Systematic Dynamics Thinking in the Innovative Teaching

by
First Author Name
Ge zhou, senior high school teacher, Nanjing, China
Second Author Name
Cai Caifu, senior high school teacher, Nanjing, China
Third Author Name
Song Changjie, senior high school teacher, Nanjing, China

Abstract：

There are two parts. First, Systematic dynamics in students innovational activities. The second, Systems dynamics in physics theory study. Student's achievement indicated that, with the system pondered instructs student's innovation, may sharpen student's innovation ability, causes the student to experience the innovation pleasure, raises students' innovation spirit.

Key word: system dynamics, physics teaching, innovative teaching

Text:

In daily life, systematic thinking plays an important role. For example, in order to cut down on criminal cases, the plan drawn from traditional ways of thinking is that the Public Safety Department invests more police force. But if we use the method of systematic thinking, we will find that solving the problem of unemployment is vital. Nowadays, the fast-developing society demands innovation; meanwhile, some complicated problems occur, such as the environment problem, population problem. All these problems are expected to be solved by means of systematic thinking. The goal of our education is to make students gain the quality of innovation, and we educators should help them achieve this through making them think systematically.

Part One: Systematic dynamics and students innovational activities

A system is a group of interacting, interrelated, or interdependent elements forming a complex whole to fulfill one function. When instructing students' innovational activities, we summarize the following methods.

1) System combination innovation

Toothbrush and toothpaste are different from each other while

related to each other at the same time. Their common purpose is to brush teeth. So, we can see them as a system. In order to make brushing teeth easier, shops tie them together for sale. This is what we called systematical combination innovation. Another case in point is that we put machine gun on the plane and made a battle plane. We defy systematical combination innovation as follows, combining of different elements for a common purpose.

2) System elements improvement

We can improve an element of a system in order to achieve better function of the system. This is called elements improvement. Let's take the example of toothbrush and toothpaste again. Usually, when the toothbrush is used, its handle may be well preserved while the brush hair can no longer be used. We invented toothbrush with a changeable brush. This kind of toothbrushes is more economical. Elements improvement also applies to the improvement of toothpaste. The experiments show that, if we change the round paste tube lip into flat one, the chance for the paste on the toothbrush to slip down to the sink goes down.

3) System structure expansion

If two different systems have a similar or same system structure, the means of innovation in one system can be well applied to the other. This is what we called system structure expansion. For example, the system of toothbrush and toothpaste is similar to that of ink and brush. Therefore, we can use the methods we have mentioned above in the improvement of this system and invent anti-spilled ink box and point-replaceable pen.

4) System elements replacement

If one system has the function which is similar to what is needed, replace one or several elements in this system and make it have a new function needed. This innovation is called system elements replacement. For example, a lipstick is a simple system formed by gypsum object and flexible structure. If you replace the gypsum element with a small screwdriver, you will invent portable screwdriver. If you replace it with a refill, you will invent a portable ball-pen. And so on.

5) Cloning System Elements

Cloning System Elements is to turn one element to several and to give the system new abilities. For instance, a medical stethoscope

is a simple system formed by a sound collector and a sound tube. If you add some sound tubes to the system, you can invent a multi-tubed stethoscope. Used in medical education, it will be much more useful.

There are many, various methods of developing students' creative abilities via developing their systematic thinking abilities. But there is just one goal, which is to give students the ability of systematic thinking and creating.

The followings are the works of two creative activity groups.

I. The advanced blackboard invented by students using Systematic Creation Method.

1. Confirming aim:

To improve the design of blackboard which is popular at present to make it more rational.

2. Creating system structure:

You need chalks to write on blackboard. You need a wiper to wipe it out. After that, ashes come. Ashes will affect the teachers' and students' health.

So blackboard, chalk, wiper, ashes, teachers' and students' health form a system, which is called the "Blackboard System".

3. System Element Analysis:

In this round, students mainly analyzed the element of the blackboard and the wiper in the system. they improved the blackboard and the wiper as well.

