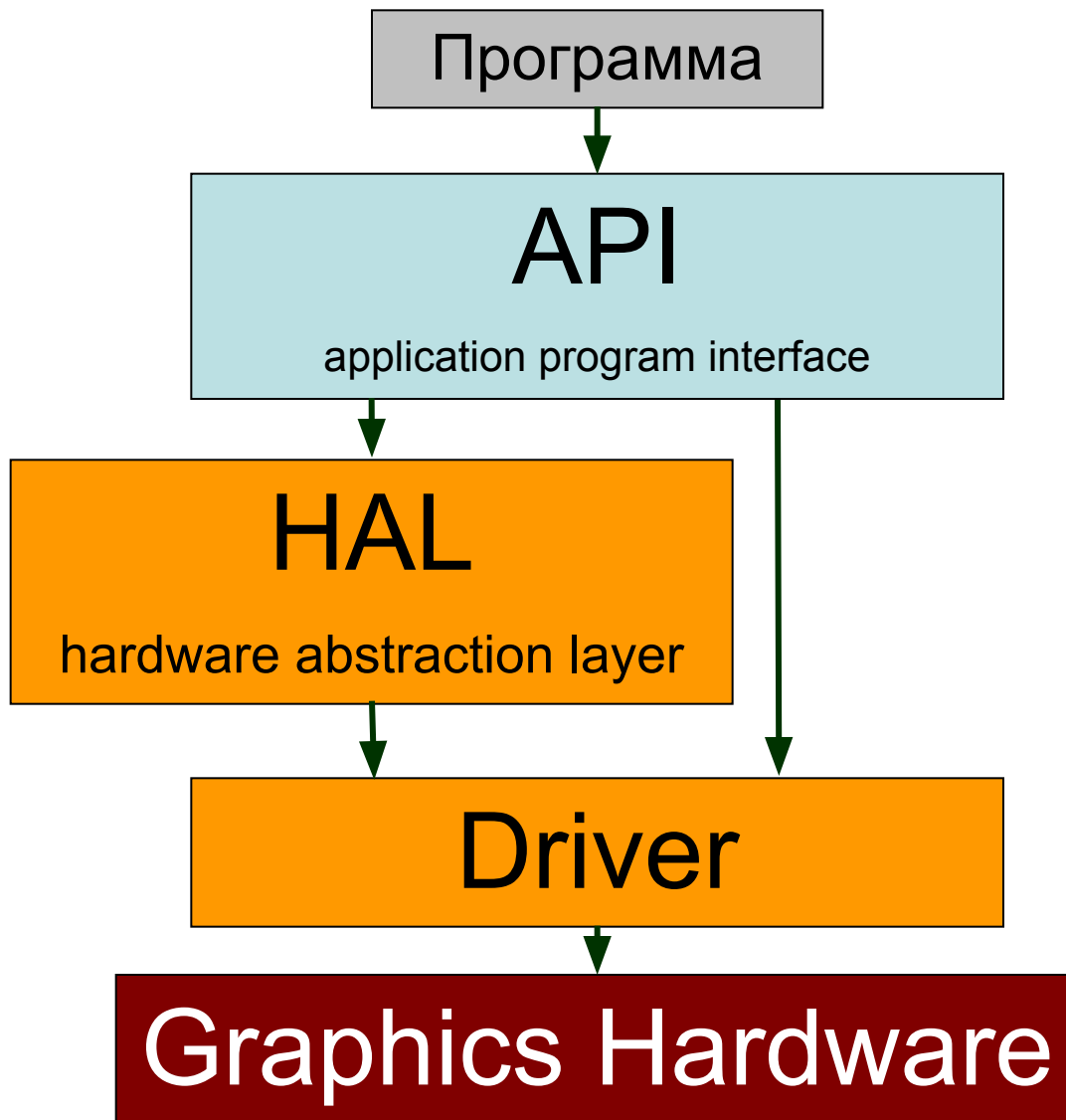


Компьютерная графика реального времени.

URL: <http://www.school30.spb.ru/cgsg/cgc/>

E-mail: CGSG@yandex.ru



- **Open GL** – open graphics library
 (SGI, 90-е годы, версии 1.0-4.2)
 - GLUT - OpenGL Utility Toolkit
 (<http://www.opengl.org/resources/libraries/glut/>)
 - GLEW - OpenGL Extension Wrangler Library
 (<http://glew.sourceforge.net/>)
 - GLM - OpenGL Mathematics (<http://glm.g-truc.net/>)
 - ...

- **Microsoft Direct3D** – часть MS DirectX
 (1992 RenderMorphics, версии 2.0-11.0)
 - D3DX – retained mode toolkit
 - XNA - Xbox New Architecture
 (<http://msdn.microsoft.com/ru-ru/xna/>)

```

PIXELFORMATDESCRIPTOR pfd = {0};

pfd.nSize = sizeof(PIXELFORMATDESCRIPTOR);
pfd.dwFlags =
    PFD_SUPPORT_OPENGL | PFD_SUPPORT_GDI | PFD_DOUBLEBUFFER;
pfd.iPixelFormat = PFD_TYPE_RGBA;
pfd.cColorBits = 32;
pfd.cDepthBits = 24;
pfd.cStencilBits = 8;

i = ChoosePixelFormat(hDC, &pfd);
DescribePixelFormat(hDC, i, sizeof(PIXELFORMATDESCRIPTOR), &pfd);

SetPixelFormat(hDC, i, &pfd);

hRC = wglCreateContext(hDC);
wglMakeCurrent(hDC, hRC);
    
```

```

#include <glut.h>

glutInitDisplayMode (GLUT_RGBA | GLUT_DOUBLE | GLUT_DEPTH) ;
glutInitWindowSize (640, 480) ;
glutInitWindowPosition (0, 0) ;
glutCreateWindow ("OpenGL Sample") ;

glutDisplayFunc (Display) ;
glutIdleFunc (Idle) ;
glutReshapeFunc (Reshape) ;
glutKeyboardFunc (Keyboard) ;

MyInit () ;

glutMainLoop () ;

```

```

void Reshape( int w, int h )
{
    glViewport(0, 0, w, h);
    glMatrixMode(GL_PROJECTION);
    glLoadIdentity();
    gluPerspective(60, (double)w / h, 1, 100);
    gluLookAt(5, 5, 5, 0, 0, 0, 0, 1, 0);
    glMatrixMode(GL_MODELVIEW);
}

void Display( void )
{
    glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT);
    .
    .
    .
    glFinish();
    glutSwapBuffers();
}

void Idle( void )
{
    glutPostRedisplay();
}

void Keyboard( char key, int x, int y )
{
    if (key == 27)
        exit(0);
}

