GenBrush

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Introduction

GenBrush is a C library providing structures and functions for creating 2D/3D, bitmap/vector, still/animated graphics on various supports.

It can be use as a monolithic library, or as an interface with another graphical library (Cairo/GTK). The choice can be made through a single compilation option.

GenBrush is based on the following model: the scene to be represented graphically is composed of Objects viewed by an Eye, interpreted by a Hand and recreated with a Tool applying an Ink on a Surface made of Layers.

The currently available implementations for these entities are:

- Object: Point (VecFloat), SCurve, Shapoid
- Eye: Orthographic, Isometric
- Hand: Default

- Tool: PixelPlotter
- Ink: Solid
- Surface: Image (TGA), GBApp, GBWidget
- Layer: divided into background, inside and foreground layers; blending modes: Default (overwritting), Normal, Over

For details refer to the following sections.

The library can easily be extended to match the user needs. Foreseen extensions of the entities are for example:

- Object: BBody, ...
- Eye: Perspective, ...
- Hand: Human (approximation of the viewed object), ...
- Tool: Pen, Brush, ...
- Ink: Generic (BBody), UVMapping
- Surface: Full support of TGA, other image formats, innterface with Cairo only, ...
- Layer: other blending modes, ...

A graphic can then be created with the GenBrush library by describing the scene as a set of Pods, which are combinations of an Object, an Eye, a Hand, a Tool, an Ink and a Layer. The rendering of each Pod processes sequentially the original Object through the other entities to generates pixels into the Layer. Once all the Pods have been processed, the Layers are blended to generate RGBA final pixels in the Surface. The scene description can be modified after creation. Pods use references to entities, meaning that if a parameter of, for example, an Ink is modified all the Pods attached to this Ink will be recalculated at the next rendering.

Several rendering of the same scene are optimized to recalculate only the final pixels affected by the entities which has been modified since the previous rendering. It is the reponsibility of the user to notify GenBrush when an entity has been modified.

The user can apply post processing to the surface at the end of each rendering. Currently implemented post processing are:

- Normalization by hue

Finally, the user can create scaled or cropped copies of a Genbrush.

The GenBrush library uses the `PBErr`, `PBMath`, `GSet`, `Shapoid`, `BCurve` libraries, and GTK if compiled as an interface for this library.

1 Definitions

1.1 Object

The scene to be represented graphically can be described using Points, SCurves and Shapoids.

1.1.1 Point

Points are a single point in space (any dimensions from 2). After projection through the Eye, the first two dimensions are the coordinates in the Layer, the third dimension is the depth, and the following dimensions are parameters for the other entities. If a dimension is needed but not provided by the Point its value is considered to be 0.0.

1.1.2 SCurve

SCurves are curves in space (any dimensions from 2). After projection through the Eye, the first two dimensions are the coordinates in the Layer, the third dimension is the depth, and the following dimensions are parameters for the other entities. If a dimension is needed but not provided by the Point its value is considered to be 0.0.

1.1.3 Shapoid

Shapoids are surfaces (if dimension equals 2) or volumes (if dimension is greater than 2) in space. After projection through the Eye, the first two dimensions are the coordinates in the Layer, the third dimension is the depth,

and the following dimensions are parameters for the other entities. If a dimension is needed but not provided by the Point its value is considered to be 0.0.

1.2 Eye

The Eye create a projection of an Object from the original space coordinates system toward the Layer space coordinates system. The projected Object is always of the same type as the original Object, only its component are affected by the projection.

The Eye always sees the Object in 3 dimensions. If the Object has only two dimensions, the Eye considers it has a third one with values equal to 0.0. If the Object has more than 3 dimensions, the Eye applies the projection on the first 3 ones and leaves the other dimensions unchanged.

All the Eyes have a translation, a scale and rotation parameters. The first, second and third components of the projected Object are multiplied repectively by the first, second and third components of the scale vector. The rotation angle (in radians) is a 2D rotation applied on the two first components of the scaled projected Object. Finally the translation 2D vector is added to the rotated scaled projected Object. The translation acts as a translation of the viewed object in the plane of the Layer, the scale acts like a zoom on the viewed object, and the rotation like a tilt of the Eye. Given $\overrightarrow{t}$, $\overrightarrow{s}$ and θ the translation, scale and rotation of the Eye the translated rotated scaled version O' of the projected version of Object O can be obtained as follow:

$$O' = \begin{bmatrix} s_x cos\theta & -s_y sin\theta & 0.0 \\ s_x sin\theta & s_y cos\theta & 0.0 \\ 0.0 & 0.0 & s_z \end{bmatrix} O + \begin{pmatrix} t_x \\ t_y \\ 0.0 \end{pmatrix} \quad (1)$$

1.2.1 Orthographic

The Orthographic Eye creates projection of Objects onto planes aligned with the original coordinates system. It has 6 views: front, rear, left, right, top, bottom. For each view the translated rotated scaled projected version O' of the Object O can be obtained as follow:

- front:

$$O' = \begin{bmatrix} s_x cos\theta & -s_y sin\theta & 0.0 \\ s_x sin\theta & s_y cos\theta & 0.0 \\ 0.0 & 0.0 & s_z \end{bmatrix} O + \begin{pmatrix} t_x \\ t_y \\ 0.0 \end{pmatrix} \quad (2)$$

- rear:

$$O' = \begin{bmatrix} -s_x cos\theta & -s_y sin\theta & 0.0 \\ -s_x sin\theta & s_y cos\theta & 0.0 \\ 0.0 & 0.0 & -s_z \end{bmatrix} O + \begin{pmatrix} t_x \\ t_y \\ 0.0 \end{pmatrix} \quad (3)$$

- top:

$$O' = \begin{bmatrix} s_x cos\theta & 0.0 & -s_y sin\theta \\ s_x sin\theta & 0.0 & s_y cos\theta \\ 0.0 & -s_z & 0.0 \end{bmatrix} O + \begin{pmatrix} t_x \\ t_y \\ 0.0 \end{pmatrix} \quad (4)$$

- bottom:

$$O' = \begin{bmatrix} s_x cos\theta & 0.0 & s_y sin\theta \\ s_x sin\theta & 0.0 & -s_y cos\theta \\ 0.0 & s_z & 0.0 \end{bmatrix} O + \begin{pmatrix} t_x \\ t_y \\ 0.0 \end{pmatrix} \quad (5)$$

- left:

$$O' = \begin{bmatrix} 0.0 & -s_y sin\theta & -s_x cos\theta \\ 0.0 & s_y cos\theta & -s_x sin\theta \\ s_z & 0.0 & 0.0 \end{bmatrix} O + \begin{pmatrix} t_x \\ t_y \\ 0.0 \end{pmatrix} \quad (6)$$

- right:

$$O' = \begin{bmatrix} 0.0 & -s_y sin\theta & s_x cos\theta \\ 0.0 & s_y cos\theta & s_x sin\theta \\ -s_z & 0.0 & 0.0 \end{bmatrix} O + \begin{pmatrix} t_x \\ t_y \\ 0.0 \end{pmatrix} \quad (7)$$

1.2.2 Isometric

The Isometric Eye creates 3D projection of Objects without simulation of the perspective. It adds two other rotations to the Eye: the rotation around the second dimension in the original coordinates system, and the rotation around the first dimension in the Layer coordinates system. Given θ_y and θ_r the angle in radians of these two rotations, the translated rotated scaled

projected version O' of the Object O can be obtained as follow:

$$O' = \begin{bmatrix} M_{00} & M_{10} & M_{20} \\ M_{01} & M_{11} & M_{21} \\ M_{02} & M_{12} & M_{22} \end{bmatrix} O + \begin{pmatrix} t_x \\ t_y \\ 0.0 \end{pmatrix} \tag{8}$$

where

$$\begin{aligned} M_{00} &= s_x cos\theta cos\theta_y - s_y sin\theta sin\theta_y sin\theta_r \\ M_{01} &= s_x sin\theta cos\theta_y + s_y cos\theta sin\theta_y sin\theta_r \\ M_{02} &= s_z sin\theta_y cos\theta_r \\ M_{10} &= -s_y sin\theta cos\theta_r \\ M_{11} &= s_y cos\theta cos\theta_r \\ M_{12} &= -s_z sin\theta_r \\ M_{20} &= -s_x cos\theta sin\theta_y - s_y sin\theta cos\theta_y sin\theta_r \\ M_{21} &= -s_x sin\theta sin\theta_y + s_y cos\theta cos\theta_y sin\theta_r \\ M_{22} &= s_z cos\theta_y cos\theta_r \end{aligned} \tag{9}$$

1.3 Hand

The Hand interprets each viewed Object and creates a new instance of one or several Objects (possibly of types differents from the one of the original Object). This interpreted version of the Object is the one which will actually be traced by the Tool. For example a Hand may convert a volume object into its outline curve version.

The Hand may be parameterized by the components of dimensions from the 4th one of the Object.

A given Hand type may not be defined for all types of Object. If the user tries to apply a Hand on an unsupported Object, the Hand simply does nothing and the Object won't appear in the Surface.

1.3.1 Default

The default hand simply creates a copy of the Object created by the Eye.

1.4 Tool

The Tool translates each Object created by the Hand into pixels of Ink stacked into the Layers. It generally runs through the Object's internal

coordinates, calculates the rounded coordinates of the Object (coordinates in the Layer coordinates system) and the coordinates of the original Object (coordinates in the global coordinates system), then get the Inks value at theses coordinates and add the corresponding pixels in the Layers.

The Tool may be parameterized by the components of dimensions from the 4th one of the Object(s).

A given Tool type may not be defined for all types of Object. If the user tries to apply a Tool on an unsupported Object, the Tool simply does nothing and the Object won't appear in the Surface.

1.4.1 Plotter

If the Plotter draws a Point, it adds one pixel at the rounded position in the Layer. The depth of the pixel is equals to the 3rd dimension of the Point if it has one, 0.0 else. The ink value is calculated by using a 3D vector null for the internal position as a Point doesn't have internal position.

If the Plotter draws a SCurve, it runs through the SCurve from beginning to end by small increment of its internal parameter equals to $0.5/l$ where l is the length (or its approximation) of the SCurve. If the SCurve has only 2 dimensions, the Plotter considers the 3rd as being always equal to 0.0. At each step the Plotter checks if it has move to a different voxel, i.e. if at least one of the rounded value of the 3 first dimensions has changed. If so, the Plotter calculates the Ink value at this position and adds the equivalent pixel to the Layer.

If the Plotter draws a Shapoid, it checks for each voxel of the bounding box of the Shapoid if the center of the voxel is inside the Shapoid, and if so adds a pixel into the Layer at the position (2 first dimension) and depth (3rd dimension) of this voxel. If the Shapoid has only 2 dimensions, a 3rd one always equals to 0.0 is considered. The internal coordinates for a given voxel can be calculated thanks to the Shapoid functions.

1.5 Ink

The Ink converts coordinates into RGBA values. It takes as input internal coordinates (in the Object internal coordinates system), external coordinates

(in the global coordinates system) and layer coordinates. Layer coordinates have integer values whlie the others have floating values. An Ink may ignore some or all of the coordinates given as parameter, and to be able to proces any kind of object should be resilient to lower than expected dimensions for these coordinates (typically by assuming the missing dimensions are equals to 0.0).

The Ink may be parameterized by the components of dimensions from the 4th one of the Object(s).

1.5.1 Solid

The Solid Ink returns a RGBA value set by the user, regardless of the coordinates given as parameters.

1.6 Surface

A Surface is a set of Layers plus an array of RGBA values (the final pixels). It is an abstraction level which allows to manipulate any kind of output for the rendering process: a file on the hard drive, a window on the screen, a widget in another application, ...

The result of the rendering of a scene is stored as individual pixels in the Layers of the Surface, and when the Surface is requested for update, these pixels are blended into the final pixels.

A Surface has a background color which is used has a fallback when blending pixels of Layers (see below for detail).

1.6.1 Image

An Image Surface is an image file saved on a physical media when the Surface is requested for update. Currently the Image Surface supports the following formats:

- TGA: supports only 16, 24 or 32 bits per pixel, uncompressed or RLE RGB (data types 2 and 10)

An Image Surface can also load an image from a physical media toward a new Layer. The new Layer is then created with the dimensions of the image, depth of pixels are set to 0.0, parameters of the new Layer to their default

value.

1.6.2 GBWidget

A GBWidget Surface is a Surface compatible with the GTK library. It can return a GtkWidget drawing area to be used on the GTK side (added to a container, attached to an idle function, ...). The rendering of the Surface automatically update the GTK drawing area.

1.6.3 GBApp

A GBApp Surface is a full GtkApplication allowing the user to simply display graphics content on screen. The GTK windows created has a fixed size defined by the user. The rendering of the Surface refreshes the content of the window. An idle function can be set by the user to create animation. The GBApp Surface can return a GtkWidget on which the user could attached more event handler to extend the behaviour of the window.

1.7 Layer

A Layer is a an array of stacked pixels (RGBA value, depth value and blend mode). A Layer has a position in its Surface and dimensions eventually larger or smaller than its Surface's dimensions. The Layer content is always clipped to its Surface when rendering.

The Layers are stacked in the Surface in three levels:

- Background: Pixels of Layers in Background level are rendered in the order defined by the stack, or in the order their original Object has been added to the Layer for the case of several Objects in the same Layer. For example, pixels of layerA will be hided by pixels of layerB if layerA is before layerB in the stack of Layers. Another example, pixels of objectA will be hided by pixels of objectB, both in the same Layer, if objectA has been added to the Layer before objectB.
- Inside: Pixels of Inside Layers always hide pixels of Background Layers. The order of addition into the scene of Inside Layers doesn't matter. Pixels are always reordered according to their depth accross all Inside

Layers upon rendering. Pixels with lower depth hide pixels with higher depth.

- Foreground: Pixels of Foreground layers always hide pixels of Inside and Background Layers. Pixels of Layers in Background level are rendered in the order defined by the stack, or in the order their original Object has been added to the Layer for the case of several Objects in the same Layer. For example, pixels of layerA will be hided by pixels of layerB if layerA is before layerB in the stack of Layers. Another example, pixels of objectA will be hided by pixels of objectB, both in the same Layer, if objectA has been added to the Layer before objectB.

The position of a Layer in the stack, or its level, can be modified by the user after creation.

To create the final pixels, stacked pixels are blended according to their blending mode. The blending mode of a given stacked pixel is the one of its Layer at the time of rendering. The blending occurs from top to bottom (from the end of the Foreground stack toward the beginning of the Background stack). The blending starts with the highest stacked pixel, and then blend it with its blending mode on the stacked pixel below, and so on downward. Blending stops as soon as the alpha value of the resulting final pixel reaches its maximal value (255) for optimization. If the blending operation reaches the bottom of the stack and the alpha value has still not reached its maximum, one last blend occurs with a pixel equals to the background color of the Surface.

The blending modes are detailed below (where $rgba$ is the higher pixel, $rgba'$ is the lower pixel. res is the result pixel and the blending mode is the blending mode of the higher pixel.

1.7.1 Default

The Default blending mode simply overwrites the lower pixel to the final pixel.

1.7.2 Normal

The Normal blending mode calculates the RGBA value as follow:

$$\begin{cases} res(red) = \lfloor (1.0 - u)rgba(red) + u * rgba'(red) + 0.5 \rfloor \\ res(green) = \lfloor (1.0 - u)rgba(green) + u * rgba'(green) + 0.5 \rfloor \\ res(blue) = \lfloor (1.0 - u)rgba(blue) + u * rgba'(blue) + 0.5 \rfloor \\ res(alpha) = \lfloor MIN(255.0, rgba(alpha) + rgba'(alpha)) + 0.5 \rfloor \end{cases} \tag{10}$$

where

$$u = 0.5 * (1.0 + (rgba(alpha) - rgba'(alpha))/255.0) \tag{11}$$

1.7.3 Over

The Over blending mode calculates the RGBA value as follow:

$$\begin{cases} res(red) = \lfloor (1.0 - u)rgba(red) + u * rgba'(red) + 0.5 \rfloor \\ res(green) = \lfloor (1.0 - u)rgba(green) + u * rgba'(green) + 0.5 \rfloor \\ res(blue) = \lfloor (1.0 - u)rgba(blue) + u * rgba'(blue) + 0.5 \rfloor \\ res(alpha) = \lfloor MIN(255.0, rgba(alpha) + rgba'(alpha)) + 0.5 \rfloor \end{cases} \tag{12}$$

