for higher color density) files before being inserted in the manuscript.

Tables must be referred to either as “Tab. 1” in the middle of a phrase or as “Table 1” in the beginning of a sentence. The tables themselves as well as their titles must be centered in the breadth-wise direction. The titles of the tables should not be longer than 3 lines. The font style and size used in the tables must be similar (both in size and style) to those used in the text body. Units must be expressed in the S.I. (metric) system. Explanations, if any, should be given at the foot of the tables, not within the tables themselves.

One blank line must be left before and after each table.

The style of table borders is left free. An example is given in Tab. 1.

Table 1. Experimental results for flexural properties of CFRC-4HS and CFRC-TWILL composites.  
Span/depth ratio = 35:1. Average results of 7 specimens.

Composite Properties	CFRC-TWILL	CFRC-4HS
Flexural Strength (MPa) <sup>(1)</sup>	209 ± 10	180 ± 15
Flexural Modulus (GPa) <sup>(1)</sup>	57.0 ± 2.8	18.0 ± 1.3
Mid-span deflection at the failure stress (mm)	2.15 ± 1.90	6.40 ± 0.25

<sup>(1)</sup> measured at 25°C

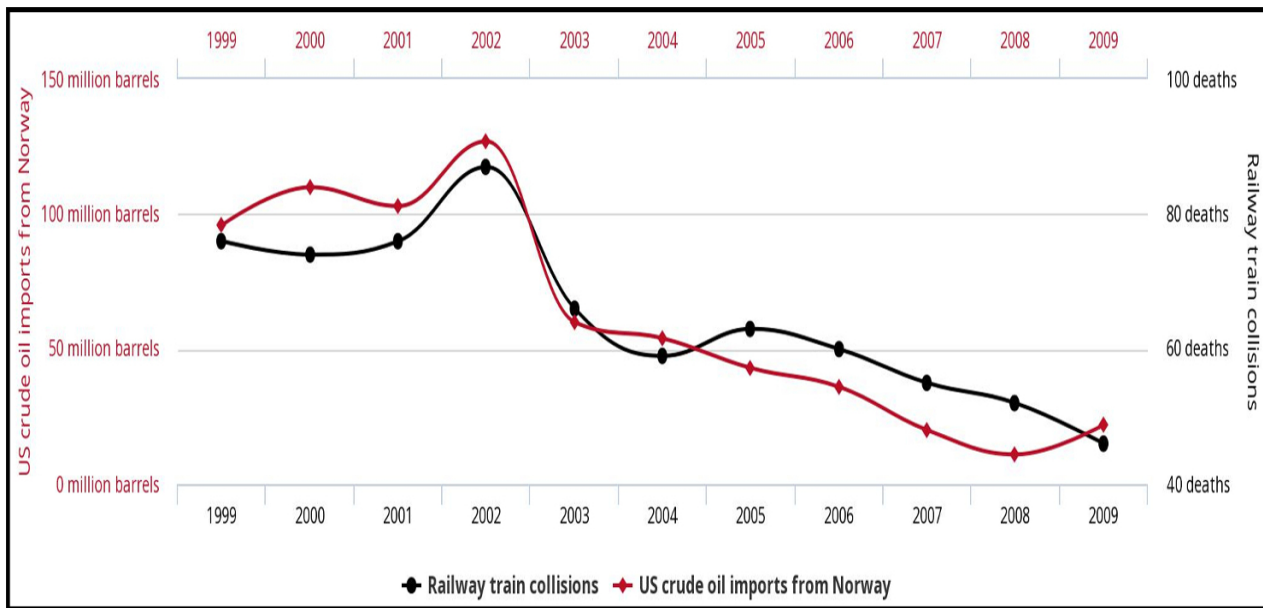


Figure 1. United States crude oil imports from Norway versus number of drivers killed in collision with railway train.  
Available from: <http://tylervigen.com/spurious-correlations>

## 6. ACKNOWLEDGEMENTS

This optional section must be placed before the list of references.

## 7. REFERENCES

The list of references must be introduced as a new section, located at the end of the extended abstract. The first line of each reference must be aligned at left. All the other lines must be indented by 0.5 cm from the left margin. All references included in the reference list must have been mentioned in the text.

References must be listed in alphabetical order, according to the last name of the first author. See the following examples:

- Machado, R., Rodrigues, M. and Nascimento, D., 2011. “Previsão da Demanda Intermitente pelo método de Croston Modificado e a Distribuição de Erlang”. In *XXXI Encontro Nacional de Engenharia de Produção*. Belo Horizonte, p. 15.
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- Villani, E., 2004. *Modelagem e Análise De Sistemas Supervisórios*. Ph.D. thesis, Universidade de São Paulo. URL <http://www.teses.usp.br/teses/disponiveis/3/3132/tde-08062004-131133/>.
- Xinglong, P. and Guo, H., 2011. “Research on the Application of Discrete Event System Based on Controlled Petri Net”. *2011 Third International Conference on Measuring Technology and Mechatronics Automation*, pp. 91–94. doi:10.1109/ICMTMA.2011.594. URL <http://ieeexplore.ieee.org/lpdocs/epic03/wrapper.htm?arnumber=5721431>.