They did creative work on the element of the moving direction of the blackboard. By breaking through the confinement of the regular blackboard moving directions, they designed a new type of blackboard which can move left and right and can be split in the middle.

On the element of the wiper, students combined bigger wipers and smaller ones instead of using small ones only.

4. Simulated Tests:

After designing, they made a blackboard system model and did some simulated tests.

Results:

1. The movement towards left and right of the blackboard solves the problem that it couldn't be clearly seen because of the reflection of light.

2. The new type of movement develops the use of the space behind the blackboard. We can put wipers, chalks or rulers inside that space to leave the classroom and the platform tidier.

3. Using bigger wipers together with smaller ones reduces the ashes that is produced. This can reduce the affect on teachers' health while increasing work efficiency.

II. Students' study on the effect of different-colored lights on the growth of plants using Systematic Creation Method.

1. Confirming aim:
   What do broad bean seedlings prefer to when they are growing.
2. Creating system structure:
   The growth of broad bean seedlings needs sunlight. The system being studied is just the system composed by the seedlings and the sunlight.
3. Analyzing system element: The broad bean seeds transform through the photosynthesis the solar energy as the chemical energy, the sunlight is made by many different colors of light, using the element decomposition to create the innovation, and the sunlight is resolved into seven different colors of light. And we study each color of the light influence the broad bean seeds' growth.
4. System tests: Let the same broad bean seeds grow separately in seven kind of different colors illumination environment, the result is the seed under the red and blue light grows very well.

5. Systems expansions:

(1) If this system can expand to the agricultural production, alters to the farmer uncle's big plastic tents color red or the blue color, may enhance the growth speed of the broad bean seeds the growth speed, reduces the growth cycle, enhances the profit.

(2) In this system, use the electric current to influence the broad bean seeds growing, to study the electric current’s influence to the plant growth.

(Pictures)

Student's achievement indicated that, with the system pondered instructs student's innovation, may sharpen student's innovation ability, causes the student to experience the innovation pleasure, raises students' innovation spirit.

Part Two: Systems dynamics selective breeding physics theory study

In the systems dynamics and in the middle school physics teaching union practice, the way to let the students understand the system ponder is: to carry on the simple system model establishment, grasping one kind of computer simulation experimental software (we choose STELLA), to encourage the students to carry on discovering, so that they can find some questions they have in daily study, and through the utilization system ponder method and the computer simulation experiment, to solve the problem. Our goal is to enable students to use the system ponder method in the physical study, raises the student theoretical level and the innovation ability. Under example can prove this point..

In the physics developing process, Aristotle once thought the speed which heavy objects fall was faster than the light objects; Galileo results in that the speed of falling is not decided by the objects’ quality through the famous Leaning Tower of Pisa. Are objects’ falling

speed related to quality of the objects? This question is the kinematics most basic question. The students use the system pondered and the computer simulation method to have conducted the analysis research to two masters' theories, study their respective existence rationality, deepen this question, and have carried on the expansion to this question.

Step One: Confirm the goal.

Study the rules of the falling body movement and learn the relationship between the pellet's speed and the pellet's quality.

Step Two: Establish structure charts.

The pellet in the whereabouts process, the initial velocity is a zero, only receives gravity the function. Under the action of gravity, the pellet momentum had the change; the momentum change has caused the speed change, the speed change to cause the pellet position change directly. Nearby the earth's surface, may think the gravity acceleration is invariable, and then connects the gravity and the gravity acceleration, the momentum and the speed physical quantity is the pellet quality, therefore, might establish "the motion of free-falling body system structure earth".