where

$$u = rgba(alpha)/255.0 \tag{13}$$

2 Interface

2.1 genbrush.h

```
// ============ GENBRUSH.H ================

#ifndef GENBRUSH_H
#define GENBRUSH_H

// About the coordinates systems:
// In input, the coordinates system must be a left handed
// coordinates system, with x toward the right, y toward the top and
// z away from the viewer.
//   y
//   ^ z
//   |/
//   -->x
// So the front view of a GBEyeOrtho has x to the right, y to the top
// and z as the depth component (positive is away from the viewer).
//   y
//   ^
//   |
//  z-->x
// For a GBEyeIsometric, x is toward the top-right, y is toward the top
// and z is toward the top-left.
//   y
// z ^ x
```

```
//  \|/
// In output, the coordinates system of the surface is x toward the
// right and y toward the top, with the origin at the bottom-left of
// the surface.
//   y
//   ^
//   |
//   -->x
// In GBSurface, the final pixels are stored in rows from left to
// right, the first row is the top row in the surface.

// ================= Include =================

#include <stdlib.h>
#include <stdio.h>
#include <math.h>
#include <string.h>
#include <stdbool.h>
#include "pberr.h"
#include "pbmath.h"
#include "gset.h"
#include "shapoid.h"
#include "bcurve.h"

// ================= Define ==================

// Color index in _rgba
// for CAIRO_FORMAT_ARGB32 :
#define GBPixelRed 2
#define GBPixelGreen 1
#define GBPixelBlue 0
#define GBPixelValue 2
#define GBPixelSaturation 1
#define GBPixelHue 0
#define GBPixelAlpha 3

#define GBColorWhite (GBPixel){ \
    ._rgba[GBPixelAlpha]=255,._rgba[GBPixelRed]=255, \
    ._rgba[GBPixelGreen]=255,._rgba[GBPixelBlue]=255}
#define GBColorBlack (GBPixel){ \
    ._rgba[GBPixelAlpha]=255,._rgba[GBPixelRed]=0, \
    ._rgba[GBPixelGreen]=0,._rgba[GBPixelBlue]=0}
#define GBColorTransparent (GBPixel){ \
    ._rgba[GBPixelAlpha]=0,._rgba[GBPixelRed]=0, \
    ._rgba[GBPixelGreen]=0,._rgba[GBPixelBlue]=0}
#define GBColorRed (GBPixel){ \
    ._rgba[GBPixelAlpha]=255,._rgba[GBPixelRed]=255, \
    ._rgba[GBPixelGreen]=0,._rgba[GBPixelBlue]=0}
#define GBColorGreen (GBPixel){ \
    ._rgba[GBPixelAlpha]=255,._rgba[GBPixelRed]=0, \
    ._rgba[GBPixelGreen]=255,._rgba[GBPixelBlue]=0}
#define GBColorBlue (GBPixel){ \
    ._rgba[GBPixelAlpha]=255,._rgba[GBPixelRed]=0, \
    ._rgba[GBPixelGreen]=0,._rgba[GBPixelBlue]=255}

// ================= Data structure ==================

typedef struct GBPixel {
  // Pixel values
  union {
    unsigned char _rgba[4];
    unsigned char _hsva[4];
```

```
  };
} GBPixel;

typedef enum GBLayerBlendMode {
  GBLayerBlendModeDefault, // Simple overwritting
  GBLayerBlendModeNormal, // Blending according to relative alpha
  GBLayerBlendModeOver // Blending according to alpha of top pix
} GBLayerBlendMode;

typedef enum GBLayerStackPosition {
  GBLayerStackPosBg, // Layers' pixels are stacked according to their
                     // index
  GBLayerStackPosInside, // Layers' pixels are stacked according to
                         // their depth
  GBLayerStackPosFg // Layers' pixels are stacked according to their
                    // index
} GBLayerStackPosition;

typedef struct GBStackedPixel {
  // Pixel values
  GBPixel _val;
  // Depth
  float _depth;
  // BlendMode
  GBLayerBlendMode _blendMode;
}  GBStackedPixel;

typedef struct GBLayer {
  // Position in the GBSurface of the bottom left corner of the GBLayer
  // (coordinates of the bottom left corner in the GBSurface are 0,0)
  // (x toward right, y toward top)
  VecShort2D _pos;
  // Previous position
  VecShort2D _prevPos;
  // Dimension
  VecShort2D _dim;
  // _dim[0] x _dim[1] GSet of StackedPixel (stored by rows)
  GSet* _pix;
  // Composition
  GBLayerBlendMode _blendMode;
  // Modified flag
  bool _modified;
  // Position in stack
  GBLayerStackPosition _stackPos;
  // Scale
  VecFloat2D _scale;
  // Previous scale
  VecFloat2D _prevScale;
} GBLayer;

typedef enum GBPPType {
  GBPPTypeNormalizeHue
} GBPPType;

typedef struct GBPostProcessing {
  enum GBPPType _type;
} GBPostProcessing;

typedef enum GBSurfaceType {
  GBSurfaceTypeDefault,
  GBSurfaceTypeImage
#if BUILDWITHGRAPHICLIB == 1
```

```
    , GBSurfaceTypeApp, GBSurfaceTypeWidget
#endif
} GBSurfaceType;

typedef struct GBSurface {
  // Type of the surface
  GBSurfaceType _type;
  // Dimension (x toward right, y toward top)
  VecShort2D _dim;
  // Background color
  GBPixel _bgColor;
  // Set of GBLayer
  GSet _layers;
  // Final pixels
  GBPixel* _finalPix;
} GBSurface;

typedef struct GBSurfaceImage {
  // Parent GBSurface
  GBSurface _surf;
  // File name
  char* _fileName;
} GBSurfaceImage;

typedef enum GBEyeType {
  GBEyeTypeOrtho,
  GBEyeTypeIsometric
} GBEyeType;

typedef struct GBEye {
  // Type
  GBEyeType _type;
  // Scale
  VecFloat3D _scale;
  // (0,0) in graphical element is translated at _orig in the surface
  VecFloat2D _orig;
  // Rotation of the eye (clockwise, radians)
  float _theta;
  // Projection matrix from real space to surface space
  // Transformation are applied in the following order in the
  // surface space:
  // scale, rotation, translation
  MatFloat* _proj;
} GBEye;

typedef enum GBEyeOrthoView {
  // View from ...
  GBEyeOrthoViewFront,
  GBEyeOrthoViewRear,
  GBEyeOrthoViewTop,
  GBEyeOrthoViewBottom,
  GBEyeOrthoViewLeft,
  GBEyeOrthoViewRight
} GBEyeOrthoView;

typedef struct GBEyeOrtho {
  // GBEye data
  GBEye _eye;
  // Orientation of the orthographic projection
  GBEyeOrthoView _view;
} GBEyeOrtho;
```

```
typedef struct GBEyeIsometric {
  // GBEye data
  GBEye _eye;
  // Rotation right handed around y (in radians, initially 0.0)
  float _thetaY;
  // Rotation right handed around the right direction in the surface
  // (in radians, in [-pi/2, pi/2], initially pi/4)
  float _thetaRight;
} GBEyeIsometric;

typedef enum GBHandType {
  GBHandTypeDefault
} GBHandType;

typedef struct GBHand {
  // Type
  GBHandType _type;
} GBHand;

typedef struct GBHandDefault {
  // Parent
  GBHand _hand;
} GBHandDefault;

typedef enum GBToolType {
  GBToolTypePlotter
} GBToolType;

typedef struct GBTool {
  // Type
  GBToolType _type;
} GBTool;

typedef struct GBToolPlotter {
  // Parent
  GBTool _tool;
} GBToolPlotter;

typedef enum GBInkType {
  GBInkTypeSolid
} GBInkType;

typedef struct GBInk {
  // Type
  GBInkType _type;
} GBInk;

typedef struct GBInkSolid {
  // Parent
  GBInk _ink;
  // Color
  GBPixel _color;
} GBInkSolid;

typedef enum GBObjType {
  GBObjTypePoint,
  GBObjTypeShapoid,
  GBObjTypeSCurve
} GBObjType;

typedef struct GBObjPod {
  // Type
```

```
  GBObjType _type;
  // Source object
  union {
    VecFloat* _srcPoint;
    Shapoid* _srcShapoid;
    SCurve* _srcSCurve;
  };
  // Object projected through eye
  union {
    VecFloat* _eyePoint;
    Shapoid* _eyeShapoid;
    SCurve* _eyeSCurve;
  };
  // GSet of projected Points (VecFloat) through eye + hand
  GSetVecFloat _handPoints;
  // GSet of projected Shapoids through eye + hand
  GSetShapoid _handShapoids;
  // GSet of projected Shapoids through eye + hand
  GSetSCurve _handSCurves;
  // Eye
  GBEye* _eye;
  // Hand
  GBHand* _hand;
  // Tool
  GBTool* _tool;
  // Ink
  GBInk* _ink;
  // Layer
  GBLayer* _layer;
} GBObjPod;

typedef enum GBScaleMethod {
  GBScaleMethod_AvgNeighbour
} GBScaleMethod;
#define GBScaleMethod_Default GBScaleMethod_AvgNeighbour

typedef struct GenBrush {
  // Surface of the GenBrush
  GBSurface* _surf;
  // Set of GBObjPod to be drawn
  GSet _pods;
  // Set of GBPostProcessing to be apply at the end of GBUpdate
  GSet _postProcs;
} GenBrush;

// ================ Functions declaration ====================

// ---------------- GBPixel -------------------------

// Blend the pixel 'pix' into the pixel 'that'
// BlendNormal mixes colors according to their relative alpha value
// and add the alpha values
void GBPixelBlendNormal(GBPixel* const that , const GBPixel* const pix);

// Blend the pixel 'pix' into the pixel 'that'
// BlendOver mixes colors according to the alpha value of 'pix'
// and add the alpha values
void GBPixelBlendOver(GBPixel* const that, const GBPixel* const pix);

// Return the blend result of the stack of Pixel 'stack'
// If there is transparency down to the bottom of the stack, use the
// background color 'bgColor'
```

```
// If the stack is empty, return a transparent pixel
GBPixel GBPixelStackBlend(const GSet* const stack,
  const GBPixel* const bgColor);

// Return true if the GBPixel 'that' and 'tho' are the same, else false.
#if BUILDMODE != 0
inline
#endif
bool GBPixelIsSame(const GBPixel* const that, const GBPixel* const tho);

// Convert the GBPixel 'that' from RGB to HSV. Alpha channel is unchanged
GBPixel GBPixelRGB2HSV(const GBPixel* const that);

// Convert the GBPixel 'that' from HSV to RGB. Alpha channel is unchanged
GBPixel GBPixelHSV2RGB(const GBPixel* const that);

// ---------------- GBLayer -------------------------

// Create a new GBLayer with dimensions 'dim'
// The layer is initialized with empty stacks of pixel
// _pos = (0,0)
// blendMode = GBLayerBlendModeDefault
// stackPos = GBLayerStackPosBg
GBLayer* GBLayerCreate(const VecShort2D* const dim);

// Free the GBLayer 'that'
void GBLayerFree(GBLayer** that);

// Get the area of the layer (width * height)
#if BUILDMODE != 0
inline
#endif
int GBLayerArea(const GBLayer* const that);

// Get the position of the GBLayer 'that'
#if BUILDMODE != 0
inline
#endif
VecShort2D* GBLayerPos(const GBLayer* const that);

// Get a copy of the position of the GBLayer 'that'
#if BUILDMODE != 0
inline
#endif
VecShort2D GBLayerGetPos(const GBLayer* const that);

// Set the position of the GBLayer 'that' to 'pos'
// If the flag _modified==false _prevPos is first set to _pos
// and _modified is set to true
#if BUILDMODE != 0
inline
#endif
void GBLayerSetPos(GBLayer* const that, const VecShort2D* const pos);

// Get the previous position of the GBLayer 'that'
#if BUILDMODE != 0
inline
#endif
VecShort2D* GBLayerPrevPos(const GBLayer* const that);

// Get a copy of the previous position of the GBLayer 'that'
#if BUILDMODE != 0
```

```
inline
#endif
VecShort2D GBLayerGetPrevPos(const GBLayer* const that);

// Get the scale of the GBLayer 'that'
#if BUILDMODE != 0
inline
#endif
VecFloat2D* GBLayerScale(const GBLayer* const that);

// Get a copy of the scale of the GBLayer 'that'
#if BUILDMODE != 0
inline
#endif
VecFloat2D GBLayerGetScale(const GBLayer* const that);

// Set the scale of the GBLayer 'that' to 'scale'
// If the flag _modified==false _prevScale is first set to _scale
// and _modified is set to true
#if BUILDMODE != 0
inline
#endif
void GBLayerSetScale(GBLayer* const that, const VecFloat2D* const scale);

// Get the previous scale of the GBLayer 'that'
#if BUILDMODE != 0
inline
#endif
VecFloat2D* GBLayerPrevScale(const GBLayer* const that);

// Get a copy of the previous scale of the GBLayer 'that'
#if BUILDMODE != 0
inline
#endif
VecFloat2D GBLayerGetPrevScale(const GBLayer* const that);

// Get the dimensions of the GBLayer 'that'
#if BUILDMODE != 0
inline
#endif
VecShort2D* GBLayerDim(const GBLayer* const that);

// Get a copy of the dimensions of the GBLayer 'that'
#if BUILDMODE != 0
inline
#endif
VecShort2D GBLayerGetDim(const GBLayer* const that);

// Get a copy of the blend mode of the GBLayer 'that'
#if BUILDMODE != 0
inline
#endif
GBLayerBlendMode GBLayerGetBlendMode(const GBLayer* const that);

// Set the blend mode of the GBLayer 'that' to 'blend'
// Set the flag _modified to true
#if BUILDMODE != 0
inline
#endif
void GBLayerSetBlendMode(GBLayer* const that,
  const GBLayerBlendMode blend);
```

```
// Get a copy of the modified flag of the GBLayer 'that'
#if BUILDMODE != 0
inline
#endif
bool GBLayerIsModified(const GBLayer* const that);

// Set the modified flag of the GBLayer 'that' to 'flag'
#if BUILDMODE != 0
inline
#endif
void GBLayerSetModified(GBLayer* const that, const bool flag);

// Get a copy of the stack position of the GBLayer 'that'
#if BUILDMODE != 0
inline
#endif
GBLayerStackPosition GBLayerGetStackPos(const GBLayer* const that);

// Set the stack position of the GBLayer 'that' to 'pos'
// Set the flag _modified to true
#if BUILDMODE != 0
inline
#endif
void GBLayerSetStackPos(GBLayer* const that,
  const GBLayerStackPosition pos);

// Get the stacked pixels of the GBLayer 'that'
#if BUILDMODE != 0
inline
#endif
GSet* GBLayerPixels(const GBLayer* const that);

// Get the stacked pixels of the GBLayer 'that' at position 'pos'
// 'pos' must be inside the layer
#if BUILDMODE != 0
inline
#endif
GSet* GBLayerPixel(const GBLayer* const that,
  const VecShort2D* const pos);

// Get the stacked pixels of the GBLayer 'that' at position 'pos'
// If 'pos' is out of the layer return NULL
#if BUILDMODE != 0
inline
#endif
GSet* GBLayerPixelSafe(const GBLayer* const that,
  const VecShort2D* const pos);

// Add the pixel 'pix' with depth 'depth' on top of the stack at
// position 'pos' of GBLayer 'that'
// Set the flag _modified to true
// 'pos' must be inside the layer
// If the pixel is completely transparent (_rgba[GBPixelAlpha]==0)
// do nothing
#if BUILDMODE != 0
inline
#endif
void GBLayerAddPixel(GBLayer* const that, const VecShort2D* const pos,
  const GBPixel* const pix, const float depth);

// Add the pixel 'pix' with depth 'depth' on top of the stack at
// position 'pos' of GBLayer 'that'
```

```
// Set the flag _modified to true
// If 'pos' is out of the layer do nothing
// If the pixel is completely transparent (_rgba[GBPixelAlpha]==0)
// do nothing
#if BUILDMODE != 0
inline
#endif
void GBLayerAddPixelSafe(GBLayer* const that,
  const VecShort2D* const pos, const GBPixel* const pix,
  const float depth);

// Return true if the position 'pos' is inside the layer 'that'
// boundary, false else
#if BUILDMODE != 0
inline
#endif
bool GBLayerIsPosInside(const GBLayer* const that,
  const VecShort2D* const pos);

// Delete all the stacked pixels in the GBLayer 'that'
#if BUILDMODE != 0
inline
#endif
void GBLayerFlush(GBLayer* const that);

// Create a new GBLayer with dimensions and content given by the
// image on disk at location 'fileName'
// Return NULL if we couldn't create the layer
GBLayer* GBLayerCreateFromFile(const char* const fileName);

// Get the boundary of the GBLayer 'that' inside the GBSurface 'surf'
// The boundaries are given as a Facoid
// If the flag 'prevPos' is true, gives the bounday at the previous
// position
// Return NULL if the layer is completely out of the surface
Facoid* GBLayerGetBoundaryInSurface(const GBLayer* const that,
  const GBSurface* const surf, const bool prevPos);

// ---------------- GBPostProcessing -------------------------

// Create a static GBPostProcessing with type 'type'
GBPostProcessing* GBPostProcessingCreate(const GBPPType type);

// Create a new static GBPostProcessing with type 'type'
GBPostProcessing GBPostProcessingCreateStatic(const GBPPType type);

// Free the memory used by the GBPostProcessing 'that'
void GBPostProcessingFree(GBPostProcessing** that);

// Return the type of the GBPostProcessing 'that'
#if BUILDMODE != 0
inline
#endif
GBPPType GBPostProcessingGetType(const GBPostProcessing* const that);

// ---------------- GBSurface -------------------------

// Create a new static GBSurface with dimension 'dim' and type 'type'
// _finalPix is set to 0
// _bgColor is set to white