```

```

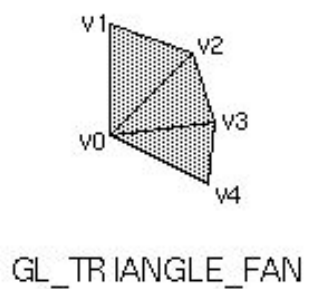
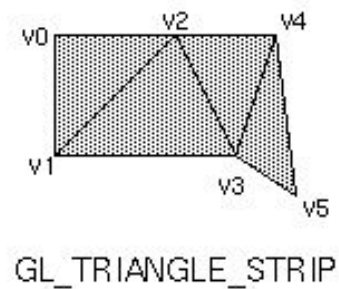
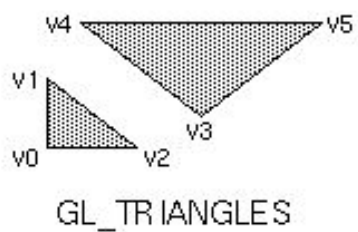
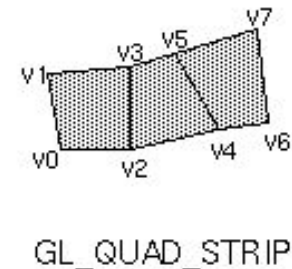
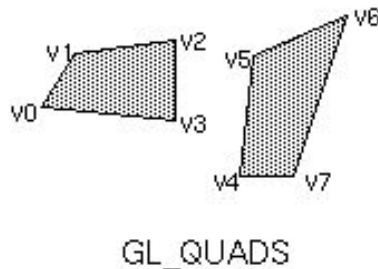
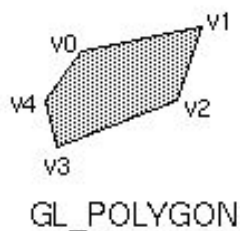
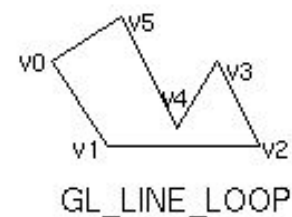
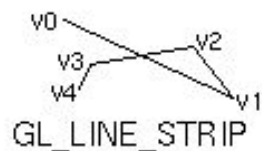
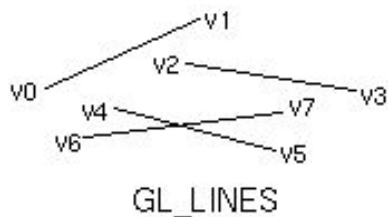
IDirect3D9 *D3D;
IDirect3DDevice9 *D3DDevice;
D3DPRESENT_PARAMETERS PresParams = {0};
D3DDISPLAYMODE dm;

if ((D3D = Direct3DCreate9(D3D_SDK_VERSION)) == NULL)
    return FALSE;

D3D->GetAdapterDisplayMode(D3DADAPTER_DEFAULT, &dm);

PresParams.Windowed = TRUE;
PresParams.hDeviceWindow = hWnd;
PresParams.BackBufferFormat = dm.Format;
PresParams.BackBufferCount = 1;
PresParams.PresentationInterval = D3DPRESENT_INTERVAL_IMMEDIATE;
PresParams.SwapEffect = D3DSWAPEFFECT_DISCARD;
PresParams.BackBufferWidth = 640;
PresParams.BackBufferHeight = 480;
PresParams.EnableAutoDepthStencil = TRUE;
PresParams.AutoDepthStencilFormat = D3DFMT_D24S8;

if (D3D->CreateDevice(D3DADAPTER_DEFAULT, D3DDEVTYPE_HAL,
    hWnd, D3DCREATE_HARDWARE_VERTEXPROCESSING,
    &PresParams, &D3DDevice) != S_OK)
{
    D3D->Release();
    return FALSE;
}
    
```



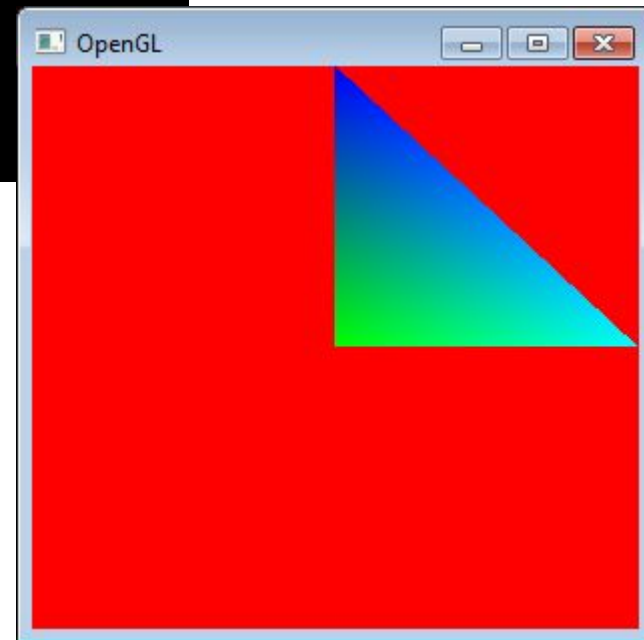

```

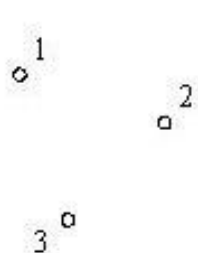
glClearColor(1, 0, 0, 1);
glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT);

glBegin(GL_TRIANGLES);
  glColor3d(0, 1, 0);
  glVertex3d(0, 0, 0);
  glColor3d(0, 1, 1);
  glVertex3d(1, 0, 0);
  glColor3d(0, 0, 1);
  glVertex3d(0, 1, 0);
glEnd();

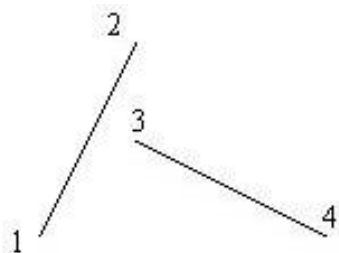
glFinish();
glutSwapBuffers();