As shows in chart 1:

(Pictures)

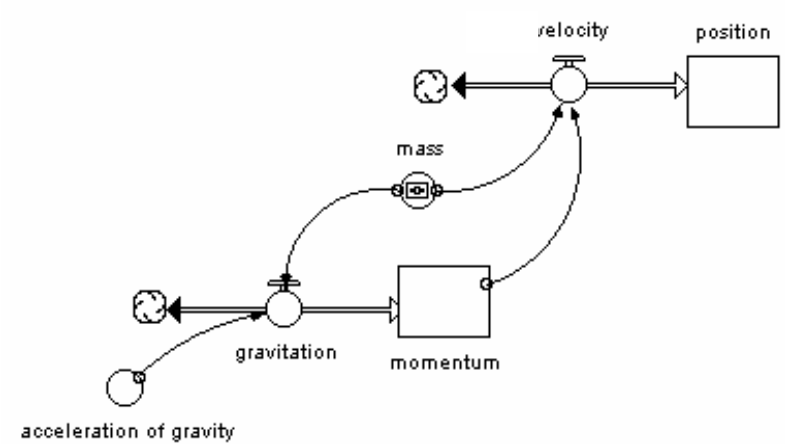

chart 1

Step Three: Build the model.

In chart 1:

momentum（t）=momentum(t-dt)+(gravity)*dt

INIT momentum=0

Momentum is according to the equation:

Gravity=mass*g

Location (t)=location(t-dt)+(speed)*dt

INIT location=100

Speed= momentum/mass

Mass=75

Step Four: Simulate an experiment.

Get the answer in chart 2 and 3 through the computer simulated experiment

(Pictures)

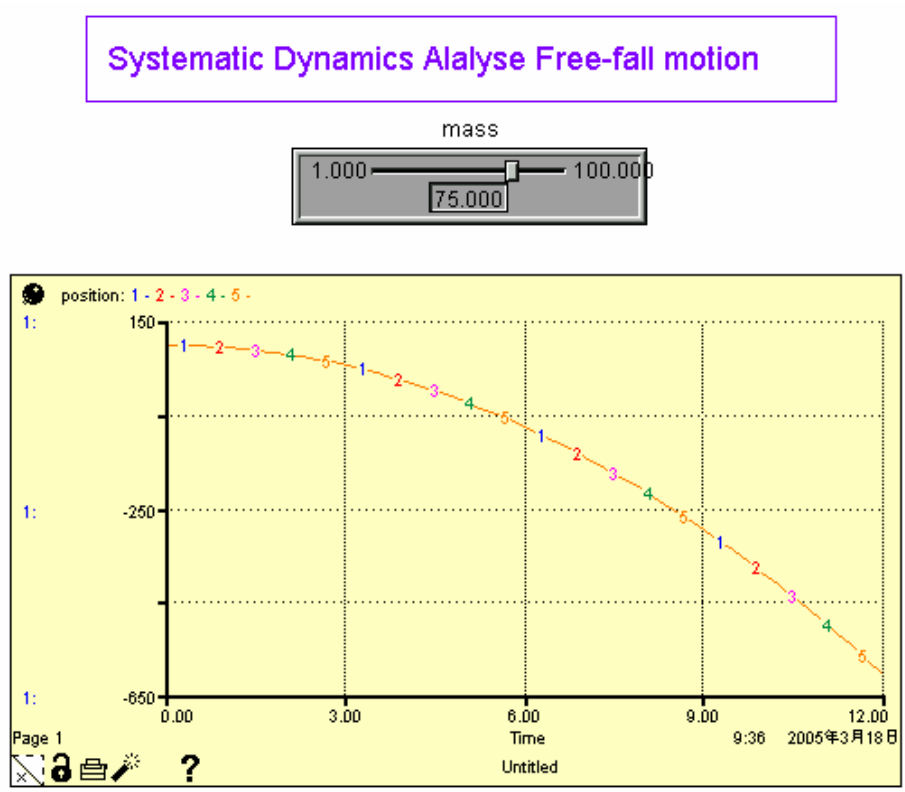

chart 2

Chart 2 shows how the speed of the ball changes with time.