GBSurface GBSurfaceCreateStatic(const GBSurfaceType type,
  const VecShort2D* const dim);
```

```
// Create a static GBSurface with dimension 'dim' and type 'type'
// _finalPix is set to 0
// _bgColor is set to white
GBSurface* GBSurfaceCreate(const GBSurfaceType type,
  const VecShort2D* const dim);

// Free the memory used by the GBSurface 'that'
void GBSurfaceFree(GBSurface** that);

// Free the memory used by the properties of the GBSurface 'that'
void GBSurfaceFreeStatic(GBSurface* const that);

// Clone the GBSurface 'that'
GBSurface GBSurfaceClone(const GBSurface* const that);

// Return true if the GBSurface 'that' has same dimension and same
// values for _finalPix as GBSurface 'surf'
// Else, return false
#if BUILDMODE != 0
inline
#endif
bool GBSurfaceIsSameAs(const GBSurface* const that,
  const GBSurface* const surf);

// Get the type of the GBSurface 'that'
#if BUILDMODE != 0
inline
#endif
GBSurfaceType GBSurfaceGetType(const GBSurface* const that);

// Get a copy of the dimensions of the GBSurface 'that'
#if BUILDMODE != 0
inline
#endif
VecShort2D GBSurfaceGetDim(const GBSurface* const that);

// Get the dimensions of the GBSurface 'that'
#if BUILDMODE != 0
inline
#endif
VecShort2D* GBSurfaceDim(const GBSurface* const that);

// Get the final pixels of the GBSurface 'that'
#if BUILDMODE != 0
inline
#endif
GBPixel* GBSurfaceFinalPixels(const GBSurface* const that);

// Get the final pixel at position 'pos' of the GBSurface 'that'
// 'pos' must be in the surface
#if BUILDMODE != 0
inline
#endif
GBPixel* GBSurfaceFinalPixel(const GBSurface* const that,
  const VecShort2D* const pos);

// Get a copy of the final pixel at position 'pos' of the GBSurface
// 'that'
// 'pos' must be in the surface
#if BUILDMODE != 0
inline
```

```
#endif
GBPixel GBSurfaceGetFinalPixel(const GBSurface* const that,
  const VecShort2D* const pos);

// Set the final pixel at position 'pos' of the GBSurface 'that' to
// the pixel 'pix'
// 'pos' must be in the surface
#if BUILDMODE != 0
inline
#endif
void GBSurfaceSetFinalPixel(GBSurface* const that,
  const VecShort2D* const pos, const GBPixel* const pix);

// Get the final pixel at position 'pos' of the GBSurface 'that'
// If 'pos' is out of the surface return NULL
#if BUILDMODE != 0
inline
#endif
GBPixel* GBSurfaceFinalPixelSafe(const GBSurface* const that,
  const VecShort2D* const pos);

// Get a copy of the final pixel at position 'pos' of the GBSurface
// 'that'
// If 'pos' is out of the surface return a transparent pixel
#if BUILDMODE != 0
inline
#endif
GBPixel GBSurfaceGetFinalPixelSafe(const GBSurface* const that,
  const VecShort2D* const pos);

// Set the final pixel at position 'pos' of the GBSurface 'that' to
// the pixel 'pix'
// If 'pos' is out of the surface do nothing
#if BUILDMODE != 0
inline
#endif
void GBSurfaceSetFinalPixelSafe(GBSurface* const that,
  const VecShort2D* const pos, const GBPixel* const pix);

// Get the area of the GBSurface 'that'
#if BUILDMODE != 0
inline
#endif
long GBSurfaceArea(const GBSurface* const that);

// Get the background color of the GBSurface 'that'
#if BUILDMODE != 0
inline
#endif
GBPixel* GBSurfaceBgColor(const GBSurface* const that);

// Get a copy of the background color of the GBSurface 'that'
#if BUILDMODE != 0
inline
#endif
GBPixel GBSurfaceGetBgColor(const GBSurface* const that);

// Set the background color of the GBSurface 'that' to 'col'
#if BUILDMODE != 0
inline
#endif
void GBSurfaceSetBgColor(GBSurface* const that,
```

```
  const GBPixel* const col);

// Return true if the position 'pos' is inside the GBSurface 'that'
// boundary, false else
#if BUILDMODE != 0
inline
#endif
bool GBSurfaceIsPosInside(const GBSurface* const that,
  const VecShort2D* const pos);

// Get the set of layers of the GBSurface 'that'
#if BUILDMODE != 0
inline
#endif
GSet* GBSurfaceLayers(const GBSurface* const that);

// Add a new GBLayer with dimensions 'dim' to the top of the stack
// of layers of the GBSurface 'that'
// Return the new GBLayer
#if BUILDMODE != 0
inline
#endif
GBLayer* GBSurfaceAddLayer(GBSurface* const that,
  const VecShort2D* const dim);

// Add a new GBLayer with the content of the image located at
// 'fileName' to the top of the stack of layers of the GBSurface 'that'
// Return the new GBLayer
#if BUILDMODE != 0
inline
#endif
GBLayer* GBSurfaceAddLayerFromFile(GBSurface* const that,
  const char* const fileName);

// Get the 'iLayer'-th layer of the GBSurface 'that'
// 'iLayer' must be valid
#if BUILDMODE != 0
inline
#endif
GBLayer* GBSurfaceLayer(const GBSurface* const that, const int iLayer);

// Get the number of layer of the GBSurface 'that'
#if BUILDMODE != 0
inline
#endif
int GBSurfaceNbLayer(const GBSurface* const that);

// Set the _modified flag of all layers of the GBSurface 'that'
// to 'flag'
#if BUILDMODE != 0
inline
#endif
void GBSurfaceSetLayersModified(GBSurface* const that, const bool flag);

// Set the stack position of the GBLayer 'layer' into the set of
// layers of the GBSurface 'that' to 'pos'
// If 'layer' can't be found in the surface do nothing
// 'pos' must be valid (0<='pos'<nbLayers)
#if BUILDMODE != 0
inline
#endif
void GBSurfaceSetLayerStackPos(GBSurface* const that,
```

```
  GBLayer* const layer, const int pos);

// Remove the GBLayer 'layer' from the set of layers of the
// GBSurface 'that'
// The memory used by 'layer' is freed
#if BUILDMODE != 0
inline
#endif
void GBSurfaceRemoveLayer(GBSurface* const that, GBLayer* layer);

// Get a GSet of Facoid representing the sub areas of the GBSurface
// 'that' affected by layers with _modified flag equal to true
// If there is no modified sub area return an empty GSet
GSetShapoid* GBSurfaceGetModifiedArea(const GBSurface* const that);

// Update the final pixels according to layers of the GBSurface 'that'
// Update only pixels affected by layers with the _modified flag
// equals to true
void GBSurfaceUpdate(GBSurface* const that);

// Reset all the final pix of the GBSurface 'that' to its
// background color, and reset all the modified flag of layers to true
void GBSurfaceFlush(GBSurface* const that);

// Apply the post processing 'post' to the final pixels in the
// GBSurface 'that'
void GBSurfacePostProcess(GBSurface* const that,
  const GBPostProcessing* const post);

// ---------------- GBSurfaceImage --------------------------

// Create a new GBSurfaceImage with dimension 'dim'
GBSurfaceImage* GBSurfaceImageCreate(const VecShort2D* const dim);

// Free the memory used by the GBSurfaceImage 'that'
void GBSurfaceImageFree(GBSurfaceImage** that);

// Clone the GBSurfaceImage 'that'
GBSurfaceImage* GBSurfaceImageClone(const GBSurfaceImage* const that);

// Get the filename of the GBSurfaceImage 'that'
#if BUILDMODE != 0
inline
#endif
char* GBSurfaceImageFileName(const GBSurfaceImage* const that);

// Set the filename of the GBSurfaceImage 'that' to 'fileName'
#if BUILDMODE != 0
inline
#endif
void GBSurfaceImageSetFileName(GBSurfaceImage* const that,
  const char* const fileName);

// Save a GBSurfaceImage 'that'
// If the filename is not set do nothing and return false
// Return true if it could save the surface, false else
bool GBSurfaceImageSave(const GBSurfaceImage* const that);

// Create a new GBSurfaceImage with one layer containing the content
// of the image located at 'fileName' and dimensions equal to the
// dimensions of the image
// If the image couldn't be loaded return NULL
```

```
GBSurfaceImage* GBSurfaceImageCreateFromFile(const char* const fileName);

// ---------------- GBEye -------------------------

// Create a new GBEye with type 'type'
GBEye GBEyeCreateStatic(const GBEyeType type);

// Free the memory used by the GBEye 'that'
void GBEyeFreeStatic(GBEye* const that);

// Return the type of the GBEye 'that'
#if BUILDMODE != 0
inline
#endif
GBEyeType _GBEyeGetType(const GBEye* const that);

// Get the scale of the GBEye
#if BUILDMODE != 0
inline
#endif
VecFloat3D* _GBEyeScale(const GBEye* const that);

// Get a copy of the scale of the GBEye
#if BUILDMODE != 0
inline
#endif
VecFloat3D _GBEyeGetScale(const GBEye* const that);

// Get the translation of the GBEye
#if BUILDMODE != 0
inline
#endif
VecFloat2D* _GBEyeOrig(const GBEye* const that);

// Get a copy of the translation of the GBEye
#if BUILDMODE != 0
inline
#endif
VecFloat2D _GBEyeGetOrig(const GBEye* const that);

// Get the rotation of the GBEye (in radians)
#if BUILDMODE != 0
inline
#endif
float _GBEyeGetRot(const GBEye* const that);

// Set the scale of the GBEye
#if BUILDMODE != 0
inline
#endif
void GBEyeSetScaleVec(GBEye* const that, const VecFloat3D* const scale);
#if BUILDMODE != 0
inline
#endif
void GBEyeSetScaleFloat(GBEye* const that, const float scale);

// Set the origin of the GBEye
#if BUILDMODE != 0
inline
#endif
void _GBEyeSetOrig(GBEye* const that, const VecFloat2D* const orig);
```

```
// Set the rotation of the GBEye (in radians)
#if BUILDMODE != 0
inline
#endif
void _GBEyeSetRot(GBEye* const that, const float theta);

// Update the projection matrix of the GBEye according to scale, rot
// and origin
void GBEyeUpdateProj(GBEye* const that);

// Get the matrix projection of the eye
#if BUILDMODE != 0
inline
#endif
MatFloat* _GBEyeProj(const GBEye* const that);

// Call the appropriate GBEye<>Process according to the type of the
// GBEye 'that'
#if BUILDMODE != 0
inline
#endif
void _GBEyeProcess(const GBEye* const that, GBObjPod* const pod);

// Return the projection through the GBEye 'that' of the Point 'point'
VecFloat* GBEyeGetProjectedPoint(const GBEye* const that,
  const VecFloat* const point);

// Return the projection through the GBEye 'that' of the SCurve 'curve'
SCurve* GBEyeGetProjectedCurve(const GBEye* const that,
  const SCurve* const curve);

// Return the projection through the GBEye 'that' of the Shapoid 'shap'
Shapoid* GBEyeGetProjectedShapoid(const GBEye* const that,
  const Shapoid* const shap);

// ---------------- GBEyeOrtho --------------------------

// Return a new GBEyeOrtho with orientation 'view'
// scale is initialized to (1,1), trans to (0,0) and rot to 0
GBEyeOrtho* GBEyeOrthoCreate(const GBEyeOrthoView view);

// Free the memory used by the GBEyeOrho 'that'
void GBEyeOrthoFree(GBEyeOrtho** that);

// Set the orientation the GBEyeOrtho 'that'
#if BUILDMODE != 0
inline
#endif
void GBEyeOrthoSetView(GBEyeOrtho* const that,
  const GBEyeOrthoView view);

// Process the object of the GBObjPod 'pod' to update the viewed object
// through the GBEyeOrtho 'that'
void GBEyeOrthoProcess(const GBEyeOrtho* const that,
  GBObjPod* const pod);

// ---------------- GBEyeIsometric --------------------------

// Return a new GBEyeIsometric with orientation 'view'
// scale is initialized to (1,1), trans to (0,0) and rot to 0
// thetaY is initialized to pi/4 and thetaRight to pi/4
GBEyeIsometric* GBEyeIsometricCreate();
```

```
// Free the memory used by the GBEyeIsometric 'that'
void GBEyeIsometricFree(GBEyeIsometric** that);

// Set the angle around Y of the GBEyeOrtho to 'theta' (in radians)
#if BUILDMODE != 0
inline
#endif
void GBEyeIsometricSetRotY(GBEyeIsometric* const that,
  const float theta);

// Set the angle around Right of the GBEyeOrtho to 'theta'
// (in radians, in [-pi/2, pi/2])
// If 'theta' is out of range it is automatically bounded
// (ex: pi -> pi/2)
#if BUILDMODE != 0
inline
#endif
void GBEyeIsometricSetRotRight(GBEyeIsometric* const that,
  const float theta);

// Get the angle around Y of the GBEyeOrtho 'that'
#if BUILDMODE != 0
inline
#endif
float GBEyeIsometricGetRotY(const GBEyeIsometric* const that);

// Get the angle around Right of the GBEyeOrtho 'that'
#if BUILDMODE != 0
inline
#endif
float GBEyeIsometricGetRotRight(const GBEyeIsometric* const that);

// Process the object of the GBObjPod 'pod' to update the viewed object
// through the GBEyeIsometric 'that'
void GBEyeIsometricProcess(const GBEyeIsometric* const that,
  GBObjPod* const pod);

// ---------------- GBHand --------------------------

// Create a new GBHand with type 'type'
GBHand GBHandCreateStatic(const GBHandType type);

// Free the memory used by the GBHand 'that'
void GBHandFreeStatic(GBHand* const that);

// Return the type of the GBHand 'that'
#if BUILDMODE != 0
inline
#endif
GBHandType _GBHandGetType(const GBHand* const that);

// Call the appropriate GBHand<>Process according to the type of the
// GBHand 'that'
#if BUILDMODE != 0
inline
#endif
void _GBHandProcess(const GBHand* const that, GBObjPod* const pod);

// ---------------- GBHandDefault --------------------------

// Create a new GBHandDefault
```

```
GBHandDefault* GBHandDefaultCreate();

// Free the memory used by the GBHandDefault 'that'
void GBHandDefaultFree(GBHandDefault** that);

// Process the viewed projection of the object in GBObjPod 'pod' into
// its handed projection through the GBHandDefault 'that'
void GBHandDefaultProcess(const GBHandDefault* const that,
  GBObjPod* const pod);

// ---------------- GBTool -------------------------

// Create a static GBTool with GBToolType 'type'
GBTool GBToolCreateStatic(const GBToolType type);

// Free the memory used by the GBTool 'that'
void GBToolFreeStatic(GBTool* const that);

// Return a copy of the type of the GBTool 'that'
#if BUILDMODE != 0
inline
#endif
GBToolType GBToolGetType(const GBTool* const that);

// Function to call the appropriate GBTool<>Draw function according to
// type of GBTool 'that'
#if BUILDMODE != 0
inline
#endif
void _GBToolDraw(const GBTool* const that, GBObjPod* const pod);

// ---------------- GBToolPlotter -------------------------

// Create a new GBToolPlotter
GBToolPlotter* GBToolPlotterCreate();

// Free the memory used by the GBToolPlotter 'that'
void GBToolPlotterFree(GBToolPlotter** that);

// Draw the object in the GBObjPod 'pod' with the GBToolPlotter 'that'
void GBToolPlotterDraw(const GBToolPlotter* const that,
  const GBObjPod* const pod);

// ---------------- GBInk -------------------------

// Return the type of the GBInk 'that'
#if BUILDMODE != 0
inline
#endif
GBInkType _GBInkGetType(const GBInk* const that);

// Free the memory used by the GBInk 'that'
void GBInkFree(GBInk* const that);

// Entry point for the GBTool<>Draw function to get the color of the
// appropriate GBInk according to the type of 'that'
// posInternal represents the position in the object internal space
// posExternal represents the position in the global coordinates system
// posLayer represents the position in the destination layer
GBPixel _GBInkGet(const GBInk* const that, const GBTool* const tool,
  const GBObjPod* const pod, const VecFloat* const posInternal,
  const VecFloat* const posExternal, const VecShort* const posLayer);
```

```
// ---------------- GBInkSolid -------------------------

// Create a new GBInkSolid with color 'col'
GBInkSolid* GBInkSolidCreate(const GBPixel* const col);

// Free the memory used by the GBInkSolid 'that'
void GBInkSolidFree(GBInkSolid** that);

// Get the color of the GBInkSolid 'that'
#if BUILDMODE != 0
inline
#endif
GBPixel GBInkSolidGet(const GBInkSolid* const that);

// Set the color of the GBInkSolid 'that' to 'col'
#if BUILDMODE != 0
inline
#endif
void GBInkSolidSet(GBInkSolid* const that, const GBPixel* const col);

// ---------------- GBObjPod -------------------------

// Create a new GBObjPod for a Point at position 'pos'
