MAPLE AND OTHER COMPUTER TOOLS USAGE IN A HIGH-SCHOOL SCIENTIFIC SOCIETY

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Summary. This article refers to the author's experience using *Maple* mathematical system and other computer tools for creating popular scientific projects in Physics and Mathematics within the scope of activities of the school scientific society.

Keywords: student scientific society, *Maple*, project.

For over 10 years our school has been working with computer mathematics system *Maple* along with various other information technologies. One of the facets of this is the activities of the student scientific society named "GEODROMchik" and headed by the Mathematics teacher A.I. Gibadullina The objectives of this student scientific society are: getting acquainted with the *Maple* package; mastering the computer tools that enable working with graphics, video, creating interactive menus; working on individual popular science projects and creation of original topical electronic journals that contain elements of scientific research and mathematical modeling. Computer mathematics is increasingly applied in a wide variety of spheres - from scientific research to mass culture production. Mathematical modeling has entered such fields as drawing and film industry. Studying and using symbol systems, *Maple* in particular, by the participants of our school society is an attempt to join the modern world culture of computer mathematical modeling.

This article describes the author's personal experience as one of the members of the school scientific society.

I got acquainted with *Maple* mathematical system working on the project *Building animated mathematical 3D model of an opening book* in the 6th form. The goal was to create a spatial animated image of an opening book by means of analytical geometry. A step-by-step programme generating this image (Tables 1 and 2) was built in *Maple* environment.

