MATHEMATICAL SIMULATION OF CONTROL SYSTEM IN MODAL VISION STUDIUM

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- History and hierarchy of MVStudium
- MvStudium's mathematical models
- MvStudium's Blocks
- Examples

MvStudium

is the tool with
graphical, UML-based
language for
modeling and simulation
of complex dynamical systems
(Object Oriented Modeling)

UML - unified modeling language, object-oriented language of prototyping of big program complexes and computing systems

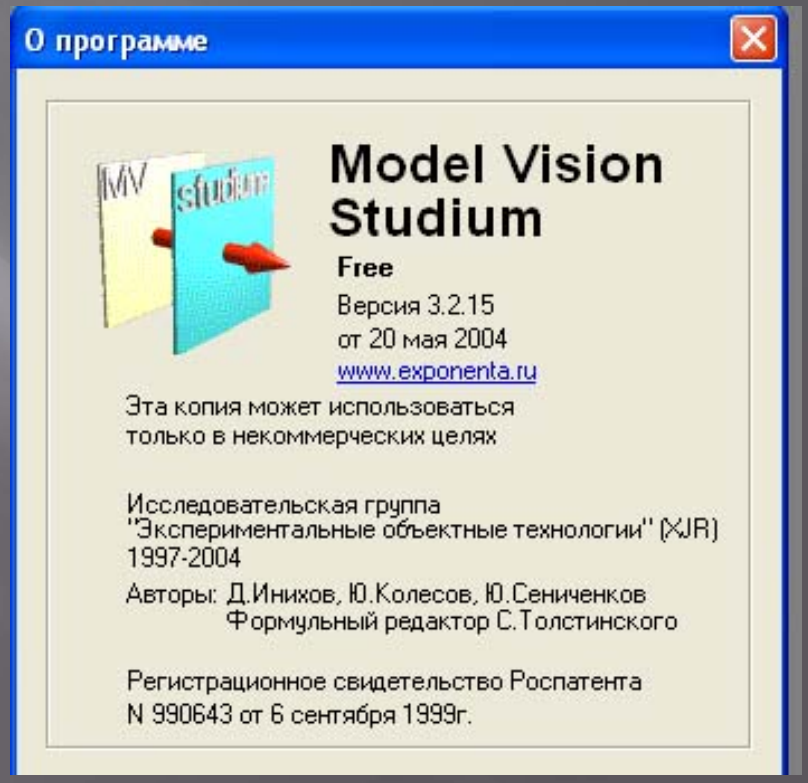
http://www.mvstudium.com

Complex dynamical system is

Large scale,
Hierarchical,
Event-driven (hybrid)
mathematical model
with dynamically changed
behavior in short time
interval

The Model Vision Family

- MV 2.1 - 1994-1996
- MVS 3.0 - 1996-2003
- MVS 4.X – 2004-2005
- MVS 5.X – 2005 – our days



CONCEPTS AND DEVELOPMENTS, INCLUDED IN BASIS OF MVS

Ole-Johan Dahl, Bjorn Myhrhaug, Kristen Nygaard

SIMULA 67

Glushkov V., Gusev V., Marjanovich T., Sachnjak M.

Tools for modeling mixed continuous and discreet systems.

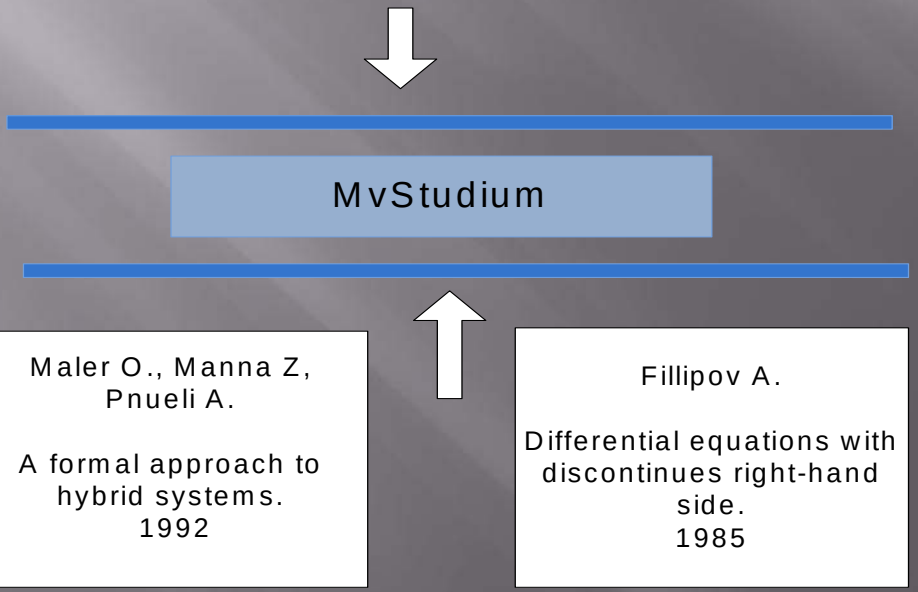
1975

Booch G. Jacobson I., Rumbaugh J.
The unified modeling language for object-oriented modeling
1977

A. Alan Pritsker.

Introduction to Simulation and SLAM II .

1986



Maler O., Manna Z, Pnueli A.

A formal approach to hybrid systems.
1992

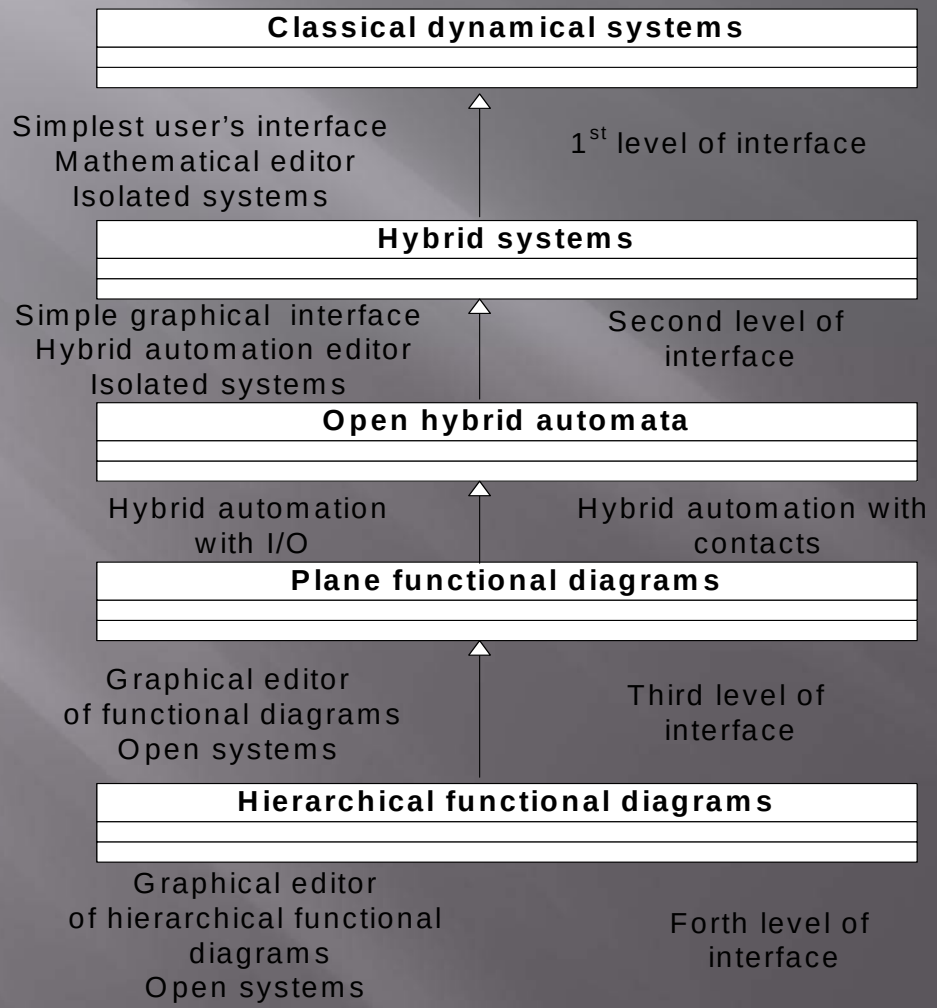
Fillipov A.