// drawn with 'eye', 'hand', 'tool' and 'ink' in layer 'layer'
// 'pos' must be a vector of 2 or more dimensions
// If 'eye', 'hand, 'tool', 'ink' or 'layer' is null return null
GBObjPod* _GBObjPodCreatePoint(VecFloat* const pos, GBEye* const eye,
  GBHand* const hand, GBTool* const tool, GBInk* const ink,
  GBLayer* const layer);

// Create a new GBObjPod for the Shapoid 'shap'
// drawn with 'eye', 'hand', 'tool' and 'ink' in layer 'layer'
// 'shap' 's dimension must be 2 or more
// If 'eye', 'hand, 'tool', 'ink' or 'layer' is null return null
GBObjPod* _GBObjPodCreateShapoid(Shapoid* const shap, GBEye* const eye,
  GBHand* const hand, GBTool* const tool, GBInk* const ink,
  GBLayer* const layer);

// Create a new GBObjPod for the SCurve 'curve'
// drawn with 'eye', 'hand', 'tool' and 'ink' in layer 'layer'
// 'curve' 's dimension must be 2 or more
// If 'eye', 'hand, 'tool', 'ink' or 'layer' is null return null
GBObjPod* _GBObjPodCreateSCurve(SCurve* const curve, GBEye* const eye,
  GBHand* const hand, GBTool* const tool, GBInk* const ink,
  GBLayer* const layer);

// Free the memory used by the GBObjPod 'that'
void GBObjPodFree(GBObjPod** that);

// Return the type of the object in the GBObjPod 'that'
#if BUILDMODE != 0
inline
#endif
GBObjType GBObjPodGetType(const GBObjPod* const that);

// Return the object in the GBObjPod 'that'
#if BUILDMODE != 0
inline
#endif
void* GBObjPodObj(const GBObjPod* const that);
```

```
// Return the object viewed by its attached eye in the GBObjPod 'that'
#if BUILDMODE != 0
inline
#endif
void* GBObjPodEyeObj(const GBObjPod* const that);

// Return the object processed as Points by its attached hand in the
// GBObjPod 'that'
#if BUILDMODE != 0
inline
#endif
GSetVecFloat* GBObjPodGetHandObjAsPoints(const GBObjPod* const that);

// Return the object processed as Shapoids by its attached hand in the
// GBObjPod 'that'
#if BUILDMODE != 0
inline
#endif
GSetShapoid* GBObjPodGetHandObjAsShapoids(const GBObjPod* const that);

// Return the object processed as SCurves by its attached hand in the
// GBObjPod 'that'
#if BUILDMODE != 0
inline
#endif
GSetSCurve* GBObjPodGetHandObjAsSCurves(const GBObjPod* const that);

// Return the eye in the GBObjPod 'that'
#if BUILDMODE != 0
inline
#endif
GBEye* GBObjPodEye(const GBObjPod* const that);

// Return the hand in the GBObjPod 'that'
#if BUILDMODE != 0
inline
#endif
GBHand* GBObjPodHand(const GBObjPod* const that);

// Return the tool in the GBObjPod 'that'
#if BUILDMODE != 0
inline
#endif
GBTool* GBObjPodTool(const GBObjPod* const that);

// Return the ink in the GBObjPod 'that'
#if BUILDMODE != 0
inline
#endif
GBInk* GBObjPodInk(const GBObjPod* const that);

// Return the layer in the GBObjPod 'that'
#if BUILDMODE != 0
inline
#endif
GBLayer* GBObjPodLayer(const GBObjPod* const that);

// Set the Point viewed by its attached eye in the GBObjPod 'that'
// to 'point'
// If 'point' is null do nothing
#if BUILDMODE != 0
inline
```

```
#endif
void _GBObjPodSetEyePoint(GBObjPod* const that, VecFloat* const point);

// Set the Shapoid viewed by its attached eye in the GBObjPod 'that'
// to 'shap'
// If 'shap' is null do nothing
#if BUILDMODE != 0
inline
#endif
void _GBObjPodSetEyeShapoid(GBObjPod* const that, Shapoid* const shap);

// Set the SCurve viewed by its attached eye in the GBObjPod 'that'
// to 'curve'
// If 'curve' is null do nothing
#if BUILDMODE != 0
inline
#endif
void _GBObjPodSetEyeSCurve(GBObjPod* const that, SCurve* const curve);

// Set the eye in the GBObjPod 'that' to 'eye'
// If 'eye' is null do nothing
#if BUILDMODE != 0
inline
#endif
void _GBObjPodSetEye(GBObjPod* const that, GBEye* const eye);

// Set the hand in the GBObjPod 'that' to 'hand'
// If 'hand' is null do nothing
#if BUILDMODE != 0
inline
#endif
void _GBObjPodSetHand(GBObjPod* const that, GBHand* const hand);

// Set the tool in the GBObjPod 'that' to 'tool'
// If 'tool' is null do nothing
#if BUILDMODE != 0
inline
#endif
void _GBObjPodSetTool(GBObjPod* const that, GBTool* const tool);

// Set the ink in the GBObjPod 'that' to 'ink'
// If 'ink' is null do nothing
#if BUILDMODE != 0
inline
#endif
void _GBObjPodSetInk(GBObjPod* const that, GBInk* const ink);

// Set the layer in the GBObjPod 'that' to 'layer'
// If 'layer' is null do nothing
#if BUILDMODE != 0
inline
#endif
void GBObjPodSetLayer(GBObjPod* const that, GBLayer* const layer);

// ---------------- GenBrush --------------------------

// Create a new GenBrush with a GBSurface of type GBSurfaceTypeImage
// and dimensions 'dim'
GenBrush* GBCreateImage(const VecShort2D* const dim);

// Free memory used by the GenBrush 'that'
void GBFree(GenBrush** that);
```

```
// Create a new GenBrush with one layer containing the content
// of the image located at 'fileName' and dimensions equal to the
// dimensions of the image
// If the image couldn't be loaded return NULL
GenBrush* GBCreateFromFile(const char* const fileName);

// Get the GBSurface of the GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
GBSurface* GBSurf(const GenBrush* const that);

// Get the set of pods of the GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
GSet* GBPods(const GenBrush* const that);

// Get the dimensions of the GenBrush 'that'
VecShort2D* GBDim(const GenBrush* const that);

// Get a copy of the dimensions of the GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
VecShort2D GBGetDim(const GenBrush* const that);

// Get the final pixels of the GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
GBPixel* GBFinalPixels(const GenBrush* const that);

// Get the final pixel at position 'pos' of the GBSurface of the GB
// 'that'
// 'pos' must be in the surface
#if BUILDMODE != 0
inline
#endif
GBPixel* GBFinalPixel(const GenBrush* const that,
  const VecShort2D* const pos);

// Get a copy of the final pixel at position 'pos' of the GBSurface
// of the GB 'that'
// 'pos' must be in the surface
#if BUILDMODE != 0
inline
#endif
GBPixel GBGetFinalPixel(const GenBrush* const that,
  const VecShort2D* const pos);

// Set the final pixel at position 'pos' of the GBSurface of the GB
// 'that' to the pixel 'pix'
// 'pos' must be in the surface
#if BUILDMODE != 0
inline
#endif
void GBSetFinalPixel(GenBrush* const that, const VecShort2D* const pos,
  const GBPixel* const pix);

// Get the final pixel at position 'pos' of the GBSurface of the GB
```

```
// 'that'
// If 'pos' is out of the surface return NULL
#if BUILDMODE != 0
inline
#endif
GBPixel* GBFinalPixelSafe(const GenBrush* const that,
  const VecShort2D* const pos);

// Get a copy of the final pixel at position 'pos' of the GBSurface
// of the GB 'that'
// If 'pos' is out of the surface return a transparent pixel
#if BUILDMODE != 0
inline
#endif
GBPixel GBGetFinalPixelSafe(const GenBrush* const that,
  const VecShort2D* const pos);

// Set the final pixel at position 'pos' of the GBSurface of the GB
// 'that' to the pixel 'pix'
// If 'pos' is out of the surface do nothing
#if BUILDMODE != 0
inline
#endif
void GBSetFinalPixelSafe(GenBrush* const that,
  const VecShort2D* const pos, const GBPixel* const pix);

// Get the type of the GBSurface of the GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
GBSurfaceType GBGetType(const GenBrush* const that);

// Get the background color of the GBSurface of the GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
GBPixel* GBBgColor(const GenBrush* const that);

// Get a copy of the background color of the GBSurface of the
// GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
GBPixel GBGetBgColor(const GenBrush* const that);

// Set the background color of the GBSurface of the GenBrush
//  'that' to 'col'
#if BUILDMODE != 0
inline
#endif
void GBSetBgColor(GenBrush* const that, const GBPixel* const col);

// Get the filename of the GBSurfaceImage of the GenBrush 'that'
// Return NULL if the surface is not a GBSurfaceImage
#if BUILDMODE != 0
inline
#endif
char* GBFileName(const GenBrush* const that);

// Set the filename of the GBSurfaceImage of the GenBrush 'that'
// to 'fileName'
// Do nothing if the surface is not a GBSurfaceImage
```

```
#if BUILDMODE != 0
inline
#endif
void GBSetFileName(GenBrush* const that, const char* const fileName);

// Update the GBSurface of the GenBrush 'that'
void GBUpdate(GenBrush* const that);

// Render the GBSurface (save on disk, display on screen, ...) of
// the GenBrush 'that'
bool GBRender(GenBrush* const that);

// Get the area of the GBSurface of the Genbrush 'that'
#if BUILDMODE != 0
inline
#endif
int GBArea(const GenBrush* const that);

// Return true if the position 'pos' is inside the GBSurface of the
// GenBrush 'that'
// boundary, false else
#if BUILDMODE != 0
inline
#endif
bool GBIsPosInside(const GenBrush* const that,
  const VecShort2D* const pos);

// Return the layers of the surface of the GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
GSet* GBLayers(const GenBrush* const that);

// Add a new GBLayer with dimensions 'dim' to the top of the stack
// of layers of the GBSurface of the GenBrush 'that'
// Return the new GBLayer
#if BUILDMODE != 0
inline
#endif
GBLayer* GBAddLayer(GenBrush* const that, const VecShort2D* const dim);

// Add a new GBLayer with content equals to the image located at
// 'fileName' to the top of the stack
// of layers of the GBSurface of the GenBrush' that'
// Return the new GBLayer
#if BUILDMODE != 0
inline
#endif
GBLayer* GBAddLayerFromFile(GenBrush* const that,
  const char* const fileName);

// Get the 'iLayer'-th layer of the GBSurface of the GenBrush 'that'
// 'iLayer' must be valid
#if BUILDMODE != 0
inline
#endif
GBLayer* GBLay(const GenBrush* const that, const int iLayer);

// Get the number of layer of the GBSurface of the GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
```

```
int GBGetNbLayer(const GenBrush* const that);

// Set the stack position of the GBLayer 'layer' into the set of
// layers of the GBSurface of the GenBrush'that' to 'pos'
// If 'layer' can't be found in the surface do nothing
// 'pos' must be valid (0<='pos'<nbLayers)
#if BUILDMODE != 0
inline
#endif
void GBSetLayerStackPos(GenBrush* const that,
  GBLayer* const layer, const int pos);

// Remove the GBLayer 'layer' from the set of layers of the
// GBSurface of the GenBrush 'that'
// The memory used by 'layer' is freed
#if BUILDMODE != 0
inline
#endif
void GBRemoveLayer(GenBrush* const that, GBLayer* layer);

// Get the number of objects in the GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
int GBGetNbPod(const GenBrush* const that);

// Add a GBObjPod for the Point at position 'pos' to the GenBrush 'that'
// drawn with 'eye', 'hand' and 'tool' in layer 'layer'
// 'pos' must be a vector of 2 or more dimensions
#if BUILDMODE != 0
inline
#endif
void _GBAddPoint(GenBrush* const that, VecFloat* const pos,
  GBEye* const eye, GBHand* const hand, GBTool* const tool,
  GBInk* const ink, GBLayer* const layer);

// Add a GBObjPod for the Shapoid 'shap' to the GenBrush 'that'
// drawn with 'eye', 'hand' and 'tool' in layer 'layer'
// 'shap' 's dimension must be 2 or more
#if BUILDMODE != 0
inline
#endif
void _GBAddShapoid(GenBrush* const that, Shapoid* const shap,
  GBEye* const eye, GBHand* const hand, GBTool* const tool,
  GBInk* const ink, GBLayer* const layer);

// Add a GBObjPod for the SCurve 'curve' to the GenBrush 'that'
// drawn with 'eye', 'hand' and 'tool' in layer 'layer'
// 'curve' 's dimension must be 2 or more
#if BUILDMODE != 0
inline
#endif
void _GBAddSCurve(GenBrush* const that, SCurve* const curve,
  GBEye* const eye, GBHand* const hand, GBTool* const tool,
  GBInk* const ink, GBLayer* const layer);

// Remove from the list of pods of the GenBrush 'that' those who
// match the 'obj', 'eye', 'hand', 'tool', 'ink' and 'layer'
// Null arguments are ignored. For example:
// GBRemovePod(that, elemA, NULL, NULL, NULL, NULL, NULL) removes all
// the pods related to the object 'elemA'
// GBRemovePod(that, elemA, NULL, handA, NULL, NULL, NULL) removes
```

```
// all the pods related to both the object 'elemA' AND 'handA'
// If all the filters are null it removes all the pods
void _GBRemovePod(GenBrush* const that, const void* const obj,
  const GBEye* const eye, const GBHand* const hand,
  const GBTool* const tool, const GBInk* const ink,
  const GBLayer* const layer);
// TODO: the filtering arguments should be in a struct

// Set the eye to 'toEye' in the pods of the GenBrush 'that' who
// match the 'obj', 'eye', 'hand', 'tool', 'ink' and 'layer'
// Null arguments are ignored. For example:
// GBSetPodEye(that, toEye, elemA, NULL, NULL, NULL, NULL, NULL)
// affects all the pods related to the object 'elemA'
// GBSetPodEye(that, toEye, elemA, NULL, handA, NULL, NULL, NULL)
// affects all the pods related to both the object 'elemA' AND 'handA'
// If all the filters are null it affects all the pods
// If 'toEye' is null, do nothing
void _GBSetPodEye(GenBrush* const that, GBEye* const toEye,
  const void* const obj, const GBEye* const eye,
  const GBHand* const hand, const GBTool* const tool,
  const GBInk* const ink, const GBLayer* const layer);
// TODO: the filtering arguments should be in a struct

// Set the hand to 'toHand' in the pods of the GenBrush 'that' who
// match the 'obj', 'eye', 'hand', 'tool', 'ink' and 'layer'
// Null arguments are ignored. For example:
// GBSetPodEye(that, toHand, elemA, NULL, NULL, NULL, NULL, NULL)
// affects all the pods related to the object 'elemA'
// GBSetPodEye(that, toHand, elemA, NULL, handA, NULL, NULL, NULL)
// affects all the pods related to both the object 'elemA' AND 'handA'
// If all the filters are null it affects all the pods
// If 'toHand' is null, do nothing
void _GBSetPodHand(GenBrush* const that, GBHand* const toHand,
  const void* const obj, const GBEye* const eye,
  const GBHand* const hand, const GBTool* const tool,
  const GBInk* const ink, const GBLayer* const layer);
// TODO: the filtering arguments should be in a struct

// Set the tool to 'toTool' in the pods of the GenBrush 'that' who
// match the 'obj', 'eye', 'hand', 'tool', 'ink' and 'layer'
// Null arguments are ignored. For example:
// GBSetPodTool(that, toTool, elemA, NULL, NULL, NULL, NULL) affects
// all the pods related to the object 'elemA'
// GBSetPodTool(that, toTool, elemA, NULL, handA, NULL, NULL) affects
// all the pods related to both the object 'elemA' AND 'handA'
// If all the filters are null it affects all the pods
// If 'toTool' is null, do nothing
void _GBSetPodTool(GenBrush* const that, GBTool* const toTool,
  const void* const obj, const GBEye* const eye,
  const GBHand* const hand, const GBTool* const tool,
  const GBInk* const ink, const GBLayer* const layer);
// TODO: the filtering arguments should be in a struct

// Set the ink to 'toInk' in the pods of the GenBrush 'that' who
// match the 'obj', 'eye', 'hand', 'tool', 'ink' and 'layer'
// Null arguments are ignored. For example:
// GBSetPodTool(that, toTool, elemA, NULL, NULL, NULL, NULL) affects
// all the pods related to the object 'elemA'
// GBSetPodTool(that, toTool, elemA, NULL, handA, NULL, NULL) affects
// all the pods related to both the object 'elemA' AND 'handA'
// If all the filters are null it affects all the pods
// If 'toInk' is null, do nothing
```

```
void _GBSetPodInk(GenBrush* const that, GBInk* const toInk,
  const void* const obj, const GBEye* const eye,