In this chart

“1” shows when the mass of ball is 1 how does the speed of the ball change with time

“2” shows when the mass of ball is 25 how does the speed of the ball change with time

“3” shows when the mass of ball is 50 how does the speed of the

ball change with time
“4” shows when the mass of ball is 75 how does the speed of the ball change with time
“5” shows when the mass of ball is 100 how does the speed of the ball change with time
The line1,2,3,4,5 coincide with each other in the chart.
(Pictures)

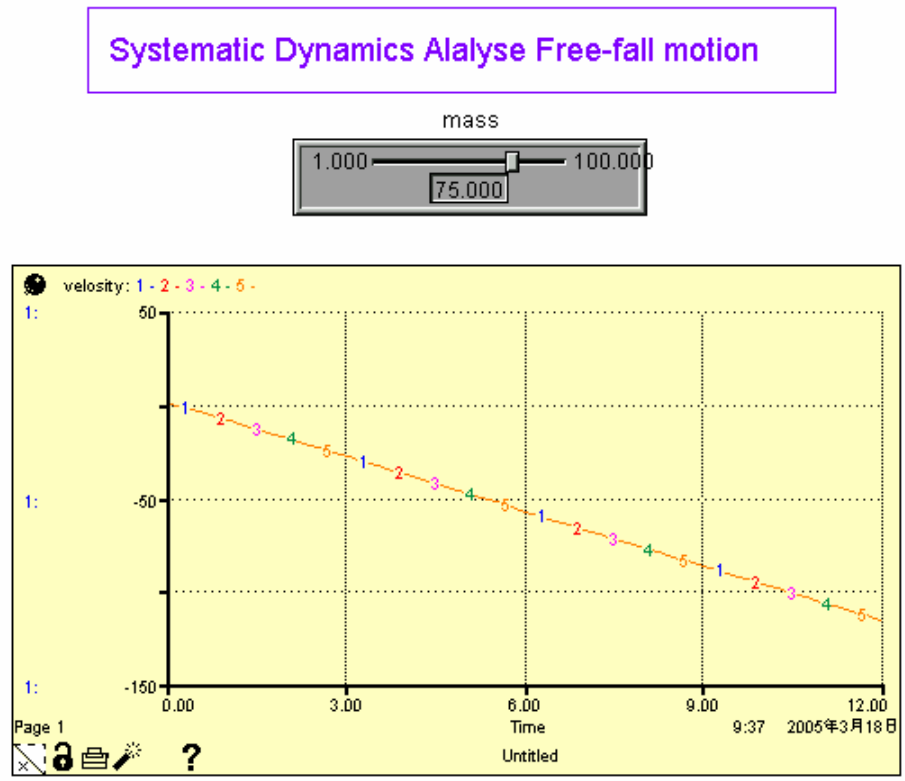

chart 3

Chart 3 describes how the speed of the small ball changes by time
“1” shows how the small ball's speed changes if it weighs 1.
“2” shows how the small ball's speed changes if it weighs 25.
“3” shows how the small ball's speed changes if it weighs 50.
“4” shows how the small ball's speed changes if it weighs 75.
“5” shows how the small ball's speed changes if it weighs 100.
From the results of the experiments in charts 2&3, students get the following conclusions:

1) Motion laws have nothing to do with the weight of the body in motion without considering air resistance.

2) In the motion of a freely falling body, the body's speed increases linearly, while the position and time changes in parabola. The reason is that the small ball's acceleration has nothing to do with its weight.

Through defining aims, constructing structural drawings, forming models, imitating tests, students can reach the same result as Galileo's experiment in Pisa. So, is Aristotle's position wrong? After systematic thinking, students find out,

In fact, the motion of the small ball is defined by not only the gravity but also the air resistance. So students develop the system model above.

Step Five: Develop the model.