Differential equations with discontinues right-hand side.
1985

The authors of SIMULA 67 offered for the first time idea of creation of special models - **classes** for the description of objects with internal properties and behavior. So there was a new approach - object-oriented

BRIEF REVIEW OF THE HIERARCHY OF MODELS

MvStudium models



MvStudium's mathematical models

Classical dynamical system (continuous time)

is a system of differential equations

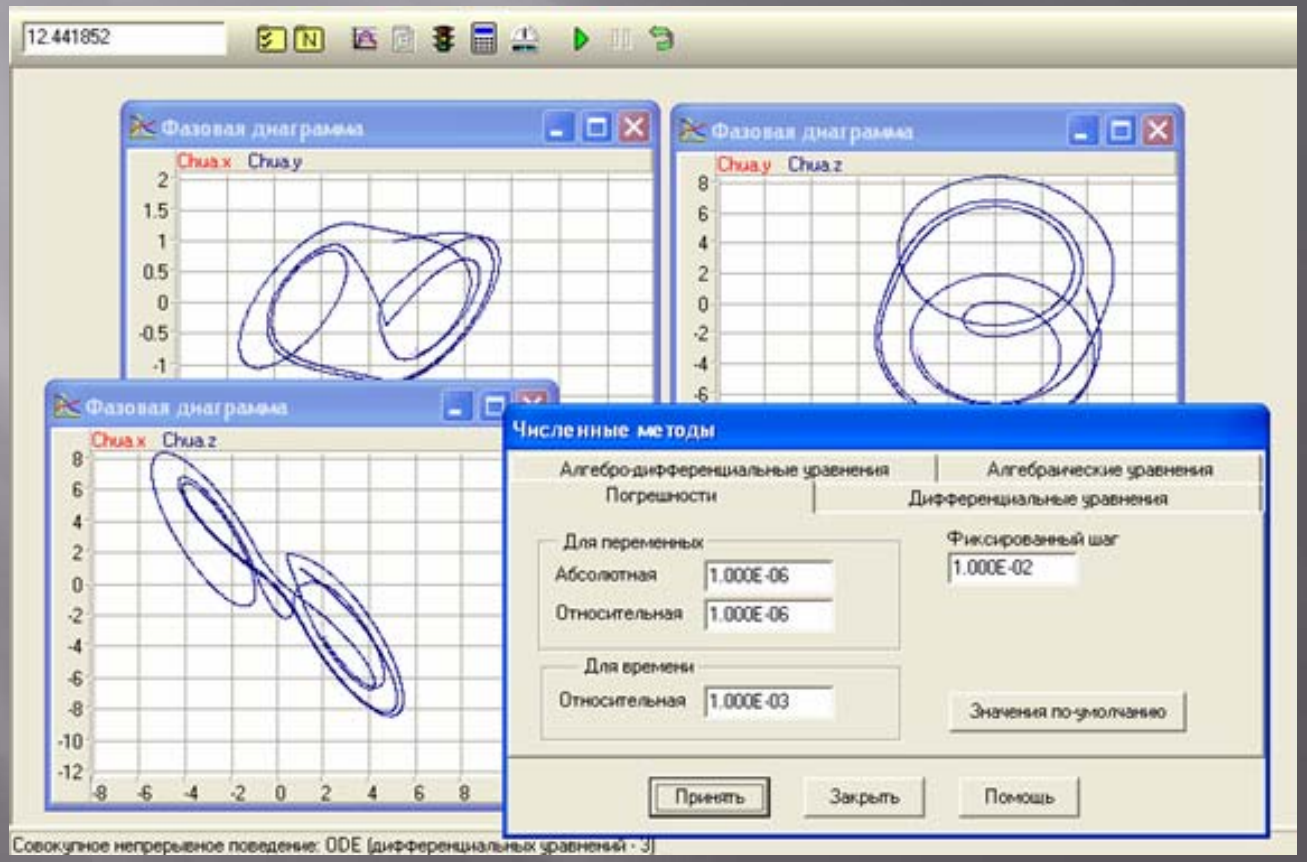
$$\frac{dx}{dt} = f(x), x \in \Re^n, x(0) = x^0$$

with right hand side $f(x)$, ensuring existence and uniqueness of the solution

$$x = x(t; x^0)$$

t – an independent real variable - continuous time

Here evident result of modeling of similar system in MVS. It is possible to be convinced, that these schedules - phase characteristics of system – are really continuous.

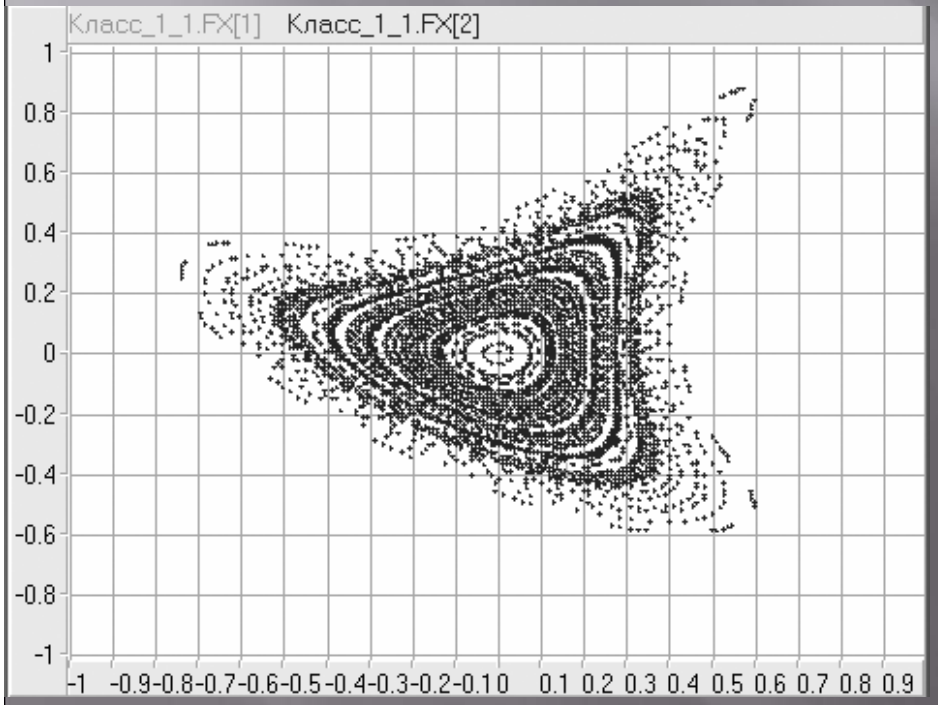


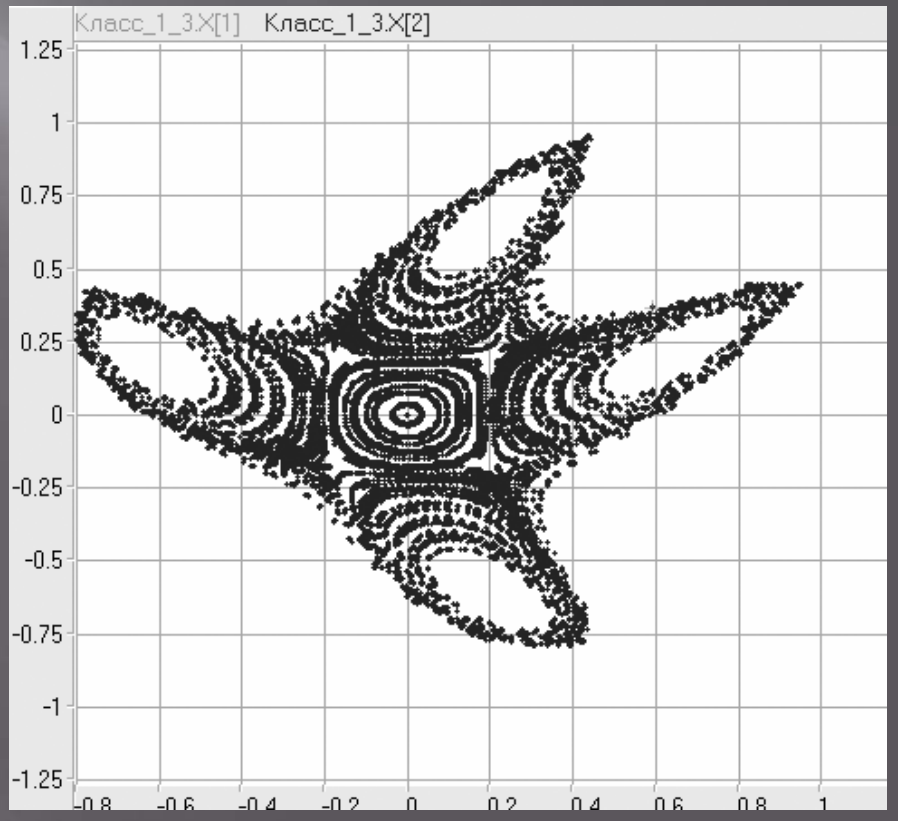
DISCREET DYNAMICAL SYSTEMS (DISCREET TIME).

$$\begin{cases} x_{n+1} = x_n \cdot \cos\alpha - \left(y_n - x_n^2\right) \cdot \sin\alpha \\ y_{n+1} = x_n \cdot \sin\alpha - \left(y_n - x_n^2\right) \cdot \cos\alpha \end{cases}$$

In discrete models we cannot speak about the differential equations because can not be a speech about derivative of function when it depends on discrete time. In such models we deal with systems of the difference equations.