  const GBHand* const hand, const GBTool* const tool,
  const GBInk* const ink, const GBLayer* const layer);
// TODO: the filtering arguments should be in a struct

// Set the layer to 'toLayer' in the pods of the GenBrush 'that' who
// match the 'obj', 'eye', 'hand', 'tool', 'ink' and 'layer'
// Null arguments are ignored. For example:
// GBSetPodLayer(that, toLayer, elemA, NULL, NULL, NULL, NULL, NULL)
// affects all the pods related to the object 'elemA'
// GBSetPodLayer(that, toLayer, elemA, NULL, handA, NULL, NULL, NULL)
// affects all the pods related to both the object 'elemA' AND 'handA'
// If all the filters are null it affects all the pods
// If 'toLayer' is null, do nothing
void _GBSetPodLayer(GenBrush* const that, GBLayer* const toLayer,
  const void* const obj, const GBEye* const eye,
  const GBHand* const hand, const GBTool* const tool,
  const GBInk* const ink, const GBLayer* const layer);
// TODO: the filtering arguments should be in a struct

// Reset all the final pix of the surface of the GenBrush 'that' to its
// background color, and reset all the modified flag of layers to true
#if BUILDMODE != 0
inline
#endif
void GBFlush(GenBrush* const that);

// Set to true the modified flag of the layers of pods attached to the
// object 'obj' in the list of pods of the GenBrush 'that'
void _GBNotifyChangeFromObj(GenBrush* const that, const void* const obj);

// Set to true the modified flag of the layers of pods attached to the
// GBEye 'eye' in the list of pods of the GenBrush 'that'
void _GBNotifyChangeFromEye(GenBrush* const that,
  const GBEye* const eye);

// Set to true the modified flag of the layers of pods attached to the
// GBInk 'ink' in the list of pods of the GenBrush 'that'
void _GBNotifyChangeFromInk(GenBrush* const that,
  const GBInk* const ink);

// Set to true the modified flag of the layers of pods attached to the
// GBHand 'hand' in the list of pods of the GenBrush 'that'
void _GBNotifyChangeFromHand(GenBrush* const that,
  const GBHand* const hand);

// Set to true the modified flag of the layers of pods attached to the
// GBTool 'tool' in the list of pods of the GenBrush 'that'
void _GBNotifyChangeFromTool(GenBrush* const that,
  const GBTool* const tool);

// Return true if the surface of the GenBrush 'that' is same as the
// surface of the GenBrush 'gb'
// Else, return false
#if BUILDMODE != 0
inline
#endif
bool GBIsSameAs(const GenBrush* const that, const GenBrush* const gb);

// Add a GBPostProcessing of type 'type' to the GenBrush 'that'
// Return the GBPostProcessing
```

```
#if BUILDMODE != 0
inline
#endif
GBPostProcessing* GBAddPostProcess(GenBrush* const that,
  const GBPPType type);

// Remove the GBPostProcessing 'post' from the GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
void GBRemovePostProcess(GenBrush* const that,
  const GBPostProcessing* const post);

// Remove all the GBPostProcessing from the GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
void GBRemoveAllPostProcess(GenBrush* const that);

// Get the 'iPost'-th post process of the GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
GBPostProcessing* GBPostProcess(const GenBrush* const that,
  const int iPost);

// Get the GSet of GBPostProcessing of the GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
GSet* GBPostProcs(const GenBrush* const that);

// Get the number of GBPostProcessing of the GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
int GBGetNbPostProcs(const GenBrush* const that);

// Remove all the GBObjPods from the GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
void GBRemoveAllPod(GenBrush* const that);

// Return a clone of the GenBrush 'that' with its final surface scaled
// to the dimensions 'dim' according to the scaling method 'scaleMethod'
GenBrush* GBScale(const GenBrush* const that,
  const VecShort2D* const dim, const GBScaleMethod scaleMethod);

// Return a clone of the GenBrush 'that' with its final surface cropped
// to the dimensions 'dim' from the lower right position 'posLR'
// If the cropping area is partially or totally outside of the
// original image, pixels outside of the image are filled with
// 'fillPix' or left to their default value (cf GBSurfaceCreate) if
// 'fillPix is NULL
GenBrush* GBCrop(const GenBrush* const that,
  const VecShort2D* const posLR, const VecShort2D* const dim,
  const GBPixel* const fillPix);

// Duplicate the final pixels of the GenBrush 'src' to the
// GenBrush 'dest' for the area starting at 'posSrc' in 'src' and
// 'posDest' in 'dest' and having dimension 'dim'
```

```
// The fragment must be fully included in both 'src' and 'dest'
void GBCopyFragment(const GenBrush* const src, GenBrush* const dest,
  const VecShort2D* const posSrc, const VecShort2D* const posDest,
  const VecShort2D* const dim);

#if BUILDWITHGRAPHICLIB == 1
#include "genbrush-GTK.h"
#endif

// ================= Polymorphism ==================

#define GBPosIndex(Pos, Dim) \
  (VecGet(Dim, 0) * VecGet(Pos, 1) + VecGet(Pos, 0))

#define GBInkGetType(Ink) _Generic(Ink, \
  GBInk*: _GBInkGetType, \
  GBInkSolid*: _GBInkGetType, \
  const GBInk*: _GBInkGetType, \
  const GBInkSolid*: _GBInkGetType, \
  default: PBErrInvalidPolymorphism) ((GBInk*)(Ink))

#define GBInkGet(Ink, Tool, Pod, PosInternal, PosExternal, PosLayer) \
  _GBInkGet((GBInk*)(Ink), (GBTool*)(Tool), Pod, \
  (VecFloat*)(PosInternal), (VecFloat*)(PosExternal), \
  (VecShort*)(PosLayer))

#define GBObjPodCreatePoint(Pos, Eye, Hand, Tool, Ink, Layer) \
  _Generic(Pos, \
  VecFloat*: _GBObjPodCreatePoint, \
  VecFloat2D*: _GBObjPodCreatePoint, \
  VecFloat3D*: _GBObjPodCreatePoint, \
  const VecFloat*: _GBObjPodCreatePoint, \
  const VecFloat2D*: _GBObjPodCreatePoint, \
  const VecFloat3D*: _GBObjPodCreatePoint, \
  default: PBErrInvalidPolymorphism) ((VecFloat*)(Pos), \
  (GBEye*)(Eye), (GBHand*)(Hand), (GBTool*)(Tool), (GBInk*)(Ink), Layer)

#define GBObjPodCreateShapoid(Shap, Eye, Hand, Tool, Ink, Layer) \
  _Generic(Shap, \
  Shapoid*: _GBObjPodCreateShapoid, \
  Facoid*: _GBObjPodCreateShapoid, \
  Spheroid*: _GBObjPodCreateShapoid, \
  Pyramidoid*: _GBObjPodCreateShapoid, \
  const Shapoid*: _GBObjPodCreateShapoid, \
  const Facoid*: _GBObjPodCreateShapoid, \
  const Spheroid*: _GBObjPodCreateShapoid, \
  const Pyramidoid*: _GBObjPodCreateShapoid, \
  default: PBErrInvalidPolymorphism) ((Shapoid*)(Shap), \
  (GBEye*)(Eye), (GBHand*)(Hand), (GBTool*)(Tool), (GBInk*)(Ink), Layer)

#define GBObjPodCreateSCurve(Curve, Eye, Hand, Tool, Ink, Layer) \
  _GBObjPodCreateSCurve(Curve, \
  (GBEye*)(Eye), (GBHand*)(Hand), (GBTool*)(Tool), (GBInk*)(Ink), Layer)

#define GBAddPoint(GB, Pos, Eye, Hand, Tool, Ink, Layer) \
  _Generic(Pos, \
  VecFloat*: _GBAddPoint, \
  VecFloat2D*: _GBAddPoint, \
  VecFloat3D*: _GBAddPoint, \
  const VecFloat*: _GBAddPoint, \
  const VecFloat2D*: _GBAddPoint, \
  const VecFloat3D*: _GBAddPoint, \
```

```
  default: PBErrInvalidPolymorphism) (GB, (VecFloat*)(Pos), \
  (GBEye*)(Eye), (GBHand*)(Hand), (GBTool*)(Tool), (GBInk*)(Ink), Layer)

#define GBAddShapoid(GB, Shap, Eye, Hand, Tool, Ink, Layer) \
  _Generic(Shap, \
  Shapoid*: _GBAddShapoid, \
  Facoid*: _GBAddShapoid, \
  Spheroid*: _GBAddShapoid, \
  Pyramidoid*: _GBAddShapoid, \
  const Shapoid*: _GBAddShapoid, \
  const Facoid*: _GBAddShapoid, \
  const Spheroid*: _GBAddShapoid, \
  const Pyramidoid*: _GBAddShapoid, \
  default: PBErrInvalidPolymorphism) (GB, (Shapoid*)(Shap), \
  (GBEye*)(Eye), (GBHand*)(Hand), (GBTool*)(Tool), (GBInk*)(Ink), Layer)

#define GBAddSCurve(GB, Curve, Eye, Hand, Tool, Ink, Layer) \
  _GBAddSCurve(GB, Curve, \
  (GBEye*)(Eye), (GBHand*)(Hand), (GBTool*)(Tool), (GBInk*)(Ink), Layer)

#define GBRemovePod(GB, Obj, Eye, Hand, Tool, Ink, Layer) \
  _GBRemovePod(GB, (void*)(Obj), (GBEye*)(Eye), (GBHand*)(Hand), \
  (GBTool*)(Tool), (GBInk*)(Ink), Layer)

#define GBObjPodGetObjAsPoint(Pod) (VecFloat*)GBObjPodObj(Pod)
#define GBObjPodGetObjAsShapoid(Pod) (Shapoid*)GBObjPodObj(Pod)
#define GBObjPodGetObjAsSCurve(Pod) (SCurve*)GBObjPodObj(Pod)

#define GBObjPodGetEyeObjAsPoint(Pod) (VecFloat*)GBObjPodEyeObj(Pod)
#define GBObjPodGetEyeObjAsShapoid(Pod) (Shapoid*)GBObjPodEyeObj(Pod)
#define GBObjPodGetEyeObjAsSCurve(Pod) (SCurve*)GBObjPodEyeObj(Pod)

#define GBObjPodSetEyePoint(Pod, Point) \
  _GBObjPodSetEyePoint(Pod, (VecFloat*)Point)
#define GBObjPodSetEyeShapoid(Pod, Shap) \
  _GBObjPodSetEyeShapoid(Pod, (Shapoid*)Shap)
#define GBObjPodSetEyeSCurve(Pod, Curve) \
  _GBObjPodSetEyeSCurve(Pod, (SCurve*)Curve)

#define GBSetPodEye(GB, ToEye, Obj, Eye, Hand, Tool, Ink, Layer) \
  _GBSetPodEye(GB, (GBEye*)(ToEye), (void*)(Obj), (GBEye*)(Eye), \
  (GBHand*)(Hand), (GBTool*)(Tool), (GBInk*)(Ink), Layer)

#define GBSetPodHand(GB, ToHand, Obj, Eye, Hand, Tool, Ink, Layer) \
  _GBSetPodHand(GB, (GBHand*)(ToHand), (void*)(Obj), (GBEye*)(Eye), \
  (GBHand*)(Hand), (GBTool*)(Tool), (GBInk*)(Ink), Layer)

#define GBSetPodTool(GB, ToTool, Obj, Eye, Hand, Tool, Ink, Layer) \
  _GBSetPodTool(GB, (GBTool*)(ToTool), (void*)(Obj), (GBEye*)(Eye), \
  (GBHand*)(Hand), (GBTool*)(Tool), (GBInk*)(Ink), Layer)

#define GBSetPodInk(GB, ToInk, Obj, Eye, Hand, Tool, Ink, Layer) \
  _GBSetPodInk(GB, (GBInk*)(ToInk), (void*)(Obj), (GBEye*)(Eye), \
  (GBHand*)(Hand), (GBTool*)(Tool), (GBInk*)(Ink), Layer)

#define GBSetPodLayer(GB, ToLayer, Obj, Eye, Hand, Tool, Ink, Layer) \
  _GBSetPodLayer(GB, ToLayer, (void*)(Obj), (GBEye*)(Eye), \
  (GBHand*)(Hand), (GBTool*)(Tool), (GBInk*)(Ink), Layer)

#define GBNotifyChangeFromObj(GB, Obj) \
  _GBNotifyChangeFromObj(GB, (void*)(Obj))
```

```
#define GBNotifyChangeFromEye(GB, Eye) \
  _GBNotifyChangeFromEye(GB, (GBEye*)(Eye))

#define GBNotifyChangeFromHand(GB, Hand) \
  _GBNotifyChangeFromHand(GB, (GBHand*)(Hand))

#define GBNotifyChangeFromTool(GB, Tool) \
  _GBNotifyChangeFromTool(GB, (GBTool*)(Tool))

#define GBNotifyChangeFromInk(GB, Ink) \
  _GBNotifyChangeFromInk(GB, (GBInk*)(Ink))

#define GBHandGetType(Hand) _Generic(Hand, \
  GBHand*: _GBHandGetType, \
  GBHandDefault*: _GBHandGetType, \
  const GBHand*: _GBHandGetType, \
  const GBHandDefault*: _GBHandGetType, \
  default: PBErrInvalidPolymorphism) ((GBHand*)(Hand))

#define GBHandProcess(Hand, Pod) _Generic(Hand, \
  GBHand*: _GBHandProcess, \
  GBHandDefault*: GBHandDefaultProcess, \
  const GBHand*: _GBHandProcess, \
  const GBHandDefault*: GBHandDefaultProcess, \
  default: PBErrInvalidPolymorphism) (Hand, Pod)

#define GBObjPodSetHand(Pod, Hand) \
  _GBObjPodSetHand(Pod, (GBHand*)(Hand))

#define GBObjPodSetEye(Pod, Eye) \
  _GBObjPodSetEye(Pod, (GBEye*)(Eye))

#define GBObjPodSetTool(Pod, Tool) \
  _GBObjPodSetTool(Pod, (GBTool*)(Tool))

#define GBObjPodSetInk(Pod, Ink) \
  _GBObjPodSetInk(Pod, (GBInk*)(Ink))

#define GBEyeGetType(Eye) _Generic(Eye, \
  GBEye*: _GBEyeGetType, \
  GBEyeOrtho*: _GBEyeGetType, \
  GBEyeIsometric*: _GBEyeGetType, \
  const GBEye*: _GBEyeGetType, \
  const GBEyeOrtho*: _GBEyeGetType, \
  const GBEyeIsometric*: _GBEyeGetType, \
  default: PBErrInvalidPolymorphism)((GBEye*)(Eye))

#define GBEyeScale(Eye) _Generic(Eye, \
  GBEye*: _GBEyeScale, \
  GBEyeOrtho*: _GBEyeScale, \
  GBEyeIsometric*: _GBEyeScale, \
  const GBEye*: _GBEyeScale, \
  const GBEyeOrtho*: _GBEyeScale, \
  const GBEyeIsometric*: _GBEyeScale, \
  default: PBErrInvalidPolymorphism)((GBEye*)(Eye))

#define GBEyeGetScale(Eye) _Generic(Eye, \
  GBEye*: _GBEyeGetScale, \
  GBEyeOrtho*: _GBEyeGetScale, \
  GBEyeIsometric*: _GBEyeGetScale, \
  const GBEye*: _GBEyeGetScale, \
  const GBEyeOrtho*: _GBEyeGetScale, \
```

```
  const GBEyeIsometric*: _GBEyeGetScale, \
  default: PBErrInvalidPolymorphism)((GBEye*)(Eye))

#define GBEyeSetScale(Eye, Scale) _Generic(Scale, \
  float: GBEyeSetScaleFloat, \
  VecFloat3D*: GBEyeSetScaleVec, \
  const float: GBEyeSetScaleFloat, \
  const VecFloat3D*: GBEyeSetScaleVec, \
  default: PBErrInvalidPolymorphism)( \
    _Generic(Eye, \
      GBEye*: Eye, \
      GBEyeOrtho*: (GBEye*)Eye, \
      GBEyeIsometric*: (GBEye*)Eye, \
      const GBEye*: Eye, \
      const GBEyeOrtho*: (GBEye*)Eye, \
      const GBEyeIsometric*: (GBEye*)Eye, \
      default: Eye), \
    _Generic(Scale, \
      float: Scale, \
      VecFloat3D*: Scale, \
      const float: Scale, \
      const VecFloat3D*: Scale, \
      default: Scale))

#define GBEyeOrig(Eye) _Generic(Eye, \
  GBEye*: _GBEyeOrig, \
  GBEyeOrtho*: _GBEyeOrig, \
  GBEyeIsometric*: _GBEyeOrig, \
  const GBEye*: _GBEyeOrig, \
  const GBEyeOrtho*: _GBEyeOrig, \
  const GBEyeIsometric*: _GBEyeOrig, \
  default: PBErrInvalidPolymorphism)((GBEye*)(Eye))

#define GBEyeGetOrig(Eye) _Generic(Eye, \
  GBEye*: _GBEyeGetOrig, \
  GBEyeOrtho*: _GBEyeGetOrig, \
  GBEyeIsometric*: _GBEyeGetOrig, \
  const GBEye*: _GBEyeGetOrig, \
  const GBEyeOrtho*: _GBEyeGetOrig, \
  const GBEyeIsometric*: _GBEyeGetOrig, \
  default: PBErrInvalidPolymorphism)((GBEye*)(Eye))

#define GBEyeSetOrig(Eye, Orig) _Generic(Eye, \
  GBEye*: _GBEyeSetOrig, \
  GBEyeOrtho*: _GBEyeSetOrig, \
  GBEyeIsometric*: _GBEyeSetOrig, \
  const GBEye*: _GBEyeSetOrig, \
  const GBEyeOrtho*: _GBEyeSetOrig, \
  const GBEyeIsometric*: _GBEyeSetOrig, \
  default: PBErrInvalidPolymorphism)((GBEye*)(Eye), Orig)

#define GBEyeGetRot(Eye) _Generic(Eye, \
  GBEye*: _GBEyeGetRot, \
  GBEyeOrtho*: _GBEyeGetRot, \
  GBEyeIsometric*: _GBEyeGetRot, \
  const GBEye*: _GBEyeGetRot, \
  const GBEyeOrtho*: _GBEyeGetRot, \
  const GBEyeIsometric*: _GBEyeGetRot, \
  default: PBErrInvalidPolymorphism)((GBEye*)(Eye))

#define GBEyeSetRot(Eye, Theta) _Generic(Eye, \
  GBEye*: _GBEyeSetRot, \
```

```
  GBEyeOrtho*: _GBEyeSetRot, \
  GBEyeIsometric*: _GBEyeSetRot, \
  const GBEye*: _GBEyeSetRot, \
  const GBEyeOrtho*: _GBEyeSetRot, \
  const GBEyeIsometric*: _GBEyeSetRot, \
  default: PBErrInvalidPolymorphism)((GBEye*)(Eye), Theta)

#define GBEyeProj(Eye) _Generic(Eye, \
  GBEye*: _GBEyeProj, \
  GBEyeOrtho*: _GBEyeProj, \
  GBEyeIsometric*: _GBEyeProj, \
  const GBEye*: _GBEyeProj, \
  const GBEyeOrtho*: _GBEyeProj, \
  const GBEyeIsometric*: _GBEyeProj, \
  default: PBErrInvalidPolymorphism)((GBEye*)(Eye))

#define GBEyeProcess(Eye, Pod) _Generic(Eye, \
  GBEye*: _GBEyeProcess, \
  GBEyeOrtho*: _GBEyeProcess, \
  GBEyeIsometric*: _GBEyeProcess, \
  const GBEye*: _GBEyeProcess, \
  const GBEyeOrtho*: _GBEyeProcess, \
  const GBEyeIsometric*: _GBEyeProcess, \
  default: PBErrInvalidPolymorphism)((GBEye*)(Eye), Pod)

#define GBEyeFree(EyeRef) _Generic(EyeRef, \
  GBEyeOrtho**: GBEyeOrthoFree, \
  GBEyeIsometric**: GBEyeIsometricFree, \
  default: PBErrInvalidPolymorphism)(EyeRef)

#define GBToolDraw(Tool, Pod) _Generic(Tool, \
  GBTool*: _GBToolDraw, \
  GBToolPlotter*: GBToolPlotterDraw, \
  const GBTool*: _GBToolDraw, \
  const GBToolPlotter*: GBToolPlotterDraw, \
  default: PBErrInvalidPolymorphism) (Tool, Pod)

#if BUILDWITHGRAPHICLIB == 0


#elif BUILDWITHGRAPHICLIB == 1

#define GBScreenshot(GB, FileName) _Generic(GB, \
  GBSurfaceApp*: GBSurfaceAppScreenshot, \
  const GBSurfaceApp*: GBSurfaceAppScreenshot, \
  GBSurfaceWidget*: GBSurfaceWidgetScreenshot, \
  const GBSurfaceWidget*: GBSurfaceWidgetScreenshot, \
  default: PBErrInvalidPolymorphism) (GB, FileName)


#endif

// ================ Inliner ====================

#if BUILDMODE != 0
#include "genbrush-inline.c"
#endif


#endif
```

