Modeling and Simulation in Education

Yuri Senichenkov

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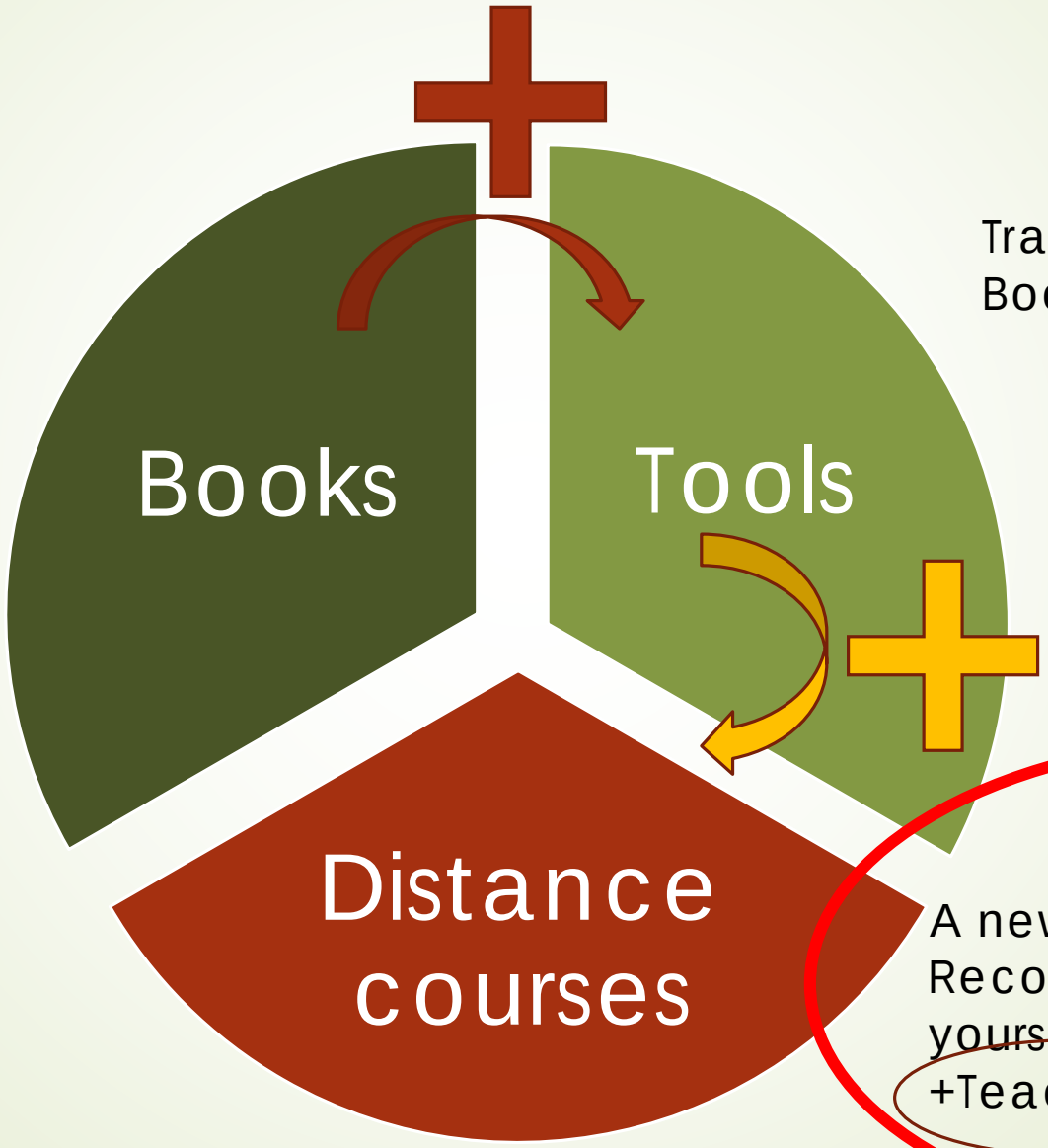
Student: I want to study modeling and simulation. What should I do if I have no relevant courses in my university? I am a user and my main interests are in applied area. I understand well, that modeling and simulation will help me, but where to start and what to choose?

where to start? what to choose?



Traditional way:
Books +Tools by yourself

A new one:
Recommended E-Books +Tools by yourself
+Teacher

Distance learning.
Modeling and simulation for engineers

What?

- Modeling – models (mathematical models)
- Simulation – tools (universal, specialized)
- Sites – Global:

  Coursera (https://www.coursera.org/),

  Open Education (https://openedu.ru)

Where?

- Sites – Local : university sites based on SAKAI, MOODLE

What do you need?

- Books – Text-books, Training-books, Tutorials, e-books
- Assignments – learning tasks, leaning models
- Tests - halfway tests, final tests

Mathematics and Computer science for Engineers

Algebra

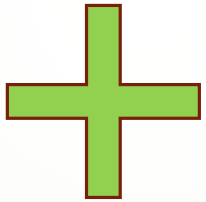
Mathematical analysis

Algorithmic languages

Probability and statistics

Numerical analysis

Theory of algorithms



Mathematical modeling

Computer modeling technologies

Bachelors

Distance learning.

Modeling and simulation for engineers

What?

- Key words: *Modeling –Simulation*
- Sites – Global:

Where?

Coursera (https://www.coursera.org/), 18/5100 %

Open Education (https://openedu.ru) 6/723 %

= 0!

Global: Coursera –modeling and simulation -18 courses

Averaged-Switch Modeling and Simulation

University of Colorado Boulder

Курс

4.7 (40) | Студентов: 3,2K | PLUS

Intermediate

Cyber-Physical Systems: Modeling and Simulation

University of California, Santa Cruz

Курс

4.6 (27) | Студентов: 5,6K | PLUS

Intermediate

Simulation and modeling of natural processes

University of Geneva

Курс

4.2 (265) | Студентов: 28K | PLUS

Mixed

Power Electronics

University of Colorado Boulder

Специализация

4.7 (2 975) | Студентов: 97K | PLUS

Intermediate

Modeling and Control of Power Electronics

University of Colorado Boulder

Специализация

4.7 (50) | Студентов: 5,3K | PLUS

Intermediate

Introduction to High-Throughput Materials Development

Georgia Institute of Technology

Курс

4.6 (144) | Студентов: 9,2K

Intermediate

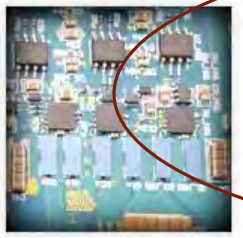
Modeling and Control of Single-Phase Rectifiers and Inverters

University of Colorado Boulder

Курс

PLUS

Intermediate



Techniques of Design-Oriented Analysis

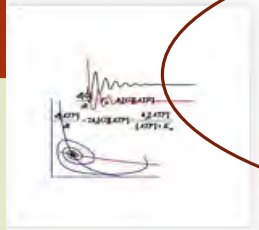
University of Colorado Boulder

Курс

4.8 (11) | PLUS

Intermediate

Coursera



Dynamical Modeling Methods for Systems Biology

Icahn School of Medicine at Mount Sinai

Курс

4.7 (182) | Студентов: 15K | PLUS

Mixed

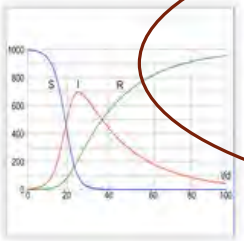
Introduction to Agent-based Modeling with NetLogo

Coursera Project Network Новое

Проект с консультациями

4.7 (68) | Студентов: 2K | PLUS

Beginner



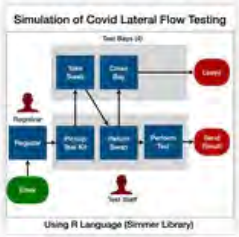
Simulating Viral Pandemics in Python

Coursera Project Network Новое

Проект с консультациями

3.7 (24) | PLUS

Intermediate



Simulation of Covid-19 Testing Process Using R Simmer

Coursera Project Network Новое

Проект с консультациями

Beginner

Modern Robotics, Course 3: Robot Dynamics

Northwestern University

Курс

4.7 (121) | Студентов: 6,9K | PLUS

Intermediate

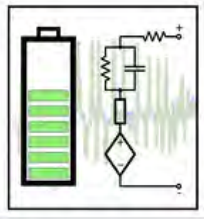
Simulation Models for Decision Making

University of Minnesota

Курс

PLUS

Beginner



Equivalent Circuit Cell Model Simulation

University of Colorado System

Курс

4.7 (259) | Студентов: 10K | PLUS

Intermediate

Structural Equation Model and its Applications | 结构方程模型及其应用 (普通话)

The Chinese University of Hong Kong

Курс

4.7 (75) | Студентов: 6,8K

Mixed

Key words: modeling and simulation + modelica

Building on the SIR Model

Imperial College London

Курс

4.8 (15) | Студентов: 1,8K | PLUS

Intermediate

Averaged-Switch Modeling and Simulation

University of Colorado Boulder

Курс

4.7 (40) | Студентов: 3,2K | PLUS

Intermediate

Cyber-Physical Systems: Modeling and Simulation

University of California, Santa Cruz

Курс

4.6 (27) | Студентов: 5,6K | PLUS

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Курс

PLUS

Intermediate

Techniques of Design-Oriented Analysis

University of Colorado Boulder

Курс

4.8 (11) | PLUS

Intermediate

Current-Mode Control

University of Colorado Boulder

Курс

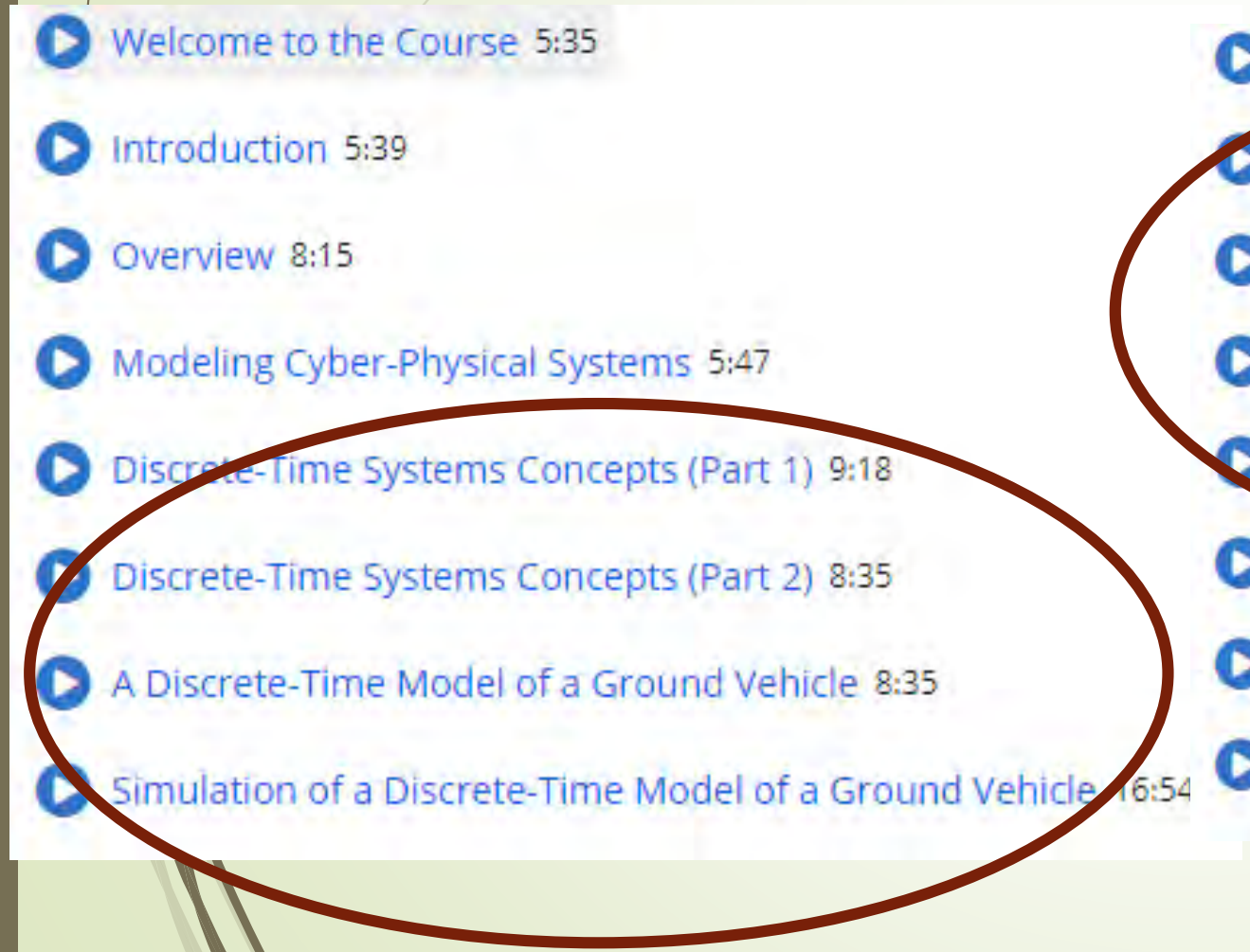
PLUS

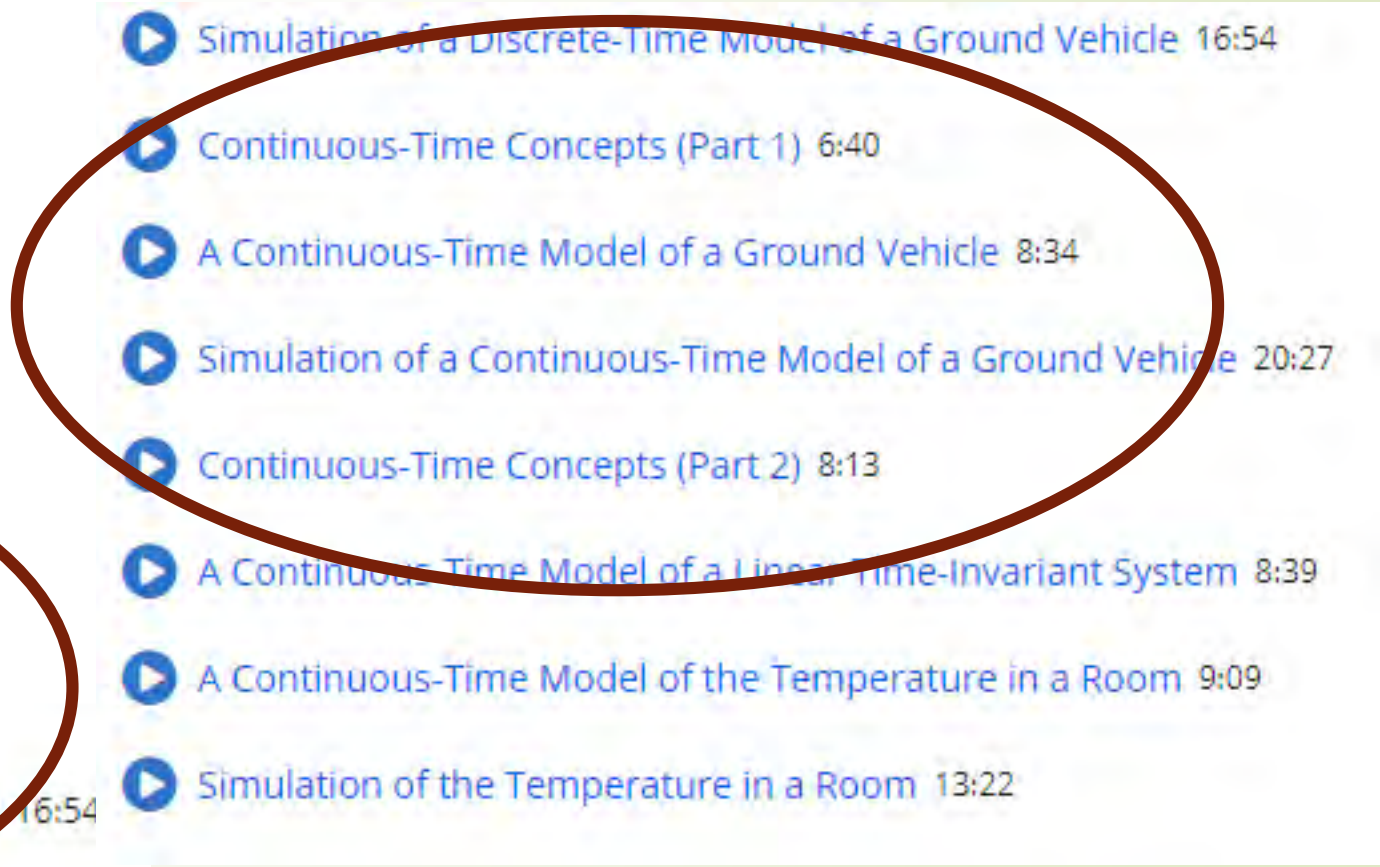
Intermediate

Cyber-Physical Systems: Modeling and Simulation https://www.coursera.org/learn/cyber-physical-systems-1#syllabus