```

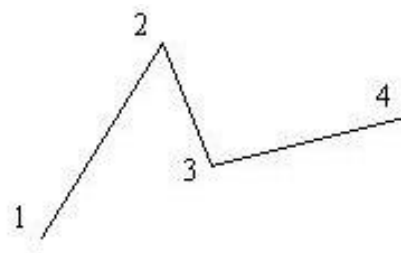




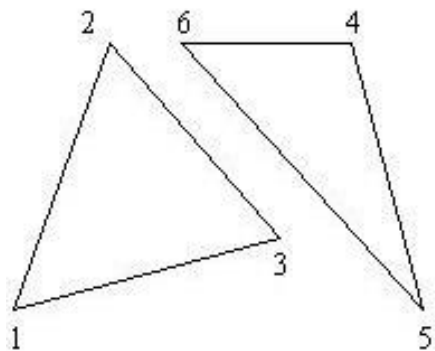
D3DPT_POINTLIST



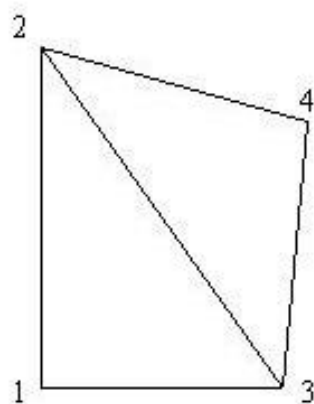
D3DPT_LINELIST



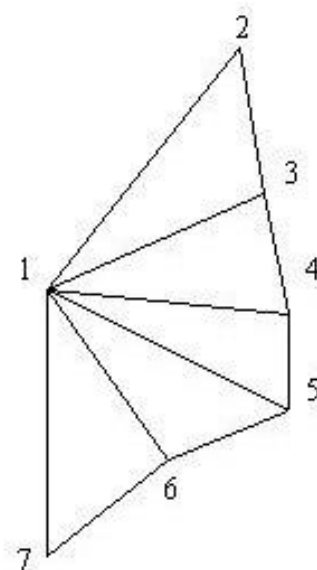
D3DPT_LINESTRIP



D3DPT_TRIANGLELIST



D3DPT_TRIANGLESTRIP



D3DPT_TRIANGLEFAN

```

D3DDevice->SetFVF(D3DFVF_XYZ | D3DFVF_DIFFUSE);
D3DDevice->Clear(0, NULL,
    D3DCLEAR_TARGET | D3DCLEAR_STENCIL | D3DCLEAR_ZBUFFER,
    D3DCOLOR_XRGB(255, 0, 0), 1.0, 0);

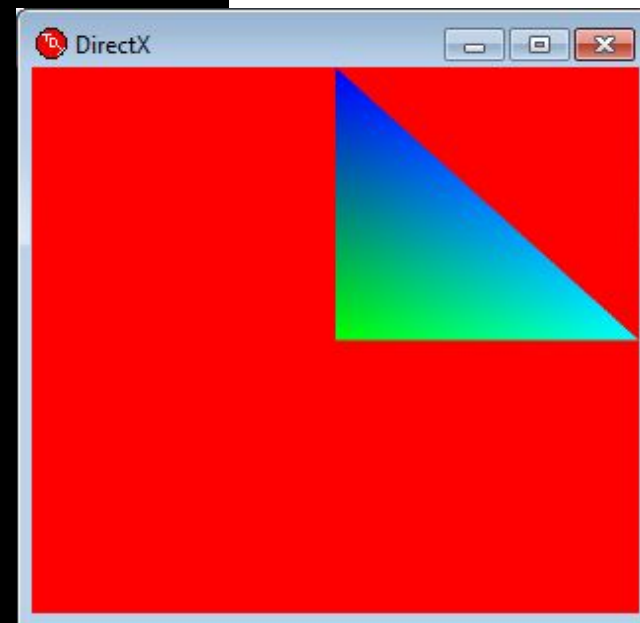
D3DDevice->BeginScene();

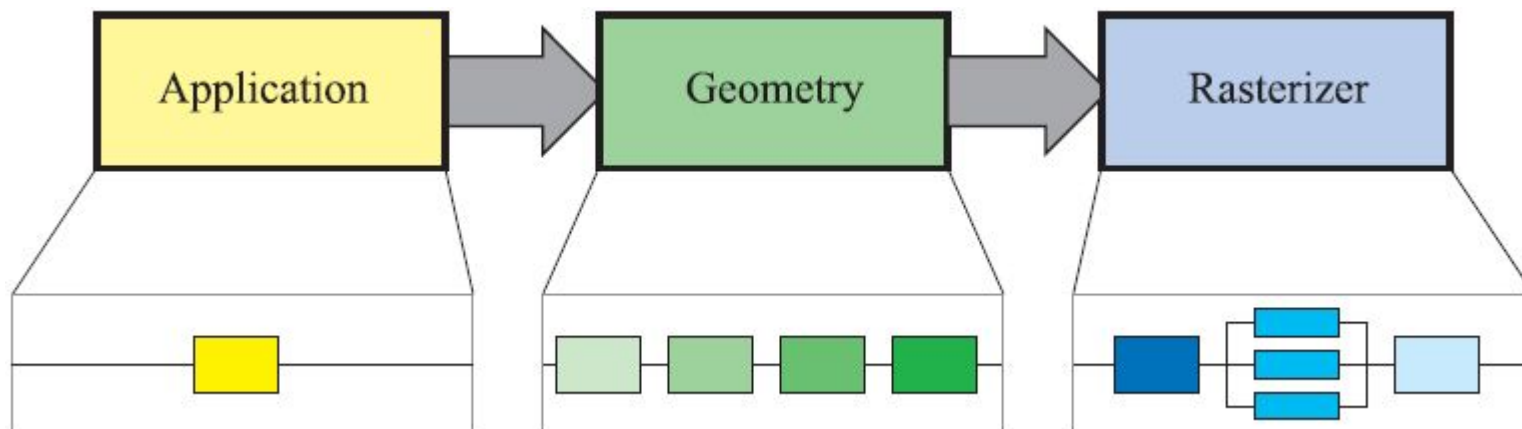