Table 1. Fragment of the programme generating an animated image.

```
> restart:
                    Connecting to additional libraries
> with (plots):
> with (plottools):
                    One of the pages generation:
s1: = polygon ([[0, 0.01, 0], [1, 0.01, 0], [1, 1, 0], [0, 1, 0]], thickness = 1, color = orange):

                    Combined elements of the book visualisation:
display (k11, s1, s2, s3, s4, s5, s6, s7, s8, s9, s10, k0, k27, title = "BOOK" scaling = constrained);

                    Turning and opening of the cover animation:
r_k11:=rotate(k11,10*Pi/9,[[0,0,0.29],[1,0,0.29]]):
plots[display](r_k11,kn_1,k0,scaling=constrained);
> anm: = seq (rotate (k11, t * Pi/9 [[0.0, 0.29], [1.0, 0.29]]), t = 0 .. 10):
> anim: = [display] plots (anm, insequence = true):
> plots [display] (kn_1, anim, scaling = constrained);
```
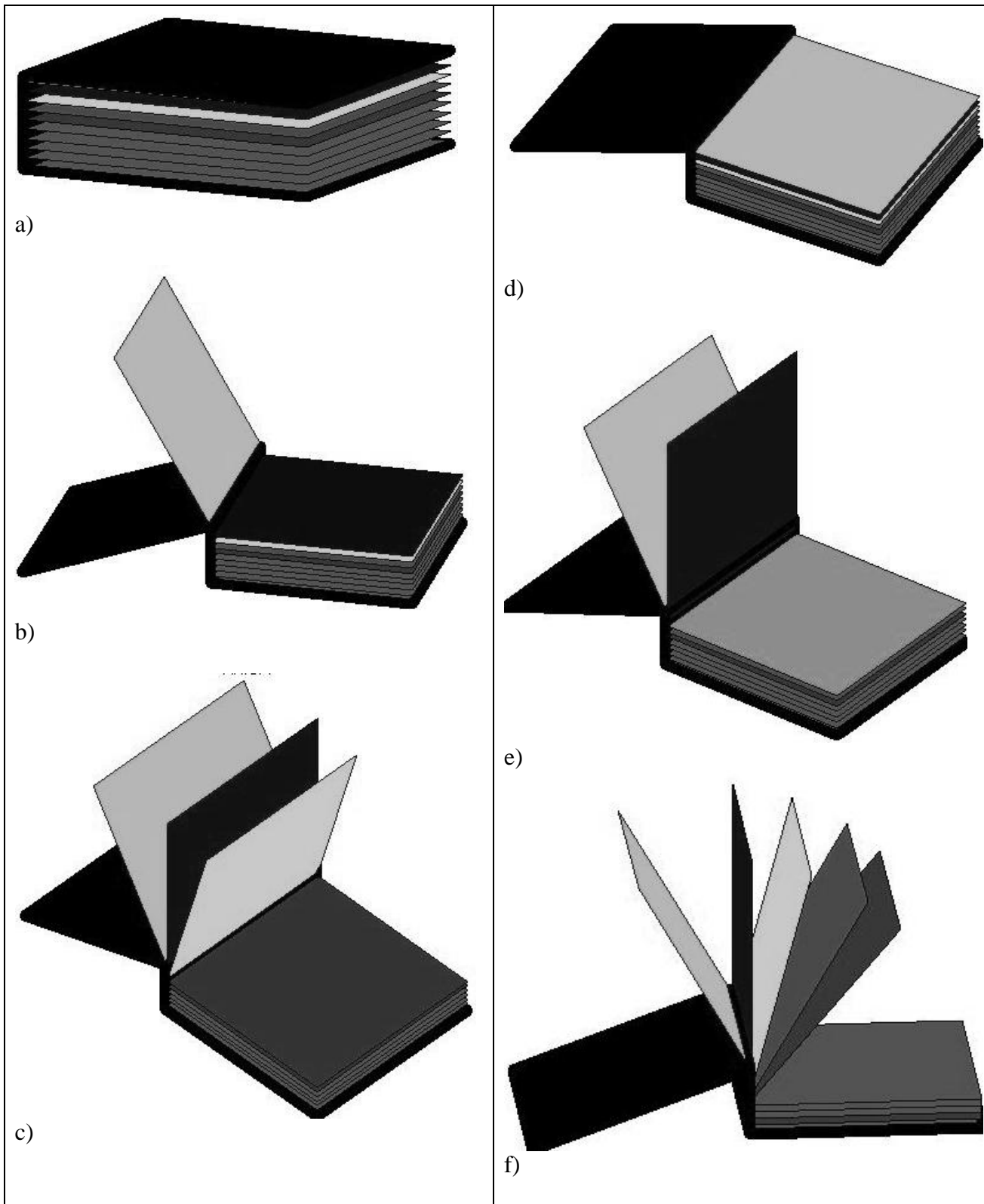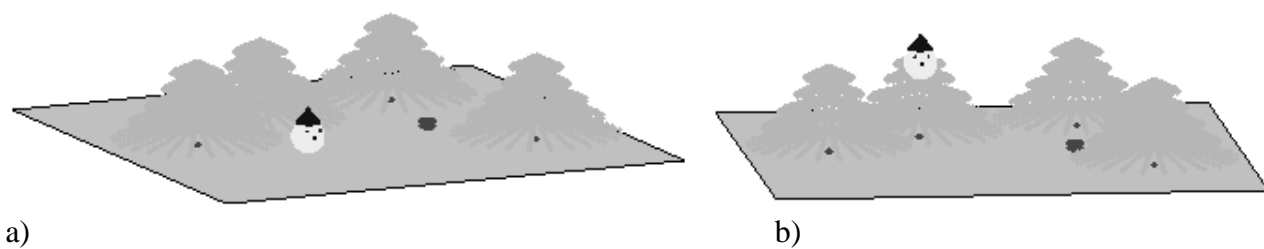
Fig. 1. Book animation frames

The following project in *Maple* environment was carried out in the 7th form in collaboration with Nigometzyanova Elsa, it is a short cartoon *Kolobok in the woods*.

a)

b)

Fig. 2. Cartoon animation frames

In the 8th form we worked on technical translation of Waterloo Maple Inc. web site [3]. As we know, this type of translating has its own peculiarities, which are not covered in the English language school curriculum, so this work helped to improve our English language proficiency.