- Basic Modeling Concepts: Discrete-time and Continuous-Time Systems
- Modeling Cyber Components: Finite State Machines, Computations, Algorithms, and a First CPS Model
- Modeling Interfaces for Cyber-Physical Systems: Conversion, Networks, and Complete CPS Models
- Trajectories in CPS and Simulations: Time Domains, Executions, and Complete CPS Models

Constance


Welcome to the Course 5:35
Introduction 5:39
Overview 8:15
Modeling Cyber-Physical Systems 5:47
Discrete-Time Systems Concepts (Part 1) 9:18
Discrete-Time Systems Concepts (Part 2) 8:35
A Discrete-Time Model of a Ground Vehicle 8:35
Simulation of a Discrete-Time Model of a Ground Vehicle 16:54

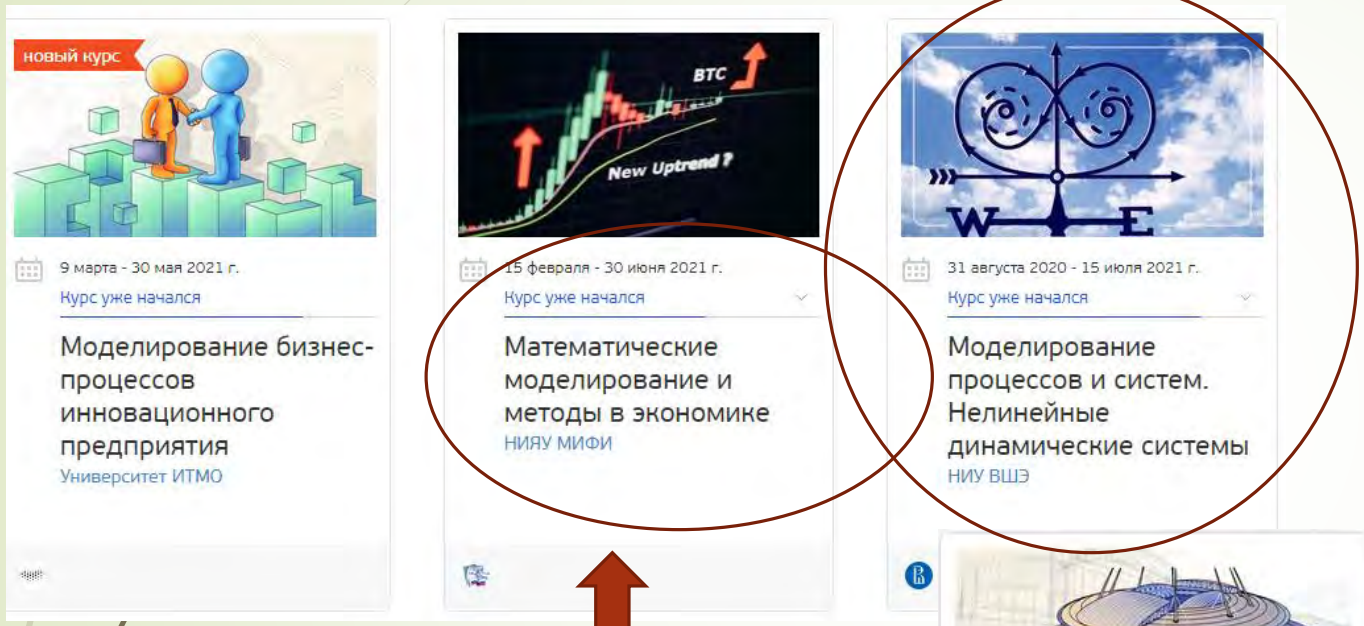

Simulation of a Discrete-Time Model of a Ground Vehicle 16:54
Continuous-Time Concepts (Part 1) 6:40
A Continuous-Time Model of a Ground Vehicle 8:34
Simulation of a Continuous-Time Model of a Ground Vehicle 20:27
Continuous-Time Concepts (Part 2) 8:13
A Continuous-Time Model of a Linear Time-Invariant System 8:39
A Continuous-Time Model of the Temperature in a Room 9:09
Simulation of the Temperature in a Room 13:22

Cyber-Physical Systems: Modeling and Simulation

- Video -15 (total time 144 min); Material for self-study -1; Tests -2
- Video -12 (total time 72 min)- Material for self-study -0; Tests -0
- Video -13 (total time 109 min)- Material for self-study -0; Tests -0
- Video -11 (total time 88 min)- Material for self-study -0; Tests -0

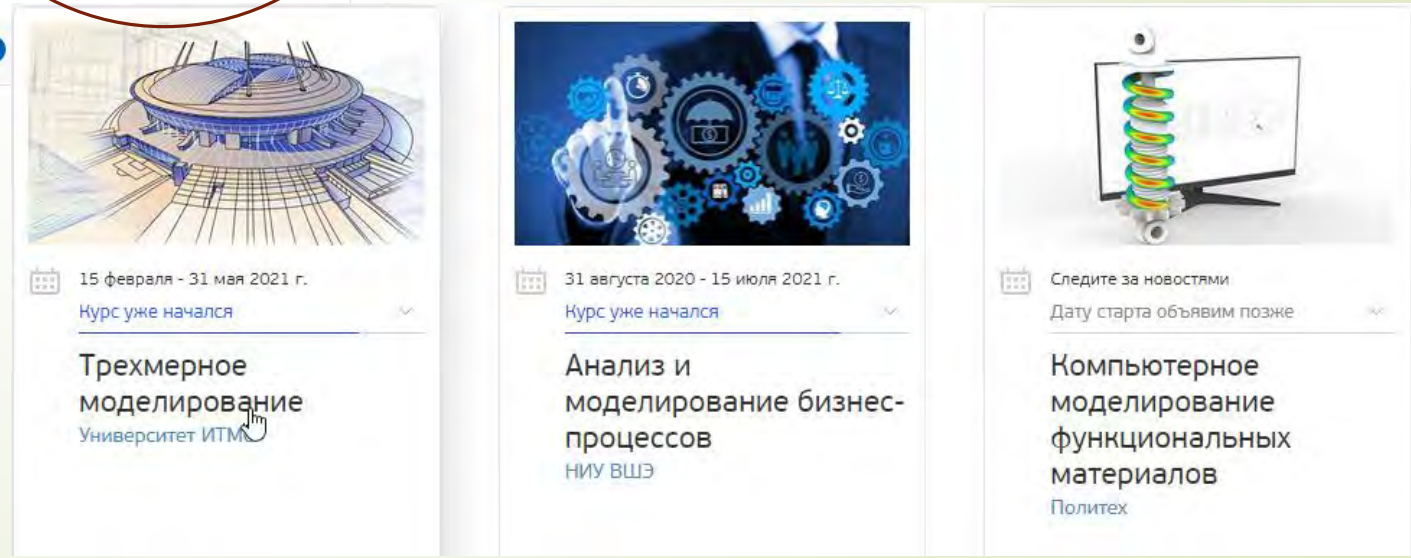
Number of students: 5,629

Local (Russia): Open Education 6 courses



Non-Linear Dynamics

Mathematical Modeling in economics



http://www.inmotion-project.net/index.php/ru/

Universität Bremen

State Marine Technical University
SMTU

POLYTECH
Peter the Great St.Petersburg Polytechnic University

Novosibirsk State Technical University

UniKL
UNIVERSITI KUALA LUMPUR

UTM
UNIVERSITI TEKNOLOGI MALAYSIA

UNED

University of Ljubljana

SPIIRAS

UTP

InMotion

Innovative teaching and learning strategies in open modelling and simulation environment for student-centered engineering education

The general aim of InMotion is to continue the reform of the system of higher education in the Engineering in Malaysia and Russian Federation to improve quality of education and teaching according to the priorities established in the Bucharest and Yerevan Communiqués and to meet the demands of Strategic Framework for European Cooperation in Education and Training (ET 2020).

When implemented the project will change the situation in Engineering education in the following ways:

- Student-centred learning will make the educational process more flexible and effectively by the choice of the desired studying areas.
- Consortium universities in MY and RU will be enabled to prepare graduates competent in the Computer Modelling and Simulation(CMSE) field.
- With Open Modelling and Simulation Environment platform (OMSE) we will create a new paradigm in respect to integration, harmonization and aggregation of various types of quality-controlled eLearning components derived from internationally operated learning and research facilities. All the consortium members will have an adaptive learning environment both meeting the needs of today and oriented towards technologies of tomorrow.
- The stakeholders will get access to the MOOCs for the LLL training of their professionals
- Prospectively, other Facultaties of partner universities and universities outside the consortium may adopt the learning environment (OMSE) and use it for teaching students in the other fields.

The principal outcomes and outputs are:

- updated Curricula with new Syllabi
- new Textbooks, guidelines
- new eLearning Materials, based on innovative teaching strategies and creative learning approaches, such as: Research Based Learning; eScience approach; Collaborative/ Personal Learning Environment; virtual labs for learning and comparison of the modern Simulation packages: Matlab, Simulink, RDM, Modelica, ISMA, Wolfram SystemModeler
- MOOCs in CMSE.

ERASMUS +, Capacity building in higher education, № 573751-EPP-1-2016-1-DE-EPPKA2-CBHE-JP

Co-funded by the Erasmus+ Programme of the European Union

The European Commission support for the production of this publication does not constitute an endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein

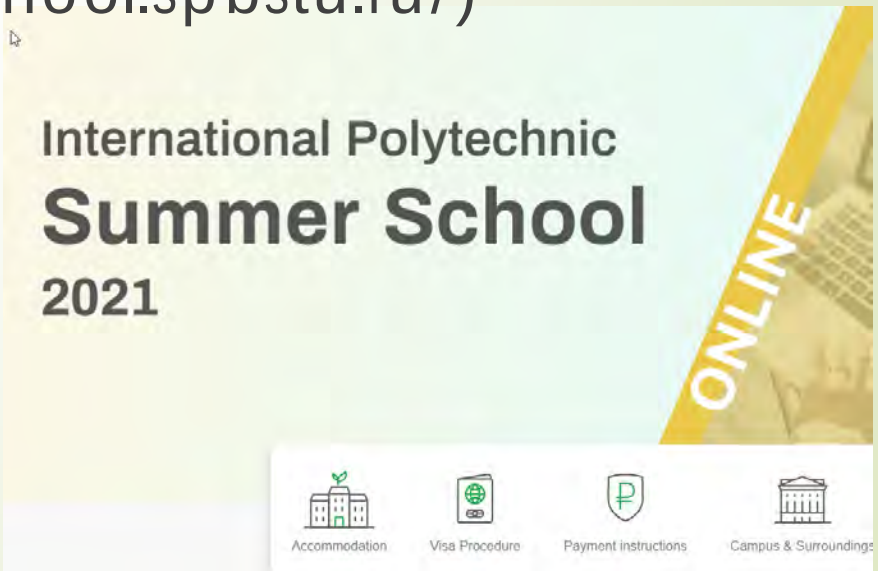
Project news

The final project meeting of InMotion steering group and conference was hold in SMTU and SPbPU in St. Petersburg on 16-18.09.2019. The members of the project steering group get together to report about the results of the project anc coordinate the work on the final report.

You can read more information about these and other events in our Newsleiter Oct 2019

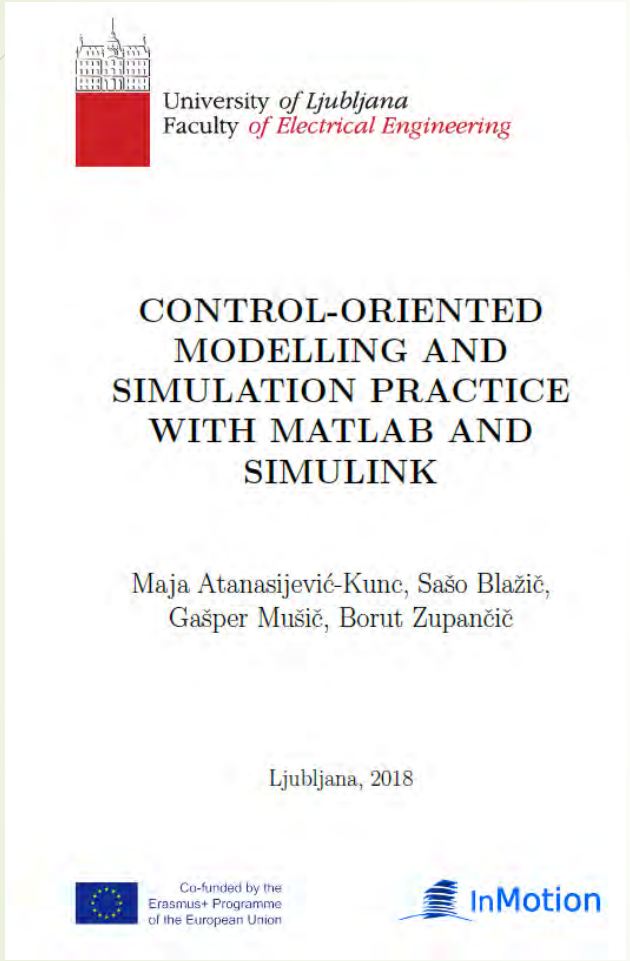
Local(Erasmus): Modeling and simulation for engineers (InMotion)

- InMotion http://inmotion-project.net/index.php/en/8-inmotio
- SPbPU – Winter school (https://summerschool.spbstu.ru/schools/winter_school/)
- SPbPU – Summer school (https://summerschool.spbstu.ru/)