D3DDevice->SetRenderState(D3DRS_LIGHTING, FALSE);
D3DDevice->SetRenderState(D3DRS_CULLMODE, D3DCULL_NONE);

struct VERTEX
{
    FLOAT X, Y, Z;
    DWORD Color;
} pnts[] =
{
    {0, 0, 0, D3DCOLOR_XRGB(0, 255, 0)},
    {1, 0, 0, D3DCOLOR_XRGB(0, 255, 255)},
    {0, 1, 0, D3DCOLOR_XRGB(0, 0, 255)},
};

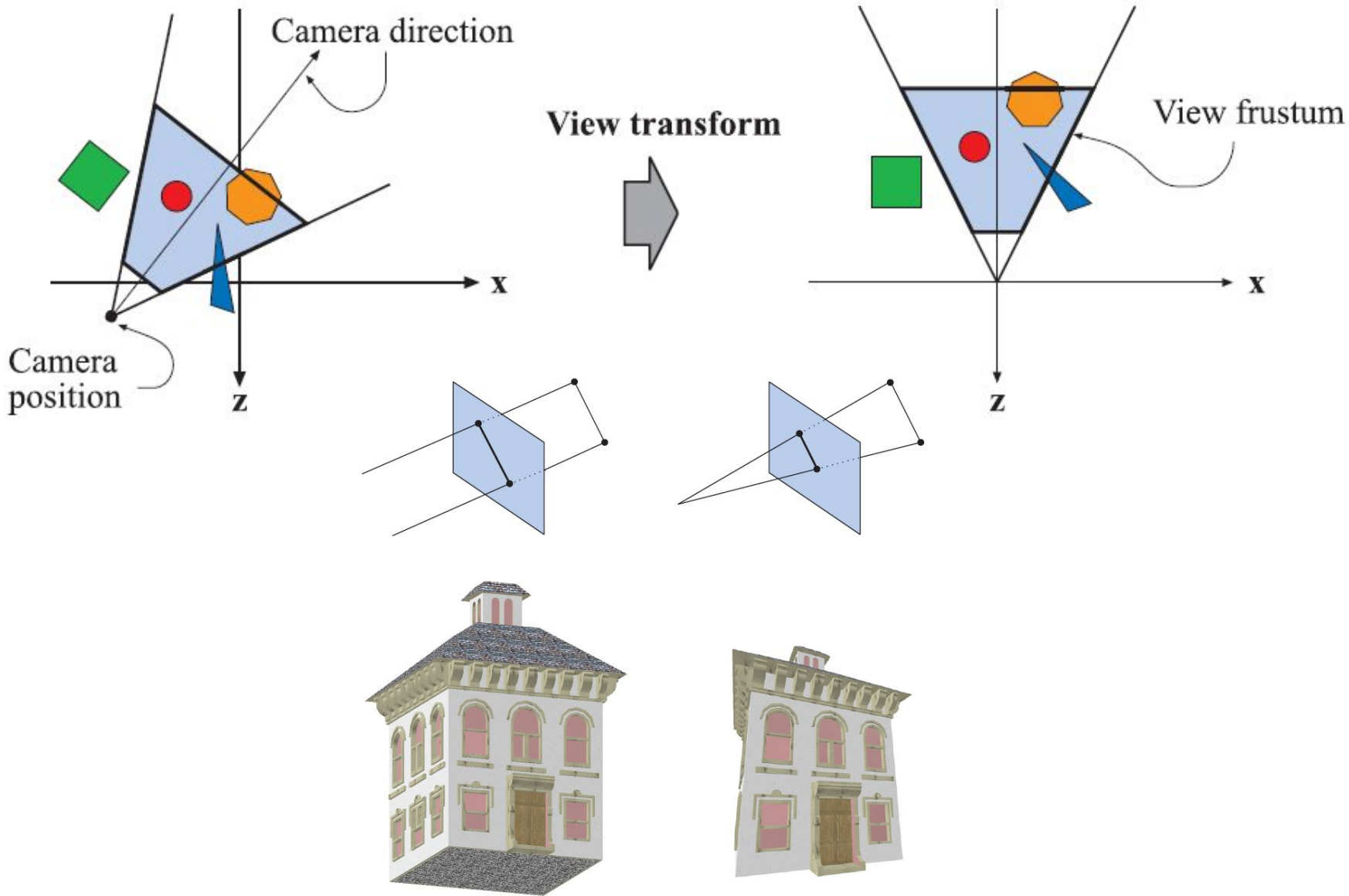
D3DDevice->DrawPrimitiveUP(D3DPT_TRIANGLELIST,
    1, pp, sizeof(VERTEX));

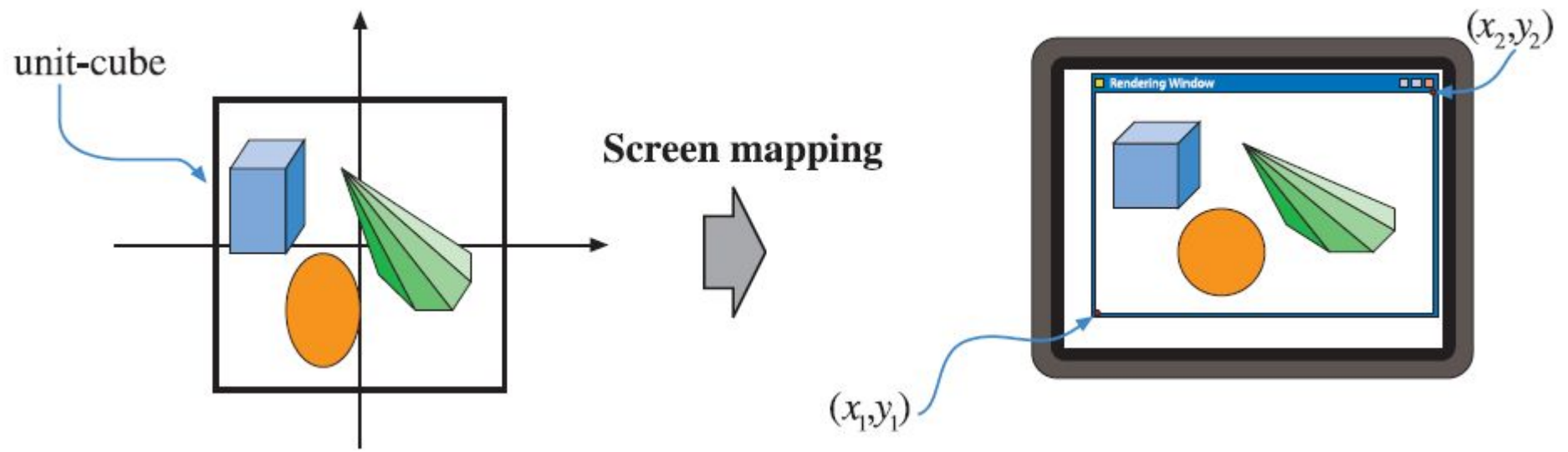
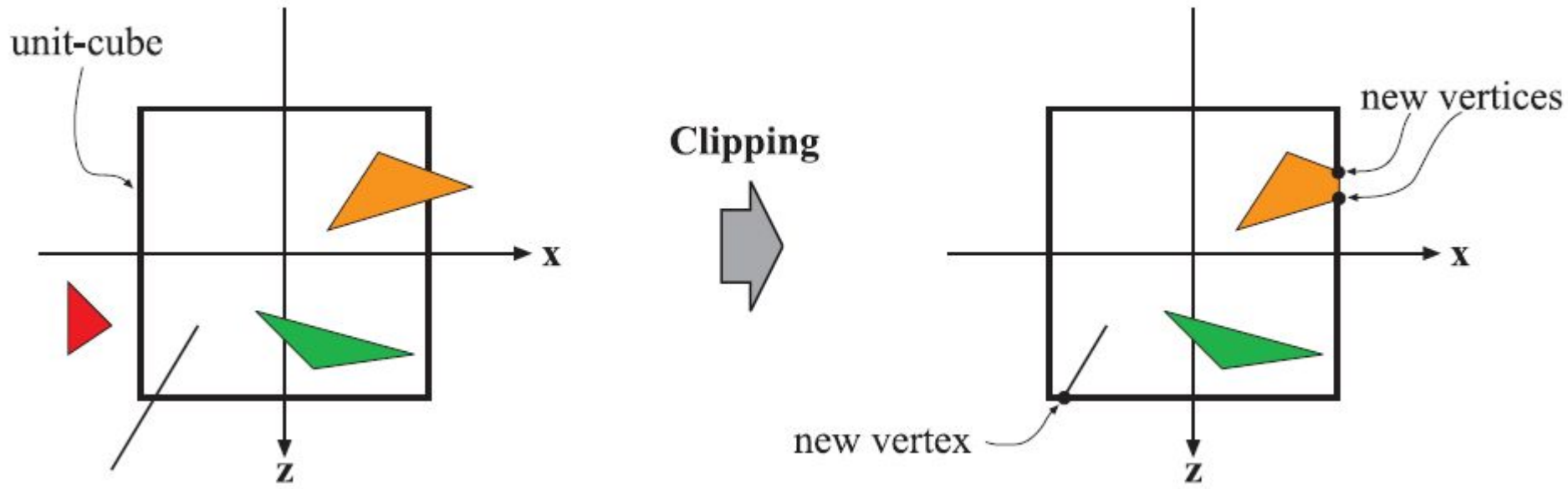
D3DDevice->EndScene();
D3DDevice->Present(NULL, NULL, NULL, NULL);
    
```

