

Real Time simulation of Tank level control system using Open Modelica done by CDAC-T

Tank Level Control System

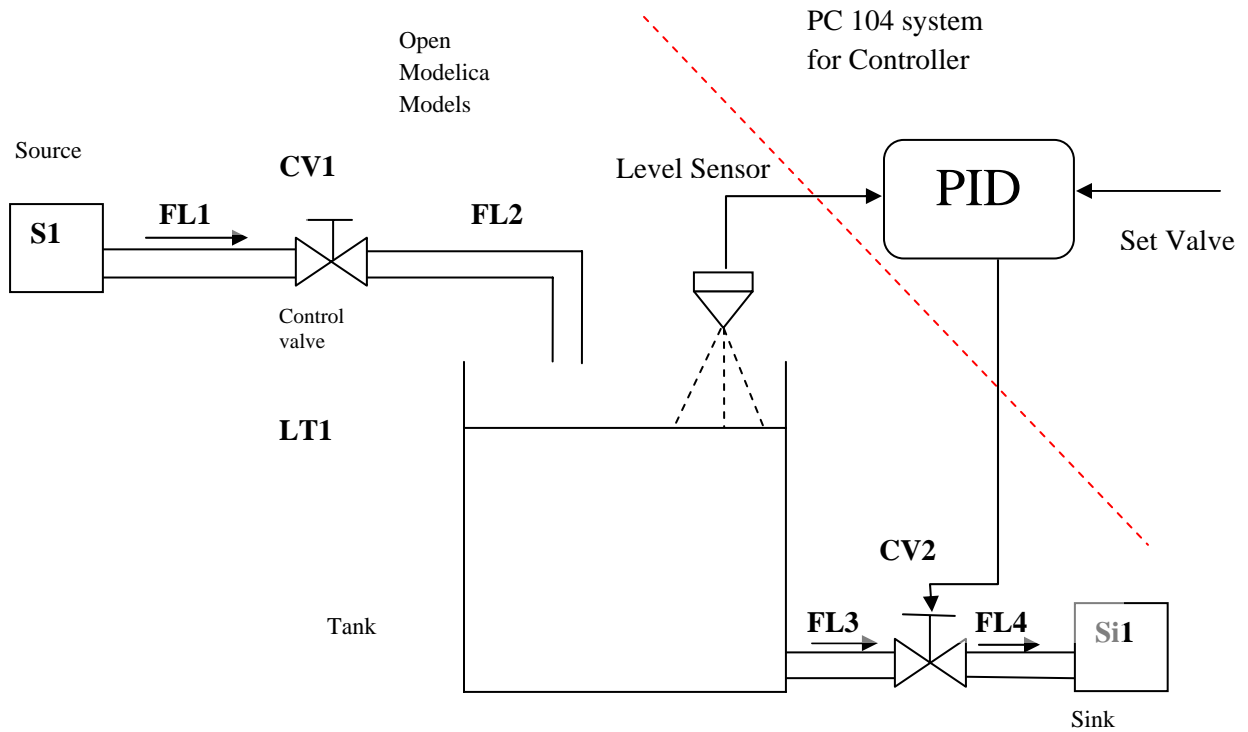


figure 1

Real-Time Simulation Set up

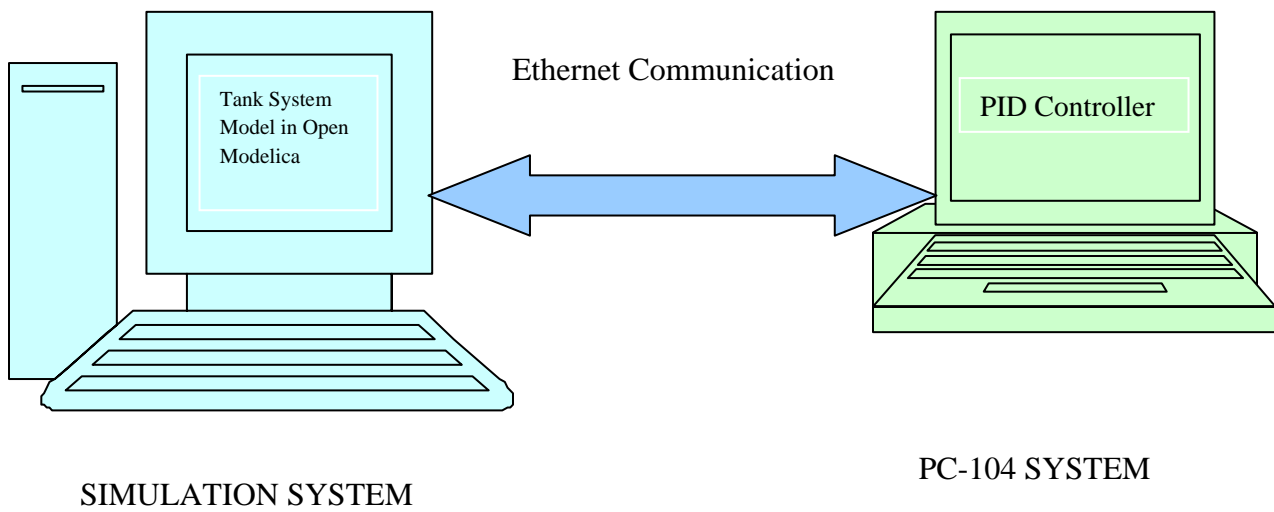
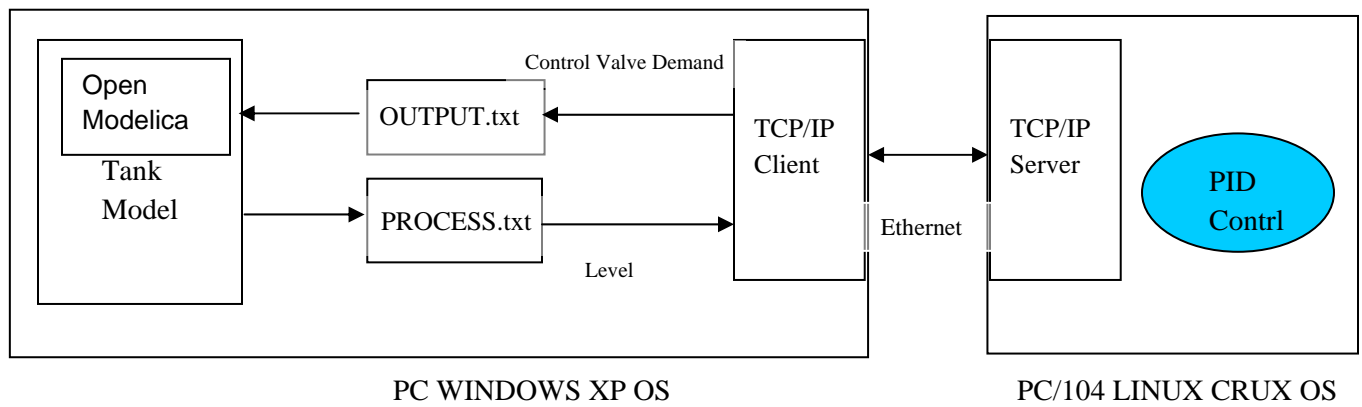


figure 2

Interface of Open Modelica Model with PC104 PID Controller with TCP Protocol: Simulation setup

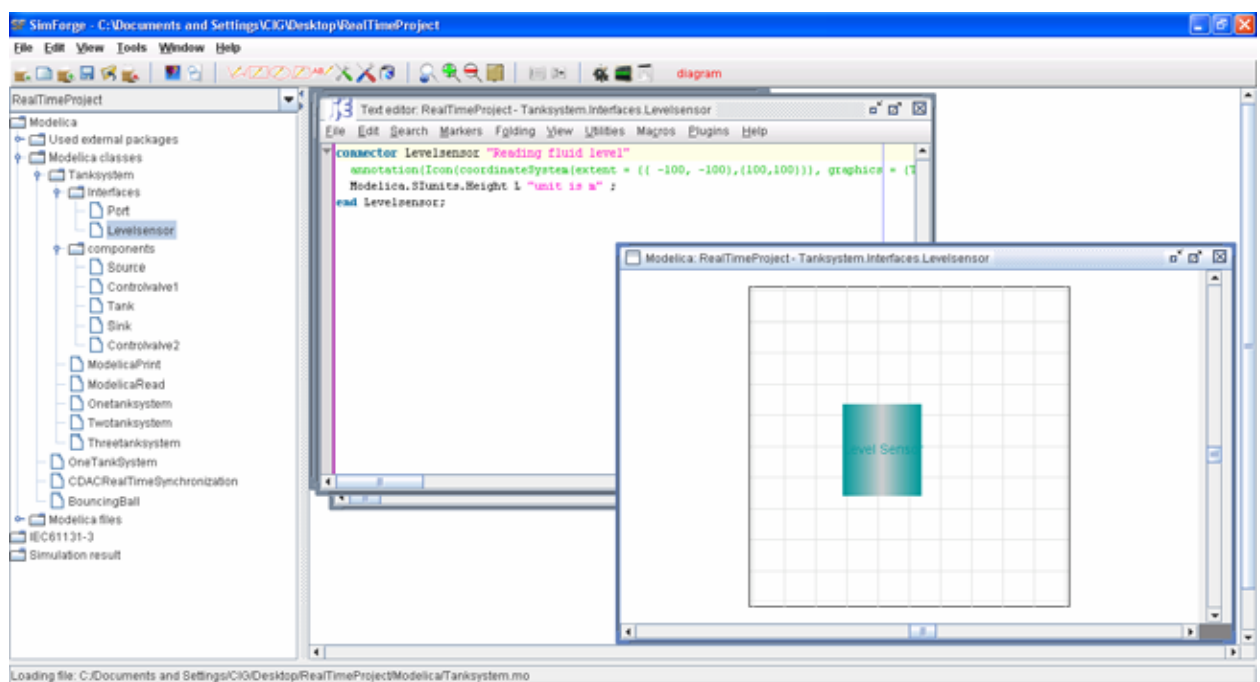
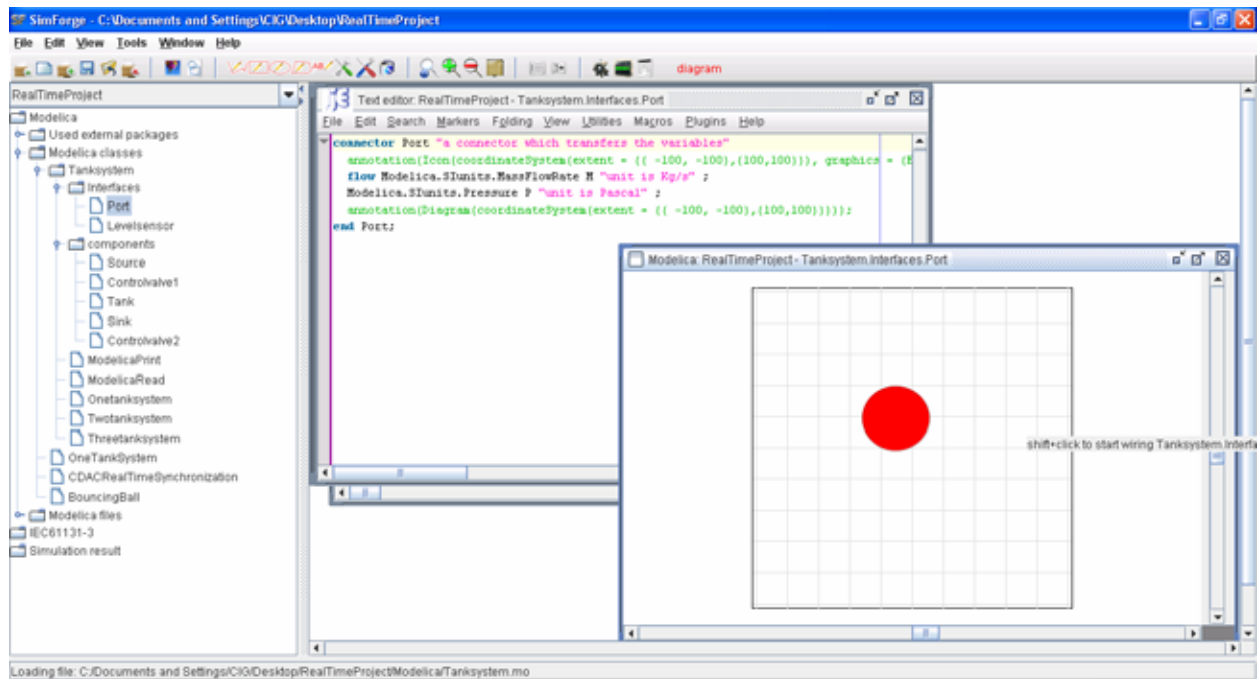