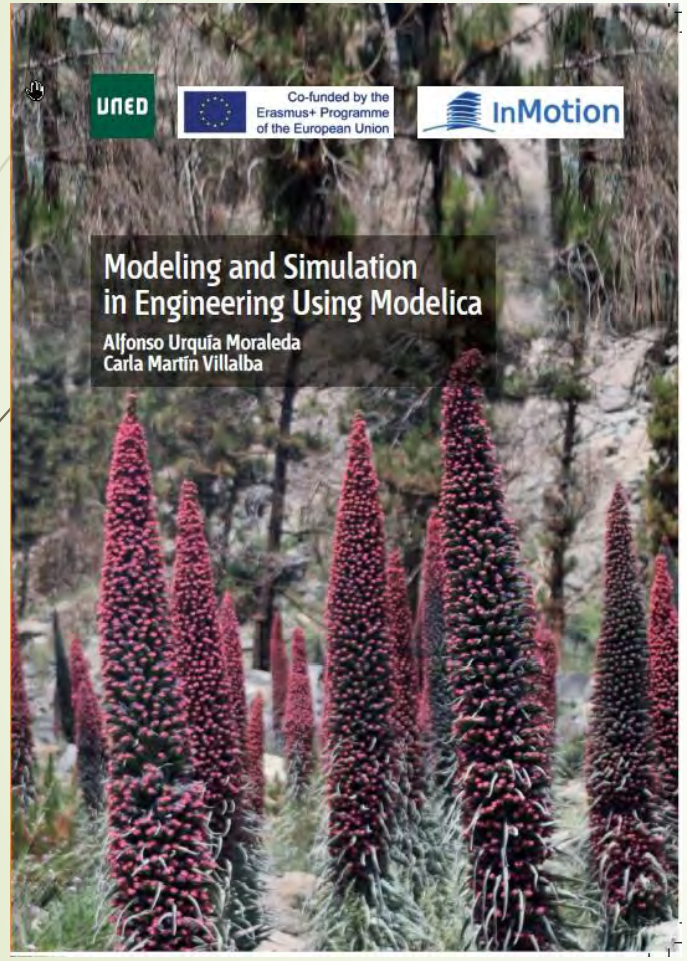
Spain, Slovenia

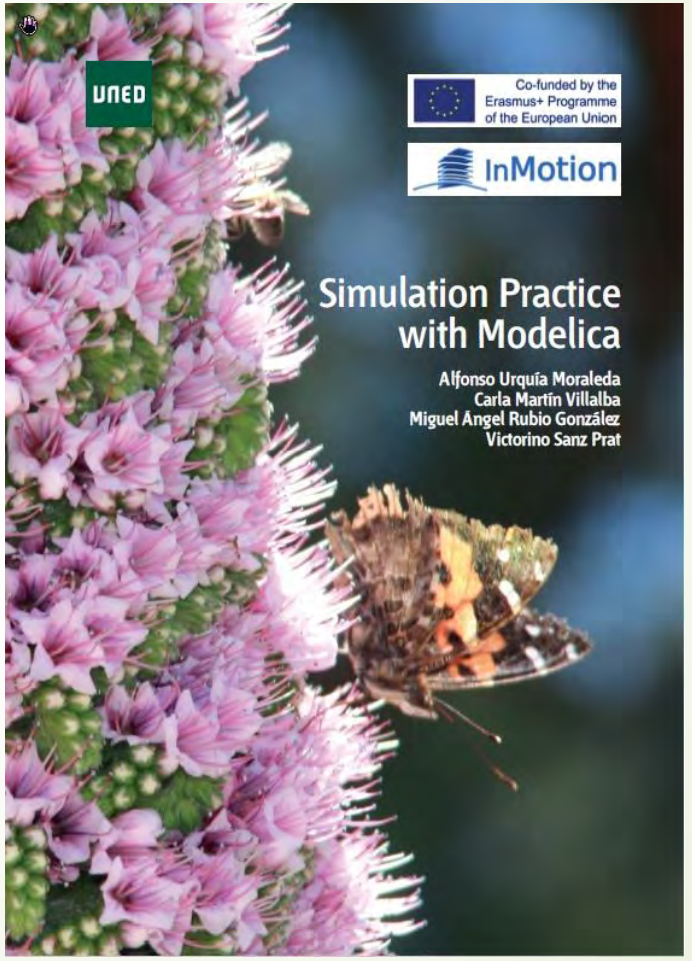
Slovenia


University of Ljubljana
Faculty of Electrical Engineering
CONTROL-ORIENTED MODELLING AND SIMULATION PRACTICE WITH MATLAB AND SIMULINK
Maja Atanasijević-Kunc, Sašo Blažič, Gašper Mušič, Borut Zupančič
Ljubljana, 2018
Co-funded by the Erasmus+ Programme of the European Union
InMotion


Университет Любляны
Факультет электротехники
КОМПЬЮТЕРНОЕ МОДЕЛИРОВАНИЕ В ТЕОРИИ АВТОМАТИЧЕСКОГО УПРАВЛЕНИЯ: МЕТОДЫ И СРЕДСТВА
Майя Атанасиевич-Кунц, Сашо Блажич, Гашпер Мушич, Борут Зупанчич
Любляна, 2017
Co-funded by the Erasmus+ Programme of the European Union

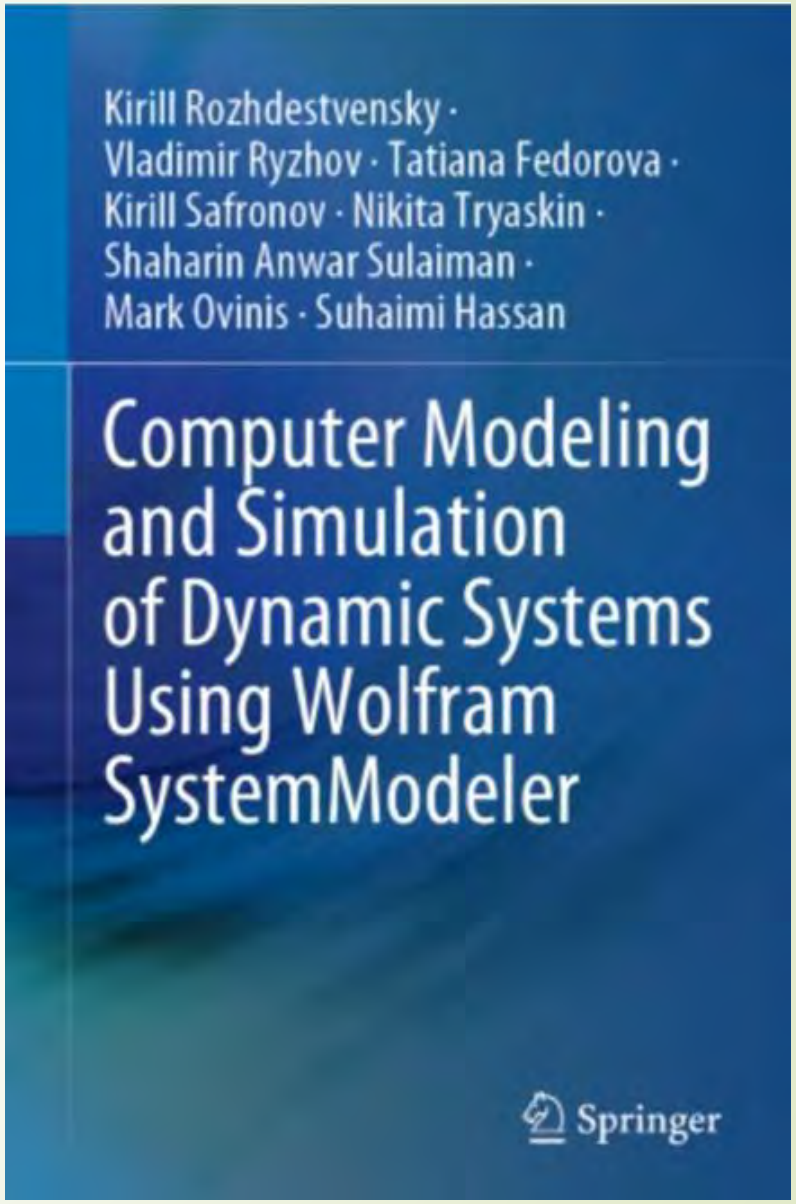
Spain


UNED
Co-funded by the Erasmus+ Programme of the European Union
InMotion
Modeling and Simulation in Engineering Using Modelica
Alfonso Urquía Moraleda
Carla Martín Villalba

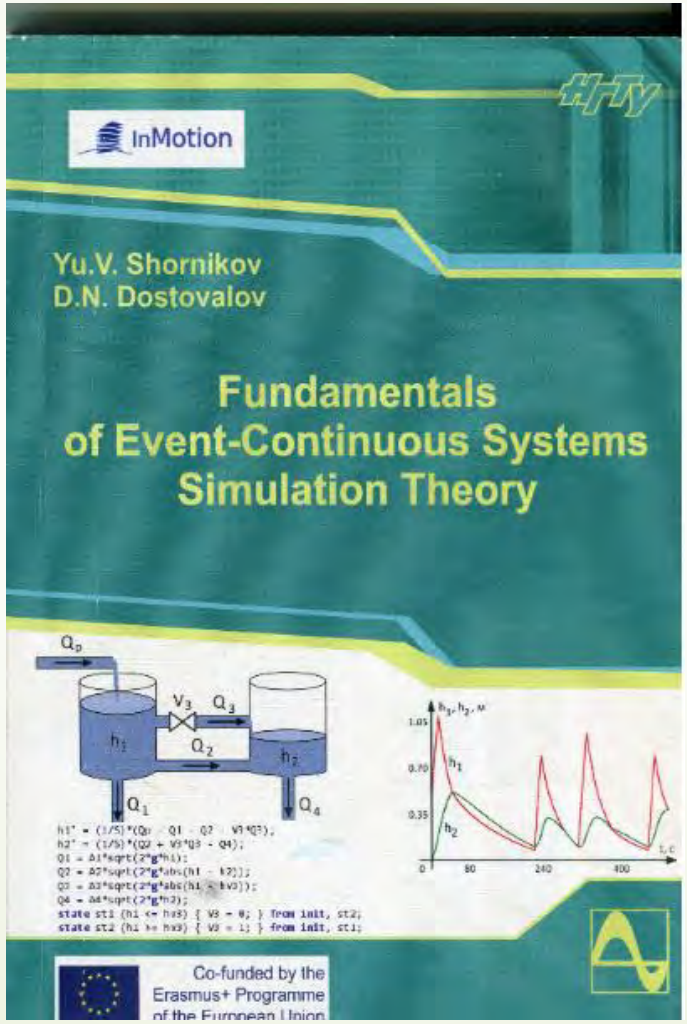

UNED
Co-funded by the Erasmus+ Programme of the European Union
InMotion
Simulation Practice with Modelica
Alfonso Urquía Moraleda
Carla Martín Villalba
Miguel Ángel Rubio González
Victorino Sanz Prat

Russia.


STATE MARINE TECHNICAL UNIVERSITY
САНКТ-ПЕТЕРБУРГСКИЙ ГОСУДАРСТВЕННЫЙ МОРСКОЙ
ТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ
19 30
ST. PETERSBURG


Kirill Rozhdestvensky ·
Vladimir Ryzhov · Tatiana Fedorova ·
Kirill Safronov · Nikita Tryaskin ·
Shaharin Anwar Sulaiman ·
Mark Ovinis · Suhaimi Hassan
Computer Modeling and Simulation of Dynamic Systems Using Wolfram SystemModeler
Springer

Russia. Hybrid systems. ISMA



Novosibirsk State Technical University

Russia. Mathematical modeling of complex dynamical systems (Text- and training books)

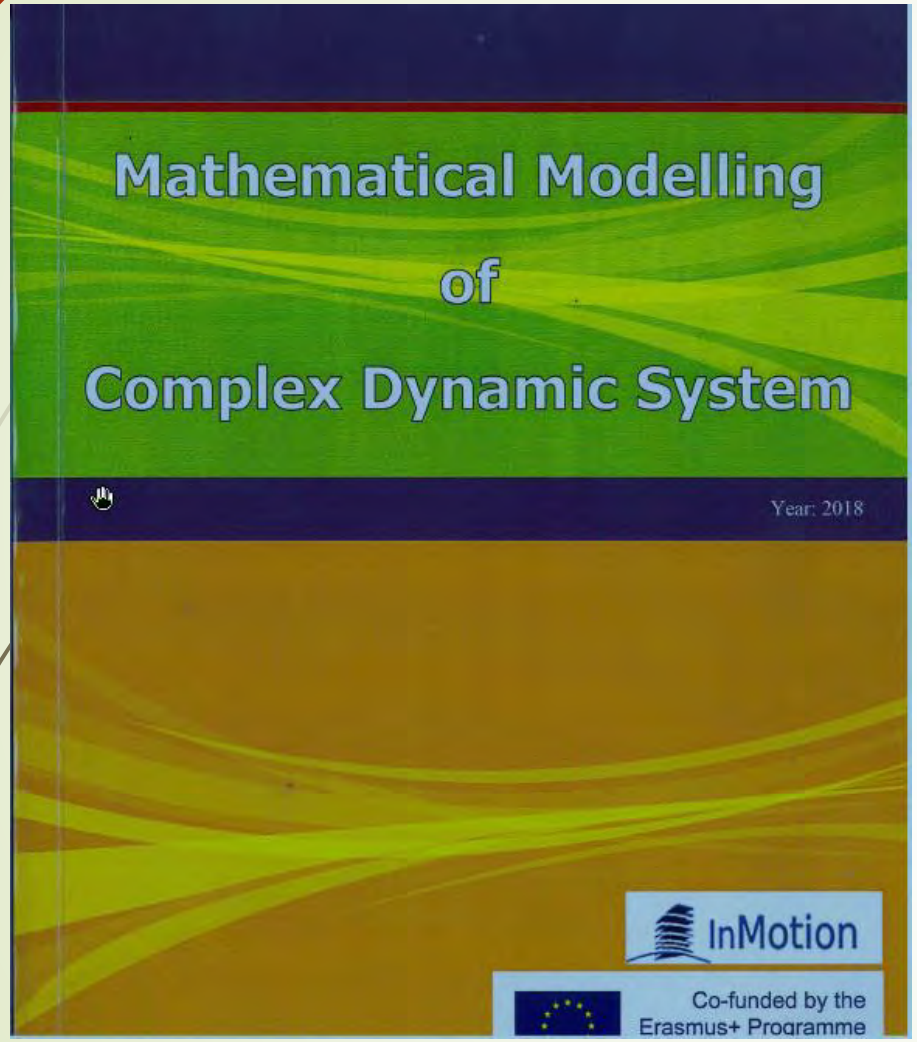
POLYTECH
Peter the Great
St. Petersburg Polytechnic
University

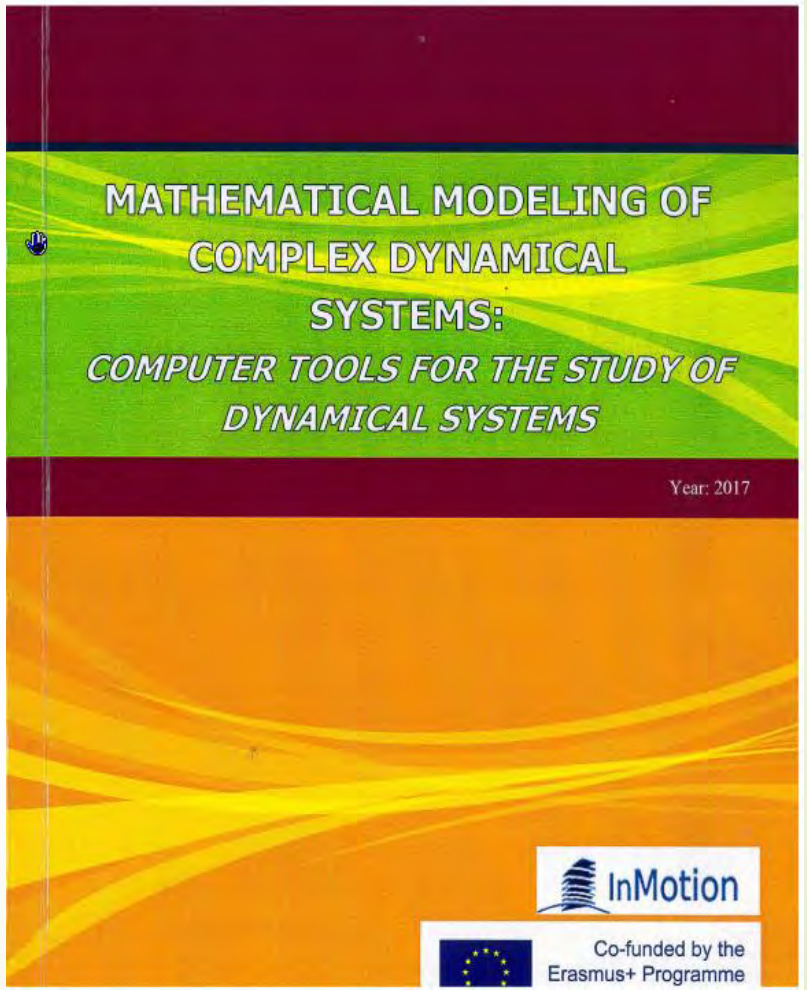
Russia. Computer modeling of complex dynamical systems (Text- and training books)