1. Constructing the structural drawings: add the factor of air resistance to the model of a freely falling body. (as Chart 4)

(Pictures)

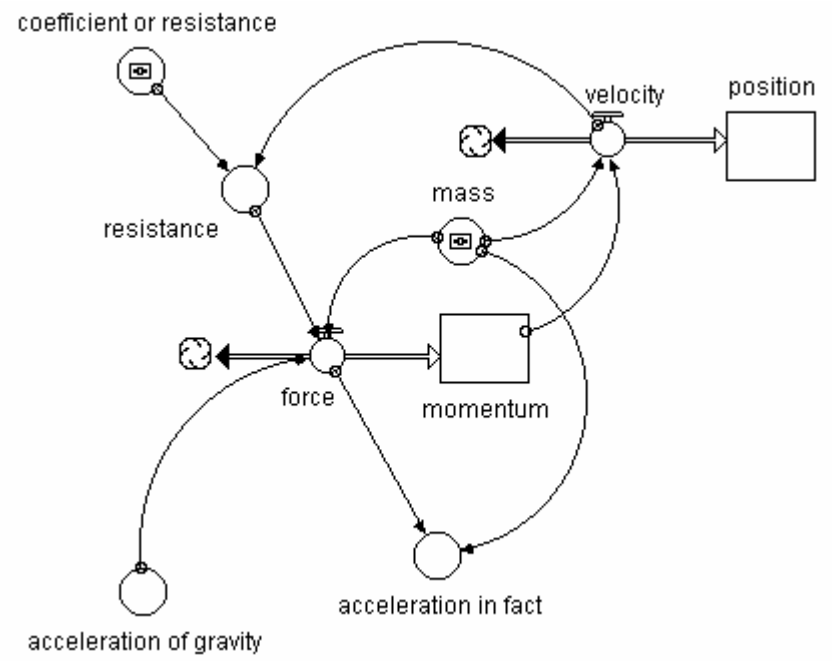

chart 4

2. Create a model.

momentum(t)= momentum(t-dt)+(total force)*dt

INIT momentum=0

INFLOWS:

Total force=mass*g-friction

Location(t)=location(t-dt)+speed*dt
INIT location=100
INFLOWS:
Speed = momentum/mass
Accelerate=total force/mass
Mass=75
G=-9.8
Friction= Friction coefficient*speed
Friction coefficient=50

3. Simulate an experiment.

The result shows in the picture 5 and 6.

(Pictures)