PC/104 – Embedded controller (compact PC)

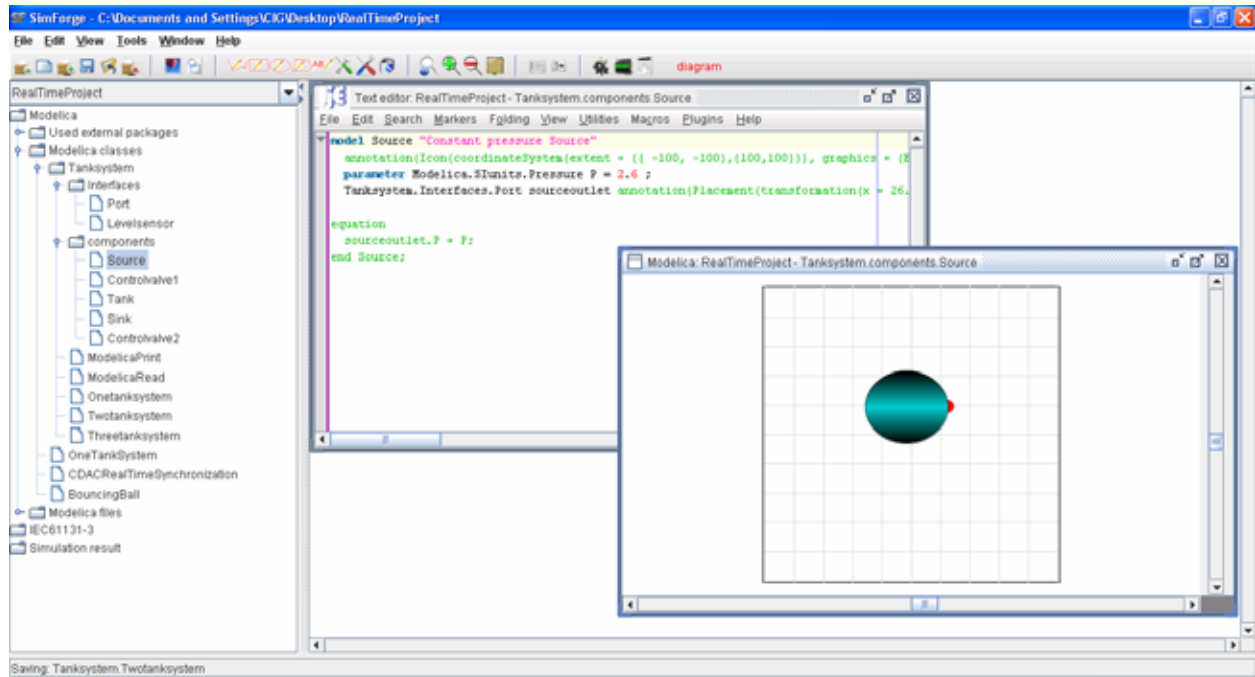
figure 3

Procedure for Simulation in Real Time using OpenModelica

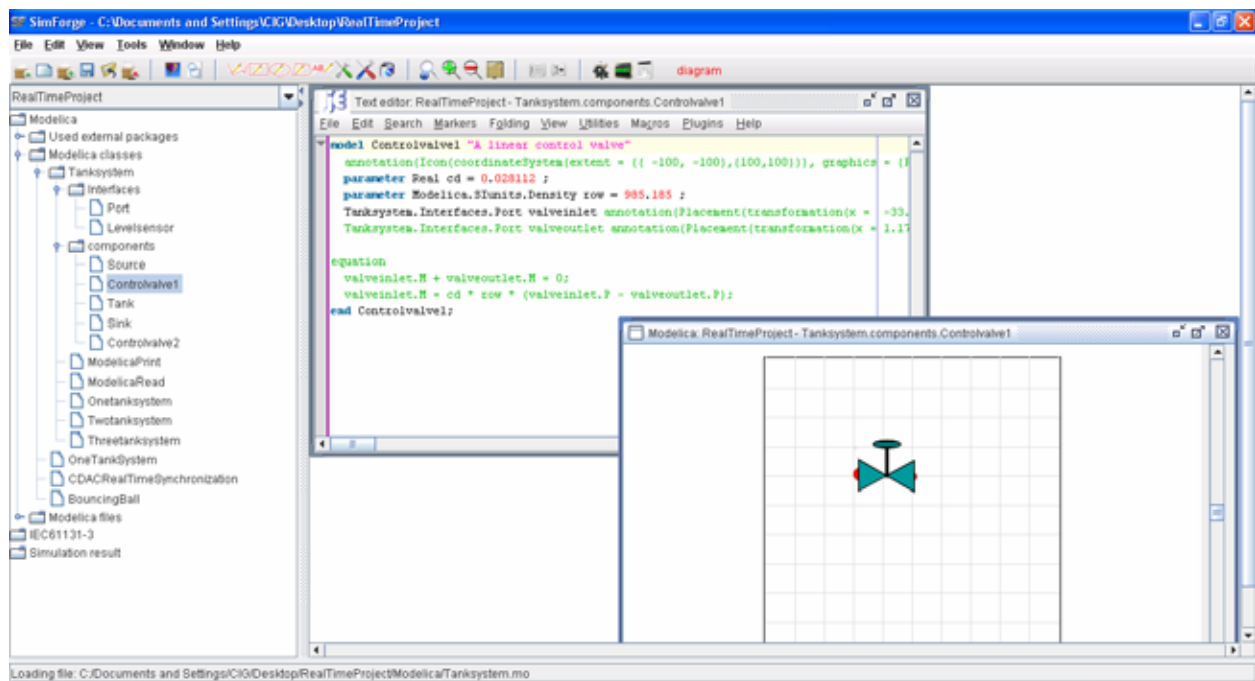
1. The tank level control system shown in figure 1, is mathematically modeled by dividing it into following sub-components: (a) Port (b) Level sensor (c) Source (d) Control valve1 & 2 (e) Tank and (f) Sink
2. The Port and Level sensor components are made as part of Interfaces package. The individual components can have a graphical representation as shown.



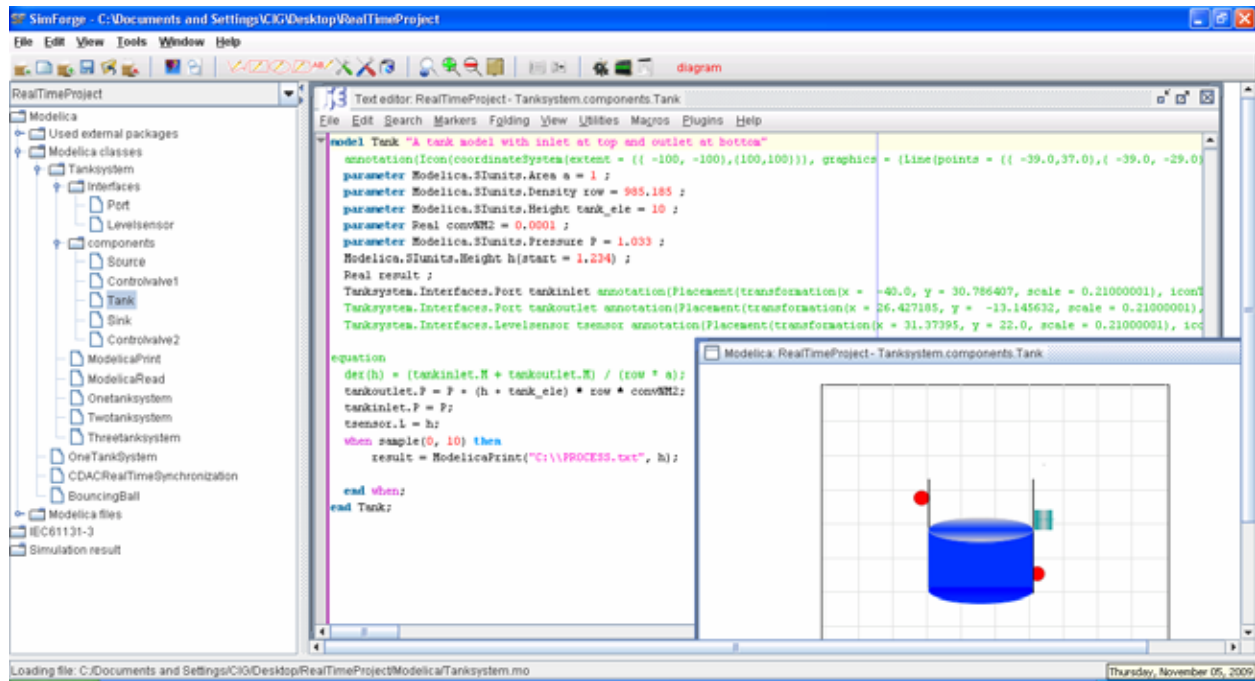
3. The Components package is made which contains Source, Control Valve1, Tank, Control valve 2, and Sink as sub-components.
4. The Source component with its graphical representation.