POLYTECH
Peter the Great
St.Petersburg Polytechnic
University

Malaysia, Johor Bahru (UTM)

English version of text- and training books

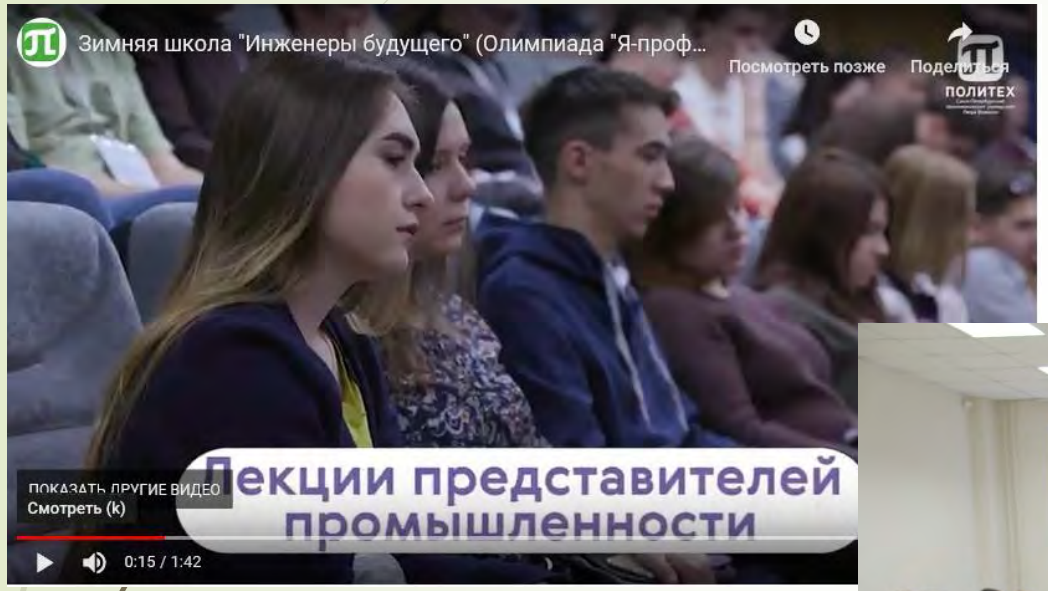




UTM

face-to-face format

Winter school 2019



face-to-face format

Summer school 2019

Summer School 2021

Computer Modeling and Simulation for Engineers

Summer School - Online/Hybrid

4 ECTS | Aug 2 - Aug 13, 2021

Professors and lecturers:

- Prof. Yuri Senichenkov, Polytech (Russia)

Program partners:

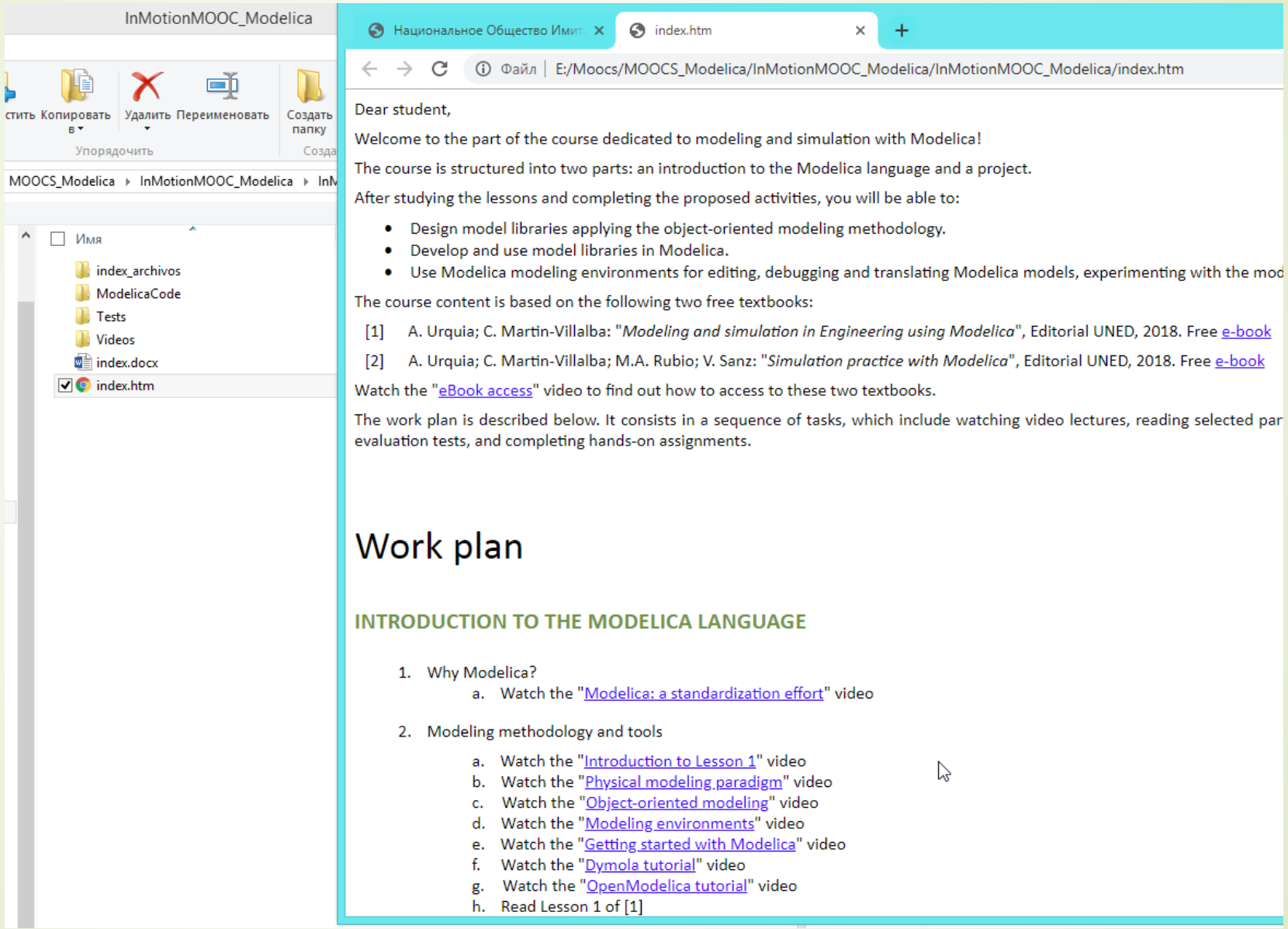
- UNED: National University of Distance Education (Spain)

Contacts:

Summer and Winter Schools Team

- summerschool@spbstu.ru
- +7 (812) 534-25-31

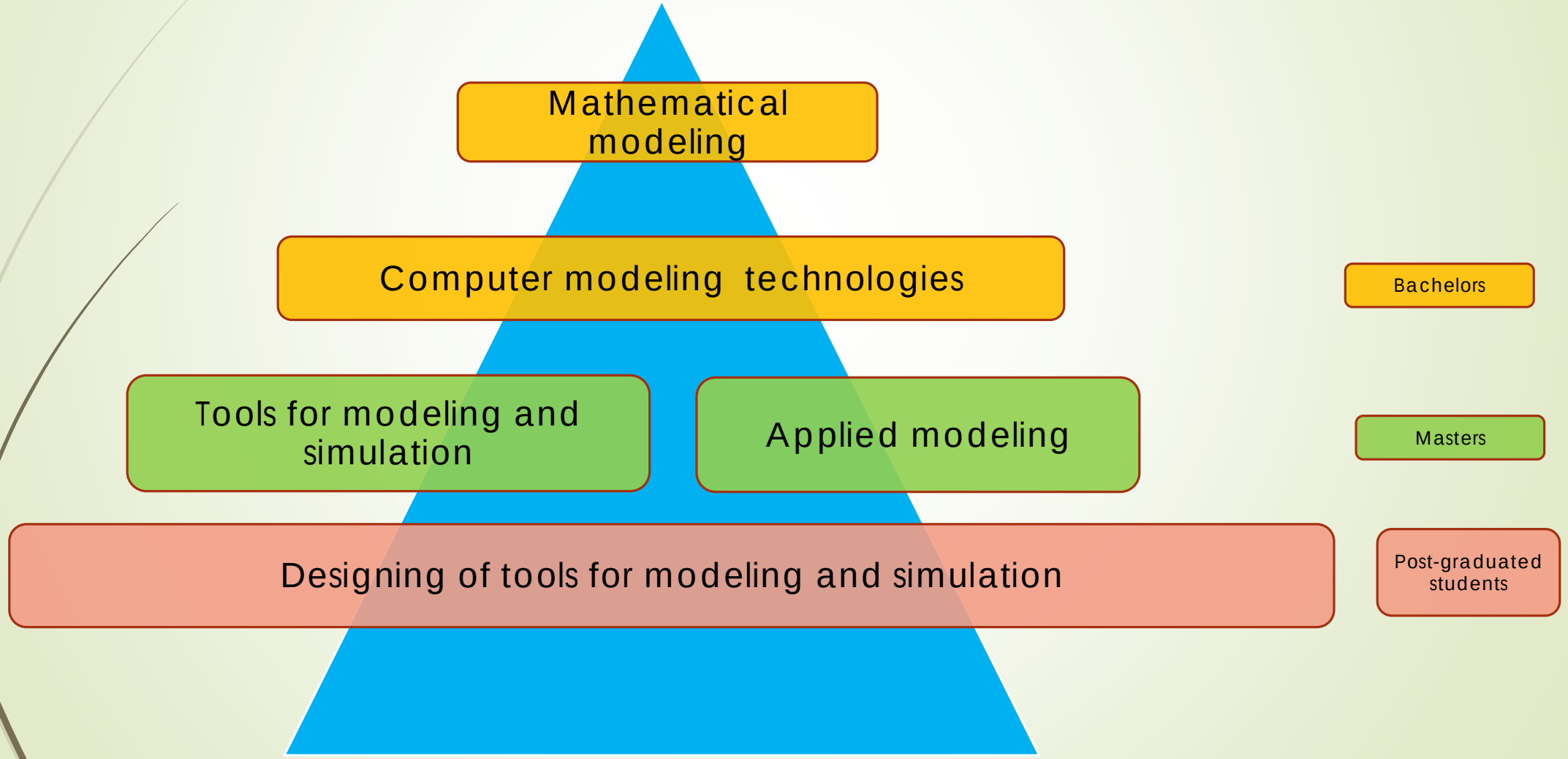
InMotion_MOOC_Modelica



Local (university level): Modeling and simulation for engineers (SPbPU)

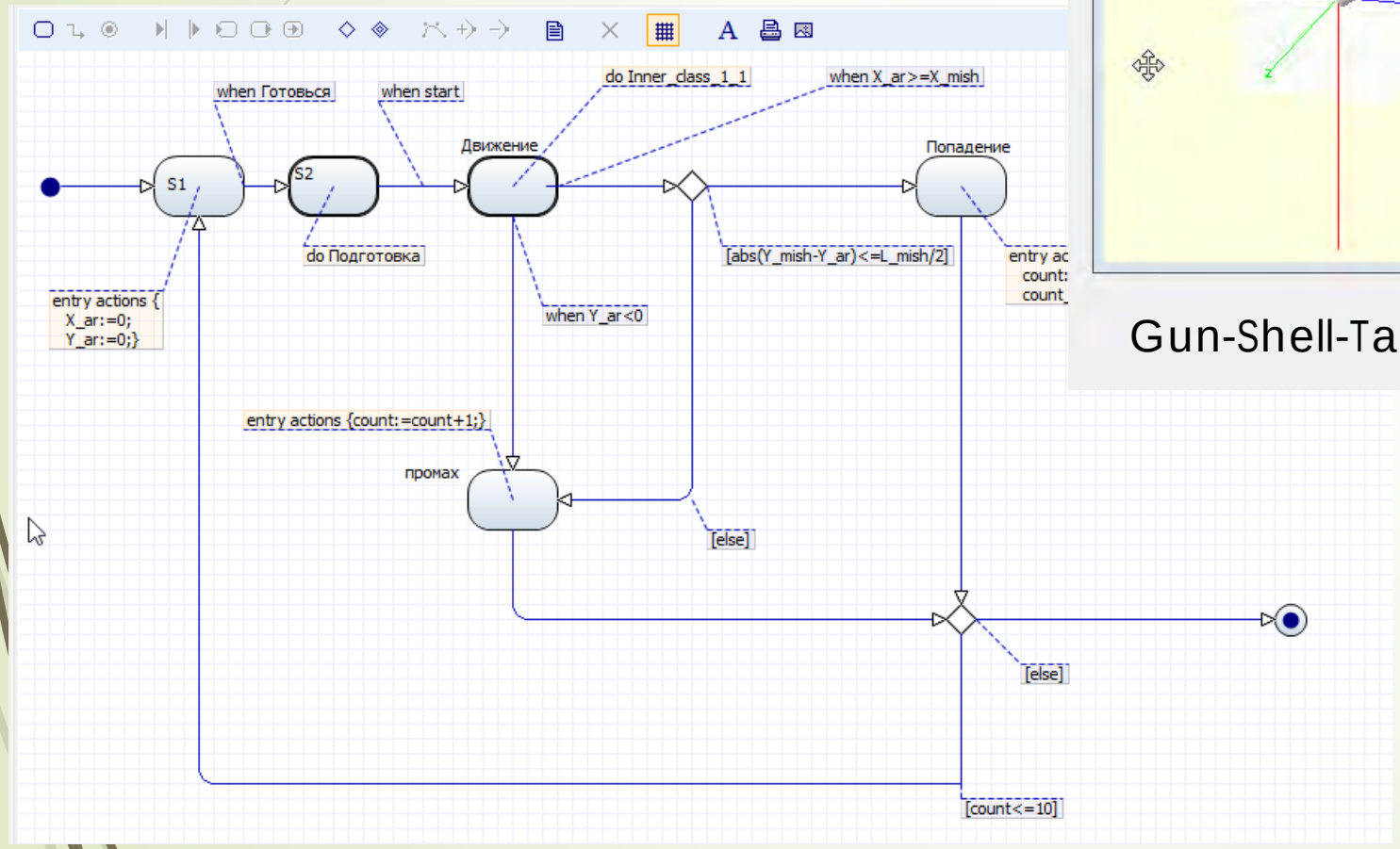
- School-leaver: Modeling for beginners
- Bachelors (users): Mathematical modeling, Computer modeling
- Masters (developers): Object-Oriented-Modeling
- Post-graduate students: Research in OOM