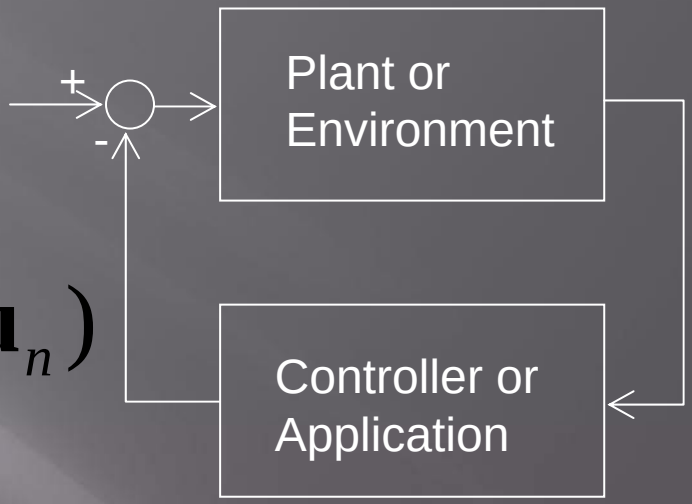
Here the result of modeling of discrete system in MVS – the received characteristic consists of separate points that corresponds to discrete system.





Discrete-continuous systems

- Object of control



$$\frac{d\mathbf{x}}{dt} = \mathbf{f}(\mathbf{x}(t), \mathbf{u}_n)$$

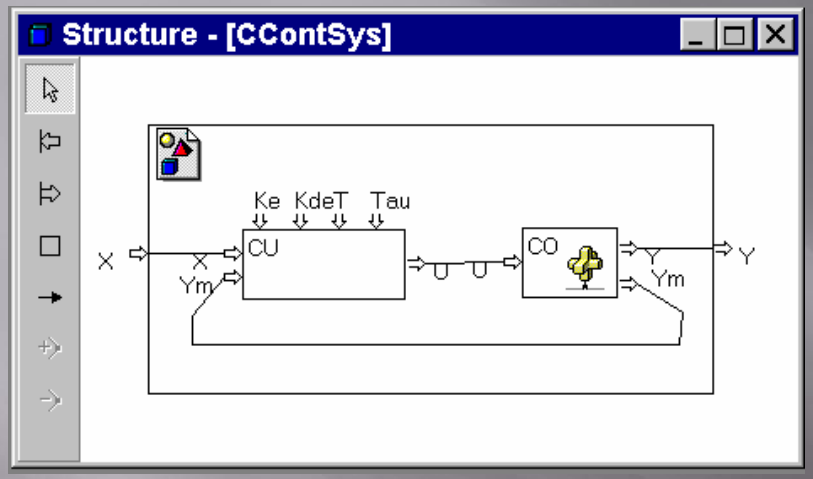
- Control

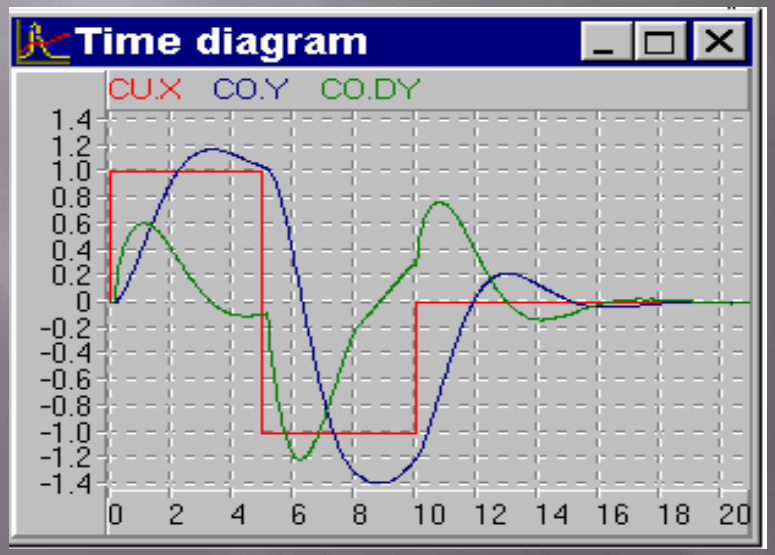
$$\mathbf{u}_{n+1} = \mathbf{G}(\mathbf{x}(t_n), \mathbf{u}_n),$$

$$\mathbf{u}_n = \mathbf{u}(t_n), t_{n+1} = t_n + h,$$

In dynamic systems can arise the processes with different scales of time. Difficulties of reproduction of such systems are obvious.

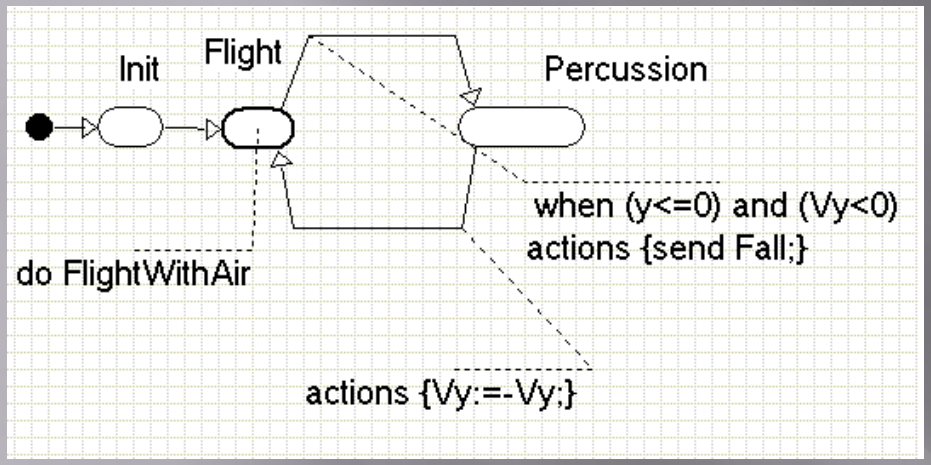
Control system

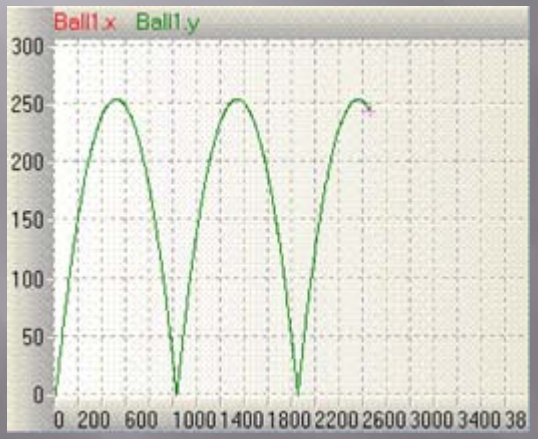




The researcher solves, which processes in object are long, and which fast. Speed of fast processes is accepted by the infinite. Such processes are authorized to change value jump, unlike the slow, no separable. Let consider a usual control system. The object of control works constantly, it is system of continuous time, and here an operating input signal comes periodically. It is discrete system.