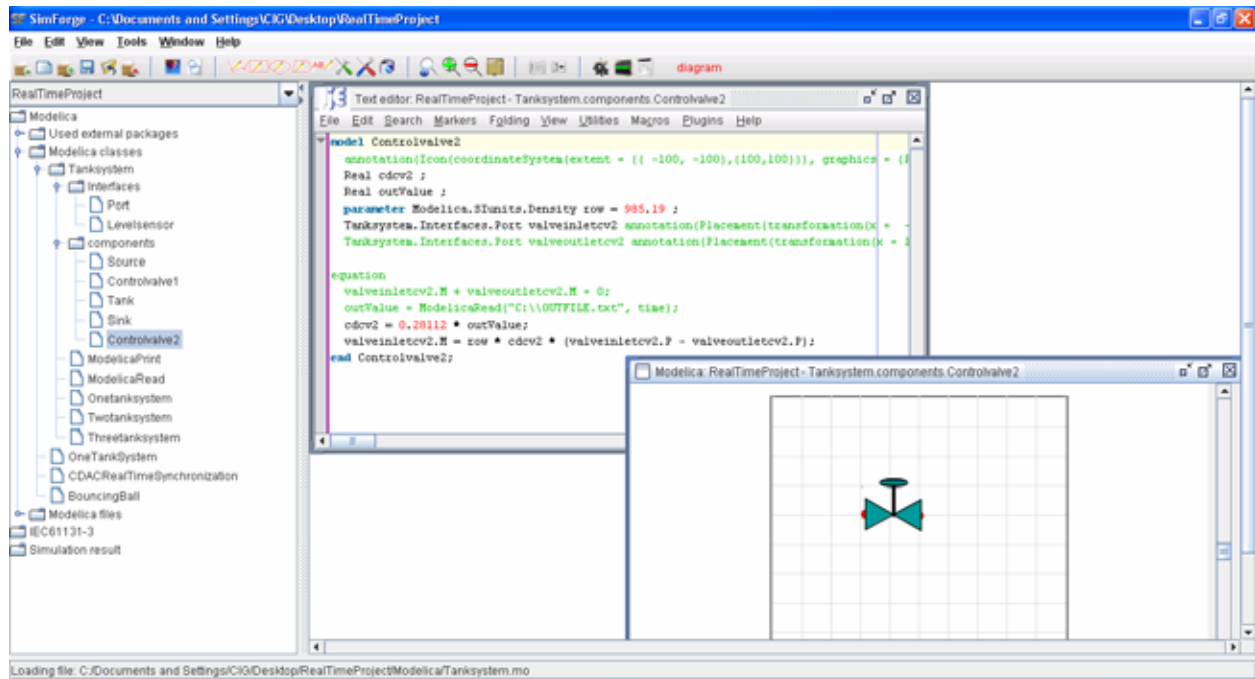
5. The Control valve 1 component with its graphical representation.



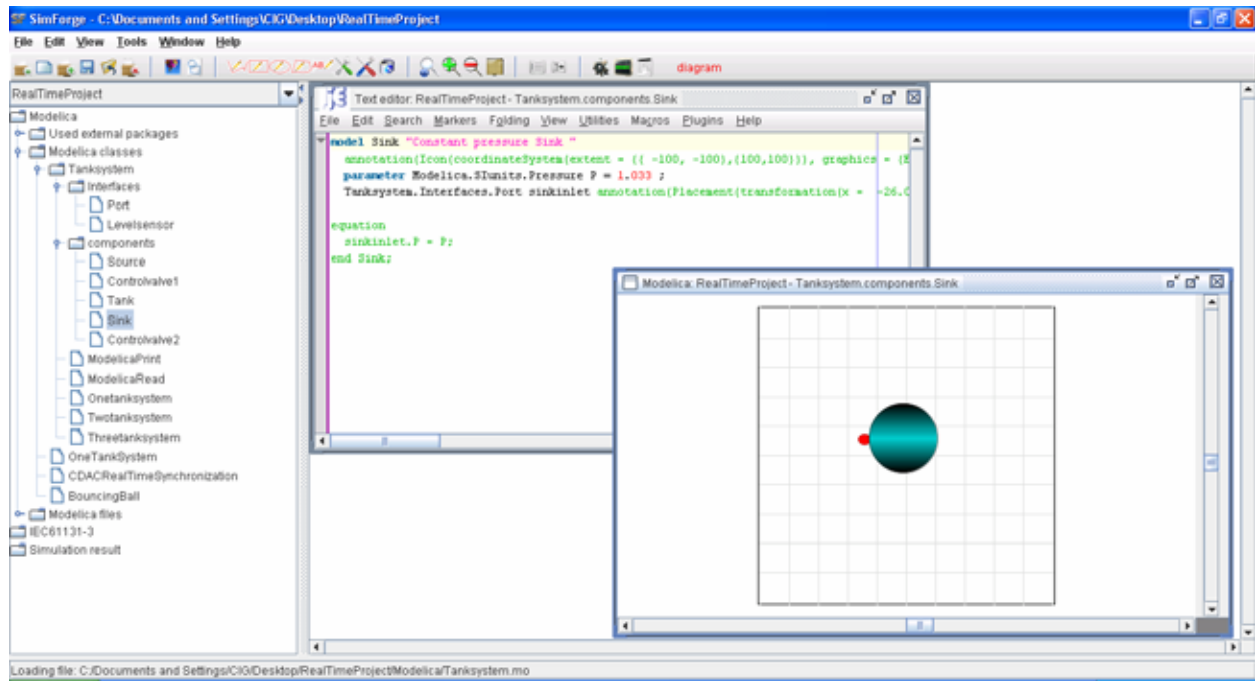
6. The Tank component with its graphical representation.



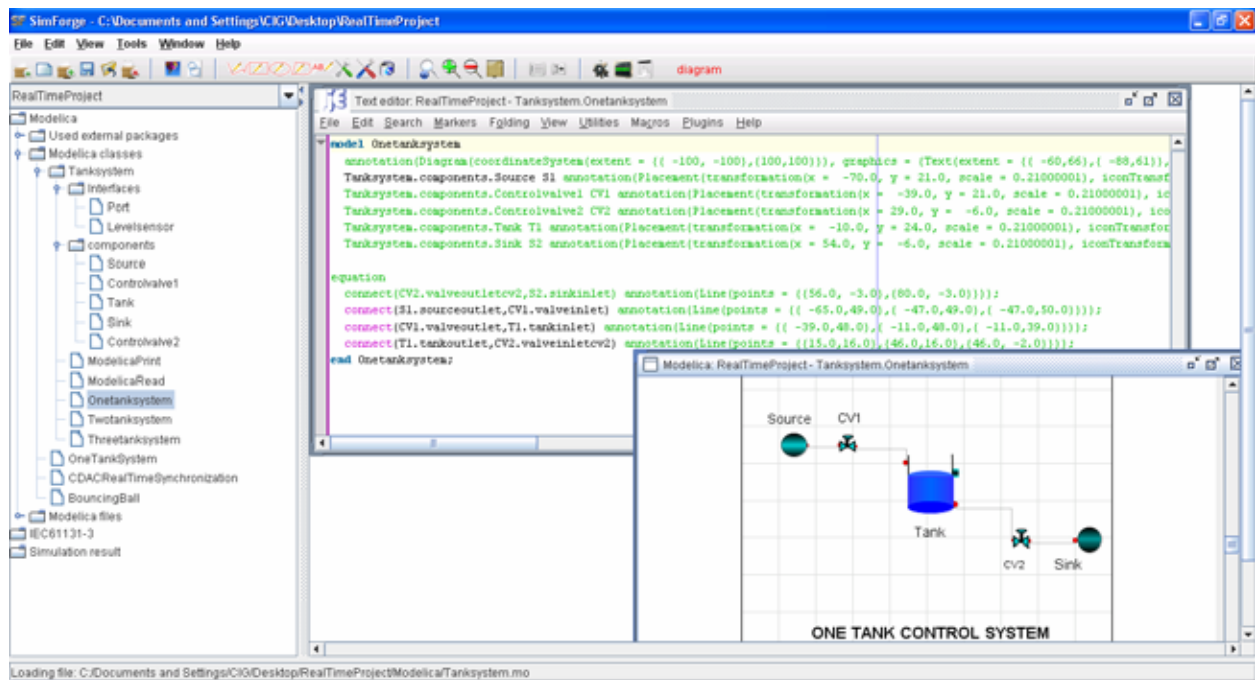
7. The Control valve 2 component with its graphical representation.