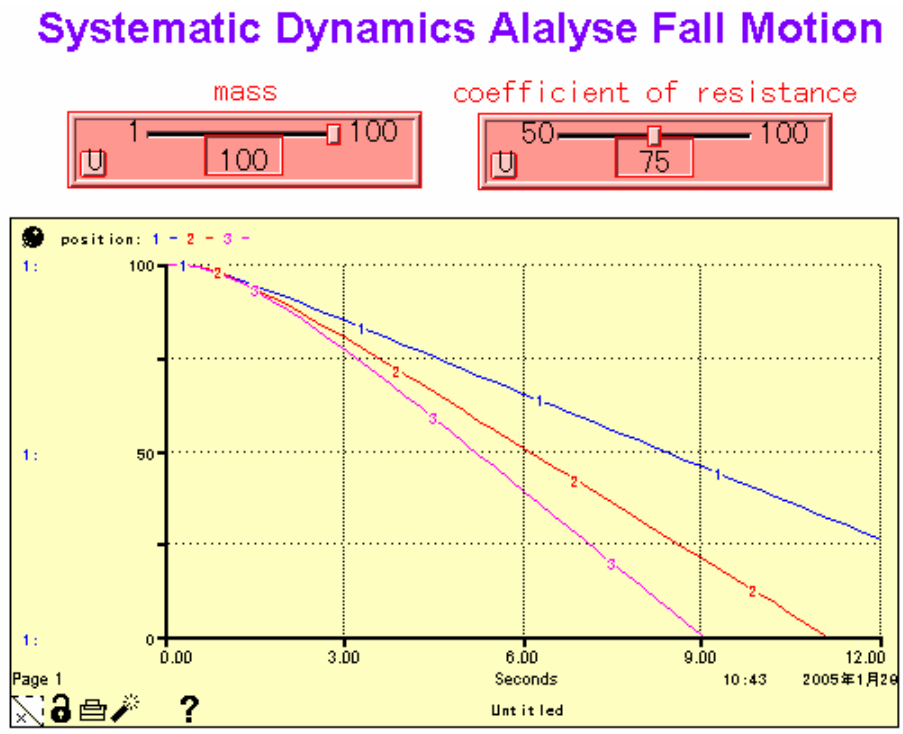

chart 5

Chart 5 shows when there is friction, how the location of the ball changes with time.

“1” shows when the mass of ball is 50 how does the location of the ball change with time.

“2” shows when the mass of ball is 75 how does the location of the ball change with time.

“3” shows when the mass of ball is 100 how does the location of the ball change with time.

(Pictures)

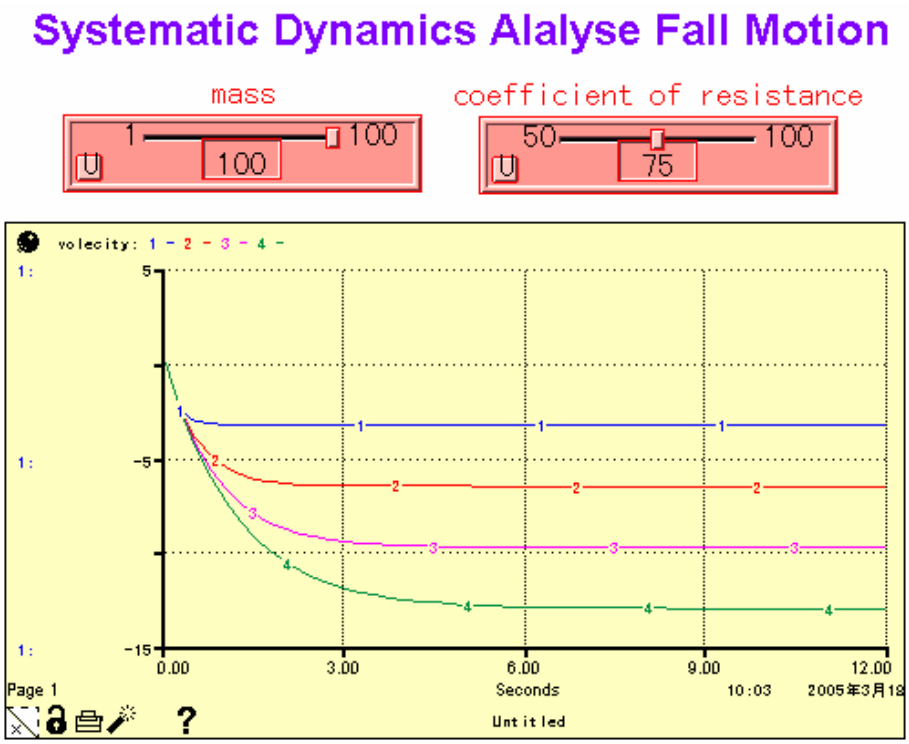

chart 6

Chart 6 shows the effect on the velocity in the process of falling brought by the changes of mass.

“1” shows the variation of the ball’s velocity with the passage of time when the mass of the ball is 25.

“2” shows the variation of the ball’s velocity with the passage of time when the mass of the ball is 50.

“3” shows the variation of the ball’s velocity with the passage of time when the mass of the ball is 75.

“4” shows the variation of the ball’s velocity with the passage of time when the mass of the ball is 100.

Through the analysis in Chart 5 and 6, students may come to the

following conclusions:

(1) The law of the motion of falling balls relates to mass when drag is considered.
(2) The heavy ball lands before the light one when drag is considered.
(3) The balls will eventually be performing the uniform motion when drag is considered. The heavy one will get a higher velocity when uniformly moving at last.