2.2 genbrush-GTK.h

```
// ============ GENBRUSH-GTK.H ================

#include <gtk/gtk.h>
#include <cairo.h>

// ================= Define ==================


// ================= Data structure ===================

typedef struct GBSurfaceApp {
  GBSurface _surf;
  // Title of the window
  char* _title;
  // Application
  GtkApplication* _app;
  // Window
  GtkWidget* _window;
  // Widget
  GtkWidget* _drawingArea;
  // cairo surface
  cairo_surface_t* _cairoSurf;
  // Idle function
  gint (*_idleFun)(gpointer);
  // Idle function time out
  int _idleMs;
  // Returned status when the application is killed
  int _returnStatus;

  // cf GBSurfaceAppCallbackDraw
  // Flipped data
  unsigned char* _flippedData;

} GBSurfaceApp;

typedef struct GBSurfaceWidget {
  GBSurface _surf;
  // Widget
  GtkWidget* _drawingArea;
  // cairo surface
  cairo_surface_t* _cairoSurf;

  // cf GBSurfaceWidgetCallbackDraw
  // Flipped data
  unsigned char* _flippedData;

} GBSurfaceWidget;

// ================ Functions declaration ====================

// Create a new GBSurfaceApp with title 'title' and
// dimensions 'dim'
GBSurfaceApp* GBSurfaceAppCreate(const VecShort2D* const dim,
  const char* const title);

// Free the GBSurfaceApp 'that'
void GBSurfaceAppFree(GBSurfaceApp** that);

// Render the GBSurfaceApp 'that'
// This function block the execution until the app is killed
```

```
// Return true if the status of the app when closed was 0, false else
bool GBSurfaceAppRender(GBSurfaceApp* const that);

// Close the GBSurfaceApp 'that'
#if BUILDMODE != 0
inline
#endif
void GBSurfaceAppClose(const GBSurfaceApp* const that);

// Refresh the content of the GBSurfaceApp 'that'
#if BUILDMODE != 0
inline
#endif
void GBSurfaceAppRefresh(const GBSurfaceApp* const that);

// Set the idle function of the GBSurfaceApp 'that' to 'idleFun'
// with a timeout of 'idleMs'
// The interface of the 'idleFun' is
// gint tick(gpointer data)
// the argument of 'idleFun' is a pointer to GBSurfaceApp
void GBSurfaceSetIdle(GBSurfaceApp* const that,
  gint (*idleFun)(gpointer), int idleMs);

// Create a new GBSurfaceWidget with dimensions 'dim'
GBSurfaceWidget* GBSurfaceWidgetCreate(const VecShort2D* const dim);

// Free the GBSurfaceWidget 'that'
void GBSurfaceWidgetFree(GBSurfaceWidget** that);

// Return the GtkWidget of the GBSurfaceWidget 'that'
#if BUILDMODE != 0
inline
#endif
GtkWidget* GBSurfaceWidgetGtkWidget(const GBSurfaceWidget* const that);

// Return the GtkWidget of the GBSurfaceApp 'that'
#if BUILDMODE != 0
inline
#endif
GtkWidget* GBSurfaceAppGtkWidget(const GBSurfaceApp* const that);

// Render the GBSurfaceWidget 'that'
void GBSurfaceWidgetRender(const GBSurfaceWidget* const that);

// Create a GenBrush with a blank GBSurfaceApp
GenBrush* GBCreateApp(const VecShort2D* const dim,
  const char* const title);

// Set the idle function of the GBSurfaceApp of the GenBrush 'that'
// to 'idleFun' with a timeout of 'idleMs'
// The interface of the 'idleFun' is
// gint tick(gpointer data)
// the argument of 'idleFun' is a pointer to GBSurfaceApp
// If the surface of the app is not a GBSurfaceTypeApp, do nothing
void GBSetIdle(GenBrush* that, gint (*idleFun)(gpointer),
  const int idleMs);

// Create a GenBrush with a blank GBSurfaceWidget
GenBrush* GBCreateWidget(const VecShort2D* const dim);

// Return the GtkWidget of the GenBrush 'that', or NULL if the surface
// of the GenBursh is not a GBSurfaceWidget
```

```
#if BUILDMODE != 0
inline
#endif
GtkWidget* GBGetGtkWidget(const GenBrush* const that);

// Take a snapshot of the GBSurfaceApp 'that' and save it to 'filename'
// Return true if successfull, flase else
bool GBSurfaceAppScreenshot(
  const GBSurfaceApp* const that,
              const char* const filename);

// Take a snapshot of the GBSurfaceWidget 'that' and save it to 'filename'
// Return true if successfull, flase else
bool GBSurfaceWidgetScreenshot(
  const GBSurfaceWidget* const that,
              const char* const filename);
```