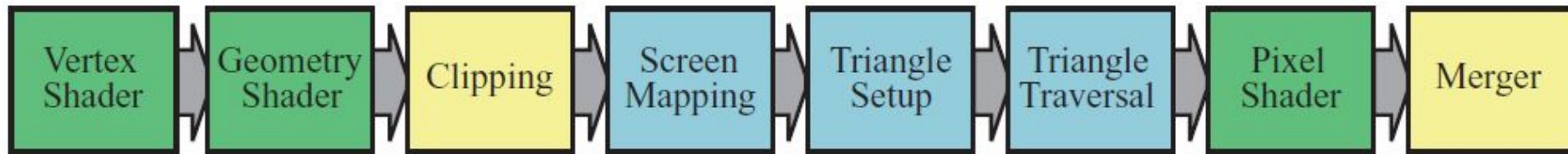




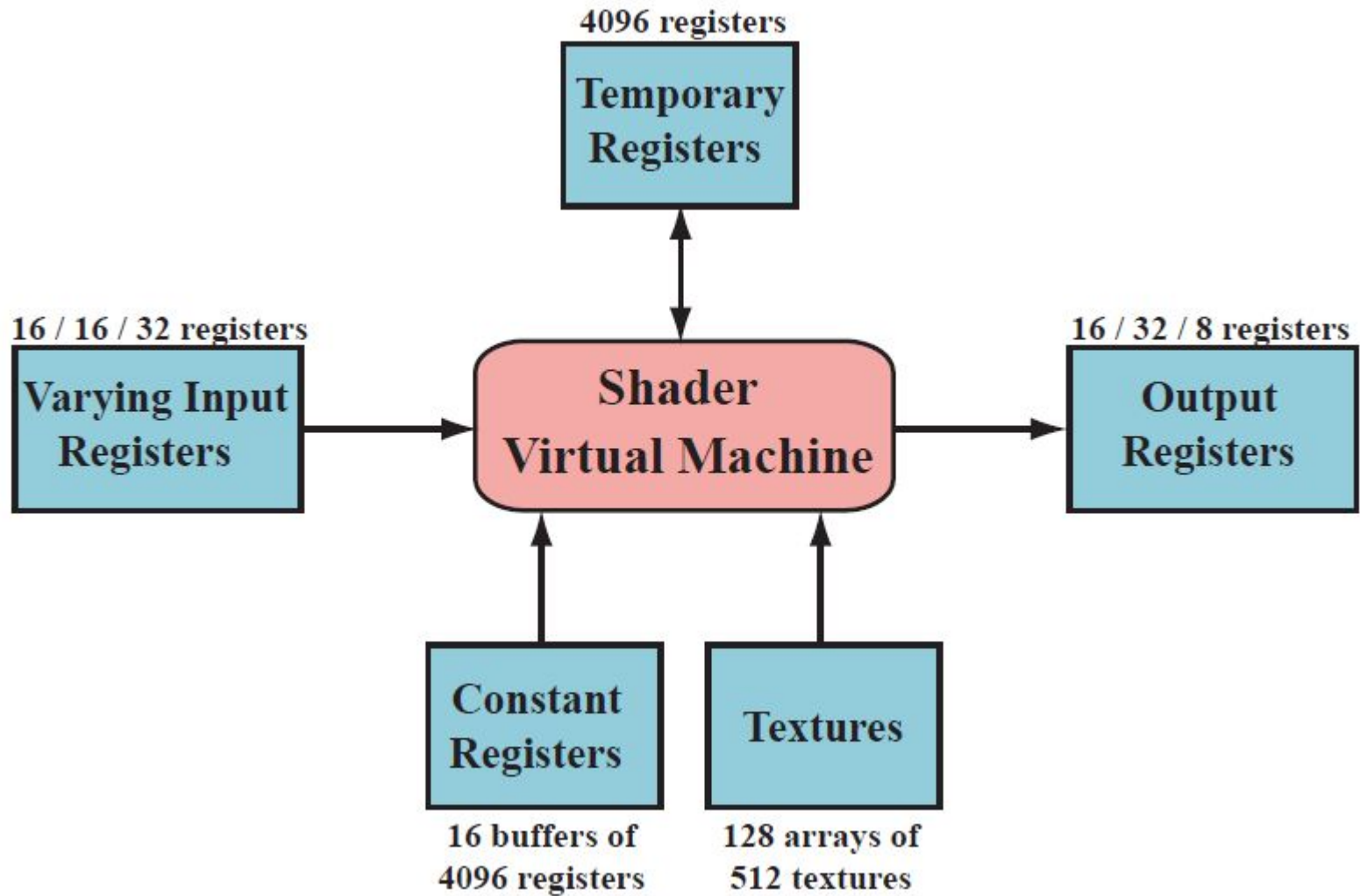








- зеленый – полностью программируемый этап
- желтый – конфигурируемый и непрограммируемый
- синий – полностью фиксированный



```

unsigned prg;
. . .
int i;

glUseProgram(prg);
i = glGetUniformLocation(prg, "time");
glUniform1f(i, Time);

glBegin(GL_TRIANGLES);
    glVertex3d(0, 0, 0);
    glVertex3d(1, 0, 0);
    glVertex3d(0, 1, 0);
glEnd();
    
```

ИСПОЛЬЗОВАНИЕ

ИНИЦИАЛИЗАЦИЯ

```

ShvText = LoadProg("test.glslv");
shv = glCreateShader(GL_VERTEX_SHADER);
glShaderSource(shv, 1, &ShvText, NULL);
glCompileShader(shv);
glGetShaderiv(shv, GL_COMPILE_STATUS, &res);
glGetShaderInfoLog(shv, sizeof(Buf), &len, Buf);

ShfText = LoadProg("test.glslf");
shf = glCreateShader(GL_FRAGMENT_SHADER);
glShaderSource(shf, 1, &ShfText, NULL);
glCompileShader(shf);
glGetShaderiv(shf, GL_COMPILE_STATUS, &res);
glGetShaderInfoLog(shf, sizeof(Buf), &len, Buf);

prg = glCreateProgram();
glAttachShader(prg, shv);
glAttachShader(prg, shf);

glLinkProgram(prg);
glGetProgramiv(prg, GL_LINK_STATUS, &res);
glGetProgramInfoLog(prg, sizeof(Buf), &len, Buf);
    
```



```

// Gouraud
varying out vec4 c;      uniform vec4 spec;
uniform vec3 eyepos;    uniform vec4 diff;
uniform vec4 amb;      uniform float spower;
uniform float time;

void main( void )
{
  vec3 p = vec3(gl_ModelViewMatrix * gl_Vertex); // transformed point to world space
  vec3 campos = vec3(eyepos); // camera position
  vec3 l = vec3(sin(time), 0, cos(time)); // vector to light position
  vec3 v = campos - p; // vector to the camera
  vec3 n = gl_NormalMatrix * gl_Normal; // transformed normal
  gl_Position = gl_ModelViewProjectionMatrix * gl_Vertex;

  const vec4 diffcolor = vec4(diff); // diffuse
  const vec4 speccolor = vec4(spec); // specular
  const vec4 ambcolor = vec4(amb); // ambient
  const vec4 specpower = vec4(spower); // specular power

  vec3 n2 = normalize(n);
  vec3 l2 = normalize(l);
  vec3 v2 = normalize(v);
  vec3 r = reflect(-v2, n2);
  vec4 diff = diffcolor * max(dot(n2, l2), 0.0);
  vec4 spec = speccolor * pow(max(dot(l2, r), 0.0), specpower);
  c = diff + spec + ambcolor;
}