These conclusions correspond with Aristotle's opinions. Therefore, the conclusion that objects which possess greater mass fall down faster than the ones which possess fewer mass is correct in real situations in which drag exists. The other conclusion that the velocity in the process of falling has nothing to do with mass is correct where there is no drag. If the drag is far from being powerful to be compared with the gravity of the object, then mass will have very little effect on velocity. The effect can even be ignored. And that is why Galileo succeeded in his experiment on the Leaning Tower.

During the research, students find out that the system of the motion of free falling bodies have the same feature as the up-vertical, the down-vertical and the horizontal projectile motion. Therefore, they think that they can use the model of free falling bodies in the analysis on the above three motions.

Step 6: Through systematic thinking, push our research on the motion of free falling bodies further onto the up-vertical projectile motion without drag.

The only difference between the motion of free falling bodies and the up-vertical projectile motion without drag is the initial velocity. So as soon as we change the initial momentum of the model, we will be able to do the experiment of the motion.

Systematic Analysis on Projectile Motions

(Pictures)

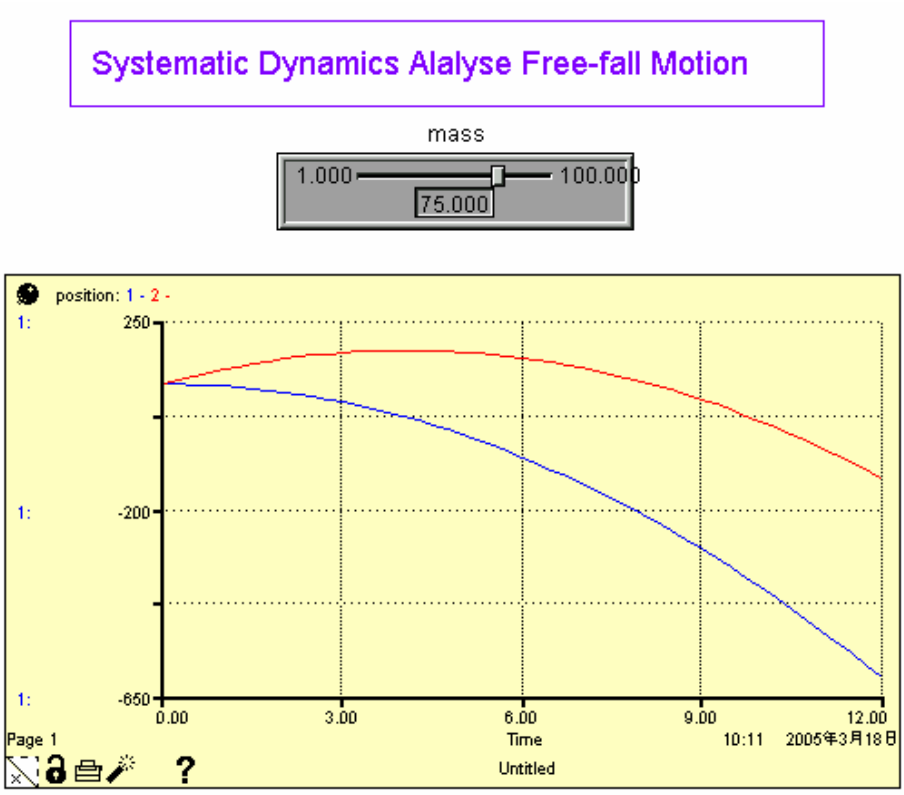

chart 7

In Chart 7, “1” shows the variation of the position of the ball which does the motion of free falling bodies.

“2” shows the variation of the position of the ball which does the up-vertical projectile motion.

Since the essences of the motion of free falling bodies and the up-vertical projectile motion are the same, the laws they obey are also the same. So if our students want to stand of the top of the Leaning Tower to do the above projectile motions in person

Reference

[1]Wu Xijun and Yuan Yonggen, Test on Systems Thinking and Decision-making, Jiangsu Science and Technology Publishing House, December, 2001.