In the 9th form I began working on electronic journal on cosmology *Universe: theory and facts*. Black holes of the universe is one of the most mysterious and exciting objects for the humanity. Studying them aroused interest in Astrophysics in general. To understand the concept of a black hole it was necessary to study the structure of the universe and its geometry [9, 10, 11, 12]. I had to comprehend complicated fundamental concepts, theories, as well as elements of further mathematics [1, 5, 6, 7, 8]. Just trying to understand the huge amount of seemingly random information required its analysis and systematisation. And then the idea of a new project came: an e-journal. The current situation in Russia is quite paradoxical: while Astrophysics is thriving, penetrating in virtually all spheres of our life, we do not have such a subject as Astronomy in our school curriculum. Therefore, such a project could fill that annoying gap and help schoolchildren, and not only schoolchildren, to learn more about the universe. The journal has the following sections: the universe, black holes, white holes, glossary, theories, non-Euclidean geometries, video experiments, interesting facts, links and references. One of the sections of the journal is comprised of *Maple* projects, inter alia, a rendered model of the curvature of space-time.

Below you can see the *Maple* programme (Table 2) for visualization of a plane deformation under a ball of a certain size. <plots>and <plottools> libraries of the package are used.

Table 2. *Maple* deformation of a plane visualization programme.

Comment	The command and the result
Depth of the "pit" function (a - width of the "pit", b - depth of the "pit")	f: = (x, a, b)-> (-b * exp (-x ^ 2/a ^ 2)); $$f := (x, a, b) \rightarrow -b\, \mathrm{e}^{\left(-\frac{x^2}{a^2}\right)}$$
Enter the parameters: "h" determines the size of the spherical body and associates it with the width of the "pit"; "k" - determines the size range of area around the "pit".	h: = 1: k: = 1:
Setting parametric equation of a straight line on the surface (plane)	L0:=(m,n)->plot3d([0,r,f(r,m,n)], phi = -2*Pi ..2*Pi, r = -10k*h..10+k*h, scaling=CONSTRAINED, numpoints = 10000, color = blue, thickness = 4):
Setting parametric equation of a surface (plane) by rotating the straight line	P0:=(m,n)->plot3d([r*cos(phi),r*sin(phi),f(r,m,n)], phi= 0..2*Pi,r=-8k*h..8+k*h, scaling=CONSTRAINED, numpoints=3000, style=POINT, color=blue):
Setting the straight line curvature rendering	L:=plots[display](seq(L0(h,i),i=0..10+k*h), insequence=true): l:=plots[display](L,insequence=true):
Setting the plane curvature rendering	p:=plots[display](seq(P0(h,i),i=0..10+k*h), insequence=true): p:=plots[display](P,insequence=true):
Setting the ball rendering (a body that has certain weight)	with(plottools):sp:=seq(sphere([0,0,-i-1.5*f(h,h,h)], f(h,h,h), style=HIDDEN,color=red),i=0..10+k*h): s:=plots[display](sp,insequence=true, scaling=CONSTRAINED):
Combining all the components of the visualisation model	plots[display](p,s,l,scaling=CONSTRAINED);

If h: = 1: k: = 1:

a)   b)

c)   d)   e)

If h: = 5: k: = 1:

f)   g)   h)
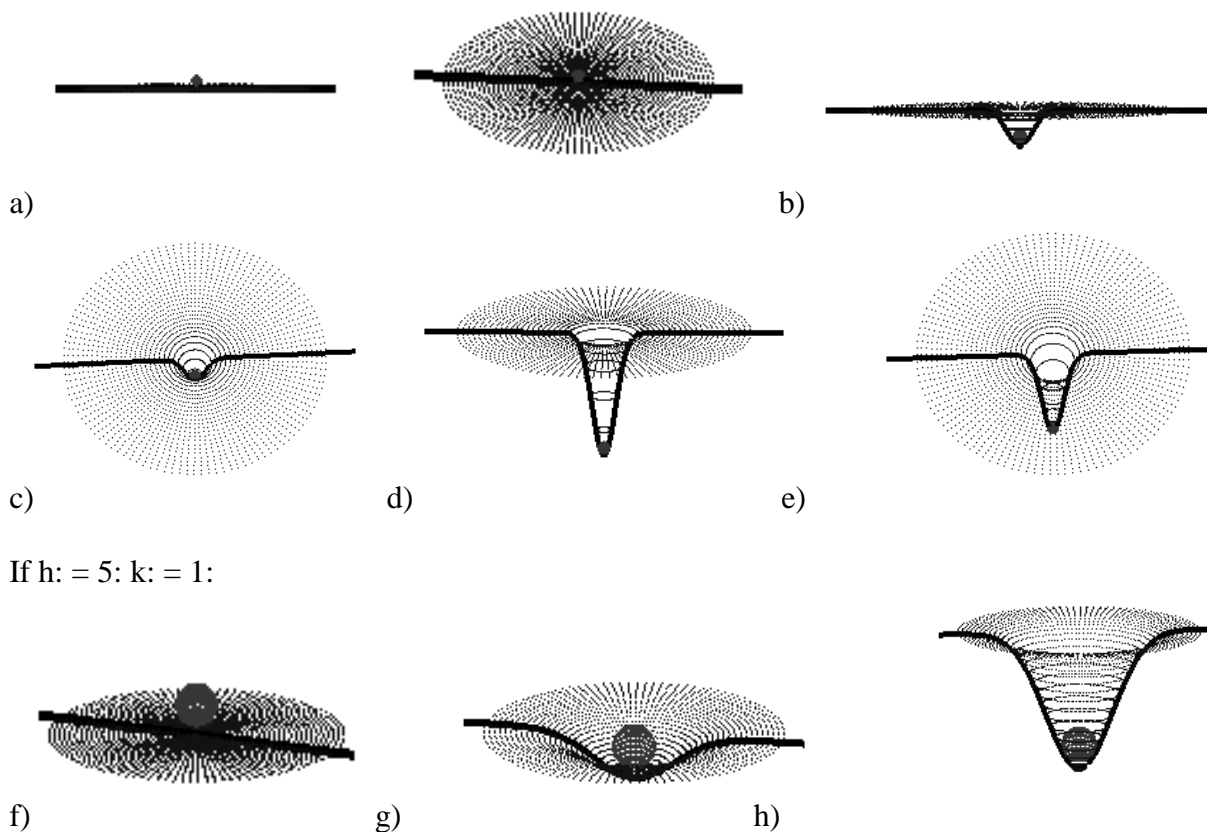
Fig. 3. Animation frames with specified parameters.

It took quite a long time to find a function for the depth of the "pit". Finally, I managed to find one after watching a lecture of A. Linde in which he spoke about exponential processes [13].

Changing parameters "n" and "k" only (that determine the dimensions of the ball and the width of the "pit") and running the programme again we can change the visualisation too.

It should be noted that I have built a mathematical model of the visualisation, rather than of the process itself.

This section is supposed to be replenished with new projects created in *Maple* environment.

The journal has a convenient system of links and is structured so that it can be quickly updated. Astrophysics is booming, so the journal will not lose its relevance.

Conclusion:

In the course of the 4 years of working in the scientific community the projects were presented on various websites, in contests, conferences and forums of federal and international levels:

- *exponenta.ru* website, in the section of student works [4];
- "KNRTU Hopes For A Nobel Prize" Research And Creative Works Contest;
- "Art-debut" Republican Contest;
- 5th International Assembly of Schoolchildren (participation and publication) [2];
- All-Russia Gorchakov Forum in St. Petersburg;
- N.I. Lobachevsky Student Scientific Conference in the Volga region;
- "Fun Science" All-Russia Festival in St. Petersburg.

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