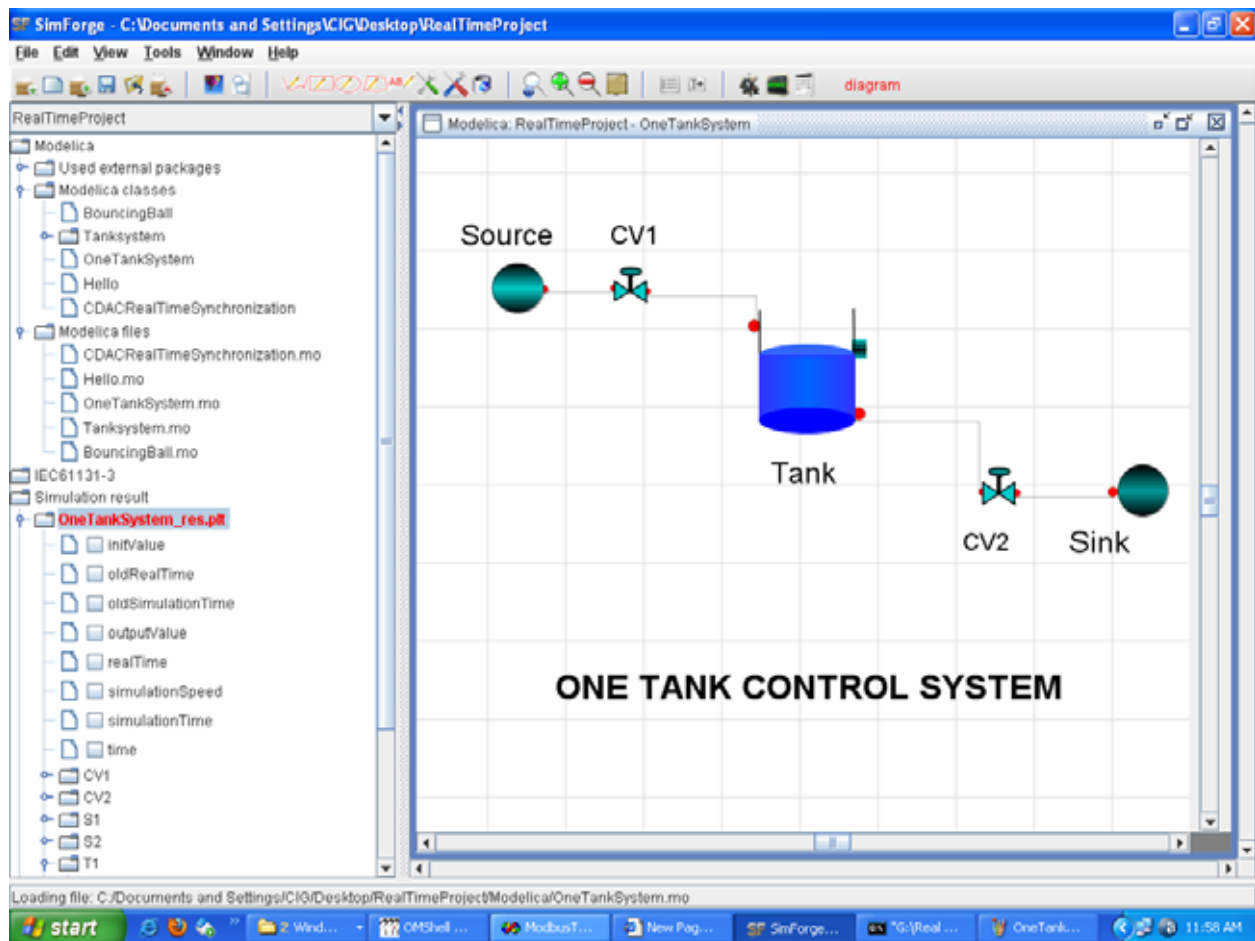


8. The Sink component with its graphical representation.



9. The One Tank System will be formed by suitably connecting the components. In graphical mode, if we drag and drop the components and connect them, the textual code will be generated.





10. The Real Time Synchronization package is made as a package.

The screenshot shows the source code for the 'CDACRealTimeSynchronization' package in the SimForge text editor. The code is written in Modelica and includes the following components:

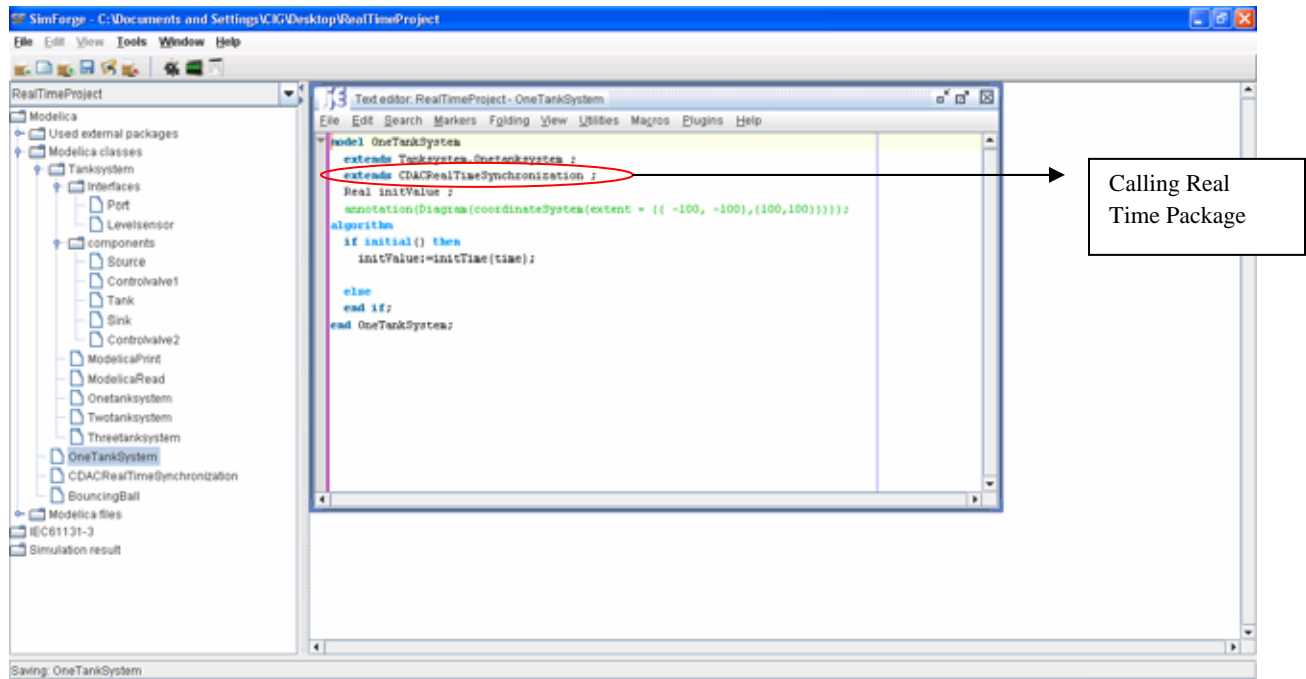
```

model CDACRealTimeSynchronization "a model which can be extended to any other models to run in realtime"
  Real outputValue ;
  Modelica.SIunits.Time realTime ;
  Modelica.SIunits.Time simulationTime ;
  Real simulationSpeed ;
  annotation(Diagram(coordinatesSystem(extent = {{ -100, -100}, {100, 100}})));
  function initTime "Initializes the hardware timer on mainboard"
    input Modelica.SIunits.Time iTime ;
    output Real p ;
    annotation(Diagram(coordinatesSystem(extent = {{ -100, -100}, {100, 100}})));
  end initTime ;
  external p = initTime(iTime) annotation(library = "libTimerFunction.o", Include = "#include \"TimerFunction.h\"");
  function getRealTime "returns the current hardware timer value of mainboard"
    input Modelica.SIunits.Time sTime ;
    output Real y ;
  end getRealTime ;
  external y = getRealTime(sTime) annotation(library = "libTimerFunction.o", Include = "#include \"TimerFunction.h\"");
  function controlSimulation "a function which controls the execution of the system"
    input Modelica.SIunits.Time rTime ;
    input Modelica.SIunits.Time oRealTime ;
    input Modelica.SIunits.Time sTime ;
    input Modelica.SIunits.Time oSimulationTime ;
    output Real sSpeed = 1.0 ;
  algorithm
    while (sTime > rTime or sSpeed > 1.1) loop
      rTime = getRealTime(sTime);
      sSpeed = (sTime - oSimulationTime) / (rTime - oRealTime);
    end while
  end controlSimulation
end CDACRealTimeSynchronization

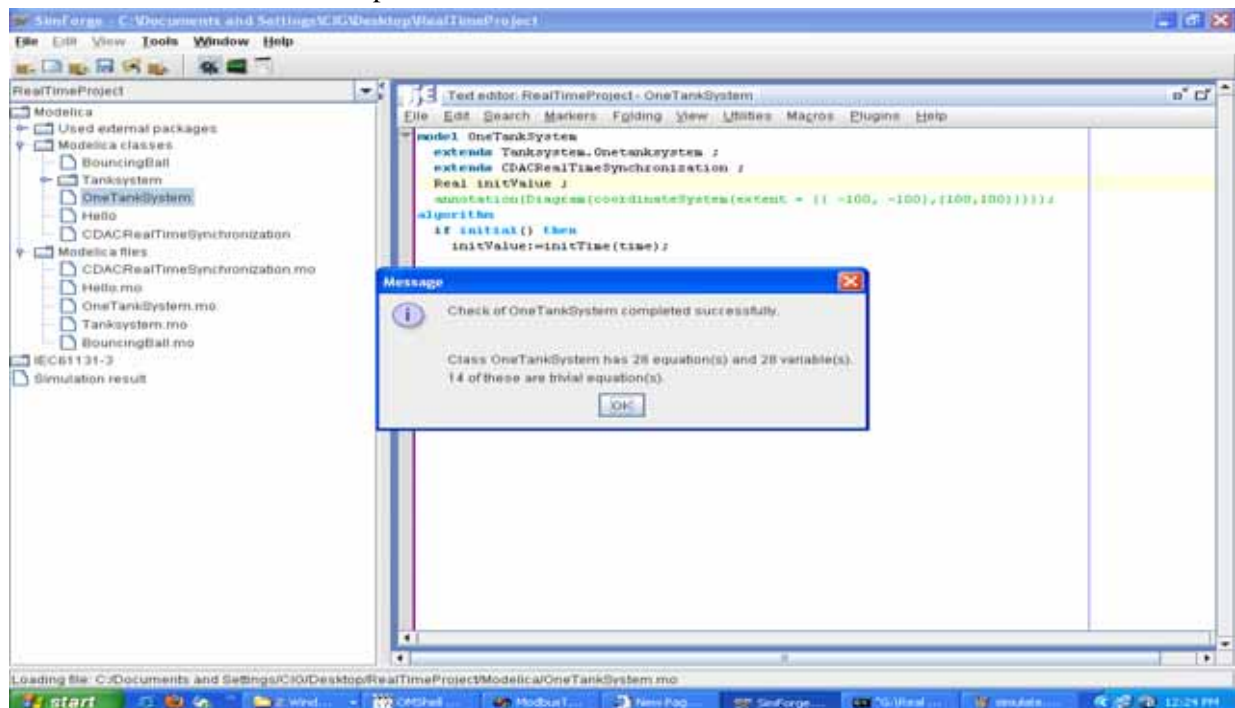
```

The status bar at the bottom indicates 'Saving: CDACRealTimeSynchronization'.