3 Code

3.1 genbrush.c

```
// ============ GENBRUSH.C ================

// ================= Include =================

#include "genbrush.h"
#if BUILDMODE == 0
#include "genbrush-inline.c"
#endif

// ================ Structure declaration ====================

// Header of a TGA file
typedef struct GBTGAHeader {
  // Origin of the color map
  short int _colorMapOrigin;
  // Length of the color map
  short int _colorMapLength;
  // X coordinate of the origin
  short int _xOrigin;
  // Y coordinate of the origin
  short int _yOrigin;
  // Width of the TGA
  short _width;
  // Height of the TGA
  short _height;
  // Length of a string located located after the header
  char _idLength;
  // Type of the color map
  char _colorMapType;
  // Type of the image
  char _dataTypeCode;
  // Depth of the color map
  char _colorMapDepth;
  // Number of bit per pixel
  char _bitsPerPixel;
  // Image descriptor
  char _imageDescriptor;
```

```
} GBTGAHeader;

// ================ Functions declaration ====================

// Function to decode rgba values when loading a TGA file
// Do nothing if arguments are invalid
void GBTGAMergeBytes(GBPixel* pixel, unsigned char* p, int bytes);

// Convert the indice of the TGA file data to the indice in layer's
// pixel according to origin position
int GBConvertToIndexLayerForTGA(int n, GBTGAHeader* header);

// Read the header of a TGA file from the stream 'stream' and store
// it into 'header'
// Return true if it could read the header, else false
bool GBReadTGAHeader(FILE* stream, GBTGAHeader* header);

// Read the body of a TGA file from the stream 'stream' and store
// it into 'pix', given the header 'header' of the file and the
// blend mode 'blendMode'
// Return true if it could read the body, else false
bool GBReadTGABody(FILE *stream, GSet* pix, GBTGAHeader* header,
  GBLayerBlendMode blendMode);

// Create a new GBLayer with dimensions and content given by the
// TGA image on disk at location 'fileName'
// Return NULL if we couldn't create the layer
GBLayer* GBLayerCreateFromFileTGA(const char* const fileName);

// Save the GBSurfaceImage 'that' as a TGA file
// Return false if the image couldn't be saved, true else
bool GBSurfaceImageSaveAsTGA(const GBSurfaceImage* const that);

// Create a new GBSurfaceImage with one layer containing the content
// of the TGA image located at 'fileName' and dimensions equal to the
// dimensions of the image
// If the image couldn't be loaded return NULL
GBSurfaceImage* GBSurfaceImageCreateFromTGA(const char* const fileName);

// Draw the Point 'point' in the GBObjPod 'pod' with the
// GBToolPlotter 'that'
void GBToolPlotterDrawPoint(const GBToolPlotter* const that,
  const VecFloat* const point, const GBObjPod* const pod);

// Draw the Shapoid 'shap' in the GBObjPod 'pod' with the
// GBToolPlotter 'that'
void GBToolPlotterDrawShapoid(const GBToolPlotter* const that,
  const Shapoid* const shap, const GBObjPod* const pod);

// Draw the SCurve 'curve' in the GBObjPod 'pod' with the
// GBToolPlotter 'that'
void GBToolPlotterDrawSCurve(const GBToolPlotter* const that,
  const SCurve* const curve, const GBObjPod* const pod);

// Update the content of the layer 'layer' of the GenBrush 'that'
// Flush the content of the layer and redraw all the pod attached to it
void GBUpdateLayer(GenBrush* const that, GBLayer* const layer);

// Get the value for the projection matrix of a GBEyeOrtho
void GBEyeOrthoGetProjVal(const GBEyeOrtho* const that,
  float* const val);
```

```
// Get the value for the projection matrix of a GBEyeIsometric
void GBEyeIsometricGetProjVal(const GBEyeIsometric* const that,
  float* const val);

// Normalize in hue the final pixels of the GBSurface 'that'
void GBSurfaceNormalizeHue(GBSurface* const that);

// Return a clone of the GenBrush 'that' with its final surface scaled
// to the dimensions 'dim' according to the scaling method AvgNeighbour
GenBrush* GBScaleAvgNeighbour(const GenBrush* const that,
  const VecShort2D* const dim);

// ================ Functions implementation ====================

// Function to decode rgba values when loading a TGA file
// Do nothing if arguments are invalid
void GBTGAMergeBytes(GBPixel* pixel, unsigned char* p, int bytes) {
  // Check arguments
  if (pixel == NULL || p == NULL)
    return;
  // Merge bytes
  if (bytes == 4) {
    pixel->_rgba[GBPixelRed] = p[2];
    pixel->_rgba[GBPixelGreen] = p[1];
    pixel->_rgba[GBPixelBlue] = p[0];
    pixel->_rgba[GBPixelAlpha] = p[3];
  } else if (bytes == 3) {
    pixel->_rgba[GBPixelRed] = p[2];
    pixel->_rgba[GBPixelGreen] = p[1];
    pixel->_rgba[GBPixelBlue] = p[0];
    pixel->_rgba[GBPixelAlpha] = 255;
  } else if (bytes == 2) {
    pixel->_rgba[GBPixelRed] = (p[1] & 0x7c) << 1;
    pixel->_rgba[GBPixelGreen] =
      ((p[1] & 0x03) << 6) | ((p[0] & 0xe0) >> 2);
    pixel->_rgba[GBPixelBlue] = (p[0] & 0x1f) << 3;
    pixel->_rgba[GBPixelAlpha] = (p[1] & 0x80);
  }
}

// Convert the indice of the TGA file data to the indice in layer's
// pixel according to origin position
int GBConvertToIndexLayerForTGA(int n, GBTGAHeader* header) {
  if ((header->_imageDescriptor & 32) == 0)
    // lower left hand corner
    return n;
  else
    // upper left hand corner
    return (header->_height - 1 -
      ((int)floor((float)n / (float)(header->_width)))) *
      header->_width + n % header->_width;
}

// Read the header of a TGA file from the stream 'stream' and store
// it into 'header'
// Return true if it could read the header, else false
bool GBReadTGAHeader(FILE* stream, GBTGAHeader* header) {
  // Declare a variable to memorize the return value of fread
  size_t ret = 0;
  // Read the header's values
  header->_idLength = fgetc(stream);
  header->_colorMapType = fgetc(stream);
```

```
  // If the color map type is not supported
  if (header->_colorMapType != 0 &&
    header->_colorMapType != 1) {
    // Stop here
    return false;
  }
  header->_dataTypeCode = fgetc(stream);
  // If the data type is not supported
  if (header->_dataTypeCode != 2 && header->_dataTypeCode != 10) {
    // Stop here
    return false;
  }
  ret = fread(&(header->_colorMapOrigin), 2, 1, stream);
  if (ret == 0) {
    // Stop here
    return false;
  }
  ret = fread(&(header->_colorMapLength), 2, 1, stream);
  if (ret == 0) {
    // Stop here
    return false;
  }
  header->_colorMapDepth = fgetc(stream);
  ret = fread(&(header->_xOrigin), 2, 1, stream);
  if (ret == 0) {
    // Stop here
    return false;
  }
  ret = fread(&(header->_yOrigin), 2, 1, stream);
  if (ret == 0) {
    // Stop here
    return false;
  }
  ret = fread(&(header->_width), 2, 1, stream);
  if (ret == 0 || header->_width <= 0) {
    // Stop here
    return false;
  }
  ret = fread(&(header->_height), 2, 1, stream);
  if (ret == 0 || header->_height <= 0) {
    // Stop here
    return false;
  }
  header->_bitsPerPixel = fgetc(stream);
  header->_imageDescriptor = fgetc(stream);
  // Origin of the screen
  // TODO: Override the initial _yOrigin
  /*if ((header->_imageDescriptor & 32) == 0)
    // lower left hand corner
    header->_yOrigin = header->_height;
  else
    // upper left hand corner
    header->_yOrigin = 0;*/
  // Return the success code
  return true;
}

// Read the body of a TGA file from the stream 'stream' and store
// it into 'pix', given the header 'header' of the file and the
// blend mode 'blendMode'
// Return true if it could read the body, else false
bool GBReadTGABody(FILE *stream, GSet* pix, GBTGAHeader* header,
```

```
GBLayerBlendMode blendMode) {
// Declare variables used during decoding
int i = 0, j = 0;
unsigned int bytes2read = 0, skipover = 0;
unsigned char p[5] = {0};
// If the number of byte per pixel is not supported
if (header->_bitsPerPixel != 16 &&
  header->_bitsPerPixel != 24 &&
  header->_bitsPerPixel != 32) {
  sprintf(GenBrushErr->_msg, "Invalid bitesPerPixel (%d)",
    header->_bitsPerPixel);
  return false;
}
// Skip the unused information
skipover += header->_idLength;
skipover += header->_colorMapType * header->_colorMapLength;
fseek(stream,skipover,SEEK_CUR);
// Calculate the number of byte per pixel
bytes2read = header->_bitsPerPixel / 8;
// Flag to manage premature end of file
bool flagPrematureEnd = false;
// For each pixel
int n = 0;
while (n < header->_height * header->_width && !flagPrematureEnd) {
  int nLayer = GBConvertToIndexLayerForTGA(n, header);
  // Read the pixel according to the data type, merge and
  // move to the next pixel
  if (header->_dataTypeCode == 2) {
    if (fread(p, 1, bytes2read, stream) != bytes2read) {
      flagPrematureEnd = true;
    } else {
      GBPixel mergedPix;
      GBTGAMergeBytes(&mergedPix, p, bytes2read);
      // Create a stacked pixel
      GBStackedPixel* stacked = PBErrMalloc(GenBrushErr,
        sizeof(GBStackedPixel));
      memcpy(&(stacked->_val), &mergedPix, sizeof(GBPixel));
      stacked->_depth = 0.0;
      stacked->_blendMode = blendMode;
      // Add the stacked pixel to the stack
      GSetAddSort(pix + nLayer, stacked, stacked->_depth);
      // Increment the index
      ++n;
      nLayer = GBConvertToIndexLayerForTGA(n, header);
    }
  } else if (header->_dataTypeCode == 10) {
    if (fread(p, 1, bytes2read + 1, stream) != bytes2read + 1) {
      flagPrematureEnd = true;
    } else {
      j = p[0] & 0x7f;
      GBPixel mergedPix;
      GBTGAMergeBytes(&mergedPix, &(p[1]), bytes2read);
      // Create a stacked pixel
      GBStackedPixel* stacked = PBErrMalloc(GenBrushErr,
        sizeof(GBStackedPixel));
      memcpy(&(stacked->_val), &mergedPix, sizeof(GBPixel));
      stacked->_depth = 0.0;
      stacked->_blendMode = blendMode;
      // Add the stacked pixel to the stack
      GSetAddSort(pix + nLayer, stacked, stacked->_depth);
      // Increment the index
      ++n;
```

```
        nLayer = GBConvertToIndexLayerForTGA(n, header);
        if (p[0] & 0x80) {
          for (i = 0; i < j; ++i) {
            GBPixel mergedPix;
            GBTGAMergeBytes(&mergedPix, &(p[1]), bytes2read);
            // Create a stacked pixel
            GBStackedPixel* stacked = PBErrMalloc(GenBrushErr,
              sizeof(GBStackedPixel));
            memcpy(&(stacked->_val), &mergedPix, sizeof(GBPixel));
            stacked->_depth = 0.0;
            stacked->_blendMode = blendMode;
            // Add the stacked pixel to the stack
            GSetAddSort(pix + nLayer, stacked, stacked->_depth);
            // Increment the index
            ++n;
            nLayer = GBConvertToIndexLayerForTGA(n, header);
          }
        } else {
          for (i = 0; i < j; ++i) {
            if (fread(p, 1, bytes2read, stream) != bytes2read) {
              sprintf(GenBrushErr->_msg, "fread failed (%s)",
                strerror(errno));
              return false;
            }
            GBPixel mergedPix;
            GBTGAMergeBytes(&mergedPix, p, bytes2read);
            // Create a stacked pixel
            GBStackedPixel* stacked = PBErrMalloc(GenBrushErr,
              sizeof(GBStackedPixel));
            memcpy(&(stacked->_val), &mergedPix, sizeof(GBPixel));
            stacked->_depth = 0.0;
            stacked->_blendMode = blendMode;
            // Add the stacked pixel to the stack
            GSetAddSort(pix + nLayer, stacked, stacked->_depth);
            // Increment the index
            ++n;
            nLayer = GBConvertToIndexLayerForTGA(n, header);
          }
        }
      }
    }
  }
  // Return the success code
  return true;
}

// ---------------- GBPixel -------------------------

// Blend the pixel 'pix' into the pixel 'that'
// BlendNormal mixes colors according to their relative alpha value
// and add the alpha values
void GBPixelBlendNormal(GBPixel* const that , const GBPixel* const pix) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pix == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pix' is null");
    PBErrCatch(GenBrushErr);
```

```
  }
#endif
  // Declare a variable for computation
  float u = 0.5 *
    (1.0 + ((float)(that->_rgba[GBPixelAlpha]) -
    (float)(pix->_rgba[GBPixelAlpha])) / 255.0);
  for (int iRgb = 4; iRgb--;)
    // Add 0.5 to the conversion to float ot avoid numeric instability
    if (iRgb == GBPixelAlpha)
      that->_rgba[iRgb] = (unsigned char)floor(
        MIN(255.0, (float)(that->_rgba[iRgb]) +
        (float)(pix->_rgba[iRgb])) + 0.5);
    else
      that->_rgba[iRgb] = (unsigned char)floor(
        (1.0 - u) * (float)(that->_rgba[iRgb]) +
        u * (float)(pix->_rgba[iRgb]) + 0.5);
}

// Blend the pixel 'pix' into the pixel 'that'
// BlendOver mixes colors according to the alpha value of 'pix'
// and add the alpha values
void GBPixelBlendOver(GBPixel* const that, const GBPixel* const pix) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pix == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pix' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Declare a variable for computation
  float u = (float)(that->_rgba[GBPixelAlpha]) / 255.0;
  for (int iRgb = 4; iRgb--;)
    // Add 0.5 to the conversion to float ot avoid numeric instability
    if (iRgb == GBPixelAlpha)
      that->_rgba[iRgb] = (unsigned char)floor(
        MIN(255.0, (float)(that->_rgba[iRgb]) +
        (float)(pix->_rgba[iRgb])) + 0.5);
    else
      that->_rgba[iRgb] = (unsigned char)floor(
        (1.0 - u) * (float)(that->_rgba[iRgb]) +
        u * (float)(pix->_rgba[iRgb]) + 0.5);
}

// Return the blend result of the stack of Pixel 'stack'
// If there is transparency down to the bottom of the stack, use the
// background color 'bgColor'
// If the stack is empty, return a transparent pixel
GBPixel GBPixelStackBlend(const GSet* const stack,
  const GBPixel* const bgColor) {
#if BUILDMODE == 0
  if (stack == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'stack' is null");
    PBErrCatch(GenBrushErr);
  }
  if (bgColor == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
```

```
    sprintf(GenBrushErr->_msg, "'bgColor' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Declare the result pixel
  GBPixel res = GBColorTransparent;
  // Declare a variable to memorize the blend mode
  GBLayerBlendMode blendMode = GBLayerBlendModeNormal;
  // If the stack is not empty
  if (GSetNbElem(stack) > 0) {
    // Initalise the result pixel with the last pixel
    GSetIterBackward iter = GSetIterBackwardCreateStatic(stack);
    GBStackedPixel* pix = GSetIterGet(&iter);
    blendMode = pix->_blendMode;
    res = pix->_val;
    // For each following pixel until we reach the bottom of the stack
    // or the opacity reaches 255
    while (res._rgba[GBPixelAlpha] < 255 && GSetIterStep(&iter)) {
      pix = GSetIterGet(&iter);
      switch (blendMode) {
        case GBLayerBlendModeDefault:
          break;
        case GBLayerBlendModeNormal:
          GBPixelBlendNormal(&res, &(pix->_val));
          break;
        case GBLayerBlendModeOver:
          GBPixelBlendOver(&res, &(pix->_val));
          break;
        default:
          break;
      }
      blendMode = pix->_blendMode;
    }
    // If we've reached the bottom of the stack and there is still
    // transparency
    if (res._rgba[GBPixelAlpha] < 255) {
      // Add the background color
      switch (blendMode) {
        case GBLayerBlendModeDefault:
          break;
        case GBLayerBlendModeNormal:
          GBPixelBlendNormal(&res, bgColor);
          break;
        case GBLayerBlendModeOver:
          GBPixelBlendOver(&res, bgColor);
          break;
        default:
          break;
      }
    }
  // Else, the stack is empty
  } else {
    // Simply copy the background pixel;
    res = *bgColor;
  }
  // Return the result pixel
  return res;
}

// Convert the GBPixel 'that' from RGB to HSV. Alpha channel is unchanged
GBPixel GBPixelRGB2HSV(const GBPixel* const that) {
#if BUILDMODE == 0
```

```
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Declare the result pixel
  GBPixel res = *that;
  // Calculate the hsv values
  float rgb[3] = {0.0, 0.0, 0.0};
  rgb[GBPixelRed] = (float)(that->_rgba[GBPixelRed]) / 255.0;
  rgb[GBPixelGreen] = (float)(that->_rgba[GBPixelGreen]) / 255.0;
  rgb[GBPixelBlue] = (float)(that->_rgba[GBPixelBlue]) / 255.0;
  float max = MAX(rgb[0], MAX(rgb[1], rgb[2]));
  float min = MIN(rgb[0], MIN(rgb[1], rgb[2]));
  float delta = max - min;
  float hsv[3] = {0.0, 0.0, 0.0};
  if (ISEQUALF(delta, 0.0))
    hsv[GBPixelHue] = 0.0;
  else if (ISEQUALF(max, rgb[GBPixelRed]))
    hsv[GBPixelHue] = 60.0 * (float)(((int)round(
      (rgb[GBPixelGreen] - rgb[GBPixelBlue]) / delta)) % 6);
  else if (ISEQUALF(max, rgb[GBPixelGreen]))
    hsv[GBPixelHue] =
      60.0 * ((rgb[GBPixelBlue] - rgb[GBPixelRed]) / delta + 2.0);
  else if (ISEQUALF(max, rgb[GBPixelBlue]))
    hsv[GBPixelHue] =
      60.0 * ((rgb[GBPixelRed] - rgb[GBPixelGreen]) / delta + 4.0);
  res._hsva[GBPixelHue] =
    (unsigned char)round(hsv[GBPixelHue] / 360.0 * 255.0);
  if (ISEQUALF(max, 0.0))
    hsv[GBPixelSaturation] = 0.0;
  else
    hsv[GBPixelSaturation] = delta / max;
  res._hsva[GBPixelSaturation] =
    (unsigned char)round(hsv[GBPixelSaturation] * 255.0);
  hsv[GBPixelValue] = max;
  res._hsva[GBPixelValue] =
    (unsigned char)round(hsv[GBPixelValue] * 255.0);
  // Return the result
  return res;
}

// Convert the GBPixel 'that' from HSV to RGB. Alpha channel is unchanged
GBPixel GBPixelHSV2RGB(const GBPixel* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Declare the result pixel
  GBPixel res = *that;
  // Calculate the rgb values
  float hsv[3] = {0.0, 0.0, 0.0};
  hsv[GBPixelHue] = (float)(that->_hsva[GBPixelHue]) / 255.0 * 360.0;
  hsv[GBPixelSaturation] =
    (float)(that->_hsva[GBPixelSaturation]) / 255.0;
  hsv[GBPixelValue] = (float)(that->_hsva[GBPixelValue]) / 255.0;
  float c = hsv[GBPixelValue] * hsv[GBPixelSaturation];
  float x = c * (1.0 - fabs((int)round(hsv[GBPixelHue] / 60.0) % 2 - 1));
```

```
  float m = hsv[GBPixelValue] - c;
  float rgb[3] = {0.0, 0.0, 0.0};
  if (hsv[GBPixelHue] < 60.0) {
    rgb[GBPixelRed] = c;
    rgb[GBPixelGreen] = x;
    rgb[GBPixelBlue] = 0.0;
  } else if (hsv[GBPixelHue] < 120.0) {
    rgb[GBPixelRed] = x;
    rgb[GBPixelGreen] = c;
    rgb[GBPixelBlue] = 0.0;
  } else if (hsv[GBPixelHue] < 180.0) {
    rgb[GBPixelRed] = 0.0;
    rgb[GBPixelGreen] = c;
    rgb[GBPixelBlue] = x;
  } else if (hsv[GBPixelHue] < 240.0) {
    rgb[GBPixelRed] = 0.0;
    rgb[GBPixelGreen] = x;
    rgb[GBPixelBlue] = c;
  } else if (hsv[GBPixelHue] < 300.0) {
    rgb[GBPixelRed] = x;
    rgb[GBPixelGreen] = 0.0;
    rgb[GBPixelBlue] = c;
  } else {
    rgb[GBPixelRed] = c;
    rgb[GBPixelGreen] = 0.0;
    rgb[GBPixelBlue] = x;
  }
  res._rgba[GBPixelRed] =
    (unsigned char)round(255.0 * (rgb[GBPixelRed] + m));
  res._rgba[GBPixelGreen] =
    (unsigned char)round(255.0 * (rgb[GBPixelGreen] + m));
  res._rgba[GBPixelBlue] =
    (unsigned char)round(255.0 * (rgb[GBPixelBlue] + m));
  // Return the result
  return res;
}

// ---------------- GBLayer --------------------------

// Create a new GBLayer with dimensions 'dim'
// The layer is initialized with empty stacks of pixel
// _pos = (0,0)
// blendMode = GBLayerBlendModeDefault
// stackPos = GBLayerStackPosBg
GBLayer* GBLayerCreate(const VecShort2D* const dim) {
#if BUILDMODE == 0
  if (dim == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'dim' is null");
    PBErrCatch(GenBrushErr);
  }
  if (VecGet(dim, 0) <= 0 || VecGet(dim, 1) <= 0) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'dim' is invalid (%d>0,%d>0)",
      VecGet(dim, 0), VecGet(dim, 1));
    PBErrCatch(GenBrushErr);
  }
#endif
  // Declare a variable to memorize the new layer
  GBLayer* that = PBErrMalloc(GenBrushErr, sizeof(GBLayer));
  // Set properties
  that->_dim = *dim;
```

```
  that->_pos = VecShortCreateStatic2D();
  that->_prevPos = VecShortCreateStatic2D();
  that->_scale = VecFloatCreateStatic2D();
  that->_prevScale = VecFloatCreateStatic2D();
  VecSet(&(that->_scale), 0, 1.0);
  VecSet(&(that->_scale), 1, 1.0);
  that->_prevScale = that->_scale;
  that->_pix = PBErrMalloc(GenBrushErr,
    sizeof(GSet) * GBLayerArea(that));
  for (int iPix = GBLayerArea(that); iPix--;)
    that->_pix[iPix] = GSetCreateStatic();
  that->_blendMode = GBLayerBlendModeDefault;
  that->_modified = true;
  that->_stackPos = GBLayerStackPosBg;
  // Return the new layer
  return that;
}

// Free the GBLayer 'that'
void GBLayerFree(GBLayer** that) {
  if (that == NULL || *that == NULL) {
    return;
  }
  // Free the memory
  if ((*that)->_pix != NULL) {
    GBLayerFlush(*that);
    free((*that)->_pix);
  }
  free(*that);
  *that = NULL;
}

// Create a new GBLayer with dimensions and content given by the
// image on disk at location 'fileName'
// Return NULL if we couldn't create the layer
GBLayer* GBLayerCreateFromFile(const char* const fileName) {
  // If the fileName is NULL
  if (fileName == NULL)
    // Nothing to do
    return NULL;
  // Call the appropriate function depending on file extension
  if (strcmp(fileName + strlen(fileName) - 4, ".tga") == 0 ||
    strcmp(fileName + strlen(fileName) - 4, ".TGA") == 0)
    return GBLayerCreateFromFileTGA(fileName);
  return NULL;
}

// Create a new GBLayer with dimensions and content given by the
// TGA image on disk at location 'fileName'
// Return NULL if we couldn't create the layer
GBLayer* GBLayerCreateFromFileTGA(const char* const fileName) {
  // Open the file
  FILE* fptr = fopen(fileName,"r");
  // If we couldn't open the file
  if (fptr == NULL)
    // Stop here
    return NULL;
  // Declare a variable to memorize the header
  GBTGAHeader h;
  // Read the header
  if (GBReadTGAHeader(fptr, &h) == false) {
    // Stop here
```

```
    fclose(fptr);
    return NULL;
  }
  // Create the layer
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, h._width);
  VecSet(&dim, 1, h._height);
  GBLayer* layer = GBLayerCreate(&dim);
  // Set a pointer to the pixels of the new layer
  GSet* pix = GBLayerPixels(layer);
  // Read the body of the TGA file
  if (GBReadTGABody(fptr, pix, &h, layer->_blendMode) == false) {
    // Stop here
    GBLayerFree(&layer);
    fclose(fptr);
    return NULL;
  }
  // Close the file
  fclose(fptr);
  // Return the new layer
  return layer;
}

// Get the boundary of the GBLayer 'that' inside the GBSurface 'surf'
// The boundaries are given as a Facoid
// If the flag 'prevPos' is true, gives the boundary at the previous
// position
// Return NULL if the layer is completely out of the surface
Facoid* GBLayerGetBoundaryInSurface(const GBLayer* const that,
  const GBSurface* const surf, const bool prevPos) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (surf == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'surf' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Declare a pointer toward the relevant position according to
  // 'prevPos'
  VecShort2D* pos =
    (prevPos == false ? GBLayerPos(that) : GBLayerPrevPos(that));
  VecFloat2D* scale =
    (prevPos == false ? GBLayerScale(that) : GBLayerPrevScale(that));
  // Get the values of the clip area made by the intersection of the
  // layer and the surface
  VecFloat2D min = VecFloatCreateStatic2D();
  VecFloat2D max = VecFloatCreateStatic2D();
  for (int i = 2; i--;) {
    VecSet(&min, i, MAX(0, floor(((float)VecGet(pos, i)) * VecGet(scale, i))));