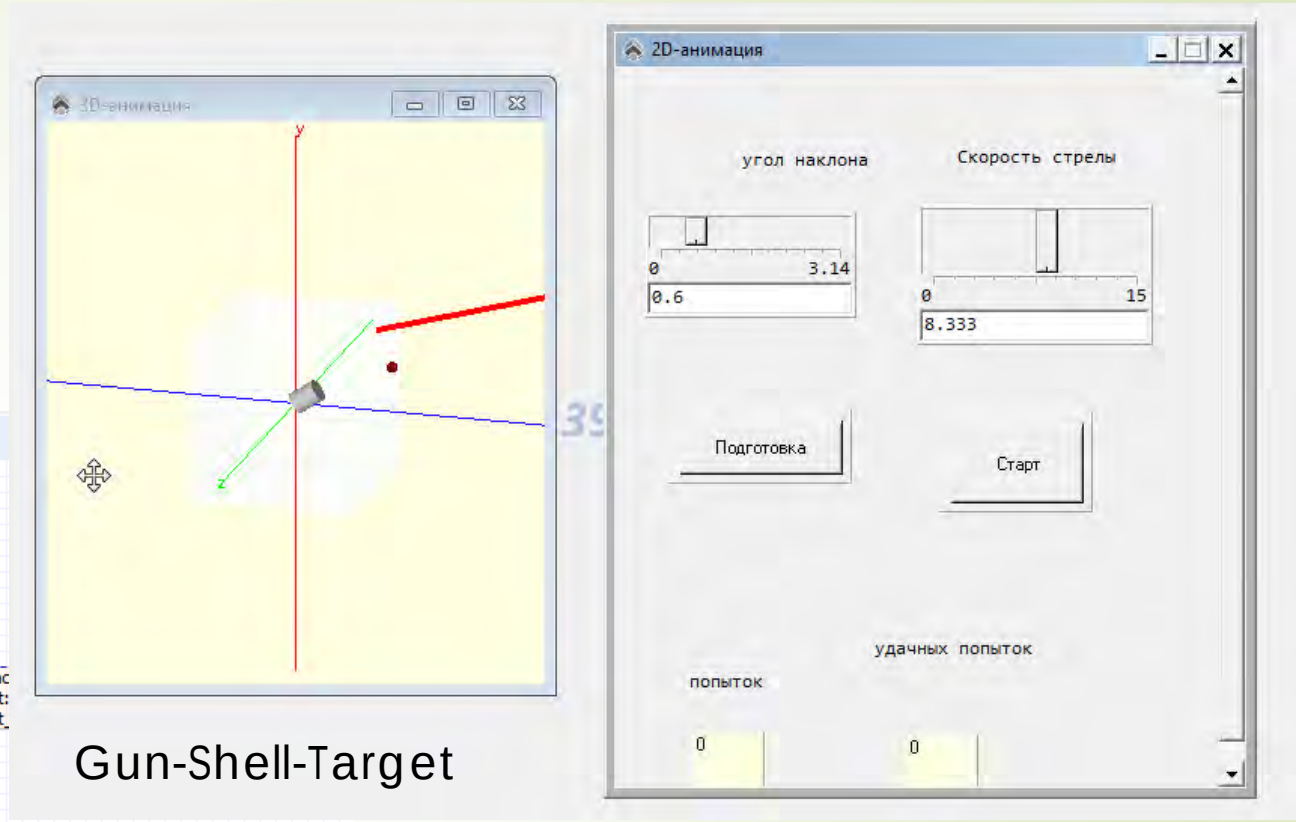
Series of disciplines «Modeling»



School-leave

- Modeling for beginners





Gun-Shell-Target

Choose Velocity and angle

Start flight

Did you get to the target?

No? Try again

Bachelors

- Modeling for beginners
- Mathematical modeling (Mathematica, Maple, Anydynamics)
- Computer Modeling (AnyDynamics, OpenModelica)

Masters

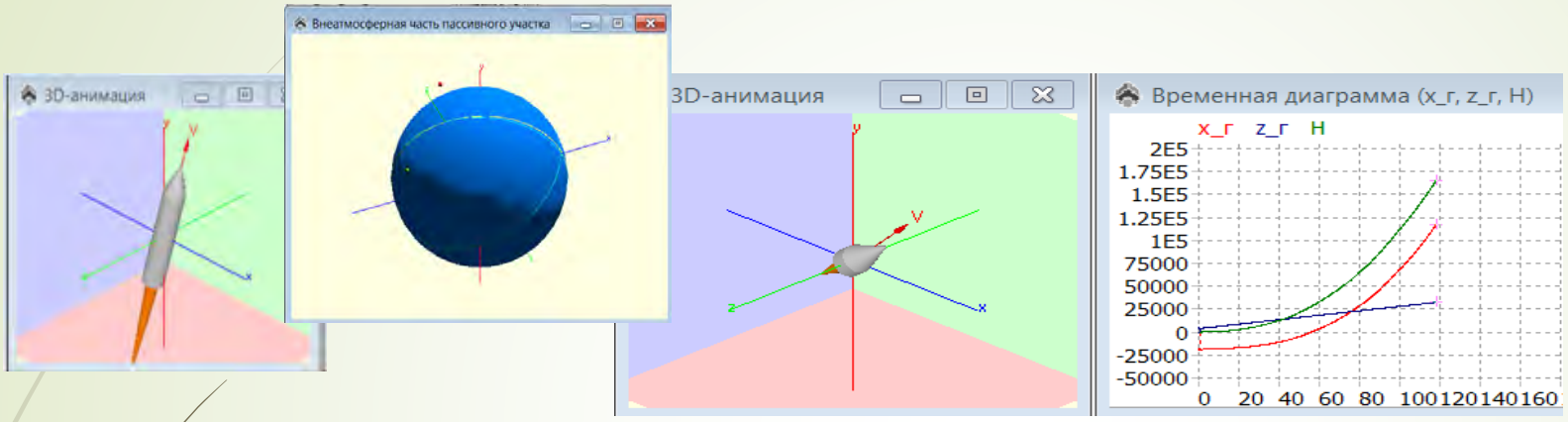
- Object-oriented Modeling (UML, AnyDynamics, OpenModelica)

Computer Modeling

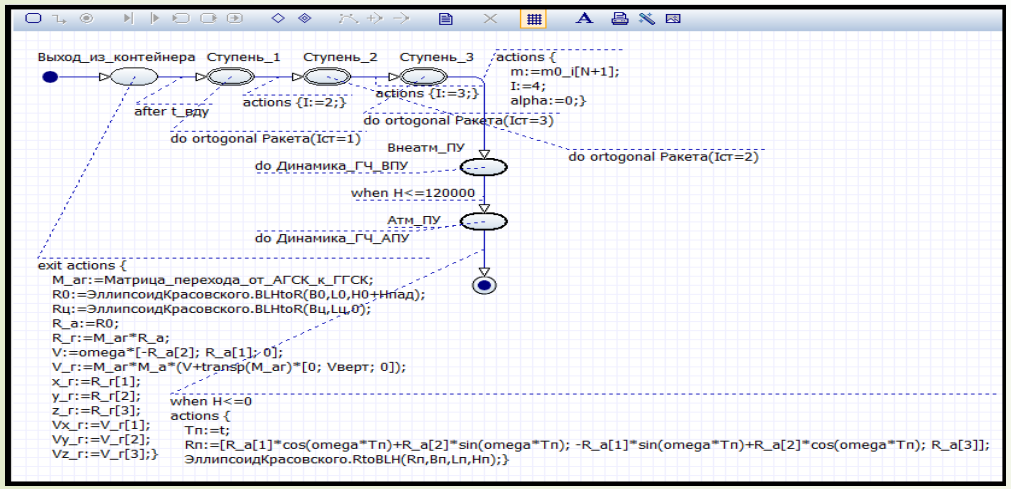
- Bachelors
- Lectures-12
- Labs -12 (AnyDynamics)
- Labs -12 (OpenModelica)

  - Isolated: continues, discrete, hybrid
  - Component models: causal-acausal
  - Components: agent-based
  - Computational experiments

Dynamical and hybrid systems



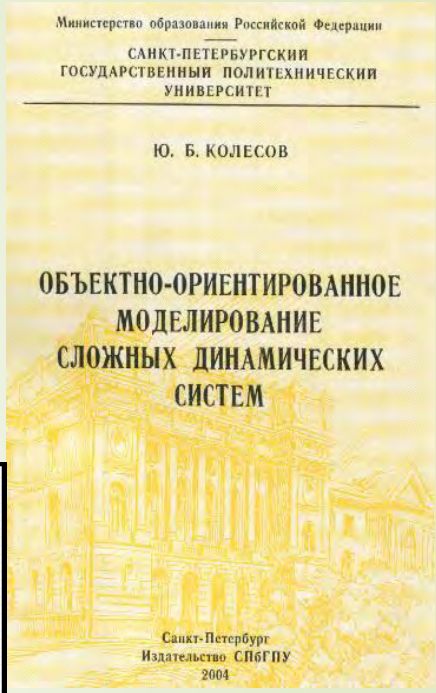
- A flight of three-stage rocket

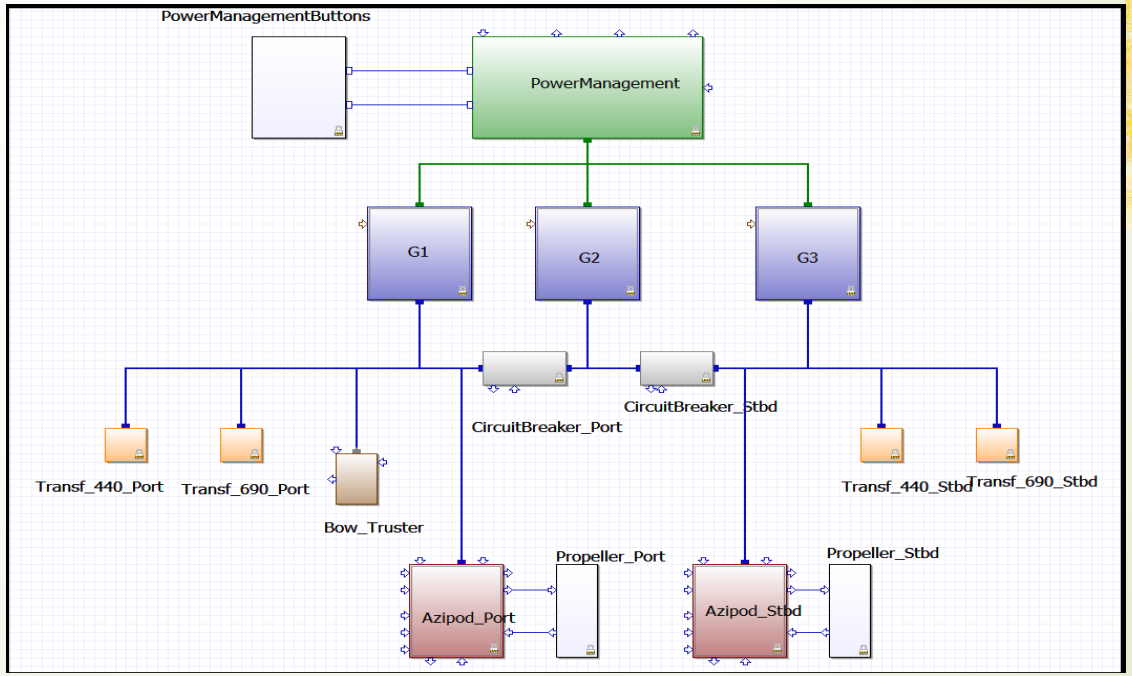


Component models with «oriented blocks» (A la Simulink)

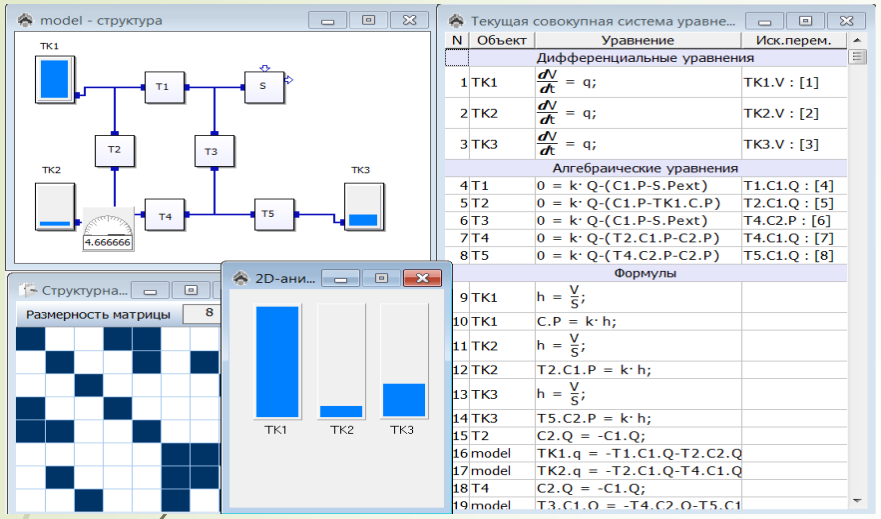
Marine simulators

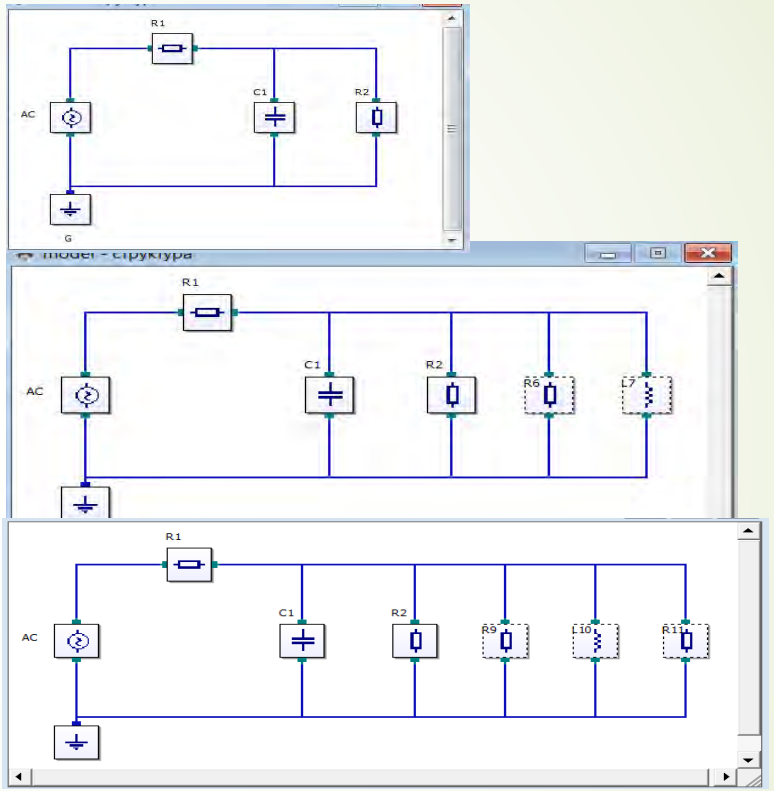
www.transas.com

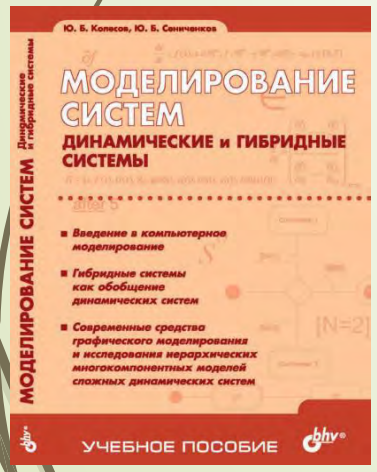




Component models with «non-oriented blocks» (A la Modelica)

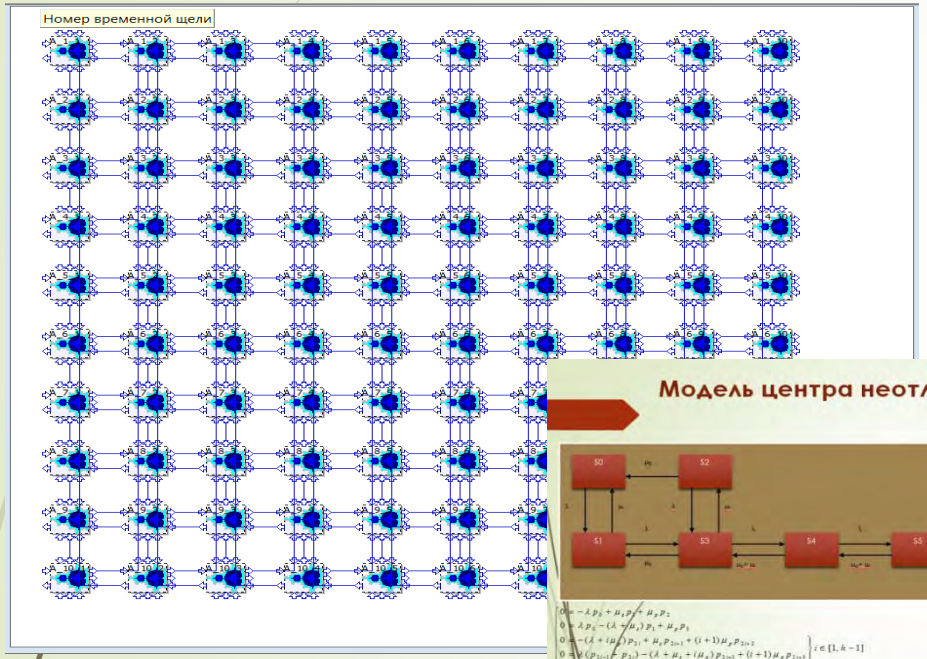


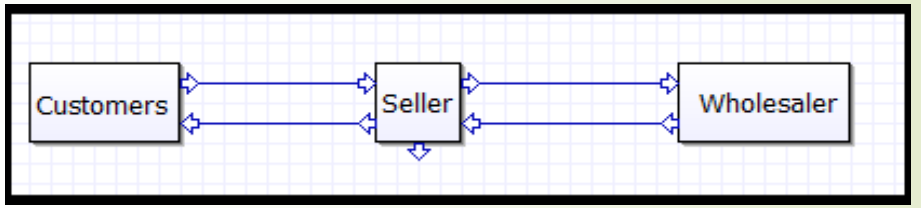




Electrical, mechanical, hydraulic and so on «physical» models

Multicomponent models with dynamical structure (no analogs)





Queuing system. Agent-based systems.