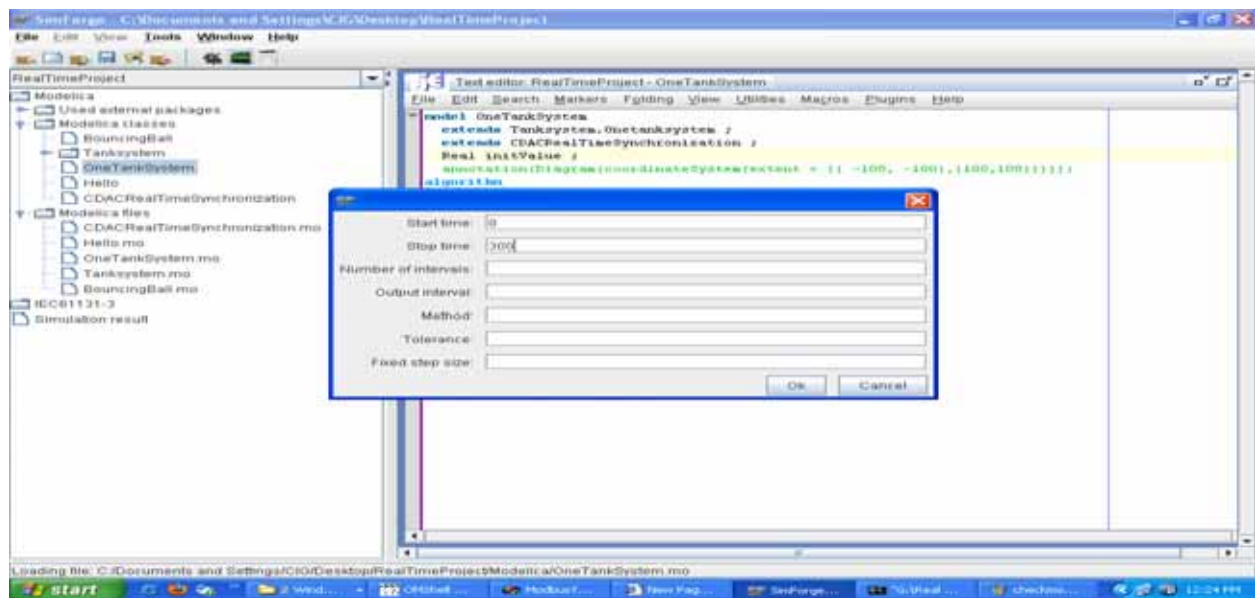
11. To achieve simulation in real time, we have to integrate it in one tank system.



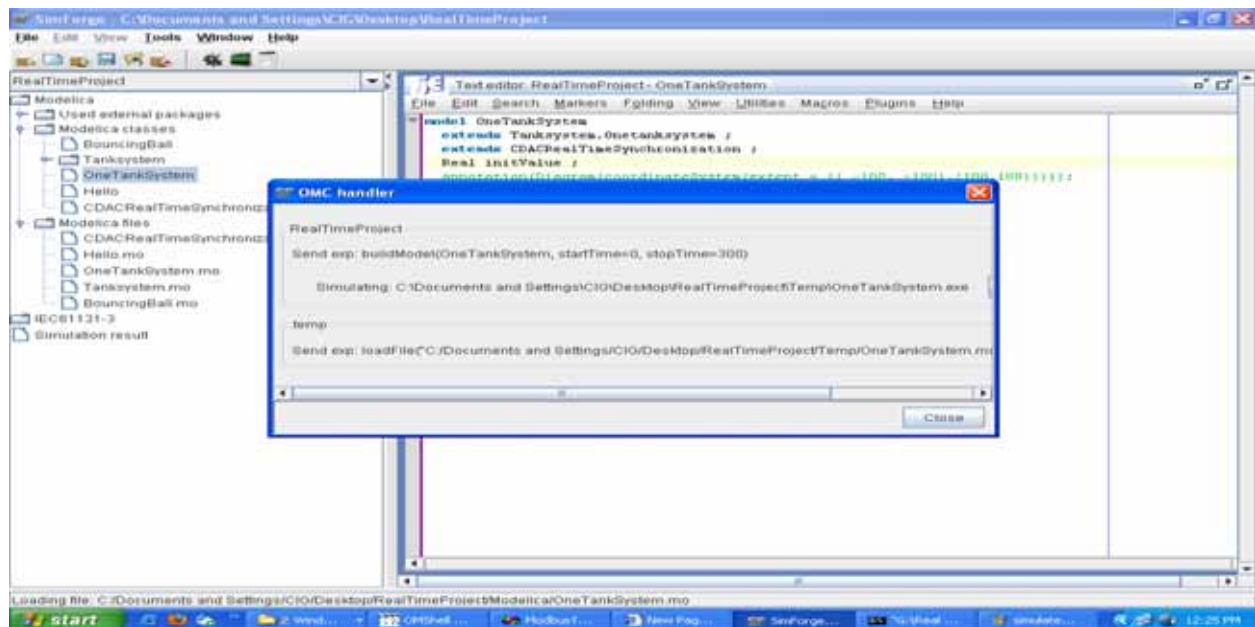
12. To run the simulation, the model should have same number of equations as the number of variables. The 'check model' option is used for it.



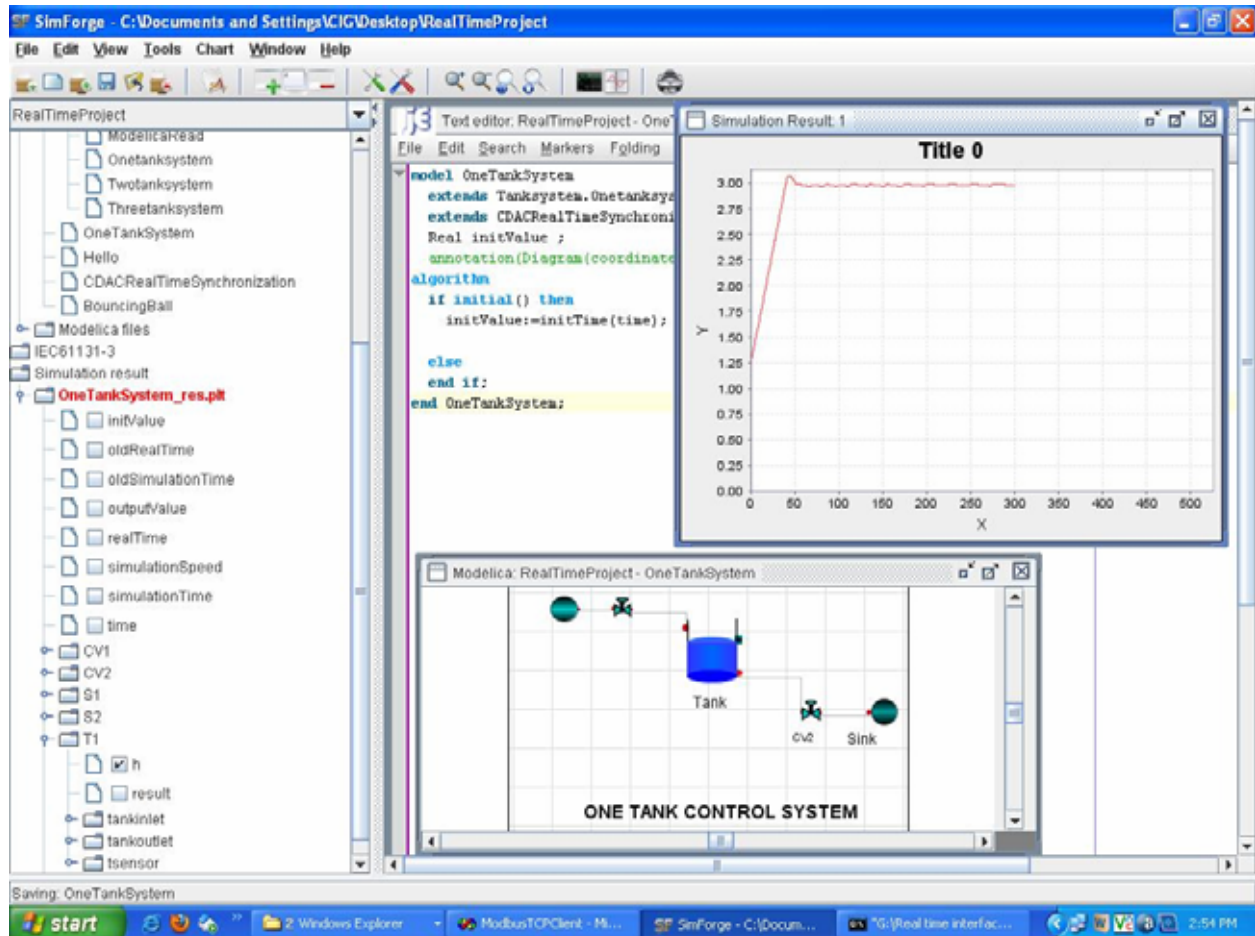
13. Now we can run the simulation. We have configure Start time and stop time.