Hybrid systems

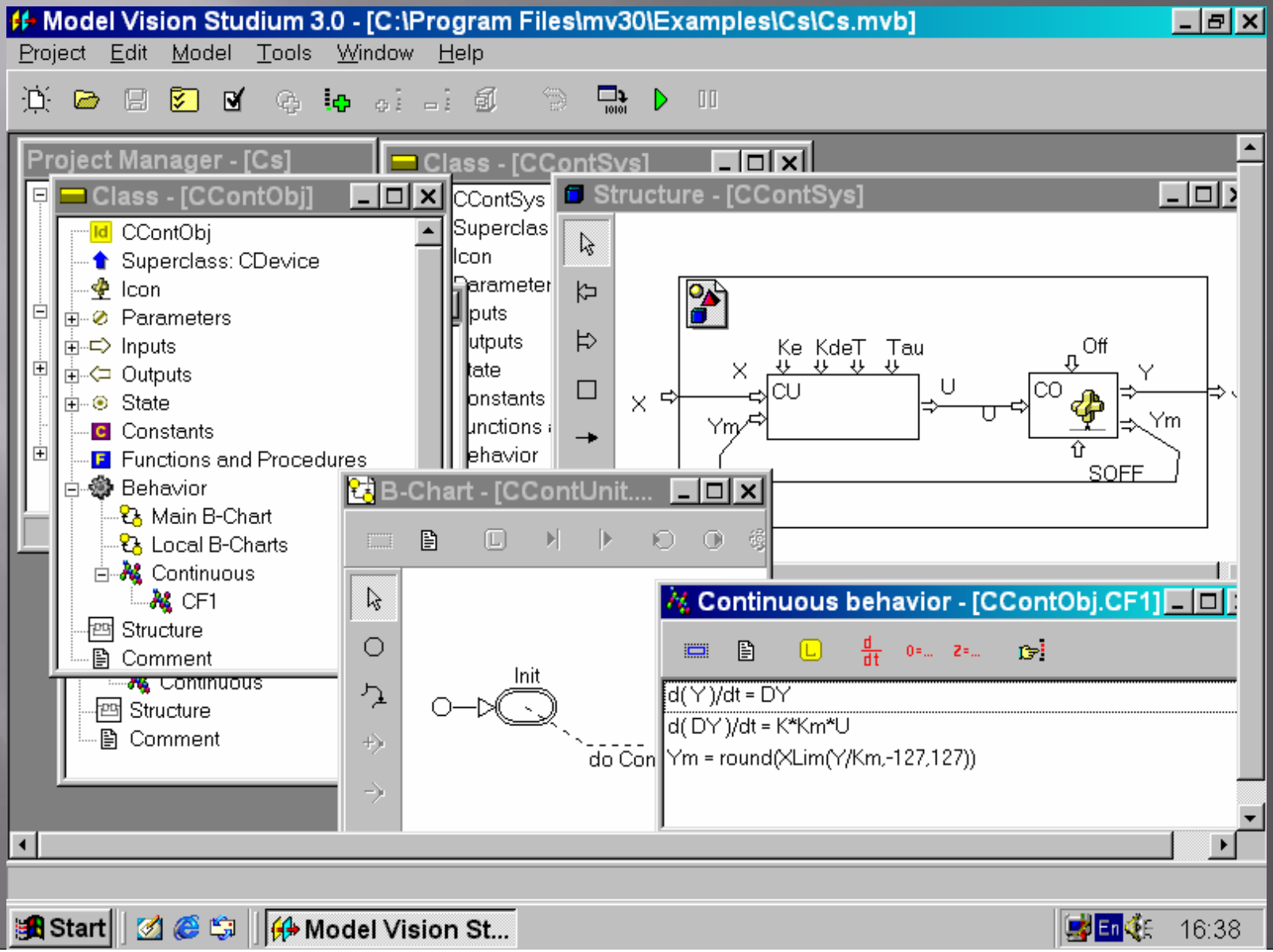




For this purpose we will allocate special condition – a contact of a body with the earth, and it allowed to replace vertical making speed at the moment of its approach a sign with the opposite, then again we reproduce the set system with new entry conditions, and so again and again. It is possible to name the mechanism generating it the hybrid automat.

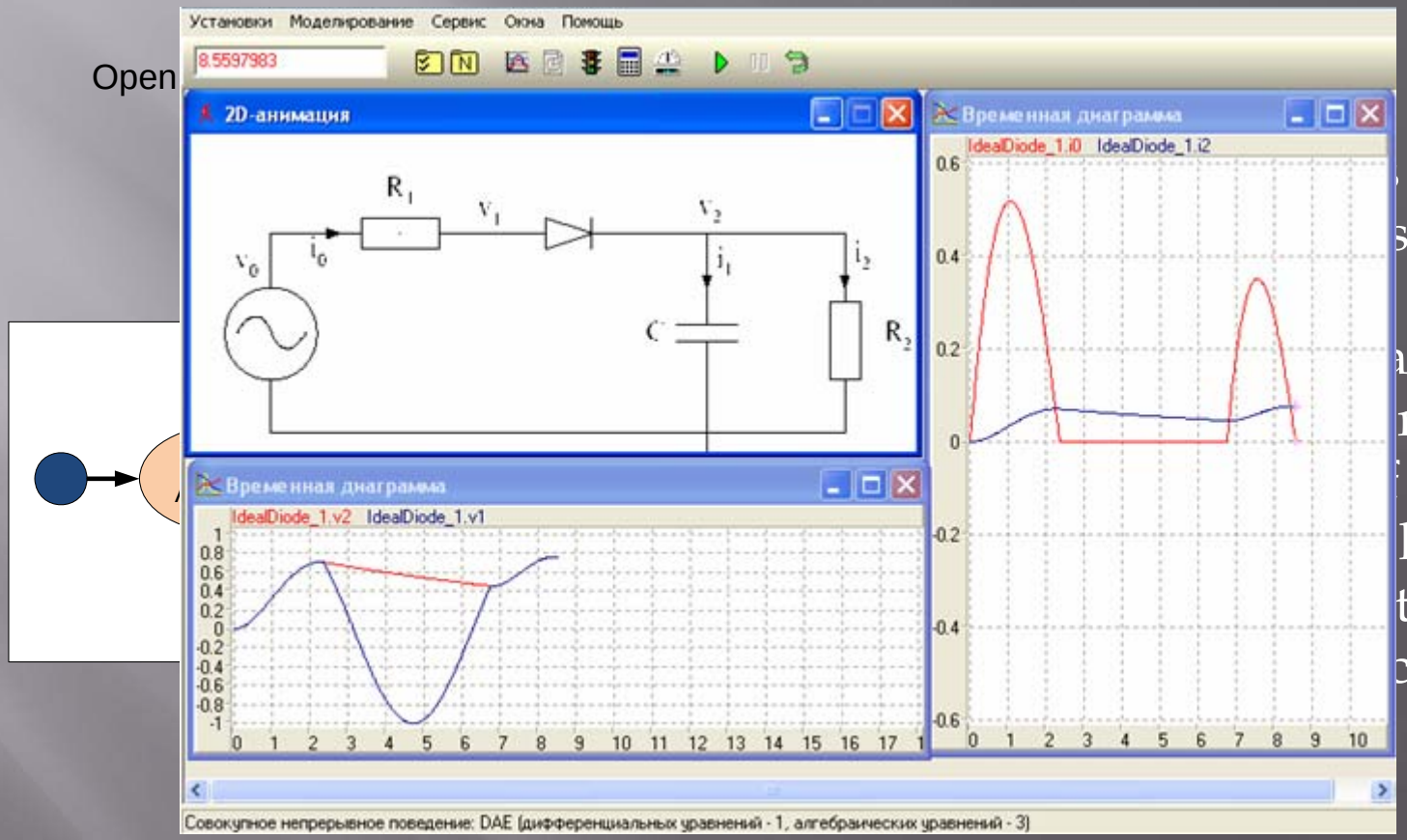
MvStudium's Blocks

OPEN INPUT/OUTPUT BLOCK



OPEN CONTACT BLOCK

Open



in
specify
the
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rising

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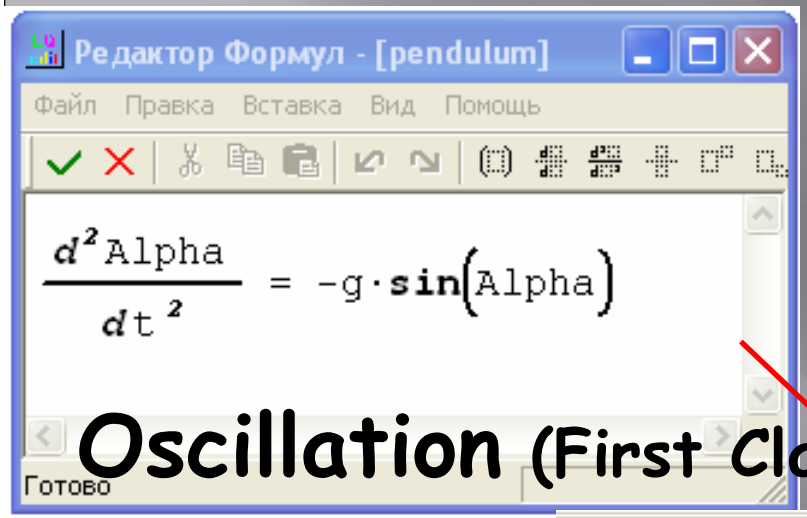
chains.