Tools (Used in Russian universities)

- Equation-based OOM-based UML-based
- Isolated Components: causal – acausal (oriented blocks -«Physical»)
- Agents
- Event-driven behavior Event-driven structure

Local: Tools+books

- AnyDynamics
- AnyLogic -
- GPPS, GPSS World
- ISMA
- OpenModelica (Dymola)
- Simulink
- SimInTech
- SystemModeler

Books: GPSS,GPSS World (In Russian)

(0+) GPSS World. Основы имитационн...

239 ₽

ЛитРес

(0+) Моделировани систем. Инструмент...

135 ₽

ЛитРес

(0+) Симуляторы GPSS World и Actor Pilgri...

79,90 ₽

ЛитРес

(0+) Моделировани информацион технологий ...

79,90 ₽

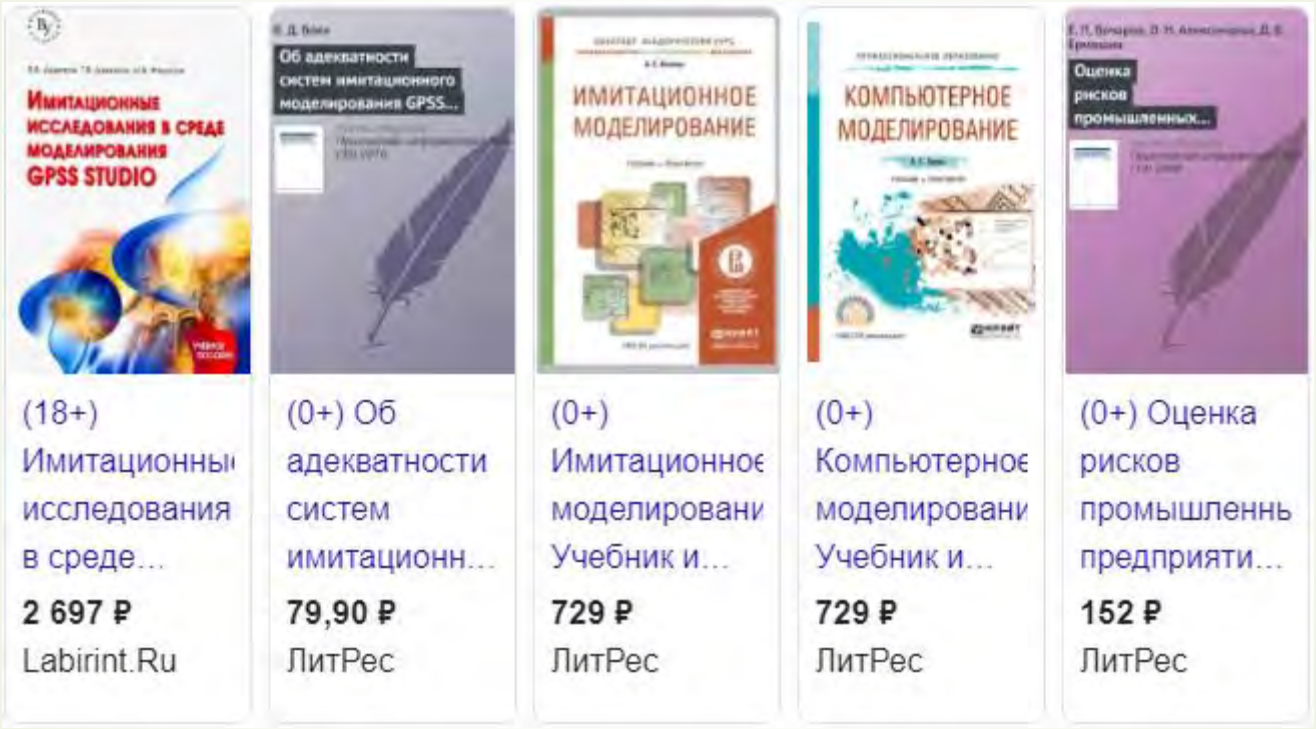
ЛитРес

(0+) Об адекватности систем имитационн...

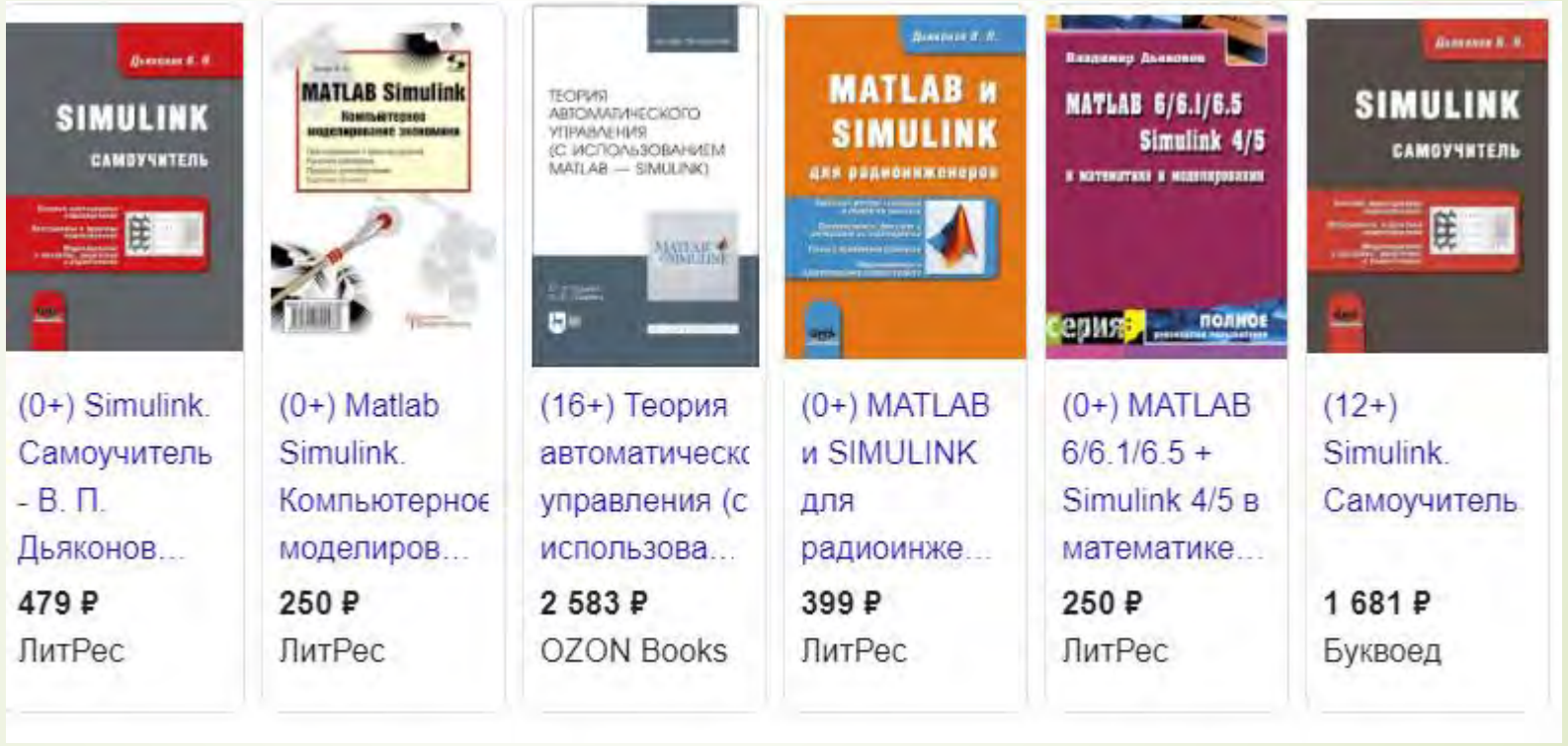
79,90 ₽

ЛитРес

Simulation modeling



Simulink



(0+) Simulink. Самоучитель - В. П. Дьяконов...
479 ₽
ЛитРес

(0+) Matlab Simulink. Компьютерное моделиров...
250 ₽
ЛитРес

(16+) Теория автоматическ управления (с использова...
2 583 ₽
OZON Books

(0+) MATLAB и SIMULINK для радиоинже...
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(12+) Simulink. Самоучитель
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AnyLogic


Илья Григорьев
anylogic
за три дня
Практическое пособие
по имитационному моделированию


Дмитрий Каталенный
ОСНОВЫ ИМИТАЦИОННОГО
МОДЕЛИРОВАНИЯ
И СИСТЕМНОГО АНАЛИЗА
В УПРАВЛЕНИИ

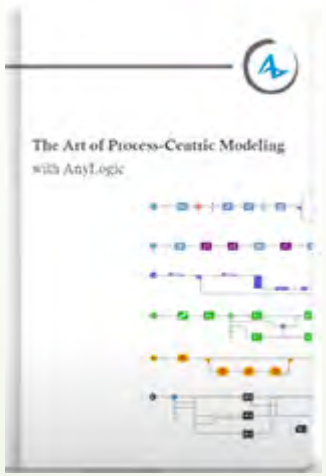

anylogic
Применение
имитационного
моделирования
при управлении
комплексными
проектами
Сергей Суслов
Дмитрий Каталевский

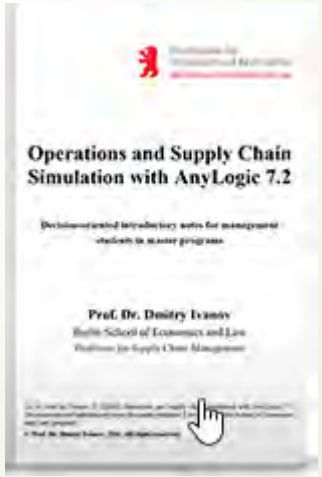

А.Г. Куприянцев
ОСНОВЫ
МОДЕЛИРОВАНИЯ СИСТЕМ

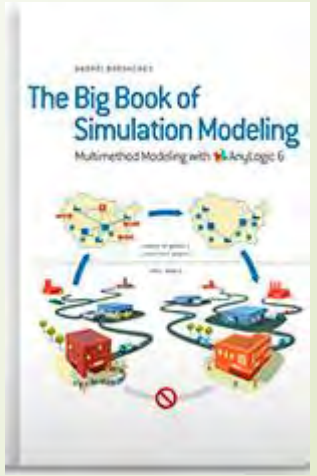

В.Д. Боев
РАБОТА С ГИС КАРТАМИ
В ANYLOGIC 7.1
Методическое пособие


ИНТУИТ
В.Д. Боев
Концептуальное проектирование
систем в AnyLogic 7 и GPSS World


anylogic
В. Д. Боев
КОМПЬЮТЕРНОЕ МОДЕЛИРОВАНИЕ


The Art of Process-Centric Modeling
with AnyLogic


Operations and Supply Chain
Simulation with AnyLogic 7.2
Prof. Dr. Dmitry Ivanov


The Big Book of
Simulation Modeling
Multimethod Modeling with AnyLogic 6

SimInTech


SIM
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ОСНОВЫ МОДЕЛИРОВАНИЯ
ТЕХНИЧЕСКИХ СИСТЕМ


ОСНОВЫ
МОДЕЛИРОВАНИЯ
ТЕХНИЧЕСКИХ СИСТЕМ

Journals:

http://www.kio.spb.ru/journal/

Computer tools in Education

Computer tools in School;

Computer tools in education, 2018
№ 1: 5–15
http://ipo.spb.ru/journal

algorithmic mathematics and mathematical modeling

VIRTUAL LAB IN MODELICA FOR AIR POLLUTION CONTROL*

C. Martín-Villalba[1], M. E. Manzur[2], A. Urquía[1]

[1]Universidad Nacional de Educación a Distancia (UNED), Spain
[2]Universidad Nacional de Tucumán, Argentina

Abstract

Interactive is a Modelica library whose goal is to facilitate the implementation of virtual labs based on Modelica models quickly and with little effort. Modelica is a free object oriented modeling language. The implementation of a virtual lab for air pollution control developed using Interactive 2.0 is discussed in this manuscript. This virtual lab has been developed to explain the dispersion of pollutants into the atmosphere to undergraduate students of Environmental Chemistry of the Universidad Nacional de Tucum´an (Argentina). Main aspects in the virtual lab development process are addressed in this discussion, including: 1) application of a systematic methodology to adapt any Modelica model into a description suitable for interactive simulation; 2) composition of the virtual lab view using Interactive. Additionally, the use of this virtual lab in the Environmental Chemistry course is discussed. Interactive is freely available at www.euclides.dia.uned.es.

Keywords: *Modelica, virtual lab, air pollution.*

Citation: C. Martín-Villalba, M. E. Manzur & A. Urquía, "Virtual Lab in Modelica for Air Pollution Control," *Computer tools in education*, no. 1, pp. 5–15, 2018.

алгоритмическая математика и математическое моделирование

Компьютерные инструменты в образовании, 2018
№ 5: 52–68
УДК: 372.862 : 519.876.5
http://ipo.spb.ru/journal
doi:10.32603/2071-2340-2018-5-52-68

КНИГИ ПРОЕКТА INMOTION

InMotioN: «Новые стратегии обучения инженеров с использованием сред визуального моделирования и открытых учебных платформ»*

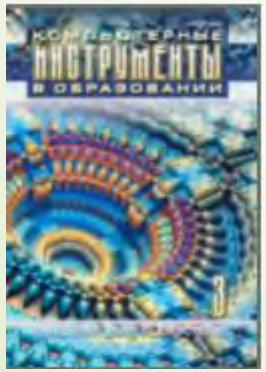
Сениченков Ю. Б.[1], Зупанчич Б.[2], Уркиа А.[3]

[1]Санкт-Петербургский политехнический университет Петра Великого, Санкт-Петербург, Россия
[2]Люблянский университет, Любляна, Словения
[3]Национальный университет дистанционного обучения, Мадрид, Испания

InMotion

Co-funded by the Erasmus+ Programme of the European Union

http://www.inmotion-project.net/index.php/ru/



Computer tools in education, 2018
№ 5: 52–68
http://ipo.spb.ru/journal
doi:10.32603/2071-2340-2018-5-52-68

BOOKS OF THE INMOTION PROJECT

InMotion: "New Engineer Learning Strategies Using Visual Modeling Environments and Open Learning Platforms "

Senichenkov Yu. B.[1], Zupančič B.[1], Urquía A.[3]

[1] Peter the Great Saint-Petersburg Polytechnic University, Saint Petersburg, Russia
[2]University of Ljubljana, Ljubljana, Slovenia
[3]Universidad Nacional de Educación a Distancia (UNED), Madrid, Spain

Abstract

The InMotion project sets as one of its goals the creation of new training courses for future engineers in mathematical modeling and computer technologies for modeling complex dynamic systems. New courses are based on textbooks and books of problems developed by project participants. In the future, books will be freely available to students in both English and Russian. This article provides a brief description of the project and presents the original introductions to the books. In addition to textbooks, eLearning courses have already been developed, which at the end of the project will be freely distributed on the Internet. Details on the project itself and the first impressions of the new courses developed will be presented in a future article.