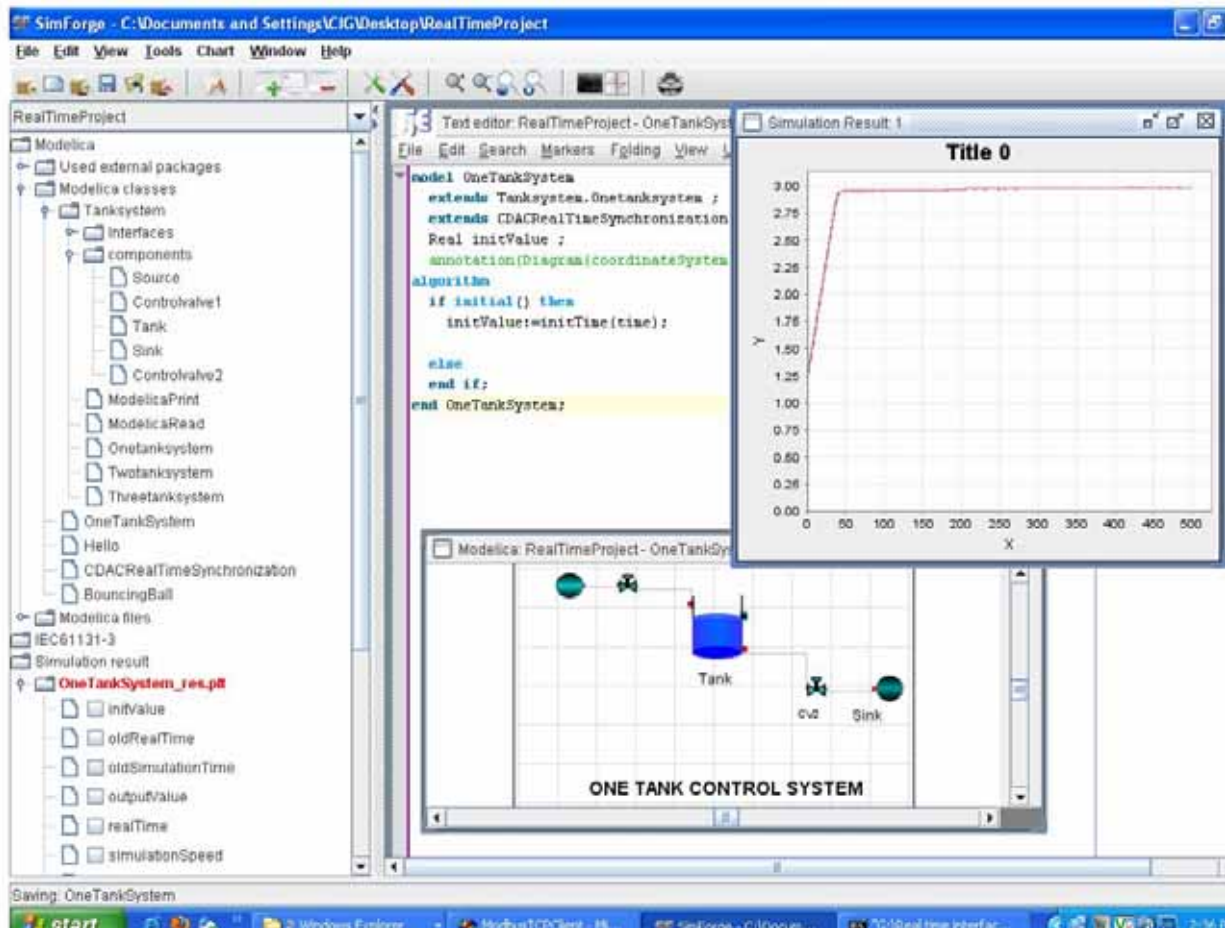
14. During simulation we can start a counter to check the real time. If we have given stop time of 60 sec, then the simulation should take exact 60 sec only.



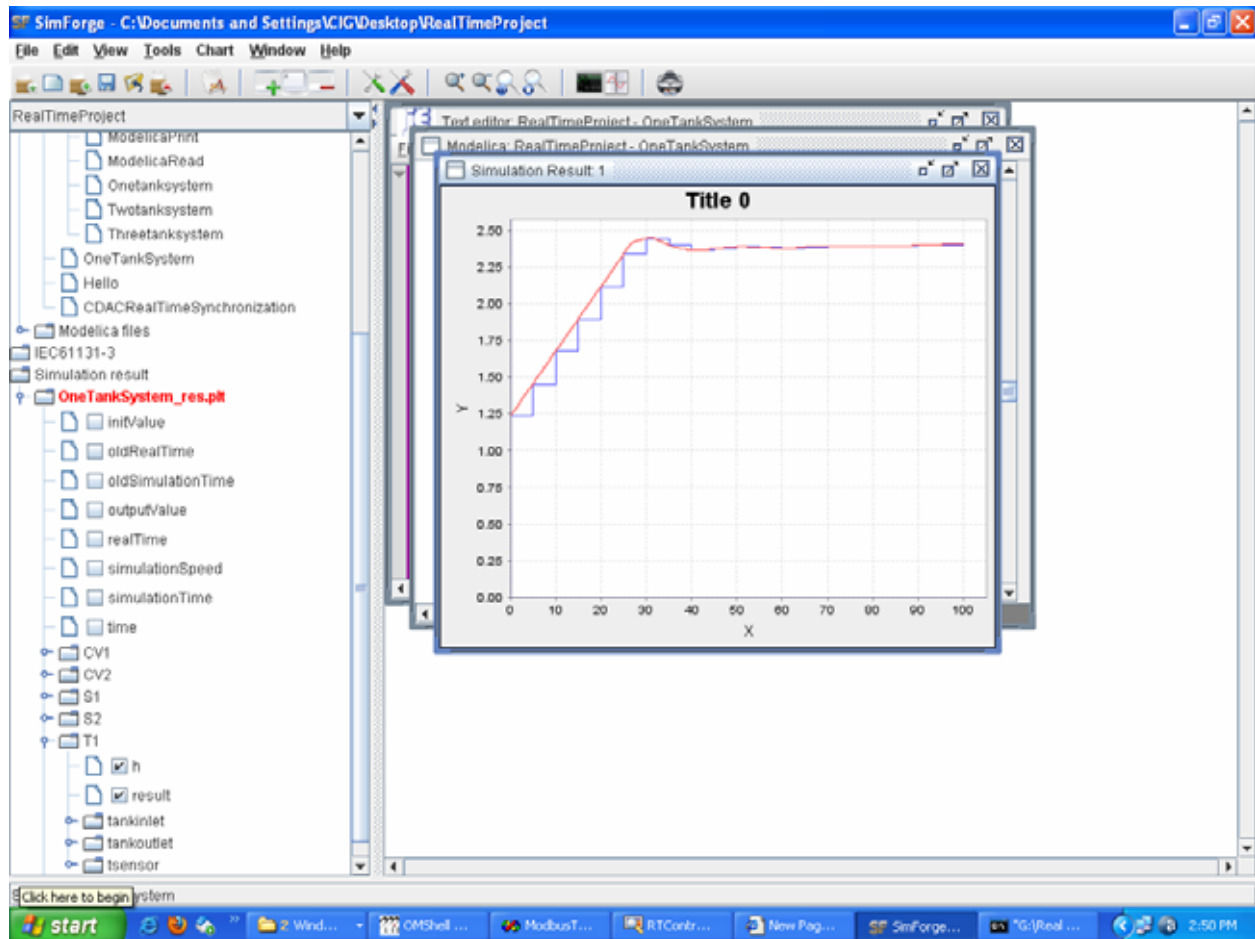
15. The simulation results can be plotted. Any variable in model can be plotted. Sampling time=0.5 sec; Set point =3.00 m; Stop time=300 sec



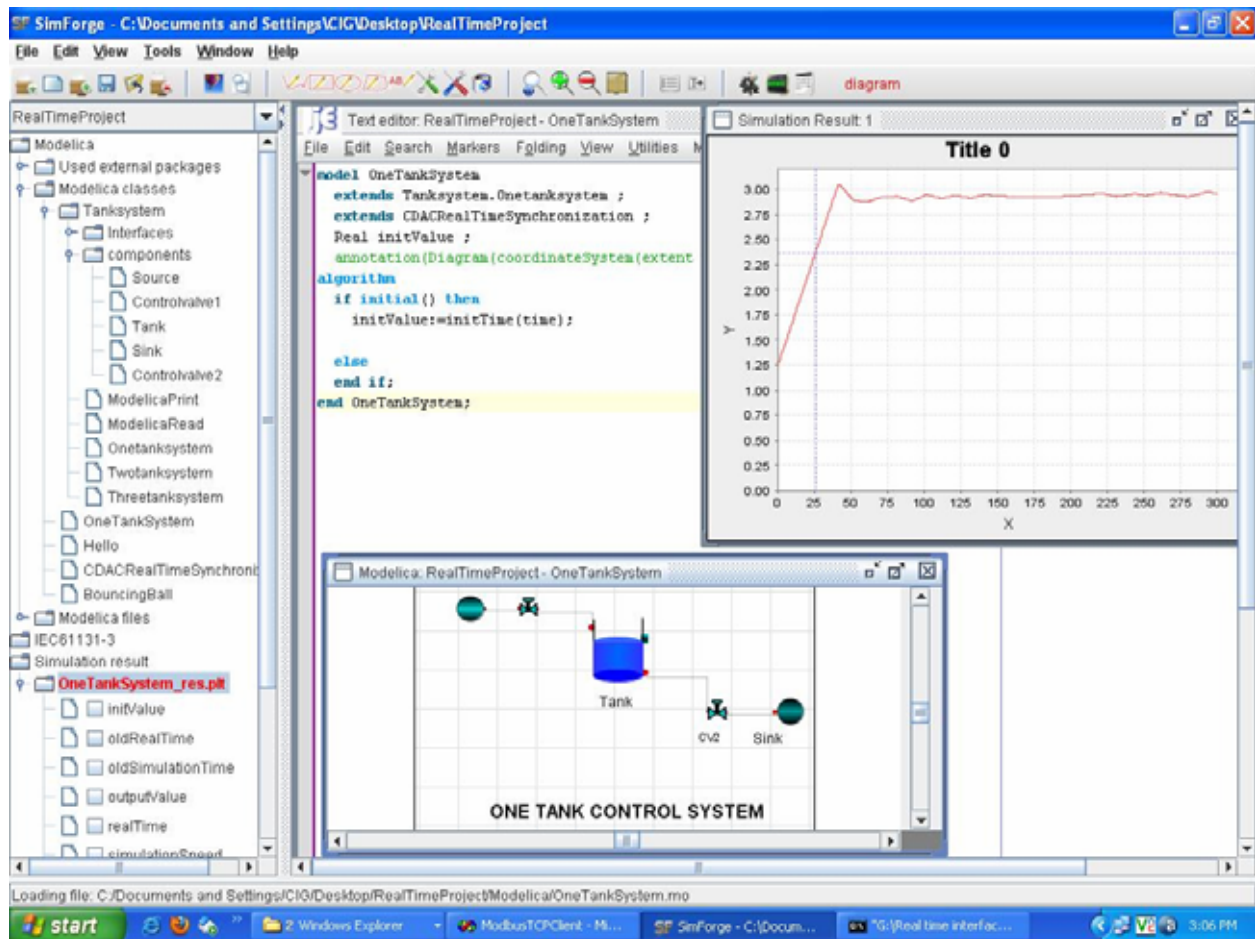
Sampling time=1 sec; Set point =2.50 m; Stop time=100 sec