```

```
// Gouraud
varying in vec4 c;

void main( void )
{
    gl_FragColor = c;
}
```

```

// Phong
varying out vec3 l;
varying out vec3 v;
varying out vec3 n;
uniform vec3 eyepos;
uniform float time;

void main( void )
{
    vec3 p = vec3(gl_ModelViewMatrix * gl_Vertex); // transformed point to world space
    vec3 campos = vec3(eyepos); // camera position

    l = vec3(sin(time), 0, cos(time)); // vector to light position
    v = campos - p; // vector to the camera
    n = gl_NormalMatrix * gl_Normal; // transformed normal
    gl_Position = gl_ModelViewProjectionMatrix * gl_Vertex;
}
    
```

```

// Phong
varying in vec4 c;

varying in vec3 l;
varying in vec3 v;
varying in vec3 n;
uniform vec4 diff;
uniform vec4 spec;
uniform vec4 amb;
uniform float spower;

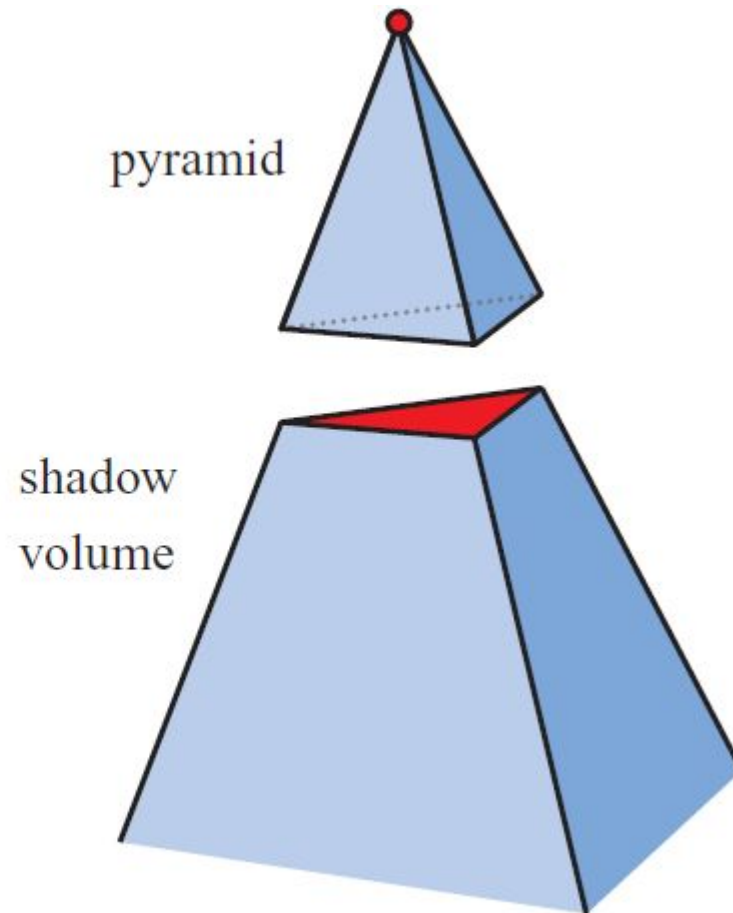
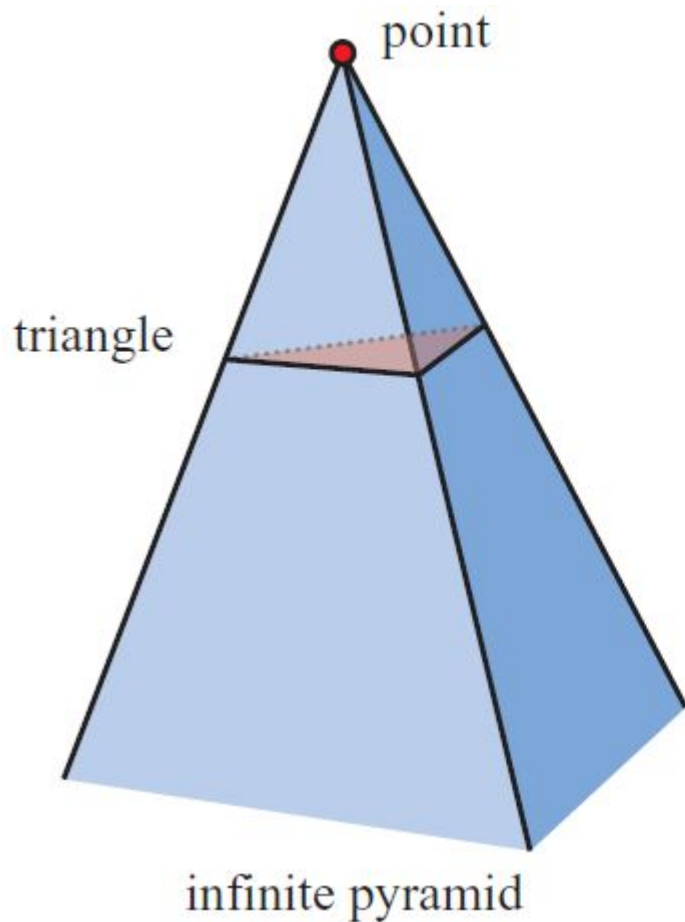
void main( void )
{
    const vec4 diffcolor = vec4(diff);    // diffuse
    const vec4 speccolor = vec4(spec);    // specular
    const vec4 ambcolor = vec4(amb);      // ambient
    const vec4 specpower = vec4(spower);  // specular power

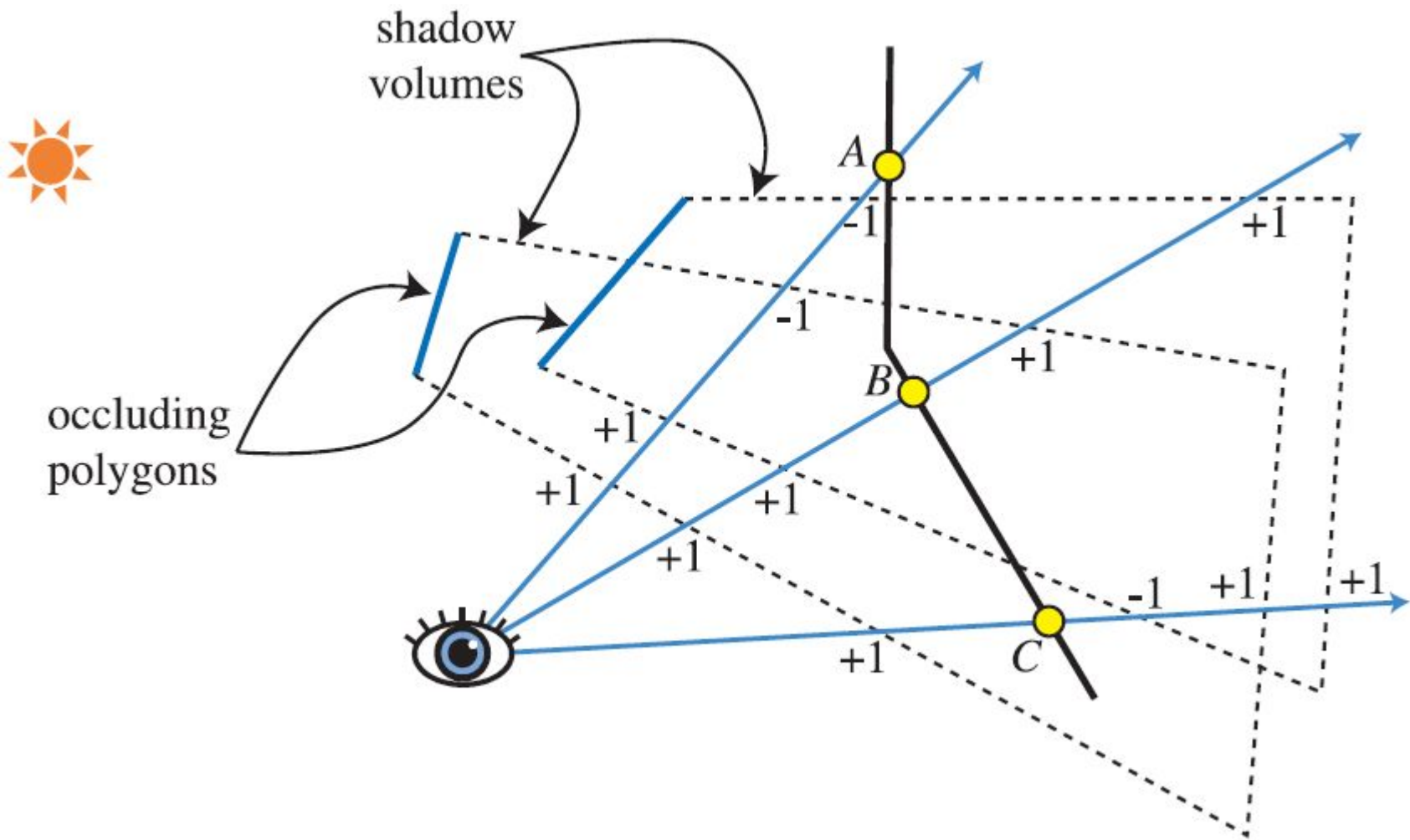
    vec3 n2 = normalize(n);
    vec3 l2 = normalize(l);
    vec3 v2 = normalize(v);
    vec3 r = reflect(-v2, n2);
    vec4 diff = diff * max(dot(n2, l2), 0.0);
    vec4 spec = spec * pow(max(dot(l2, r), 0.0), spower);

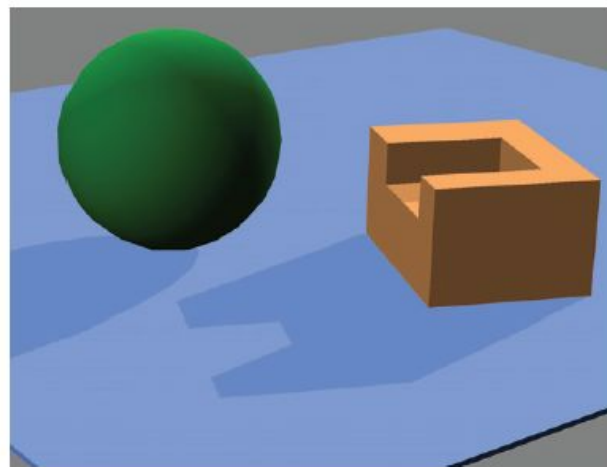
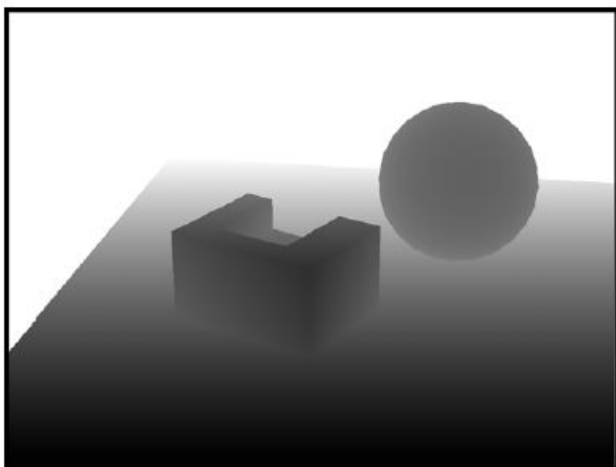
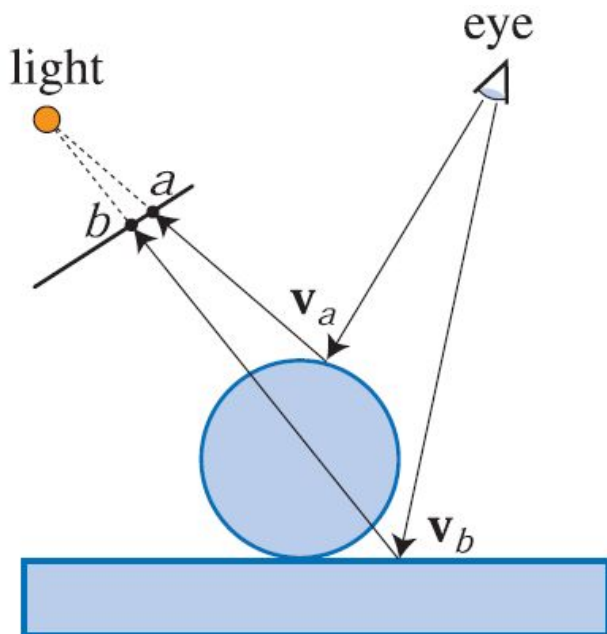
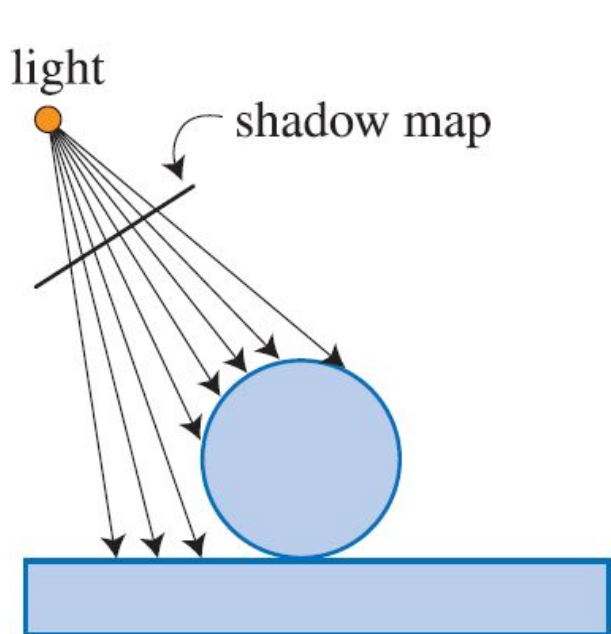
    gl_FragColor = amb + diff + spec;
}