Appendix. Tools.

1

AnyLogic for Academia

Virtual EUROSIM Simulation Seminar

May 2021

selected universities and research labs

75 out of world's top 100 universities* teach and carry out research using our products, spreading word of mouth to business

*According to QS University ranking

World's best research labs use AnyLogic

resources for academia

Free version for students

Students can quickly start learning simulation modeling by downloading the free AnyLogic PLE - it offers example models and tutorials for learning the modern methods of simulation and for developing systems thinking skills.

Complete version for academia

For teachers, researchers, and students who need advanced tools for their projects, we provide AnyLogic University Researcher. With a free 30-day trial and special pricing for non-commercial use, it is a fully functional version of AnyLogic for conducting full-scale research.

Educational resources

AnyLogic educational resources include books, how-to videos, webinars, and academic papers. Furthermore, the AnyLogic community provides a rich network of general and specialist knowledge at Stack Overflow, ResearchGate, and LinkedIn.

AnyLogic Cloud for students

Use the free AnyLogic Cloud to collaboratively develop your models online, run them remotely, and present simulation results to your peers and teachers. You can also share your models with the Cloud community, or dive into the public model library and learn from others.

resources for academia

- AnyLogic academic toolkit

The AnyLogic simulation toolkit features reading materials, videos, and guidance resources for teachers and students. It is intended to support educational and teaching processes by helping develop simulation skills with hands-on materials.

- Trainings and events

AnyLogic conducts events all over the globe: scheduled and customized training, free introductory seminars, user meetings, and an annual conference of skilled modelers sharing their knowledge and experiences.

NETSTAR – software for discrete-event simulation

2

РОССИЙСКАЯ ФЕДЕРАЦИЯ

СВИДЕТЕЛЬСТВО

о государственной регистрации программы для ЭВМ

№ 2010617178

Имитатор NETSTAR

Правообладатель(ли): *Учреждение Российской академии наук Кемеровский научный центр Сибирского отделения РАН (RU)*

Автор(ы): *Конюх Владимир Леонидович, Михайлишин Андрей Юрьевич, Зиновьев Василий Валентинович, Стародубов Алексей Николаевич (RU)*

Заявка № 2010615329
Дата поступления 27 августа 2010 г.
Зарегистрировано в Реестре программ для ЭВМ
27 октября 2010 г.

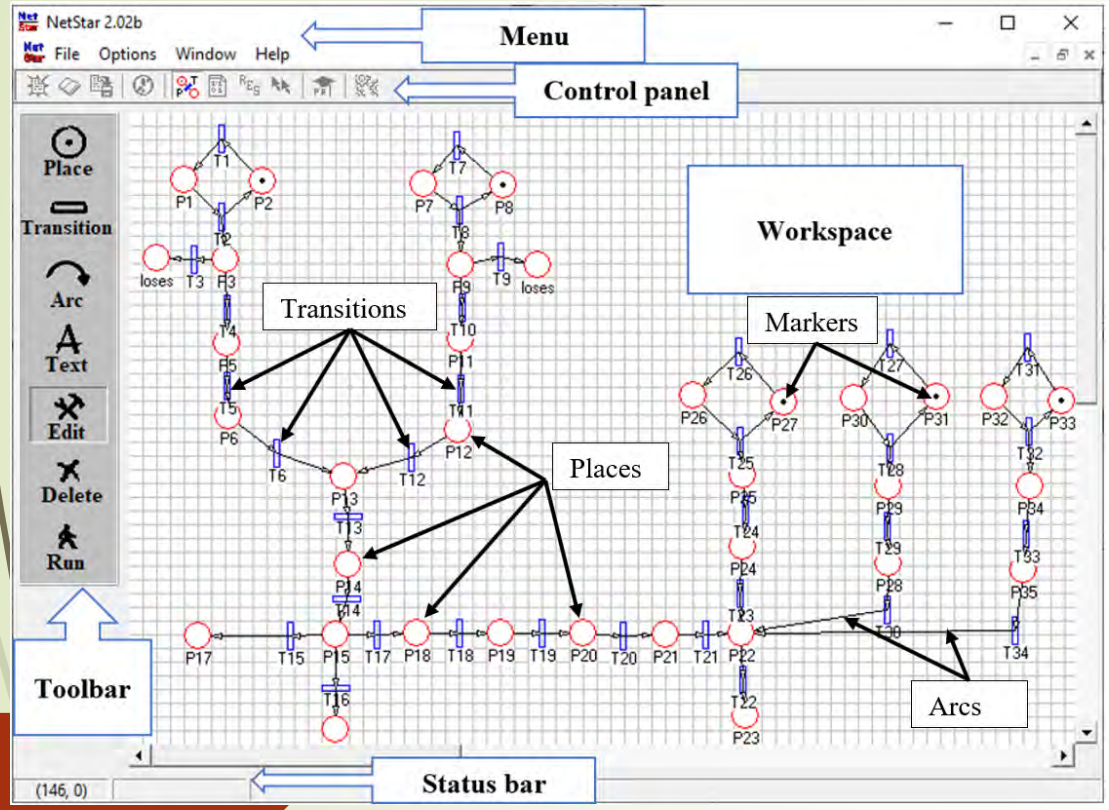
Руководитель Федеральной службы по интеллектуальной собственности, патентам и товарным знакам

Б.П. Симонов

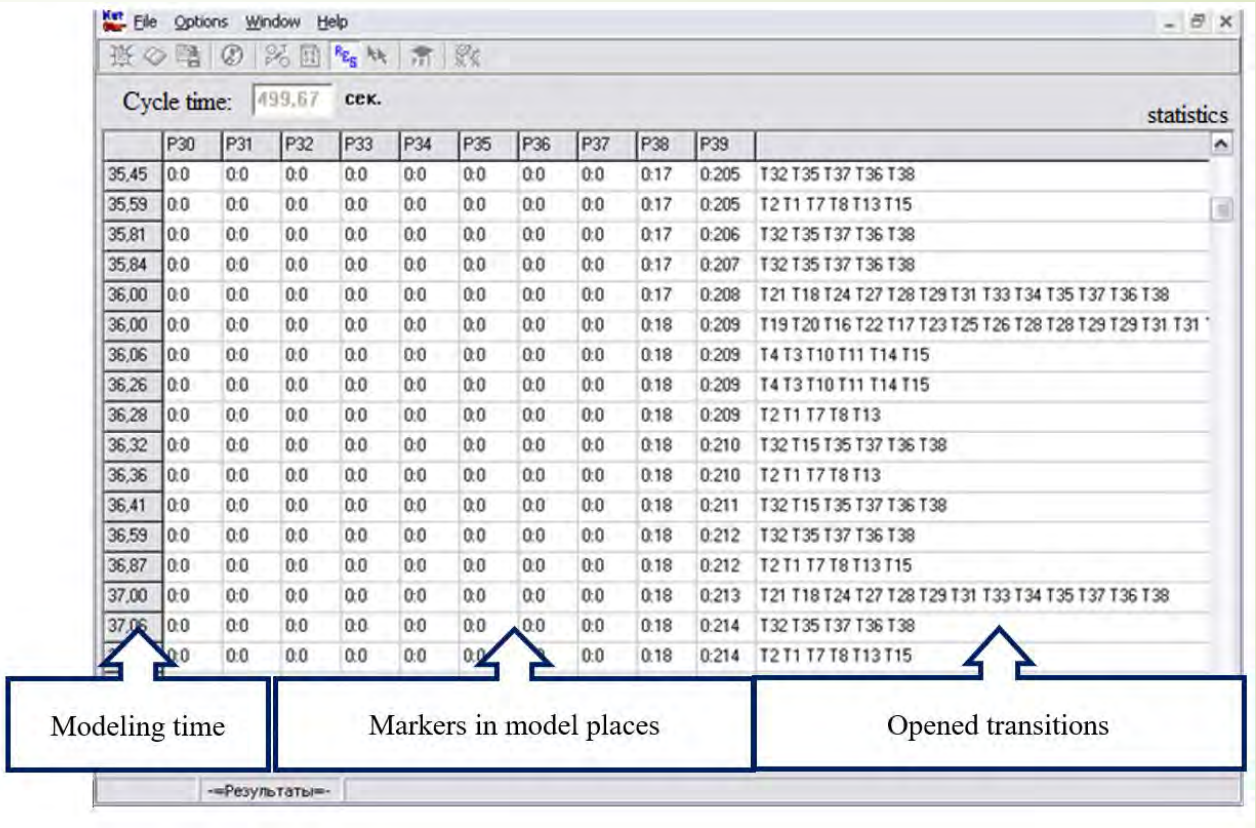
Copyright holder – «The Federal Research Center of Coal and Coal Chemistry of Siberian Branch of the Russian Academy of Sciences».

NETSTAR allows simulate systems with considering of dynamics and stochastic due to mathematical modeling language of Petri net.

NETSTAR – interface and results



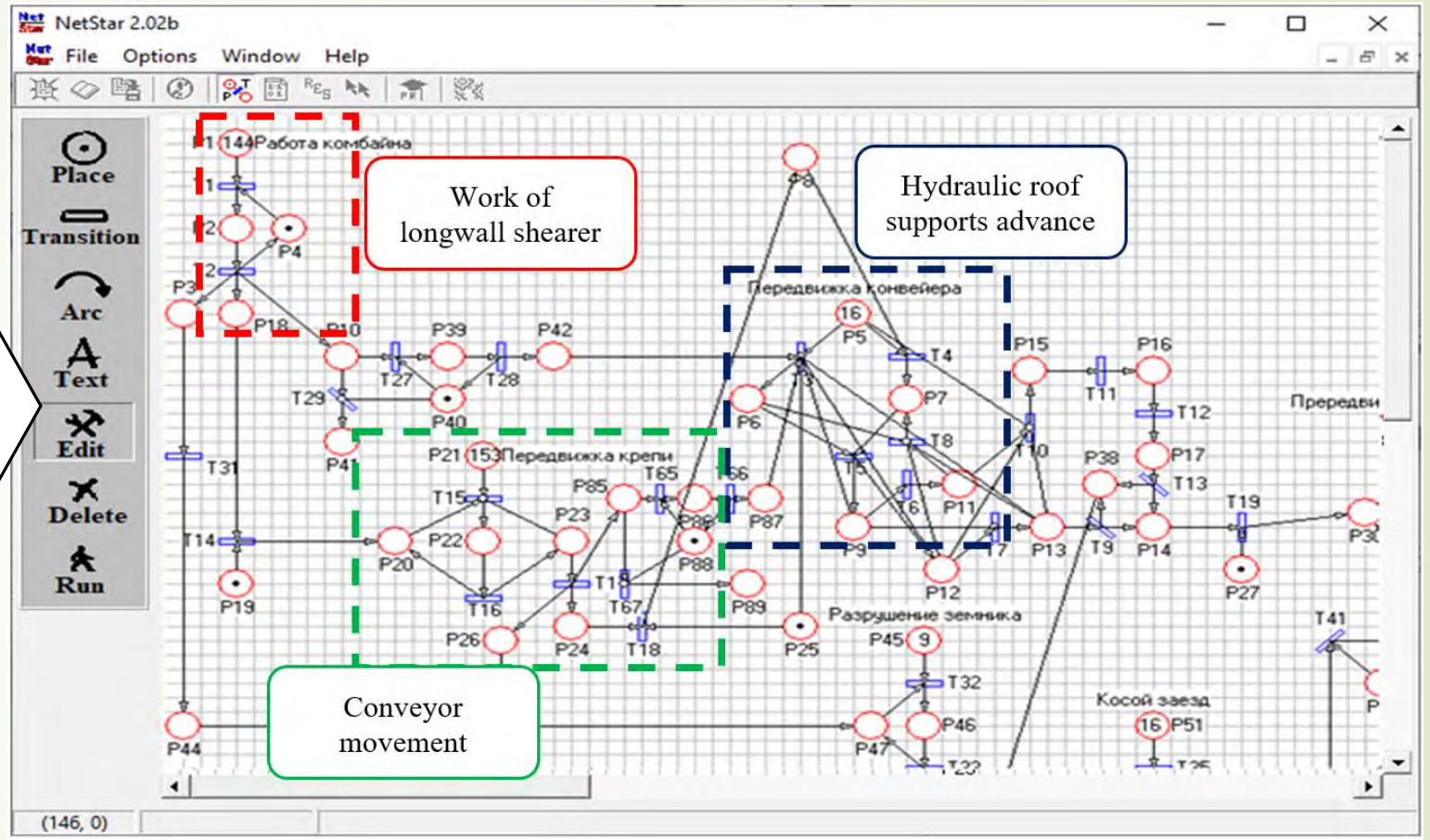
Setting the structure and parameters of the system through the graphical interface



Simulating result: system state changes in time

Simulating conducted through design of places and transitions, which are connected by arcs. Moving of markers allows consider system state changes in time.

NETSTAR – practical application



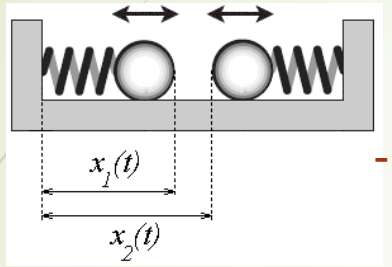
Simulating model of longwall coalmining (mine “Polysaevskaya”, Kuzbass, Russia). Experiments on model allowed to get rational technical and organizational solutions for improvement productivity of coalmine.

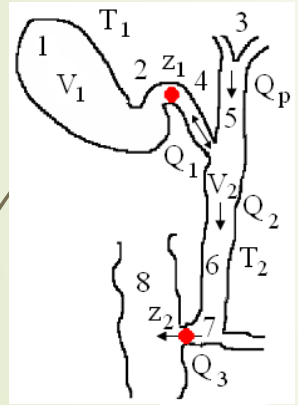
Applications of Hybrid Systems

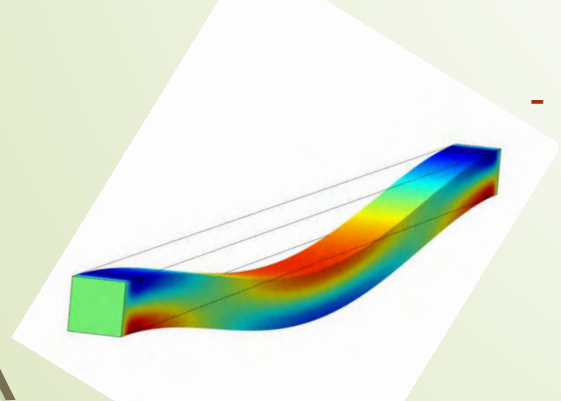
1

4

ISMA







- Mechanics;
- Electromechanics;
- Biosystems;
- Power Engineering;
- Chemical Kinetics;
- Solid Mechanics;
- etc.