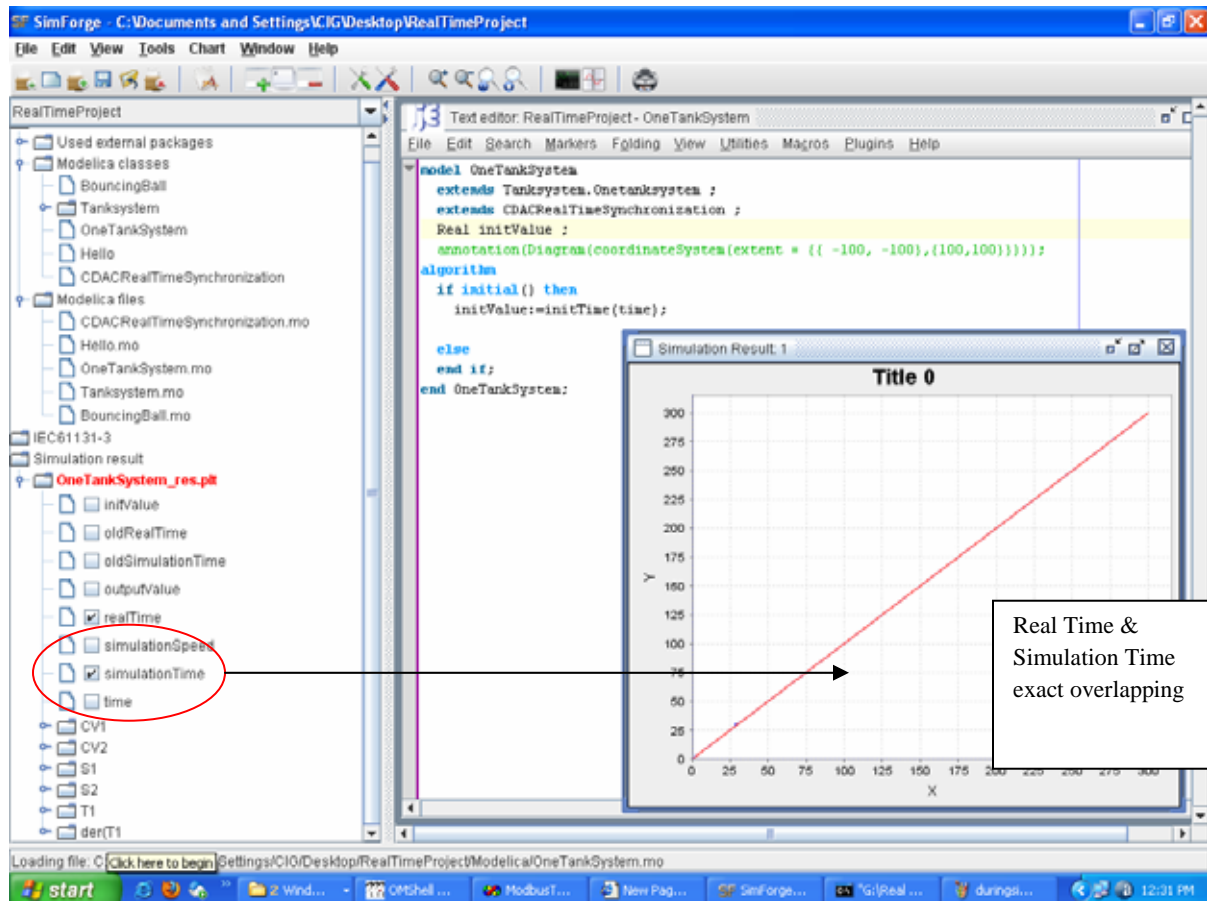
Sampling time=5 sec; Set point =2.50 m; Stop time=100 sec



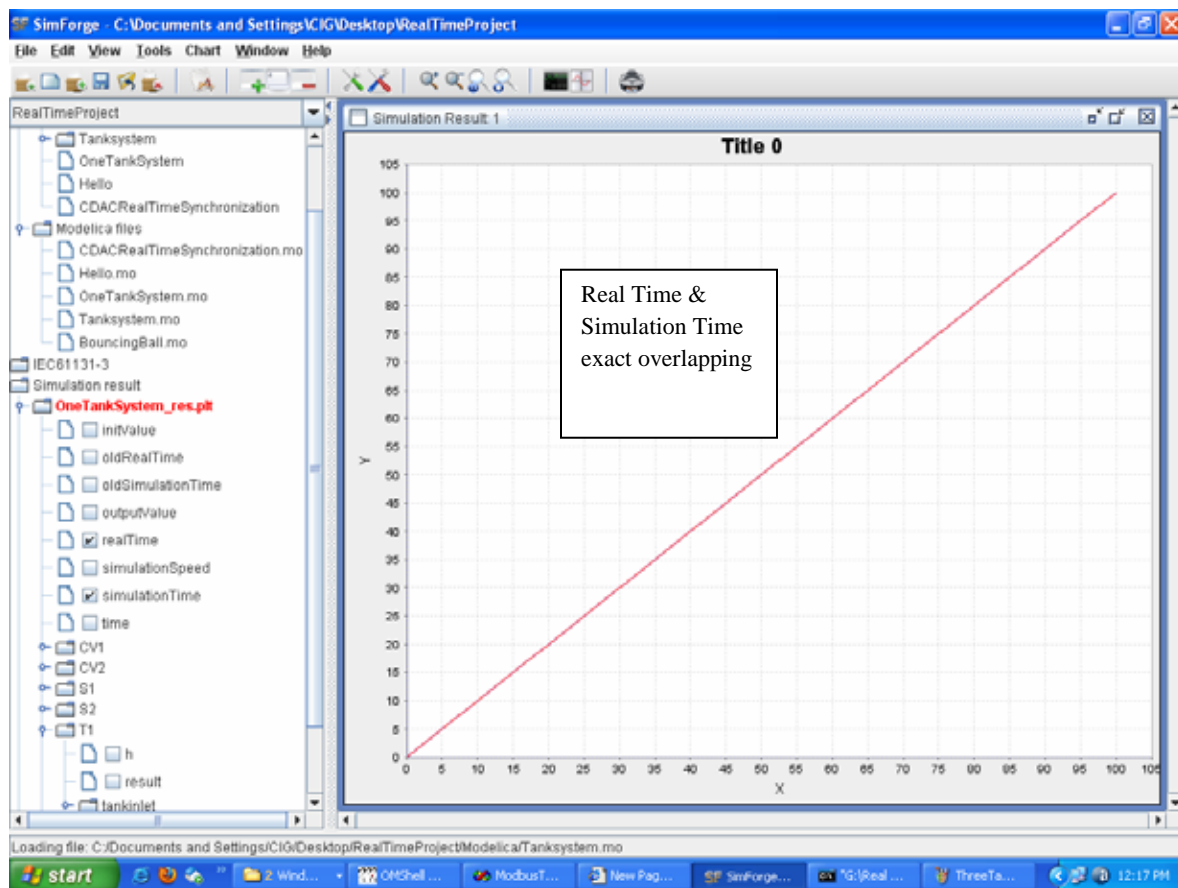
Sampling time=10 sec; Set point =3.00 m; Stop time=300 sec



16. The simulation will take exactly 300 sec as configured. The Real time and Simulation time are exactly overlapping.



The Real time and Simulation time are exactly overlapping (simulation run for 100 sec).

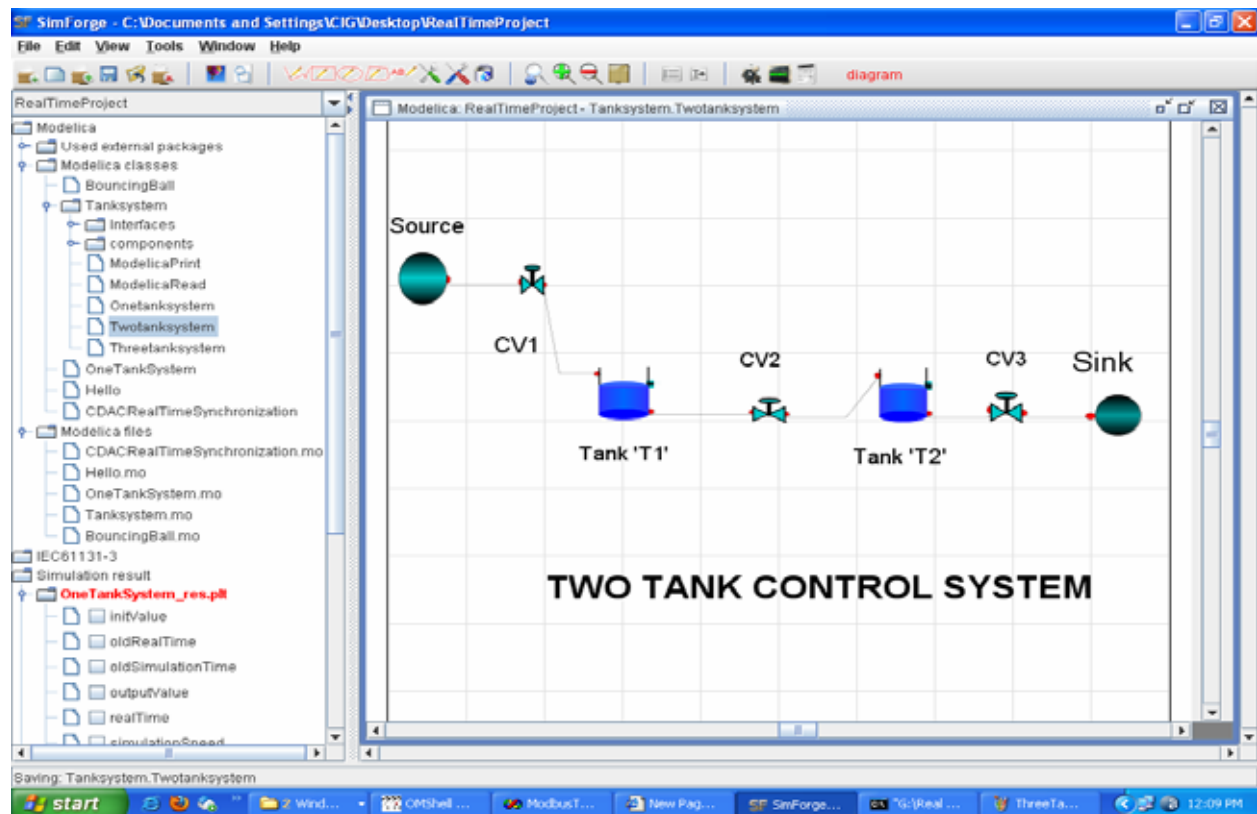


The screenshot displays the RealTimeProject software environment. The top window, titled 'Text editor: RealTimeProject - Tanksystem.Twotanksystem', contains the following code:

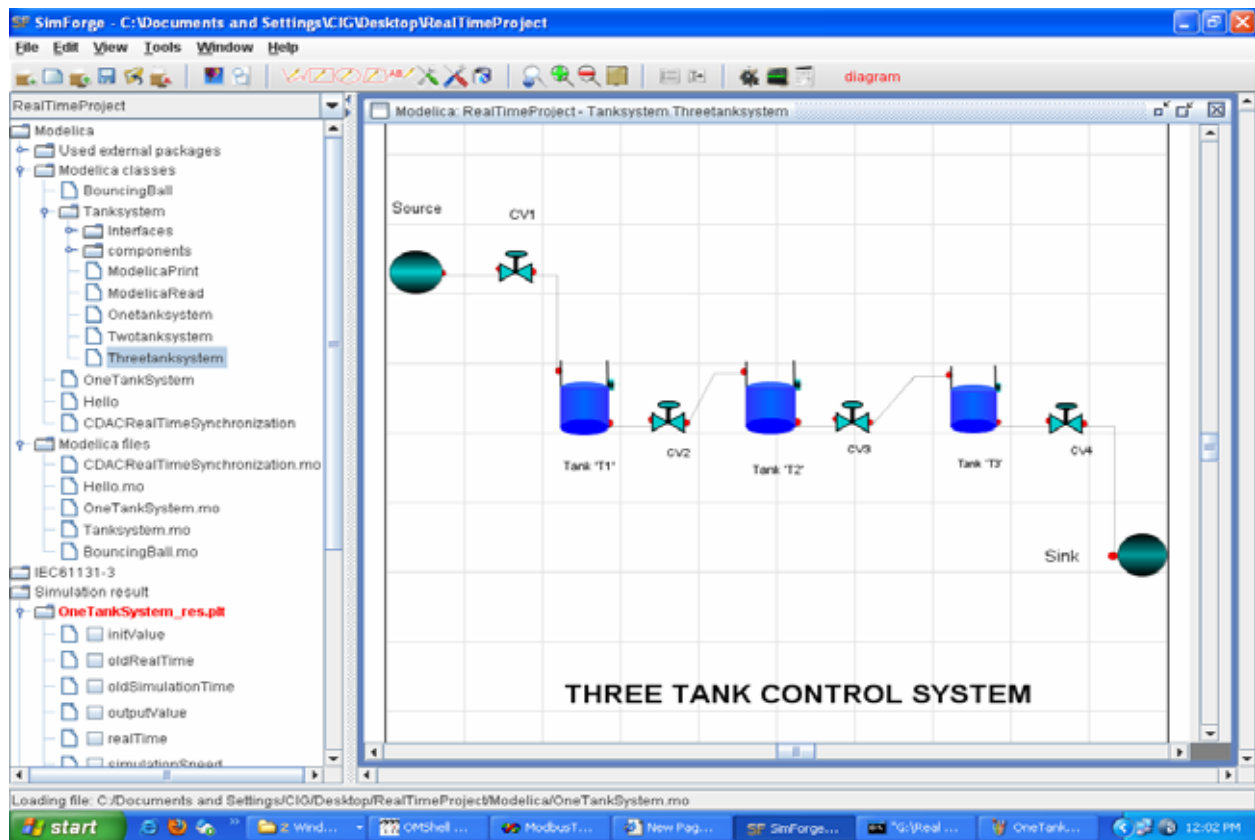
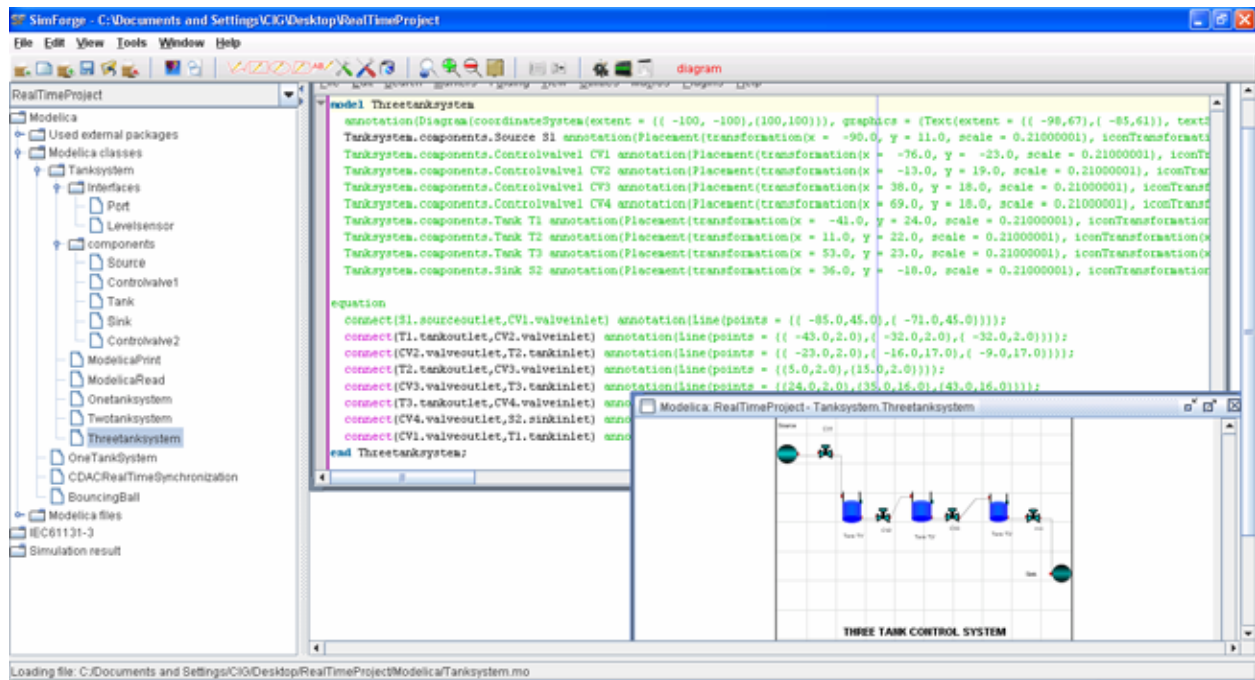
```

model Twotanksystem
  annotation(Diagram(coordinateSystem(extent = {{ -100, -100},{100,100}}), graphics = (Text(extent = {{ -79,59},{ -99
  Tanksystem.components.Source S1 annotation(Placement(transformation(x = -69.0, y = 56.0, scale = 0.21000001), icon
  Tanksystem.components.Controlvalve CV1 annotation(Placement(transformation(x = -92.0, y = 49.0, scale = 0.21000000
  Tanksystem.components.Controlvalve CV2 annotation(Placement(transformation(x = -10.0, y = 27.0, scale = 0.21000001)
  Tanksystem.components.Controlvalve CV3 annotation(Placement(transformation(x = 54.0, y = 18.0, scale = 0.21000001)
  Tanksystem.components.Tank T1 annotation(Placement(transformation(x = -13.0, y = 25.0, scale = 0.21000001), iconT1
  Tanksystem.components.Tank T2 annotation(Placement(transformation(x = 22.0, y = 22.0, scale = 0.21000001), iconT2
  Tanksystem.components.Sink S2 annotation(Placement(transformation(x = 90.0, scale = 0.21000001), iconTransformation
  equation
    connect(S1.sourceoutlet,CV1.valveinlet) annotation(line(points = {{ -84.0,40.0},{ -66.0,40.0}}));
    connect(CV1.valveoutlet,T1.tankinlet) annotation(line(points = {{ -60.0,39.0},{ -56.0,14.0},{ -47.0,14.0}}));
    connect(T1.tankoutlet,CV2.valveinlet) annotation(line(points = {{ -33.0,2.0},{ -7.0,2.0}}));
    connect(CV2.valveoutlet,T2.tankinlet) annotation(line(points = {{ 22.0,1.0},{ 17.0,1.0},{ 25.0,12.0}}));
    connect(T2.tankoutlet,CV3.valveinlet) annotation(line(points = {{ 38.0,1.0},{ 53.0,1.0},{ 53.0,12.0}}));
    connect(CV3.valveoutlet,S2.sinkinlet) annotation(line(points = {{ 53.0,12.0},{ 90.0,12.0}}));
  end Twotanksystem;
  
```

The bottom window, titled 'Modelica: RealTimeProject - Tanksystem.Twotanksystem', shows a graphical representation of the system. It includes a 'Source' block connected to 'CV1' (Control Valve 1), which is connected to 'Tank T1'. 'Tank T1' is connected to 'CV2' (Control Valve 2), which is connected to 'Tank T2'. 'Tank T2' is connected to 'CV3' (Control Valve 3), which is connected to a 'Sink' block. The diagram is labeled 'TWO TANK CONTROL SYSTEM'.



18. The three tank system is modeled in open modelica.



19. The bouncing ball problem is tested for real time simulation.