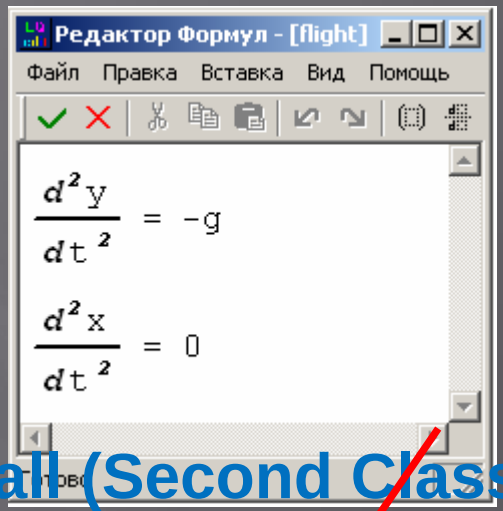
Activity: $F(\frac{dx}{dt}, x, t; x_0)$

Examples

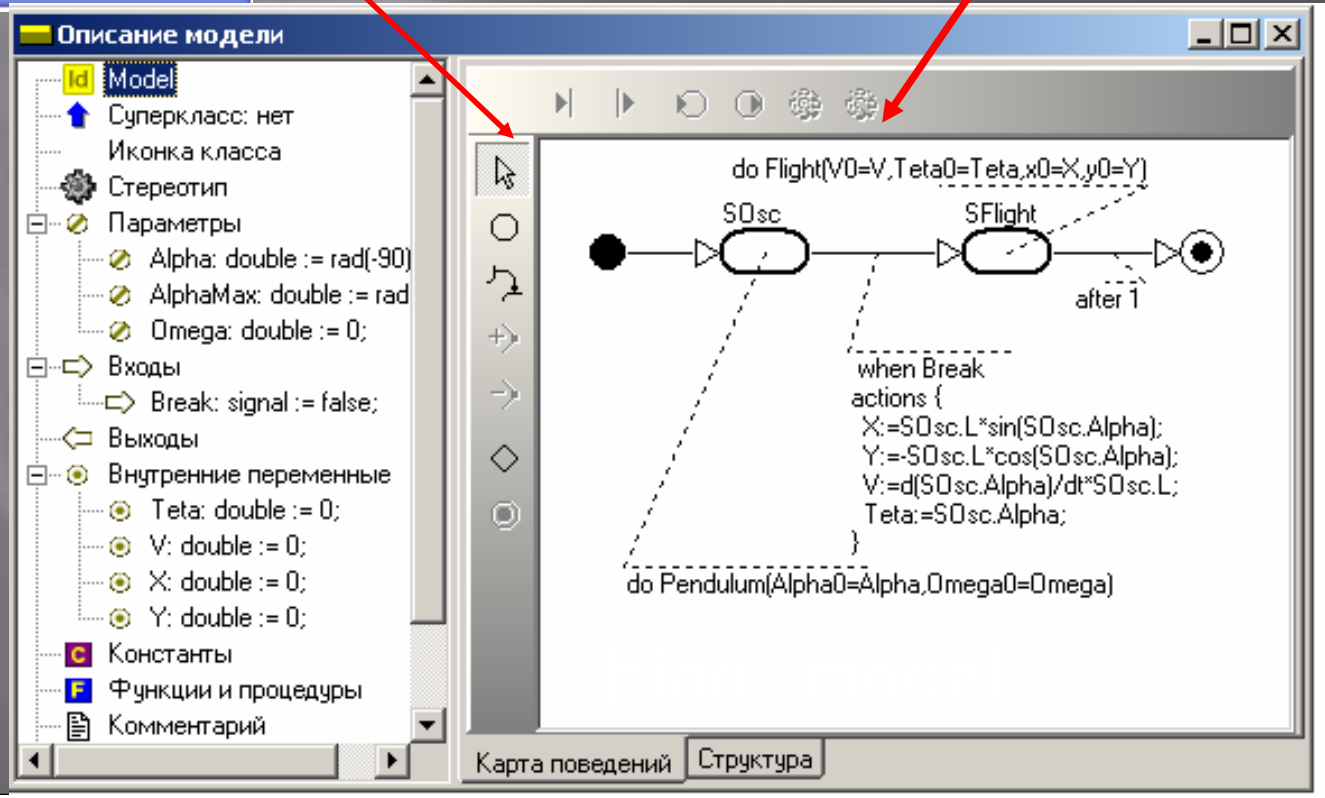
Example 1: breaking pendulum



Oscillation (First Class)

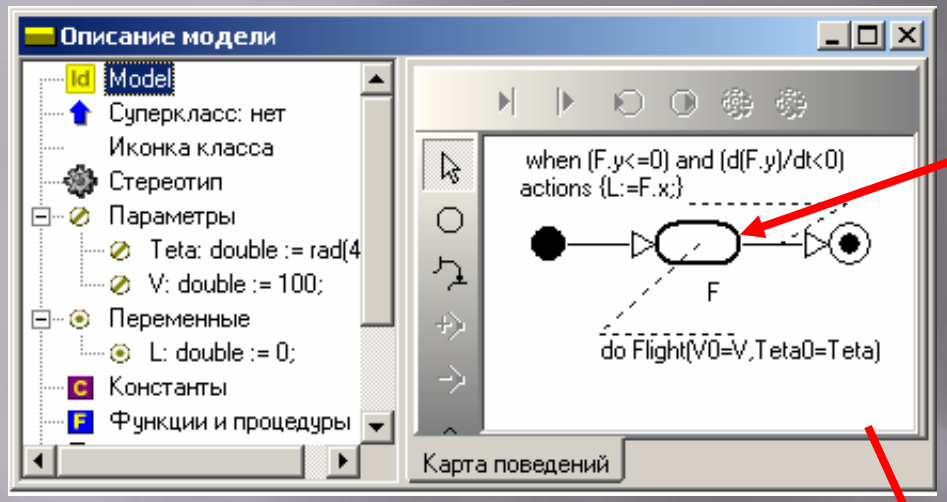


Free fall (Second Class)