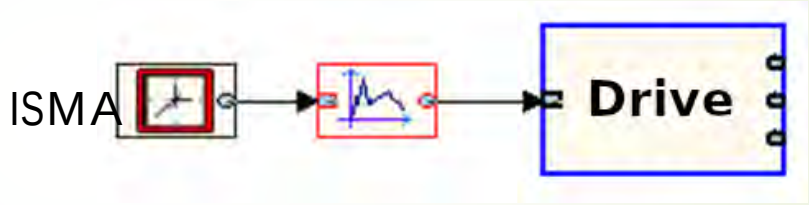
Specification in ISMA

ISMA

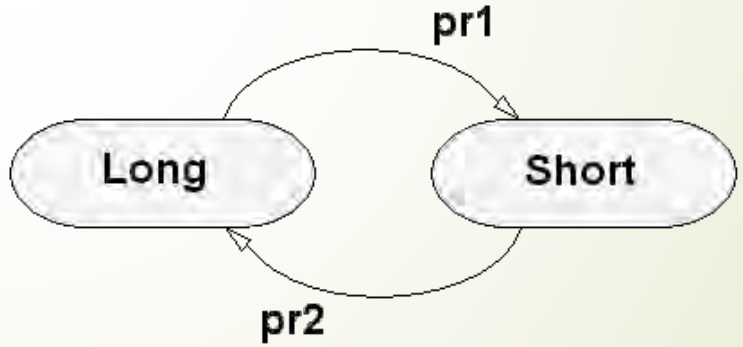
- Textual Language of States

```
st1 [ (h1<=hv3) ] is
    V3~=0;
    h1'=(1/S)*( Qp - Q1 - Q2 - V3*Q3 );
    h2'=(1/S)*( Q2 + V3*Q3 - V4*Q4);
from init, st2;
```

- Block-Textual Language



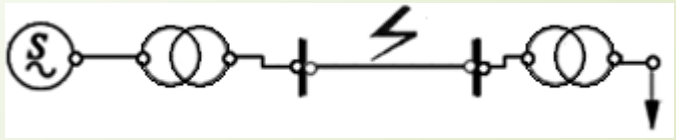
- Statecharts



- Textual and Visual Domain-Specific Languages:
  - Chemical Kinetics

```
C2H6=k1=>CH3+CH3;
CH3+C2H6=k2=>CH4+C2H5;
```

  - Power Engineering



Publications

ISMA

- Shornikov Yu. V. *Teoriia i praktika iazykovykh protsessorov : ucheb. posobie* [Theory and Practice of Language Processors : Textbook]. Novosibirsk: NSTU Publ., 2004. 203 p. Available at: https://elibrary. nstu.ru/source?bib_id=vtls000044379 [In Russian]
- Novikov E. A., Shornikov Yu. V. *Komp'iuternoe modelirovanie zhestkikh gibridnykh sistem: monografiia* [Computer Modeling and Simulation of Stiff Hybrid Systems : Monograph]. Novosibirsk, NSTU Publ., 2012. 451 p. Available at: https://elibrary.nstu.ru/source?bib_id=vtls000174515 [In Russian]
- Shornikov Yu. V., Tomilov I. N., Dostovalov D. N. *Instrumental'noe modelirovanie gibridnykh sistem : ucheb. posobie* [Computer-Aided Modeling of Hybrid Systems : Textbook]. Novosibirsk, NSTU Publ., 2014. 70 p. Available at: http://elibrary.nstu.ru/source?bib_id=vtls000202756 [In Russian]
- Shornikov Yu. V., Dostovalov D. N. *Komp'iuternoe modelirovanie dinamicheskikh sistem : ucheb. posobie* [Computer-Aided Modeling of Dynamic Systems : Textbook]. Novosibirsk, NSTU Publ., 2017. 68 p. Available at: http://elibrary.nstu.ru/source?bib_id=vtls000236114 [In Russian]
- Shornikov Yu. V., Dostovalov D. N. *Fundamentals of event-continuous system simulation theory : textbook*. Novosibirsk, NSTU Publ., 2018. 175 p. Available at: http://elibrary.nstu.ru/source?bib_id= vtls000239747
- Novikov E. A., Shornikov Yu. V. *Modelirovanie zhestkikh gibridnykh sistem : ucheb. posobie* [Modeling and Simulation of Stiff Hybrid Systems : Textbook]. Saint Petersburg, Lan Publ., 2019. 420 p. Available at: https://lanbook.com/catalog/informatika/modelirovanie-zhestkikh-gibridnykh-sistem/ [In Russian]

DVCompute Simulator, https://aivikasoft.com

- This is a collection of general-purpose Rust programming libraries (Linux, Windows, macOS) for discrete event simulation
- The simulator uses an unified approach (based on functional programming)
- The simulator supports different modes (ordinary sequential simulation, distributed simulation, nested simulation)
- The simulator implements the most popular simulation paradigms (event-oriented, process-oriented, GPSS-like blocks of transacts, partially agents) and also reactive programming based on the Observable pattern (to process the signals)

DVCompute Simulator, https://aivikasoft.com

- The simulation model is a composition of computations (monads, arrows, streams, continuations)
- The implementation uses so called "zero cost abstractions" (the computations are created on stack of the computer and then transferred to dynamic memory by demand)
- These computations are unified for all simulation modes, but we can choose any implementation of the event queue and mutable references
- GPSS-like blocks are defined via discontinuous processes, which are expressed in terms of discrete event handlers in its turn (everything works through the event queue)

DVCompute Simulator, https://aivikasoft.com

- The module of distributed simulation supports both the optimistic Time Warp method and the conservative one (MPI, super-computers)
- The nested simulation is related to Theory of Games (imagine something like a chess play, where "moves" change the state of the discrete event simulation model)

- Earlier the author, David E. Sorokin david.sorokin@gmail.com, created Aivika for the Haskell programming language. Now the goal is a higher speed of simulation with better portability among computer platforms

System of modelling of industrial and technological processes of functioning of the ship-building enterprises. AS «Sirius» 2.0





General characteristics of the AS «Sirius» 2.0

Automated system Sirius (AS «Sirius» 2.0) is purposed for carrying out complete cycle of simulation surveys of shipyards functioning processes.

A simulation study includes inputting initial data, generating simulation models, setting up and conducting experiments, preparing reporting documentation based on the results of experiments in MS Word format.

The general purpose system of imitation (discrete-event) modeling GPSS World is used as a modeling core of AS « Sirius».

The formation of models is fully automated - the initial data entered by the user is converted by the model generator according to specially written algorithms into code in the GPSS World language, which is executed by the modeling kernel.

The supported types (technology) modeling – discrete-event.

System functionality

Use of AS allows:

- To define whether production program of yard can be accomplished with set parameters of production system and construction technology
- **To define duration of main vessel's construction stages and** comparison of the same with new scheduled dates of construction
- **To detect yard production system's bottlenecks**
- **To define manufacturing facility's workload indexes (workload of** technological, crane and transportation equipment, sections, shops, building berths) when accomplishing production program
- To assess consequences of temporary de-commissioning of separate facilities, included in scope of simulation model (equipment/section/shop)
- To assess efficiency of setting into work of separate facilities, included in scope of simulation model (equipment/section/shop);
- To make up production schedules: delivery of sheet and profiled steel from steel store (steel launch), delivery of equipment from mechanical facility, delivery of pipes from pipe processing facility.

Input data for the AS «Sirius» 2.0

Composition of initial data of AS «Sirius», required for simulation modeling:

- Yard production program
- Yard plan, including layout diagram, layouts and specifications of shops, sections and composition of their equipment
- Description and specifications of vessels under construction
- Split of vessels into assembly units and large-scaled assembly-installation units
- Data on binding of assembly and assembly-installation units to construction areas
- Principal production technologies as applied to main production branches
- Description and specifications of used crane, transport and technological equipment
- Equipment maintenance schedule
- Yard operation schedule, including shift-work (plant-schedule) of yard and its separate facilities
- External deliveries schedule of assembly and assembly-installation

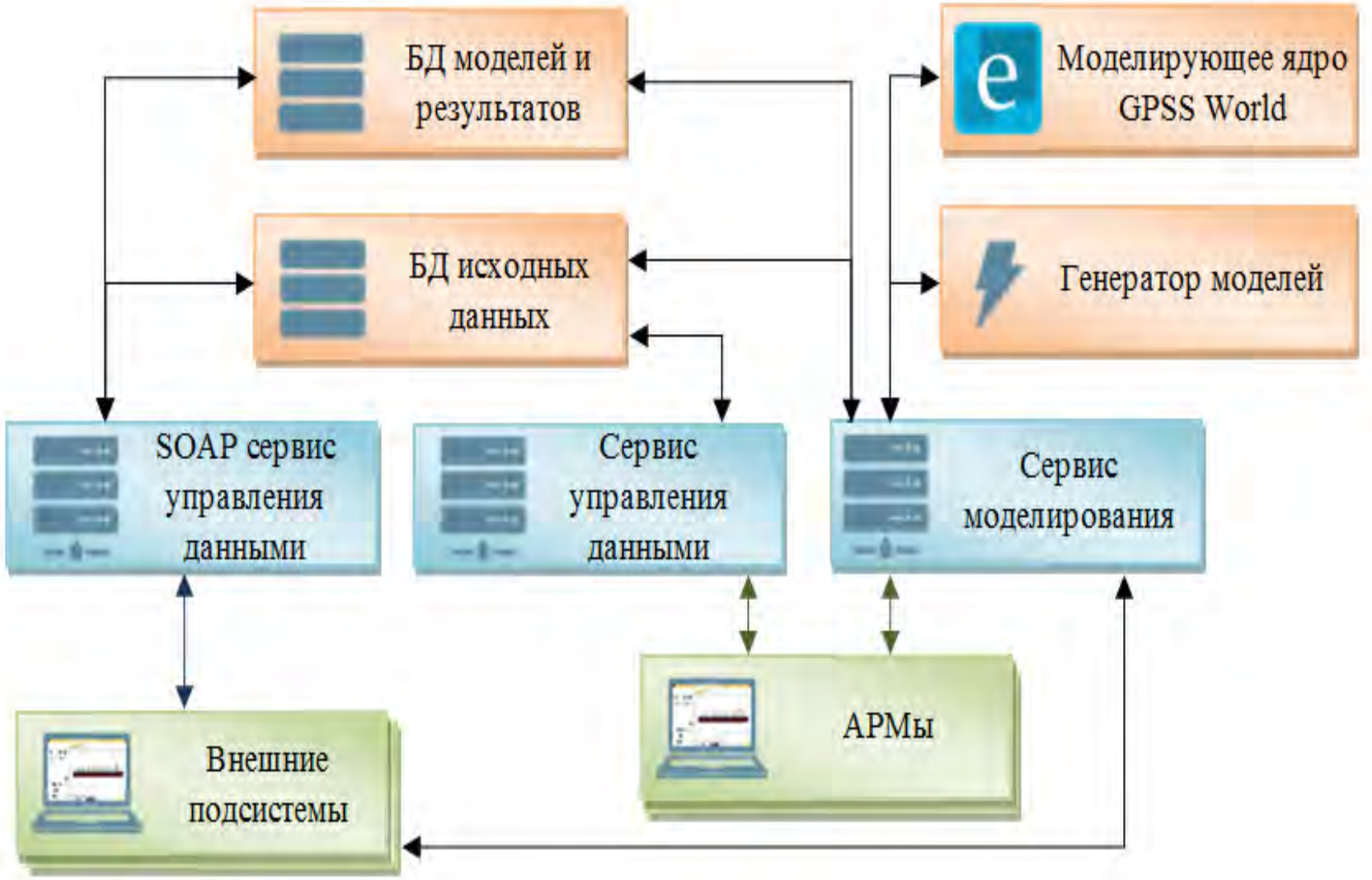
Output data of AS «Sirius» 2.0

The composition of the output data based on the simulation results:

- Data on the timing of the production program
- Diagram of the feasibility of the production program - comparison of the planned date with the simulation results
- Data on loading and utilization of production areas
- Data on loading and use of crane, transport and technological equipment
- Schedule of deliveries of rolled metal from the warehouse (including the required daily volumes of rolled metal start-up)
- Data on required buffer zones (to estimate the need for intermediate storage sites)
- Summary graphs of results (for a series of experiments)
- 2D animation of the process of building products
- Event log

AS «Sirius» 2.0 architecture

Service oriented architecture



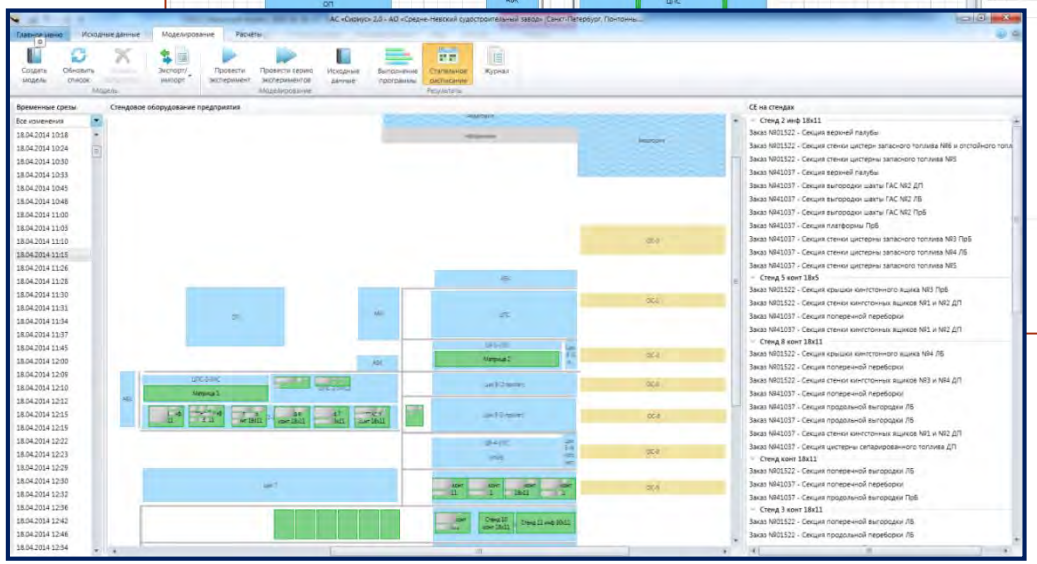
AS «Sirius» **2.0** user interface

Production program data

Data on ships under construction

Production environment data

Production layouts



Итоговые показатели | Ежемесячная загрузка в часах

Номер бригады	Наименование бригады	Общее время работы	Дек. 2020	Янв. 2021	Фев. 2021	Март 2021	Апр. 2021	Май 2021	Июнь 2021
2091.1	Степановой Ю.Г.	89127.0	207.5	695.6	672.0	743.4	720.0	744.0	719.9
2091.10	Задерчука А.С.	29186.4	207.5	410.2	672.0	744.0	703.3	744.0	719.5
2091.11	Заблицевой Н.Ю.	23139.4	207.5	727.4	554.2	743.4	720.0	743.5	371.3
2091.12	Иванова А.В.	27787.9	207.5	573.9	672.0	744.0	720.0	744.0	720.0
2091.13	Китаева Е.А.	21633.0	207.2	744.0	671.4	744.0	720.0	744.0	720.0
2091.14	Козлов Е.В.	26750.8	207.2	661.3	656.2	744.0	720.0	744.0	720.0
2091.15	Куббе И.Н.	38899.5	207.0	744.0	672.0	743.5	720.0	744.0	720.0
2091.16	Куца А.В.	18250.3	207.0	686.7	639.7	744.0	720.0	744.0	543.5
2091.17	Максимова В.С.	16170.3	206.7	744.0	628.2	743.4	720.0	744.0	539.1
2091.18	Минвалеевой Е.В.	22413.3	206.7	613.1	78.7	61.0	528.9	658.7	217.9
2091.19	Назарова Д.В.	25140.5	206.5	687.2	173.3	61.0	184.4	0.0	217.8

AS «Sirius» 2.0

The certificate
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РОССИЙСКАЯ ФЕДЕРАЦИЯ

СВИДЕТЕЛЬСТВО

о государственной регистрации программы для ЭВМ

№ 2018614213

«Приложение для автоматизированной генерации имитационных моделей, их хранения и проведения экспериментов (АС «Сириус» 2.0)»

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Руководитель Федеральной службы по интеллектуальной собственности

Г.П. Ивлиев