```









- Синхронизация

- `clock_t start;`

- • •

- `dt = (clock() - start) / (double)CLOCKS_PER_SEC;`

- `LARGE_INTEGER Start, Quant;`

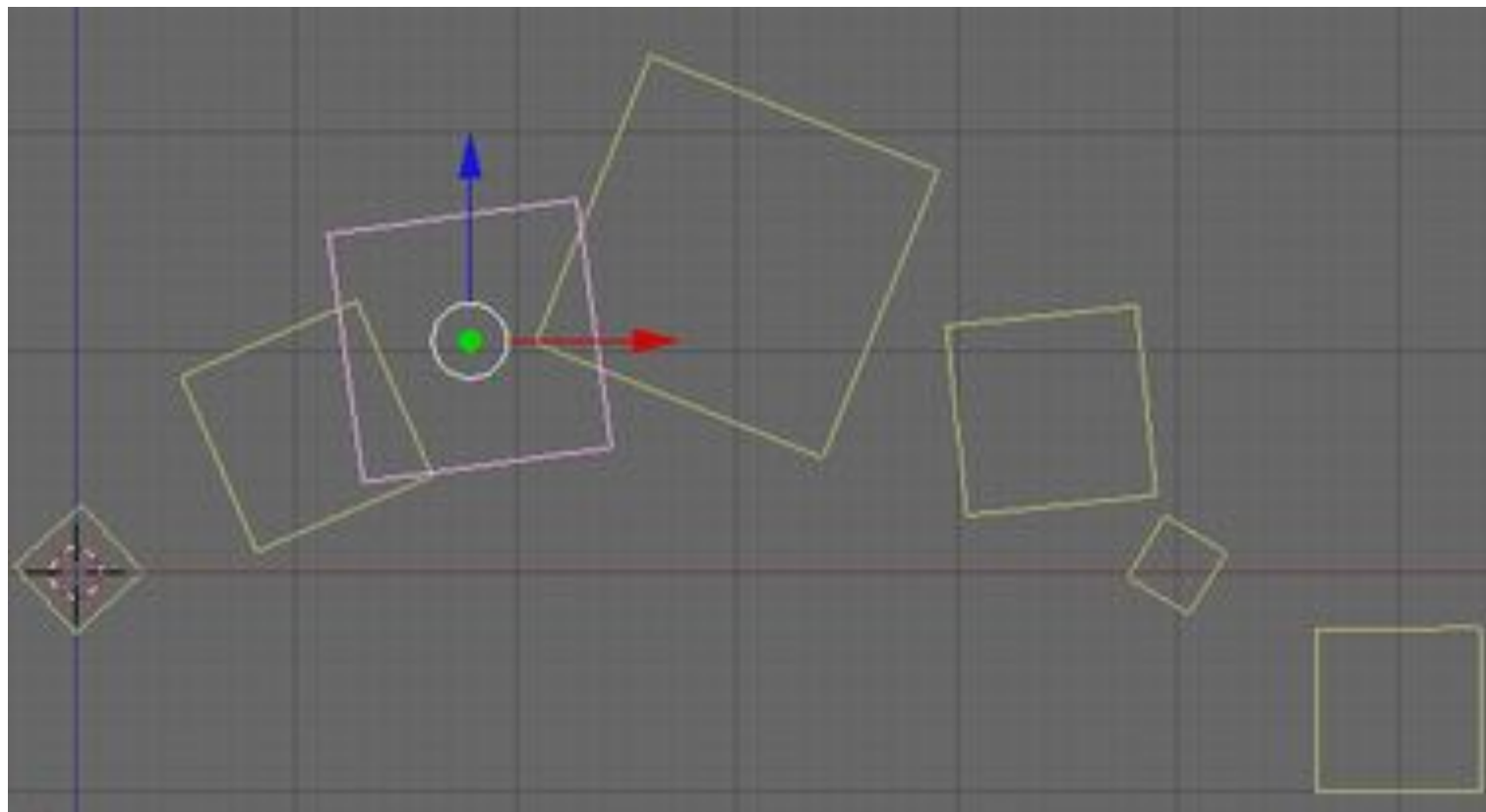
- `QueryPerformanceFrequency (&Quant) ;`