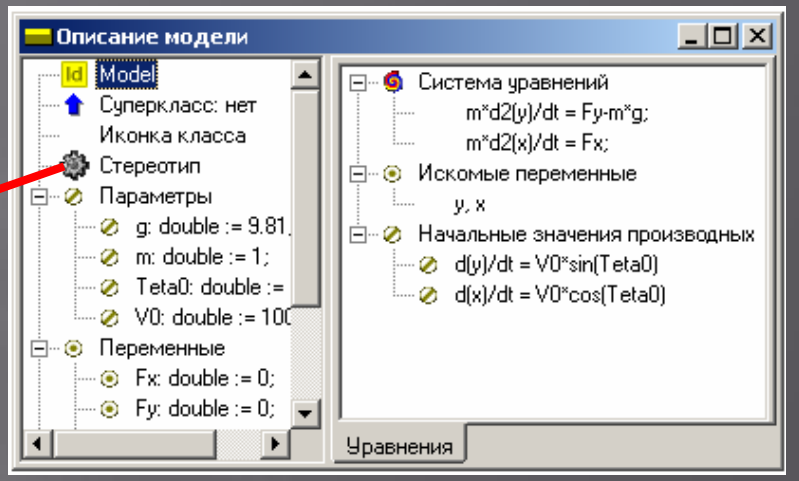


Example 2: statistical test:shell flight

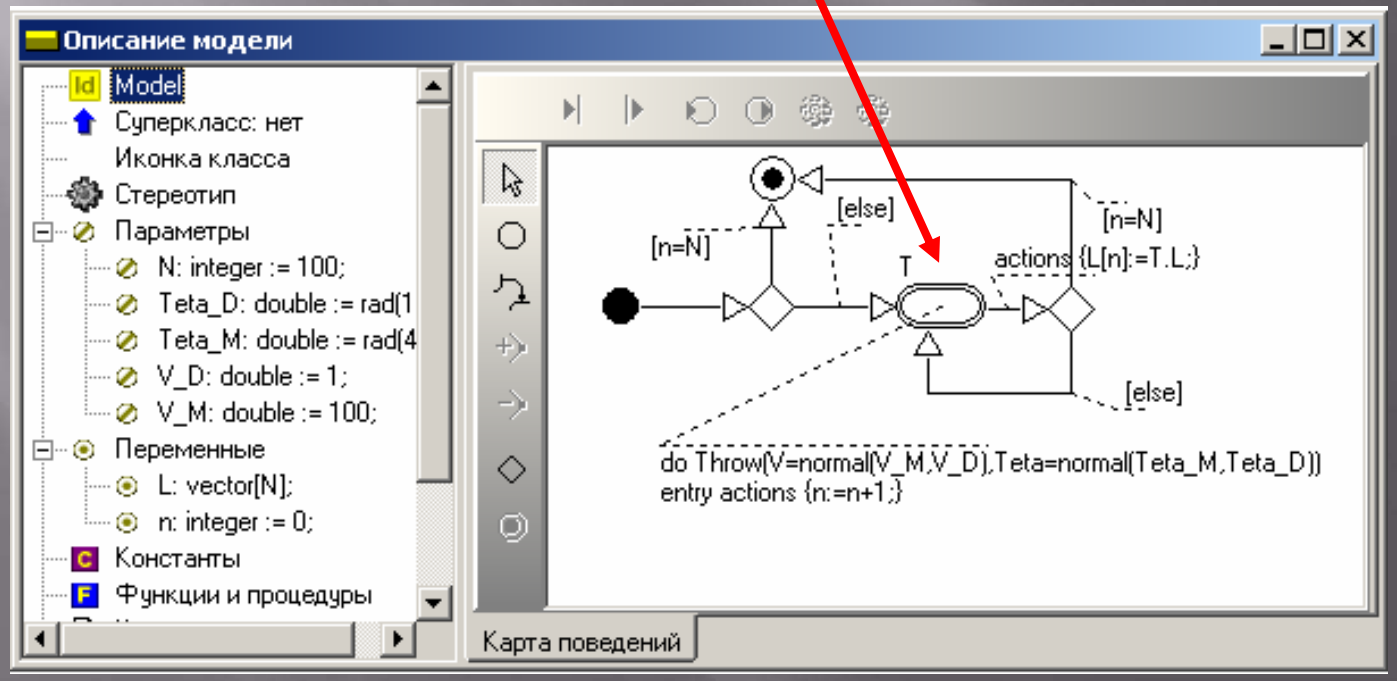
A shell flight



Equations



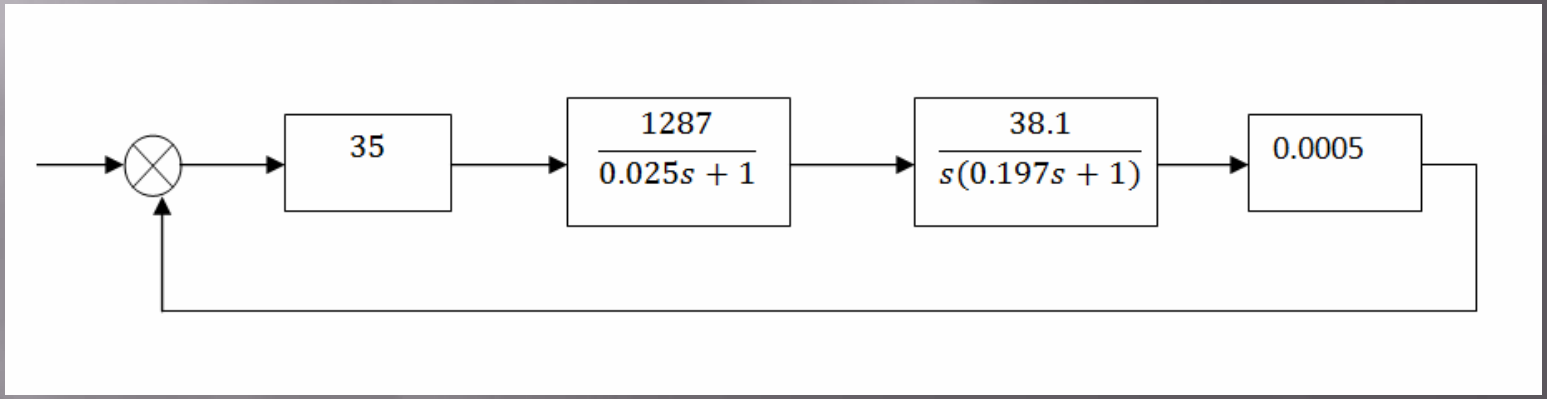
Statistical experiment



Modeling of real complex system

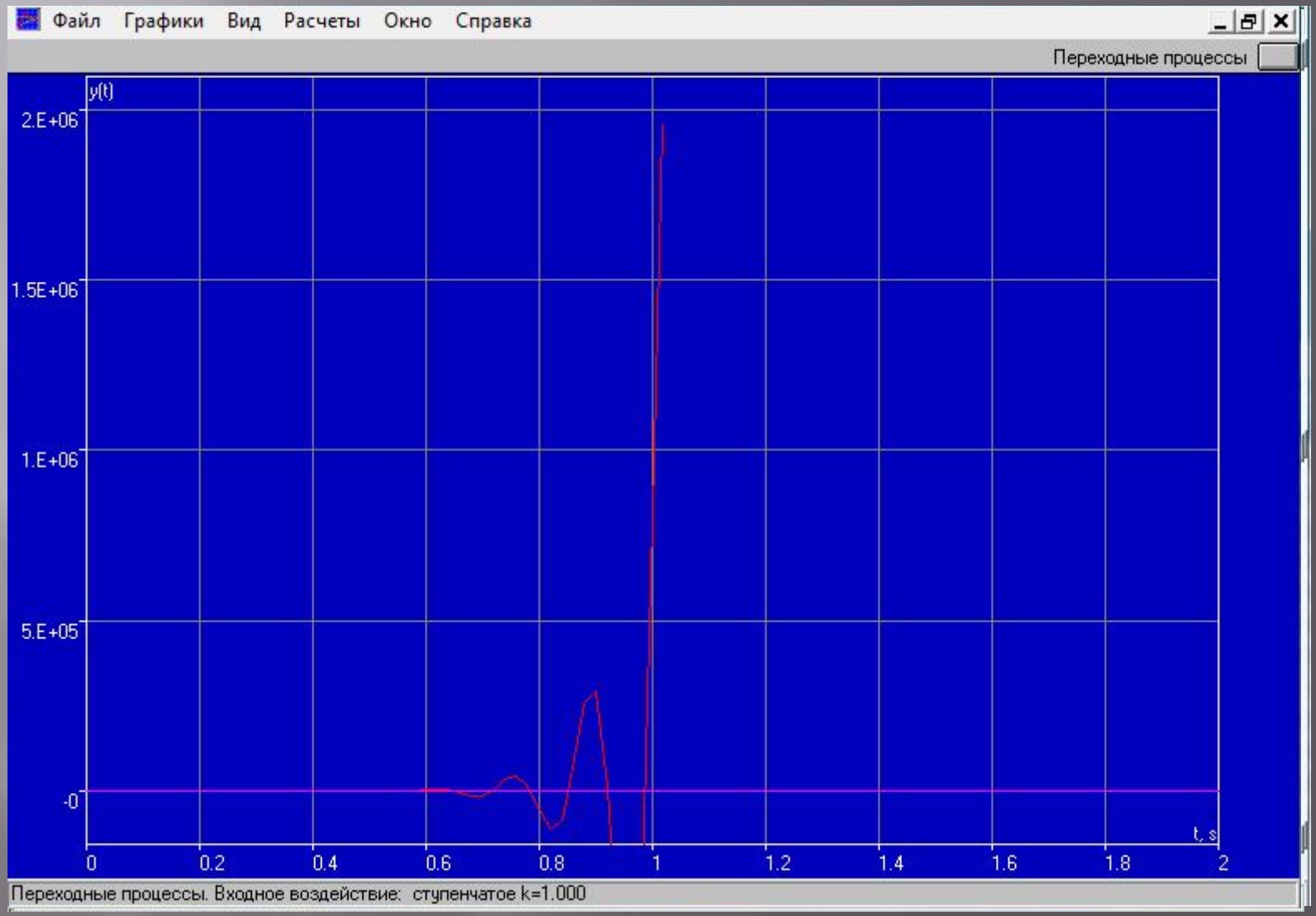
This system consists of four elements:

- Sensitive element which accepts a mismatch signal
- The amplifier which strengthens an operating signal and transmit him in the engine.
- The dysphasic asynchronous engine
- Reducer, witch transforms rotation of a shaft of the engine in turn on small degree.