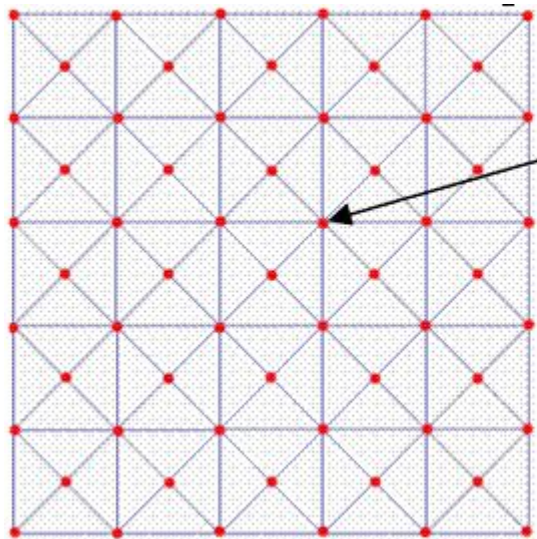
- `QueryPerformanceCounter (&Start) ;`

- • •

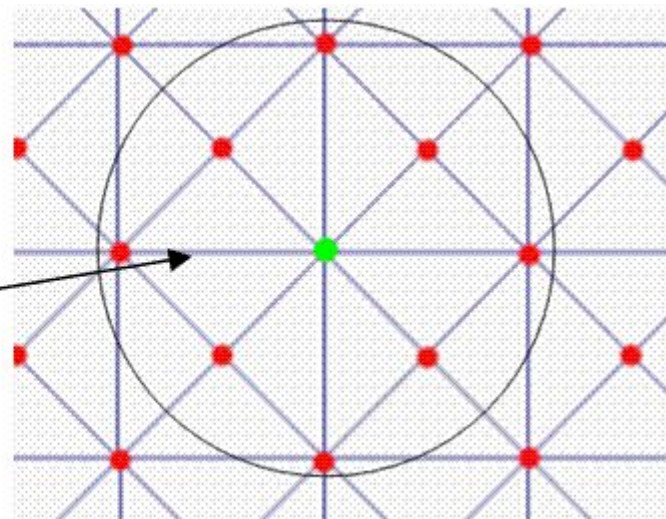
- `QueryPerformanceCounter (&Time) ;`

- `dt = (Time.QuadPart - Start.QuadPart) /`
 - `(double)Quanty.QuadPart ;`

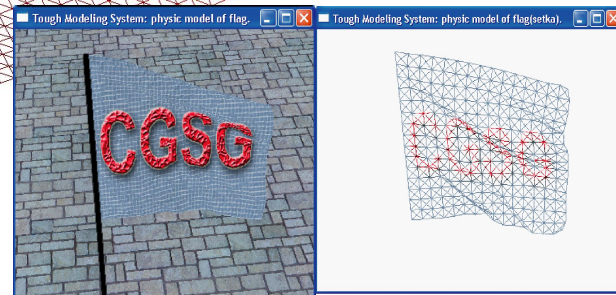
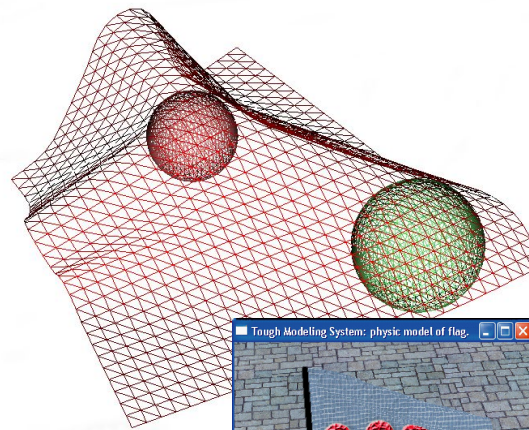
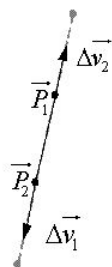
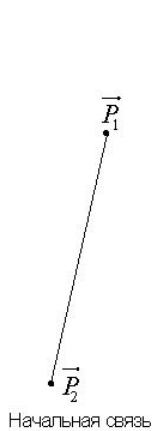




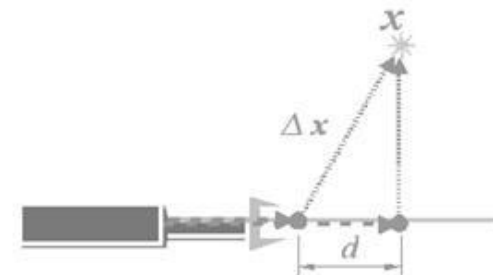
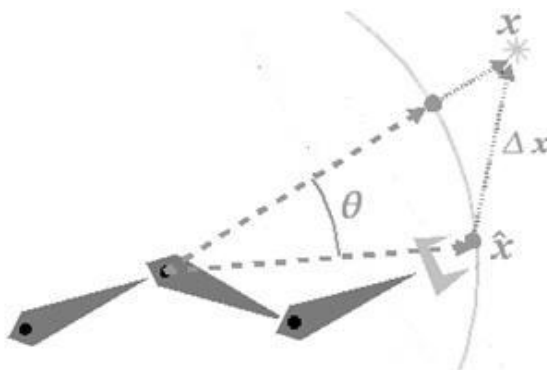
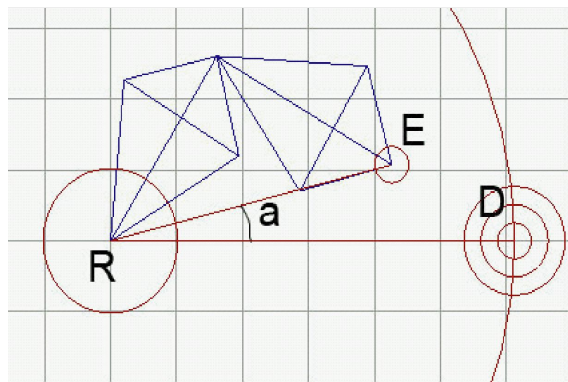
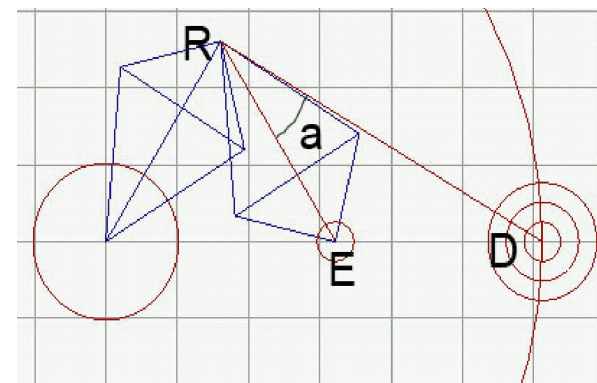
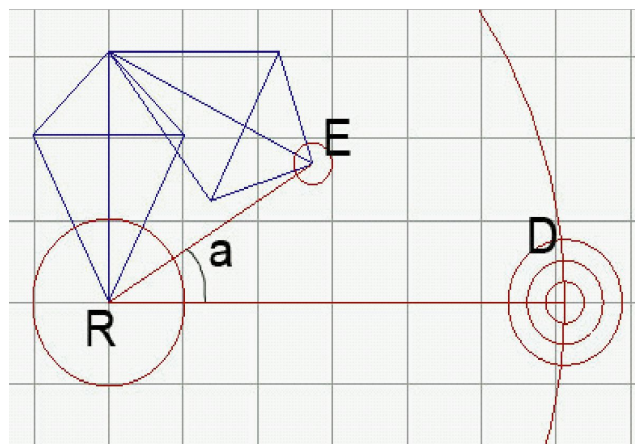
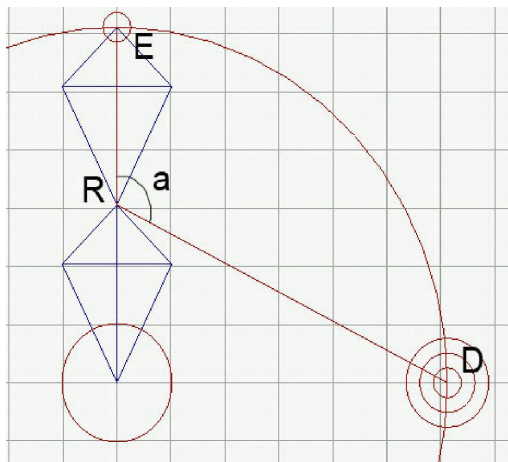
частица

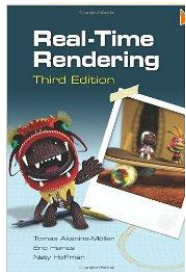


связь

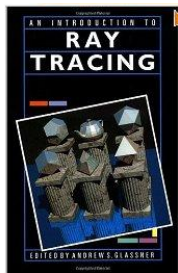


- Cyclic Coordinate Descent (CCD)**

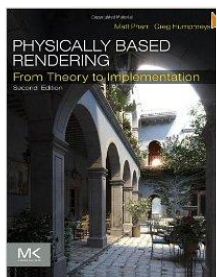




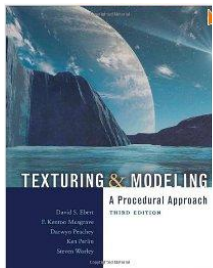
- Tomas Akenine-Moller, Eric Haines, Naty Hoffman, “Real-Time Rendering”, Third Edition, AK Peters-2008



- Andrew S. Glassner (ed.), Eric Haines, Pat Hanrahan, Robert L. Cook, James Arvo, David Kirk, Paul S. Heckbert, "An Introduction to Ray Tracing (The Morgan Kaufmann Series in Computer Graphics)", Academic Press-1989.



- Matt Pharr, Greg Humphreys, "Physically Based Rendering, Second Edition: From Theory To Implementation", Morgan Kaufmann-2010



- David S. Ebert, F. Kenton Musgrave, Darwyn Peachey, Ken Perlin, Steve Worley, "Texturing and Modeling, Third Edition: A Procedural Approach (The Morgan Kaufmann Series in Computer Graphics)", Morgan Kaufmann-2002

- **Практические задания (до зачетного занятия)**
 - Реализовать простейшую анимацию сферы с использованием библиотеки OpenGL или Direct3D (со встроенными в библиотеку возможностями фиксированного конвейера, например, освещения)
 - К предыдущему заданию добавить освещение, реализованное на шейдерах (предпочтительно на фрагментных/пиксельных для поточечного освещения).

В обоих заданиях не использовать retained библиотек (фигуру построить с использованием базовых примитивов).