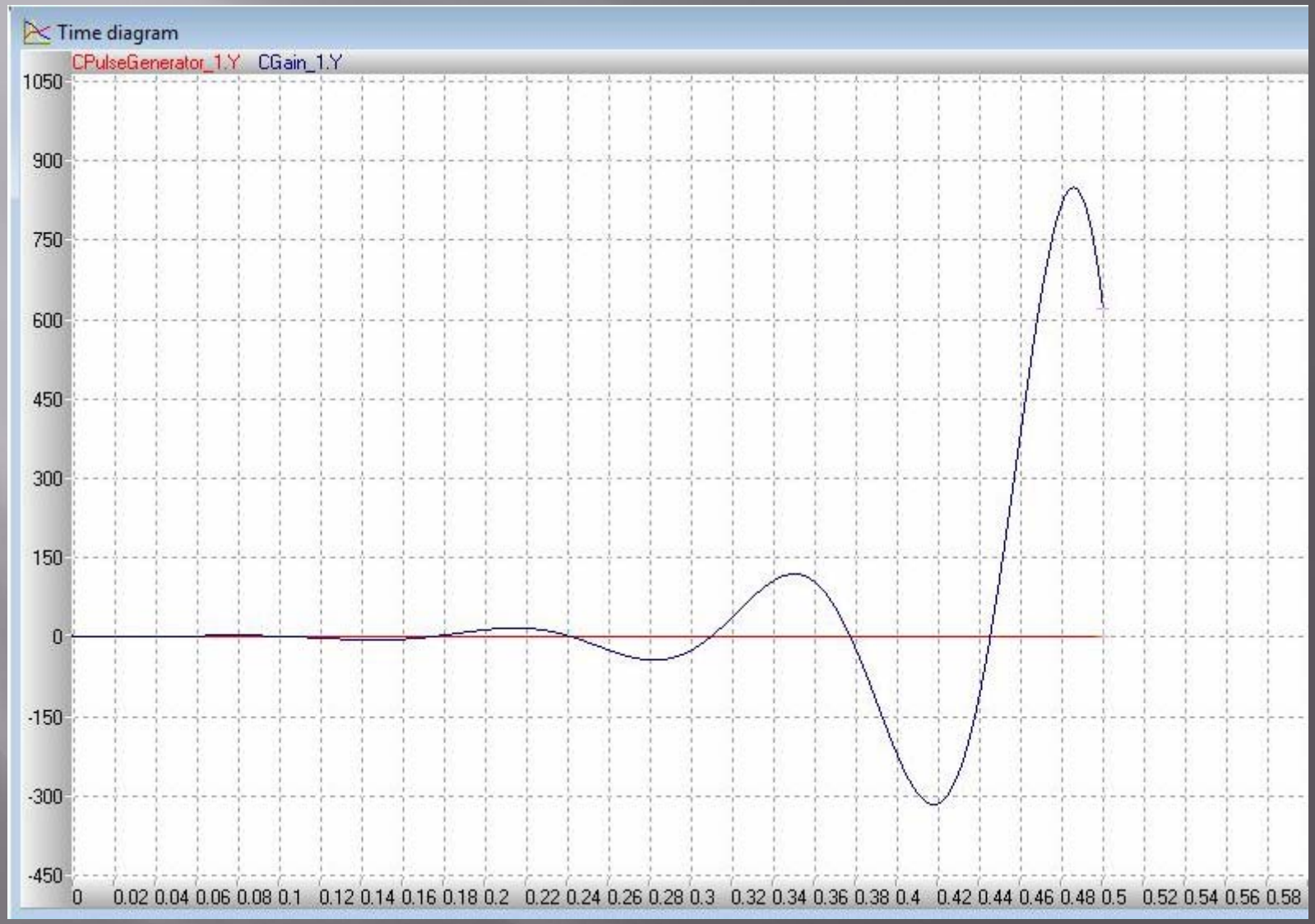


It is classical configuration of systems of such class with a negative feedback.

Model in Classic 3.0

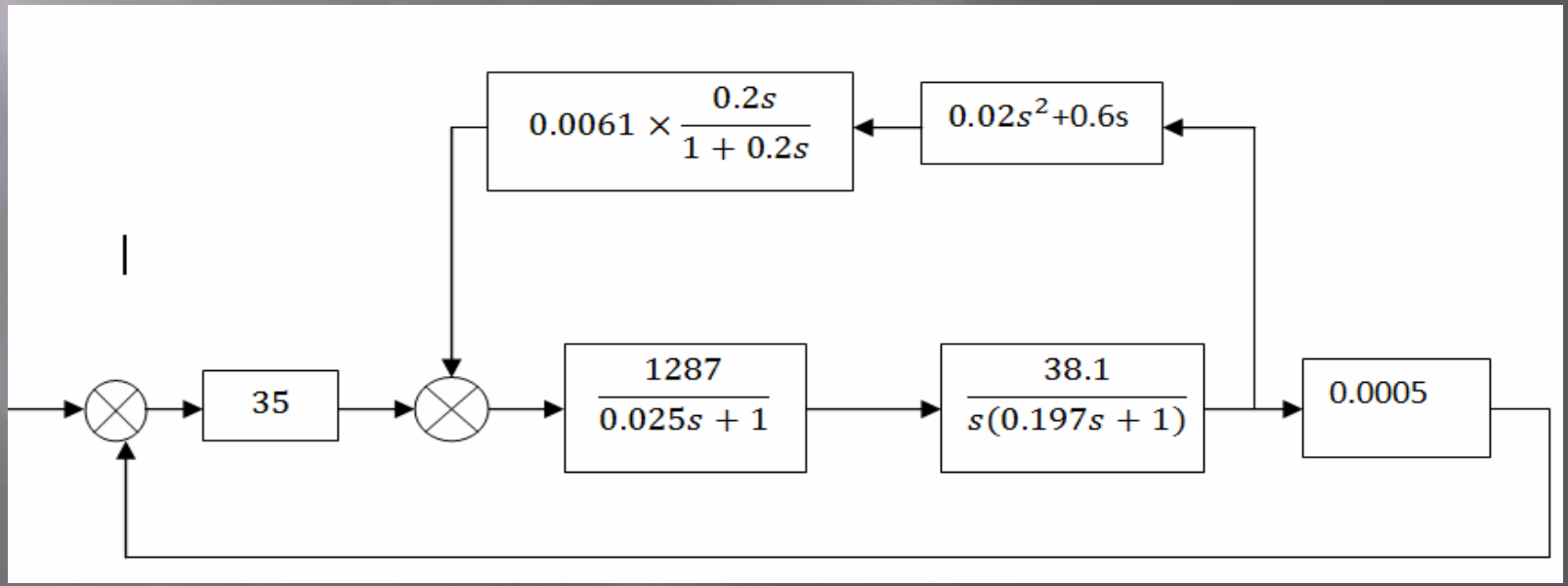


Modeling in MVStudium

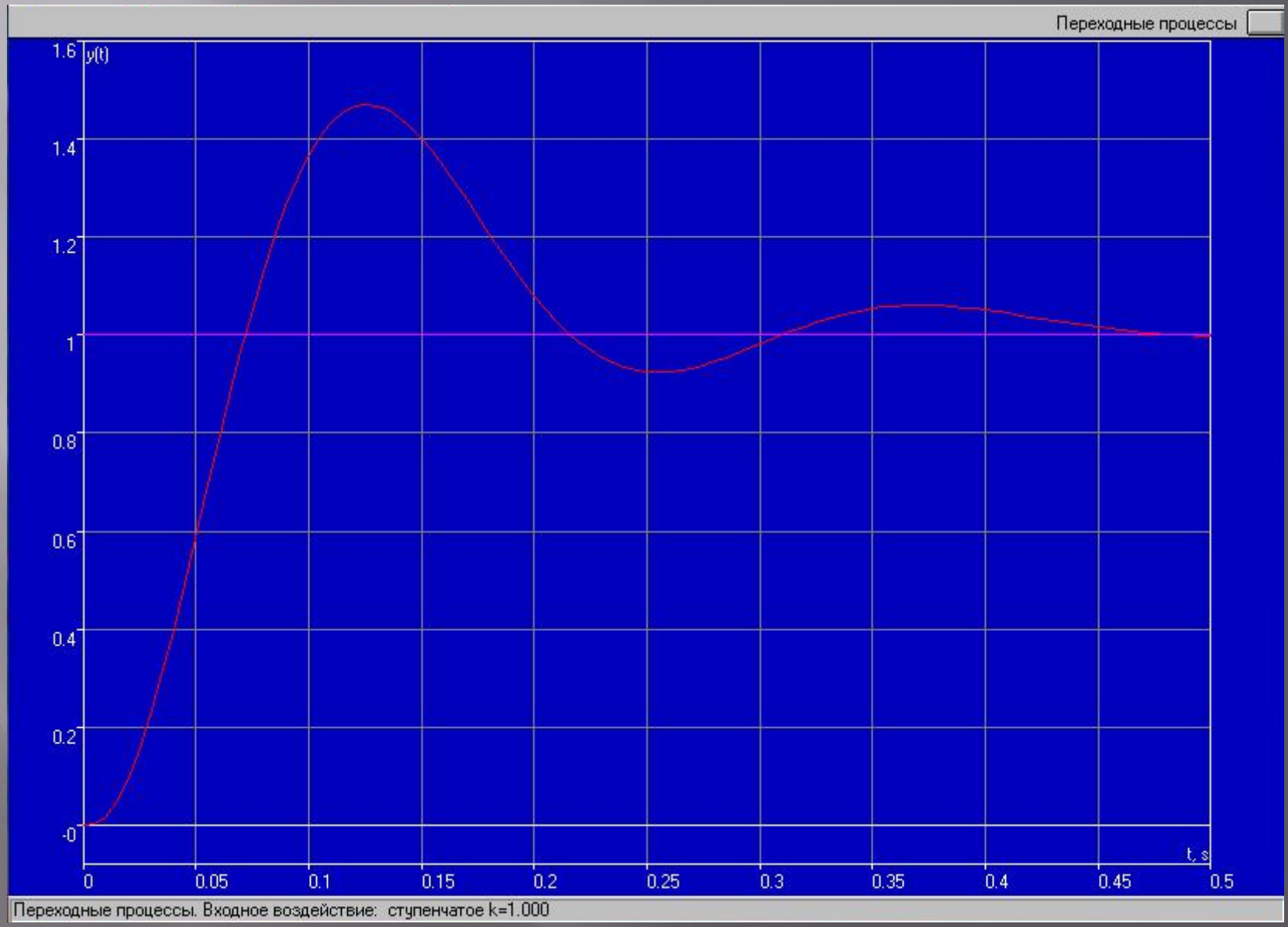


CREATION OF CORRECTED SYSTEM

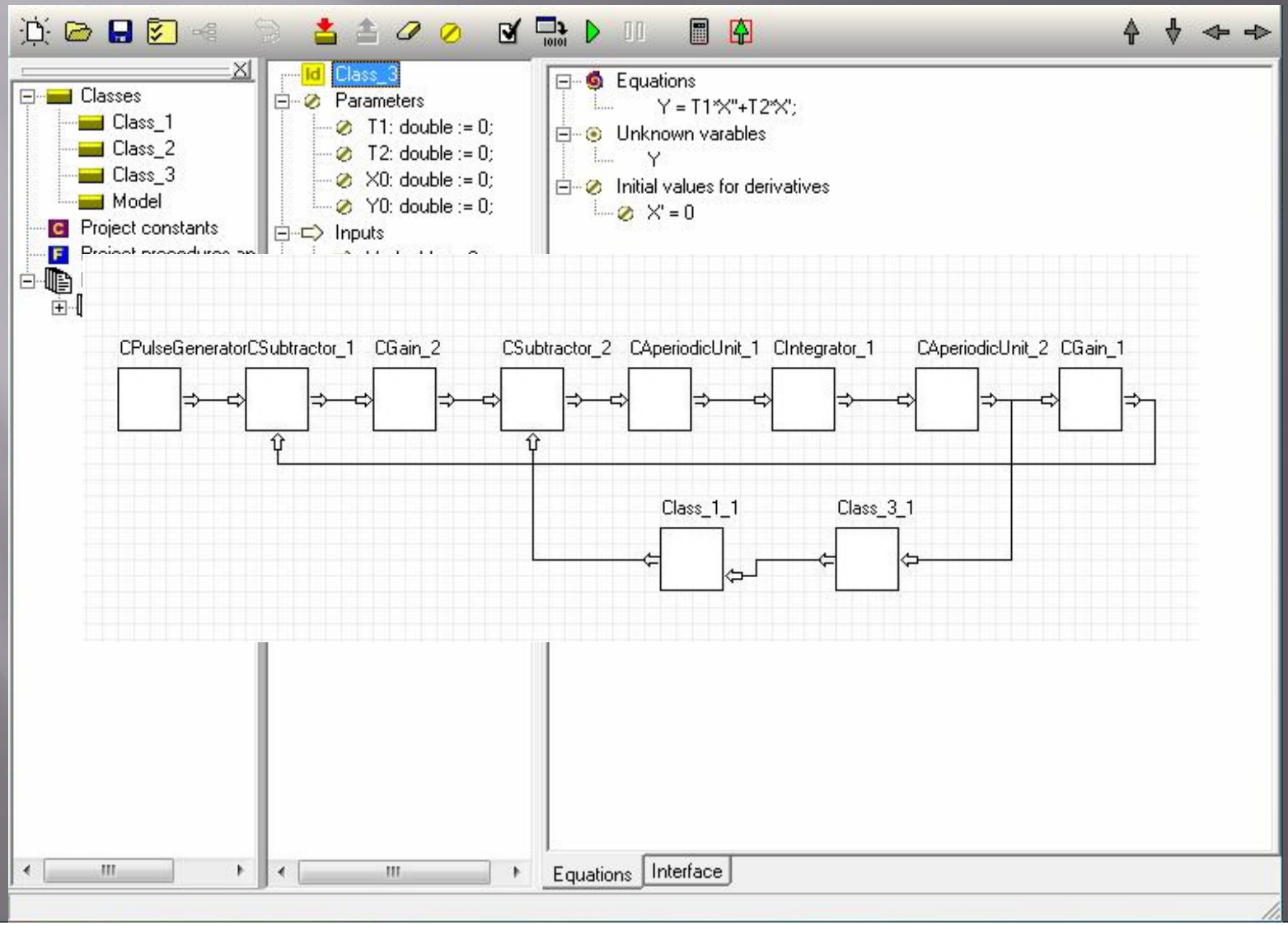
For construction of this device I used a method of construction of the desirable logarithmic characteristic offered by Russian scientist Besekersky. The given type of correction is called as parallel correction of a part of system. To the engine it is connected tachogenerator – the special device, reformative speed of rotation of the engine in pressure. And to it we include the calculated correcting device.



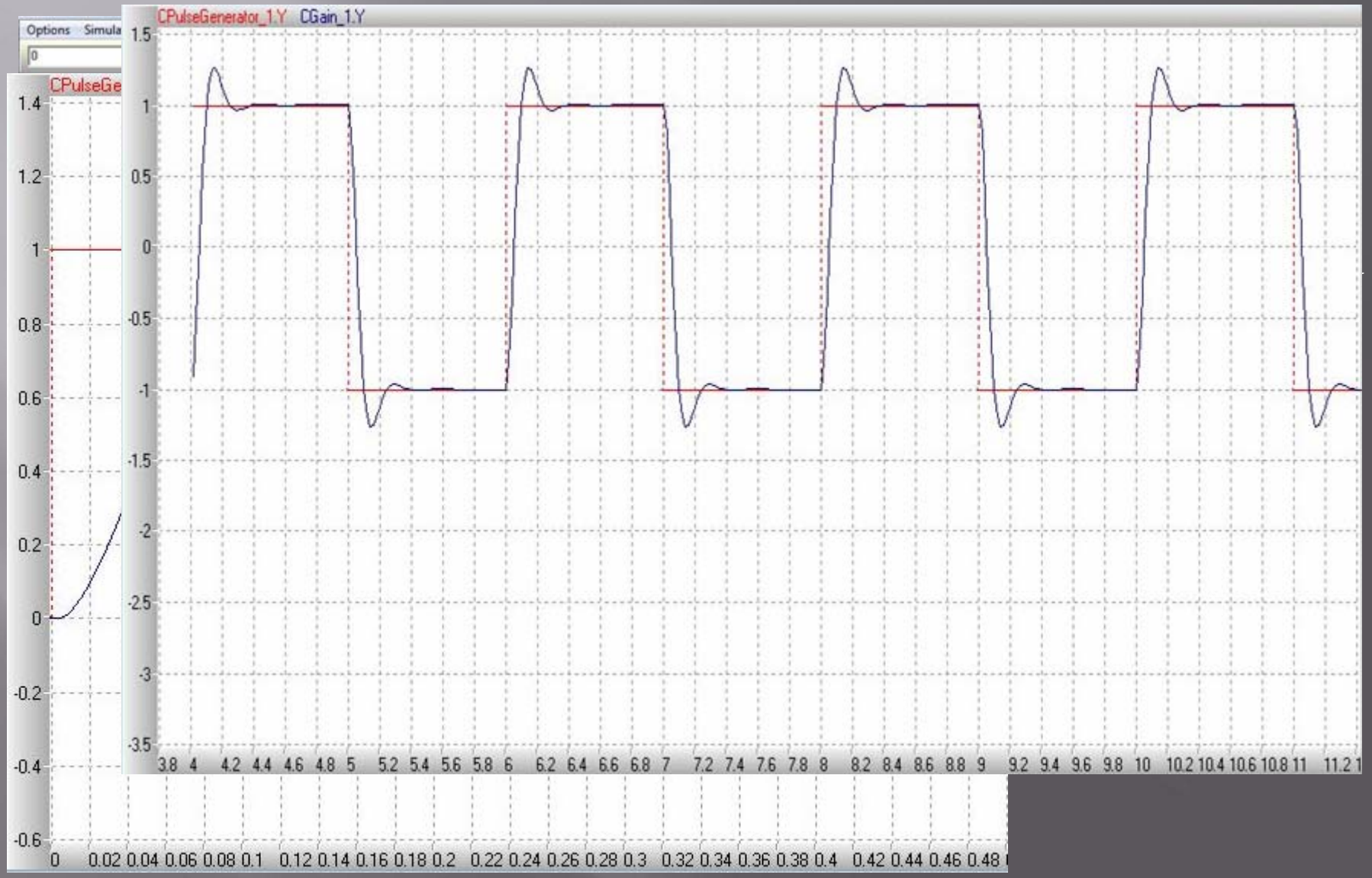
Corrected system in Classic 3.0



CORRECTED SYSTEM IN MVSTUDIUM CREATION OF PERSONAL BLOCK



MODELING OF CORRECTED SYSTEM IN MVSTUDIUM



Conclusion

In summary I can tell, that the sphere of applications MVS is really very wide, and the considered examples not a limit of its possibilities. In general, MVS – excellent tool, and I hope, that you liked it and my presentation about him.

THANKS!

http://www.mvstudium.com