    VecSet(&max, i, MIN(VecGet(GBSurfaceDim(surf), i),
      floor((float)(VecGet(GBLayerDim(that), i) + VecGet(pos, i)) * VecGet(scale, i))));
  }
  // Declare a Facoid to memorize the result
  Facoid* bound = NULL;
  // If the layer is in intersection with the surface
  VecOp(&max, 1, &min, -1);
  if (VecGet(&max, 0) > 0.0 &&
```

```
    VecGet(&max, 1) > 0.0) {
    // Set the values of the Facoid
    bound = FacoidCreate(2);
    ShapoidSetPos(bound, (VecFloat*)&min);
    ShapoidScale(bound, (VecFloat*)&max);
  }
  // Return the result
  return bound;
}

// ---------------- GBPostProcessing -------------------------

// Create a static GBPostProcessing with type 'type'
GBPostProcessing* GBPostProcessingCreate(const GBPPType type) {
  // Declare the new GBPostProcessing
  GBPostProcessing* ret = PBErrMalloc(GenBrushErr,
    sizeof(GBPostProcessing));
  // Set the properties
  ret->_type = type;
  // Return the new post processing
  return ret;
}

// Create a new static GBPostProcessing with type 'type'
GBPostProcessing GBPostProcessingCreateStatic(const GBPPType type) {
  // Declare the new GBPostProcessing
  GBPostProcessing ret;
  // Set the properties
  ret._type = type;
  // Return the new post processing
  return ret;
}

// Free the memory used by the GBPostProcessing 'that'
void GBPostProcessingFree(GBPostProcessing** that) {
  // Check argument
  if (that == NULL || *that == NULL)
    // Nothing to do
    return;
  // Free memory
  free(*that);
  *that = NULL;
}

// ---------------- GBSurface --------------------------

// Create a new static GBSurface with dimension 'dim' and type 'type'
// _finalPix is set to 0
// _bgColor is set to white
GBSurface GBSurfaceCreateStatic(const GBSurfaceType type,
  const VecShort2D* const dim) {
#if BUILDMODE == 0
  if (dim == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'dim' is null");
    PBErrCatch(GenBrushErr);
  }
  if (VecGet(dim, 0) <= 0 || VecGet(dim, 1) <= 0) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'dim' is invalid (%d>0,%d>0)",
      VecGet(dim, 0), VecGet(dim, 1));
    PBErrCatch(GenBrushErr);
```

```
  }
#endif
  // Declare the new GBSurface
  GBSurface ret;
  // Set properties
  ret._type = type;
  ret._dim = *dim;
  ret._bgColor = GBColorWhite;
  ret._layers = GSetCreateStatic();
  // Allocate memory for the final pixels
  ret._finalPix = PBErrMalloc(GenBrushErr,
    sizeof(GBPixel) * VecGet(dim, 0) * VecGet(dim, 1));
  memset(ret._finalPix, 0,
    sizeof(GBPixel) * VecGet(dim, 0) * VecGet(dim, 1));
  // Flush the surface to initialize the _finalPix with the _bgColor
  GBSurfaceFlush(&ret);
  // Return the new GBSurface
  return ret;
}

// Create a new GBSurface with dimension 'dim' and type 'type'
// _finalPix is set to 0
// _bgColor is set to white
GBSurface* GBSurfaceCreate(const GBSurfaceType type,
  const VecShort2D* const dim) {
#if BUILDMODE == 0
  if (dim == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'dim' is null");
    PBErrCatch(GenBrushErr);
  }
  if (VecGet(dim, 0) <= 0 || VecGet(dim, 1) <= 0) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'dim' is invalid (%d>0,%d>0)",
      VecGet(dim, 0), VecGet(dim, 1));
    PBErrCatch(GenBrushErr);
  }
#endif
  // Declare the new GBSurface
  GBSurface *ret = PBErrMalloc(GenBrushErr, sizeof(GBSurface));
  // Set properties
  *ret = GBSurfaceCreateStatic(type, dim);
  // Return the new surface
  return ret;
}

// Free the memory used by the properties of the GBSurface 'that'
void GBSurfaceFreeStatic(GBSurface* const that) {
  // If the pointer is null
  if (that == NULL)
    // Nothing to do
    return;
  // Free the memory
  while (GSetNbElem(&(that->_layers)) > 0) {
    GBLayer* layer = (GBLayer*)GSetPop(&(that->_layers));
    GBLayerFree(&layer);
  }
  free(that->_finalPix);
  that->_finalPix = NULL;
}

// Free the memory used by the GBSurface 'that'
```

```
void GBSurfaceFree(GBSurface** that) {
  // If the pointer is null
  if (that == NULL || *that == NULL)
    // Nothing to do
    return;
  // Free the memory
  GBSurfaceFreeStatic(*that);
  free(*that);
  *that = NULL;
}

// Clone the GBSurface 'that'
GBSurface GBSurfaceClone(const GBSurface* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Declare the clone
  GBSurface clone = *that;
  // Clone properties
  clone._finalPix = PBErrMalloc(GenBrushErr,
    sizeof(GBPixel) * GBSurfaceArea(that));
  memcpy(clone._finalPix, GBSurfaceFinalPixels(that),
    sizeof(GBPixel) * GBSurfaceArea(that));
  // Return the clone
  return clone;
}

// Get a GSet of Facoid representing the sub areas of the GBSurface
// 'that' affected by layers with _modified flag equal to true
// If there is no modified sub area return an empty GSet
GSetShapoid* GBSurfaceGetModifiedArea(const GBSurface* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Declare the GSet to memorize the areas
  GSetShapoid* areas = GSetShapoidCreate();
  // If the surface has layers
  if (GBSurfaceNbLayer(that) > 0) {
    // For each layer of the surface
    GSetIterForward iter =
      GSetIterForwardCreateStatic(GBSurfaceLayers(that));
    do {
      // Get the current layer
      GBLayer* layer = GSetIterGet(&iter);
      // If the layer is modified
      if (GBLayerIsModified(layer)) {
        // Get the boundary in surface of this layer
        Facoid* bound =
          GBLayerGetBoundaryInSurface(layer, that, false);
        // If the boundary is not empty
        if (bound != NULL) {
          // Add the boundary to the areas taking care there is no
          // overlapping areas
          FacoidAlignedAddClippedToSet(bound, areas);
```

```
          // Free memory used by the boundary
          ShapoidFree(&bound);
        }
        // If the layer has been moved we also need to repaint the
        // area at its previous position
        if (!VecIsEqual(GBLayerPos(layer), GBLayerPrevPos(layer))) {
          // Get the boundary in surface of this layer at previous
          // position
          bound = GBLayerGetBoundaryInSurface(layer, that, true);
          // If the boundary is not empty
          if (bound != NULL) {
            // Add the boundary to the areas taking care there is no
            // overlapping areas
            FacoidAlignedAddClippedToSet(bound, areas);
            // Free memory used by the boundary
            ShapoidFree(&bound);
          }
        }
      }
    } while (GSetIterStep(&iter));
  }
  // Return the areas
  return areas;
}

// Update the final pixels according to layers of the GBSurface 'that'
// Update only pixels affected by layers with the _modified flag
// equals to true
void GBSurfaceUpdate(GBSurface* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // If the surface has layers
  if (GBSurfaceNbLayer(that) > 0) {
    // Get the areas needing to be updated
    GSetShapoid* areas = GBSurfaceGetModifiedArea(that);
    // Declare some vectors to memorize pixel coordinates
    VecShort2D from = VecShortCreateStatic2D();
    VecShort2D to = VecShortCreateStatic2D();
    VecShort2D pCoord = VecShortCreateStatic2D();
    VecShort2D pLayer = VecShortCreateStatic2D();
    // Declare 3 sets for the blending of pixels
    GSet setBg = GSetCreateStatic();
    GSet setIn = GSetCreateStatic();
    GSet setFg = GSetCreateStatic();
    // For each area
    while (GSetNbElem(areas) > 0) {
      // Get the current area
      Facoid* area = (Facoid*)GSetPop(areas);
      // Facoid values are float, we need to convert to short for
      // pixel coordinates
      for (int i = 2; i--;) {
        VecSet(&from, i, (short)round(ShapoidPosGet(area, i)));
        VecSet(&to, i, (short)round(ShapoidPosGet(area, i) +
          ShapoidAxisGet(area, i, i)));
      }
      // For each pixel in the current area
      VecCopy(&pCoord, &from);
```

```
      do {
        // For each layer
        GSetIterForward iter =
          GSetIterForwardCreateStatic(GBSurfaceLayers(that));
        do {
          // Get the current layer
          GBLayer* layer = GSetIterGet(&iter);
          // Get the position of the current pixel in layer coordinates
          VecCopy(&pLayer, &pCoord);
          VecSet(&pLayer, 0, (int)floor(
            ((float)VecGet(&pLayer, 0)) /
            VecGet(GBLayerScale(layer), 0)));
          VecSet(&pLayer, 1, (int)floor(
            ((float)VecGet(&pLayer, 1)) /
            VecGet(GBLayerScale(layer), 1)));
          VecOp(&pLayer, 1.0, GBLayerPos(layer), -1.0);
          // If the current pixel is inside the layer
          if (GBLayerIsPosInside(layer, &pLayer)) {
            // Add the stacked pixels of the layer to the appropriate
            // set
            switch (GBLayerGetStackPos(layer)) {
              case GBLayerStackPosBg:
                GSetAppendSet(&setBg, GBLayerPixel(layer, &pLayer));
                break;
              case GBLayerStackPosInside:
                GSetAppendSortedSet(&setIn,
                  GBLayerPixel(layer, &pLayer));
                break;
              case GBLayerStackPosFg:
                GSetAppendSet(&setFg, GBLayerPixel(layer, &pLayer));
                break;
              default:
                break;
            }
          }
        } while (GSetIterStep(&iter));
        // Merge the 3 stacks
        GSetAppendSet(&setBg, &setIn);
        GSetAppendSet(&setBg, &setFg);
        // Update the final pixel with the blend of the stack
        GBPixel* finalPix = GBSurfaceFinalPixel(that, &pCoord);
        *finalPix = GBPixelStackBlend(&setBg, GBSurfaceBgColor(that));
        // Empty the sets of stacked pixels
        GSetFlush(&setBg);
        GSetFlush(&setIn);
        GSetFlush(&setFg);
      } while (VecShiftStep(&pCoord, &from ,&to));
      // Free the memory used by the area
      ShapoidFree(&area);
    }
    // Free memory
    GSetFree(&areas);
    // Reset the modified flag of layers
    GBSurfaceSetLayersModified(that, false);
  }
}

// Reset all the final pix of the GBSurface 'that' to its
// background color, and reset all the modified flag of layers to true
void GBSurfaceFlush(GBSurface* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
```

```
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Set all the pixel to the background color
  for (int iPix = GBSurfaceArea(that); iPix--;)
    memcpy(that->_finalPix + iPix, &(that->_bgColor), sizeof(GBPixel));
  // Reset the modified flag of layers
  GBSurfaceSetLayersModified(that, true);
}

// Apply the post processing 'post' to the final pixels in the
// GBSurface 'that'
void GBSurfacePostProcess(GBSurface* const that,
  const GBPostProcessing* const post) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (post == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'post' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Call the appropriate post processing
  switch(GBPostProcessingGetType(post)) {
    case GBPPTypeNormalizeHue:
      GBSurfaceNormalizeHue(that);
      break;
    default:
      return;
  }
}

// Normalize in hue the final pixels of the GBSurface 'that'
void GBSurfaceNormalizeHue(GBSurface* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Declare a variable to memorize the maximum possible intensity
  float maxIntensity = 255.0;
  // Declare two variables to memorize the minimum and maximum hue
  // intensity
  float min = maxIntensity;
  float max = 0.0;
  // Search the minimum and maximum intensity
  VecShort2D p = VecShortCreateStatic2D();
  do {
    GBPixel* pix = GBSurfaceFinalPixel(that, &p);
    float intensity = (float)MAX(pix->_rgba[GBPixelRed],
      MAX(pix->_rgba[GBPixelGreen], pix->_rgba[GBPixelBlue]));
    if (intensity > max)
      max = intensity;
    intensity = (float)MIN(pix->_rgba[GBPixelRed],
```

```
      MIN(pix->_rgba[GBPixelGreen], pix->_rgba[GBPixelBlue]));
    if (intensity < min)
      min = intensity;
  } while (VecStep(&p, GBSurfaceDim(that)));
  // If the image is not already normalized and is normalizable
  if (!ISEQUALF(min, max) && (min >= 1.0 || max <= maxIntensity)) {
    // Declare a variable for optimization
    float c = maxIntensity / (max - min);
    // Normalize each final pixel color
    VecSetNull(&p);
    do {
      GBPixel* pix = GBSurfaceFinalPixel(that, &p);
      float intensity = ((float)(pix->_rgba[GBPixelRed]) - min) * c;
      pix->_rgba[GBPixelRed] =
        (unsigned char)round(MIN(255.0, MAX(0.0, intensity)));
      intensity = ((float)(pix->_rgba[GBPixelGreen]) - min) * c;
      pix->_rgba[GBPixelGreen] =
        (unsigned char)round(MIN(255.0, MAX(0.0, intensity)));
      intensity = ((float)(pix->_rgba[GBPixelBlue]) - min) * c;
      pix->_rgba[GBPixelBlue] =
        (unsigned char)round(MIN(255.0, MAX(0.0, intensity)));
    } while (VecStep(&p, GBSurfaceDim(that)));
  }
}

// ---------------- GBSurfaceImage --------------------------

// Create a new GBSurfaceImage with dimension 'dim'
GBSurfaceImage* GBSurfaceImageCreate(const VecShort2D* const dim) {
#if BUILDMODE == 0
  if (dim == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'dim' is null");
    PBErrCatch(GenBrushErr);
  }
  if (VecGet(dim, 0) <= 0 || VecGet(dim, 1) <= 0) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'dim' is invalid (%d>0,%d>0)",
      VecGet(dim, 0), VecGet(dim, 1));
    PBErrCatch(GenBrushErr);
  }
#endif
  // Declare the new GBSurfaceImage
  GBSurfaceImage* ret = PBErrMalloc(GenBrushErr,
    sizeof(GBSurfaceImage));
  // Set properties
  ret->_surf = GBSurfaceCreateStatic(GBSurfaceTypeImage, dim);
  ret->_fileName = NULL;
  // Return the new surface
  return ret;
}

// Free the memory used by the GBSurfaceImage 'that'
void GBSurfaceImageFree(GBSurfaceImage** that) {
  // If the pointer is null
  if (that == NULL || *that == NULL)
    // Nothing to do
    return;
  // Free the memory
  GBSurfaceFreeStatic((GBSurface*)(*that));
  if ((*that)->_fileName != NULL) {
    free((*that)->_fileName);
```

```
    (*that)->_fileName = NULL;
  }
  free(*that);
  *that = NULL;
}

// Clone the GBSurfaceImage 'that'
GBSurfaceImage* GBSurfaceImageClone(const GBSurfaceImage* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Declare the clone
  GBSurfaceImage* clone =
    GBSurfaceImageCreate(GBSurfaceDim((GBSurface*)that));
  // Declare a variable ot memorize he newly allocated stack of pixels
  GBPixel* nFinal = clone->_surf._finalPix;
  // Clone properties
  memcpy(clone, that, sizeof(GBSurface));
  clone->_surf._finalPix = nFinal;
  memcpy(clone->_surf._finalPix,
    GBSurfaceFinalPixels((GBSurface*)that),
    sizeof(GBPixel) * GBSurfaceArea((GBSurface*)that));
  clone->_fileName = NULL;
  GBSurfaceImageSetFileName(clone, GBSurfaceImageFileName(that));
  // Return the clone
  return clone;
}

// Save a GBSurfaceImage 'that'
// If the filename is not set do nothing and return false
// Return true if it could save the surface, false else
bool GBSurfaceImageSave(const GBSurfaceImage* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (that->_fileName == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that->_fileName' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // If the file name is null, do nothing
  if (that->_fileName == NULL)
    return false;
  // Call the appropriate function depending on file extension
  if (strcmp(that->_fileName + strlen(that->_fileName) - 4,
    ".tga") == 0 ||
    strcmp(that->_fileName + strlen(that->_fileName) - 4,
    ".TGA") == 0)
    return GBSurfaceImageSaveAsTGA(that);
  return false;
}

// Save the GBSurfaceImage 'that' as a TGA file
// Return false if the image couldn't be saved, true else
```

```
bool GBSurfaceImageSaveAsTGA(const GBSurfaceImage* const that) {
  int ret;
  // Open the file
  FILE* fptr = fopen(that->_fileName, "w");
  // If we couln't open the file
  if (fptr == NULL)
    // Stop here
    return false;
  // Declare a header
  GBTGAHeader h;
  // Create the header
  h._idLength = 0;
  h._colorMapType = 0;
  h._dataTypeCode = 2;
  h._colorMapOrigin = 0;
  h._colorMapLength = 0;
  h._colorMapDepth = 0;
  h._width = VecGet(GBSurfaceDim((GBSurface*)that), 0);
  h._height = VecGet(GBSurfaceDim((GBSurface*)that), 1);
  h._xOrigin = 0;
  h._yOrigin = 0;
  h._bitsPerPixel = 32;
  h._imageDescriptor = 0;

  // Write the header
  ret = putc(h._idLength, fptr);
  if (ret == EOF) {
    fclose(fptr);
    return false;
  }
  ret = putc(h._colorMapType, fptr);
  if (ret == EOF) {
    fclose(fptr);
    return false;
  }
  ret = putc(h._dataTypeCode, fptr);
  if (ret == EOF) {
    fclose(fptr);
    return false;
  }
  ret = fwrite(&(h._colorMapOrigin), 2, 1, fptr);
  if (ret == 0) {
    fclose(fptr);
    return false;
  }
  ret = fwrite(&(h._colorMapLength), 2, 1, fptr);
  if (ret == 0) {
    fclose(fptr);
    return false;
  }
  ret = putc(h._colorMapDepth, fptr);
  if (ret == EOF) {
    fclose(fptr);
    return false;
  }
  ret = fwrite(&(h._xOrigin), 2, 1, fptr);
  if (ret == 0) {
    fclose(fptr);
    return false;
  }
  ret = fwrite(&(h._yOrigin), 2, 1, fptr);
  if (ret == 0) {
```

```
    fclose(fptr);
    return false;
  }
  ret = fwrite(&(h._width), 2, 1, fptr);
  if (ret == 0) {
    fclose(fptr);
    return false;
  }
  ret = fwrite(&(h._height), 2, 1, fptr);
  if (ret == 0) {
    fclose(fptr);
    return false;
  }
  ret = putc(h._bitsPerPixel, fptr);
  if (ret == EOF) {
    fclose(fptr);
    return false;
  }
  ret = putc(h._imageDescriptor, fptr);
  if (ret == EOF) {
    fclose(fptr);
    return false;
  }
  // Declare a variable to memorize the final layer's pixel
  GBPixel* pix = GBSurfaceFinalPixels((GBSurface*)that);
  // For each pixel
  for (int y = 0; y < h._height; ++y) {
    for (int x = 0; x < h._width; ++x) {
      // Get the index of the pixel
      int i = y * h._width + x;
      // Write the pixel values
      ret = putc(pix[i]._rgba[GBPixelBlue], fptr);
      if (ret == EOF) {
        fclose(fptr);
        return false;
      }
      ret = putc(pix[i]._rgba[GBPixelGreen], fptr);
      if (ret == EOF) {
        fclose(fptr);
        return false;
      }
      ret = putc(pix[i]._rgba[GBPixelRed], fptr);
      if (ret == EOF) {
        fclose(fptr);
        return false;
      }
      ret = putc(pix[i]._rgba[GBPixelAlpha], fptr);
      if (ret == EOF) {
        fclose(fptr);
        return false;
      }
    }
  }
  // Close the file
  fclose(fptr);
  // Return the success code
  return true;
}

// Create a new GBSurfaceImage with one layer containing the content
// of the image located at 'fileName' and dimensions equal to the
// dimensions of the image
```

```
// If the image couldn't be loaded return NULL
GBSurfaceImage* GBSurfaceImageCreateFromFile(
  const char* const fileName) {
#if BUILDMODE == 0
  if (fileName == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'fileName' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // If the file name is null, return NULL
  if (fileName == NULL)
    return NULL;
  // Call the appropriate function depending on file extension
  if (strcmp(fileName + strlen(fileName) - 4, ".tga") == 0 ||
    strcmp(fileName + strlen(fileName) - 4, ".TGA") == 0)
    return GBSurfaceImageCreateFromTGA(fileName);
  return NULL;
}

// Create a new GBSurfaceImage with one layer containing the content
// of the TGA image located at 'fileName' and dimensions equal to the
// dimensions of the image
// If the image couldn't be loaded return NULL
GBSurfaceImage* GBSurfaceImageCreateFromTGA(const char* const fileName) {
#if BUILDMODE == 0
  if (fileName == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'fileName' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Load the image into a GBLayer
  GBLayer* layer = GBLayerCreateFromFileTGA(fileName);
  // If we couldn't load the image
  if (layer == NULL)
    // Return null
    return NULL;
  // Create a new GBSurfaceImage with same dimension as the layer
  GBSurfaceImage* surf = GBSurfaceImageCreate(GBLayerDim(layer));
  // Set the background color to transparent
  GBPixel transparent = GBColorTransparent;
  GBSurfaceSetBgColor((GBSurface*)surf, &transparent);
  // Add the layer to the surf
  GSetAppend(GBSurfaceLayers((GBSurface*)surf), layer);
  // Update the surface
  GBSurfaceUpdate((GBSurface*)surf);
  // Return the new surface
  return surf;
}

// ---------------- GBEye -------------------------

// Return a new GBEye with type 'type'
// scale is initialized to (1,1), trans to (0,0) and rot to 0
GBEye GBEyeCreateStatic(const GBEyeType type) {
  // Declare a GBEye
  GBEye that;
  // Set properties
  that._type = type;
  that._scale = VecFloatCreateStatic3D();
  VecSet(&(that._scale), 0, 1.0); VecSet(&(that._scale), 1, 1.0);
```

```
  VecSet(&(that._scale), 2, 1.0);
  that._orig = VecFloatCreateStatic2D();
  VecSet(&(that._orig), 0, 0.0); VecSet(&(that._orig), 1, 0.0);
  that._theta = 0.0;
  // Allocate memory for the projection matrix
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 3); VecSet(&dim, 1, 3);
  that._proj = MatFloatCreate(&dim);
  // Return the new GBEye
  return that;
}

// Free the memory used by the GBEye
void GBEyeFreeStatic(GBEye* const that) {
  if (that == NULL)
    return;
  // Free memory
  MatFree(&(that->_proj));
}

// Update the projection matrix of the GBEye according to scale, rot
// and origin
void GBEyeUpdateProj(GBEye* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Declare a variable to memorize the values of the projection matrix
  // order is: (0,0),(0,1),(0,2),(1,0),...
  float val[12] = {0.0};
  // Set the values according to the eye type
  switch (that->_type) {
    case GBEyeTypeOrtho:
      GBEyeOrthoGetProjVal((GBEyeOrtho*)that, val);
      break;
    case GBEyeTypeIsometric:
      GBEyeIsometricGetProjVal((GBEyeIsometric*)that, val);
      break;
    default:
      break;
  }
  // Set the values to the matrix
  VecShort2D index = VecShortCreateStatic2D();
  VecShort2D dim = MatGetDim(that->_proj);
  int iVal = 0;
  do {
    MatSet(that->_proj, &index, val[iVal]);
    ++iVal;
  } while (VecStep(&index, &dim));
}

// Return the projection through the GBEye 'that' of the Point 'point'
VecFloat* GBEyeGetProjectedPoint(const GBEye* const that,
  const VecFloat* const point) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
```

```
  }
  if (point == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'point' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Allocate memory for the output vector
  VecFloat* ret = VecClone(point);
  // Create a VecFloat3D to perform the product with the projection
  // matrix
  VecFloat3D v = VecFloatCreateStatic3D();
  for (long i = MIN(VecGetDim(point), 3); i--;)
    VecSet(&v, i, VecGet(point, i));
  // Perform the product
  VecFloat* w = MatGetProdVec(that->_proj, &v);
  // Translate to origin
  for (int i = 2; i--;)
    VecSet(w, i, VecGet(w, i) + VecGet(&(that->_orig), i));
  // Copy the values into the result
  for (long i = MIN(VecGetDim(point), 3); i--;)
    VecSet(ret, i, VecGet(w, i));
  // Free the memory used for the product
  VecFree(&w);
  // Return the result
  return ret;
}

// Return the projection through the GBEye 'that' of the SCurve 'curve'
SCurve* GBEyeGetProjectedCurve(const GBEye* const that,
  const SCurve* const curve) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (curve == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'curve' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Get a copy of the curve
  SCurve* ret = SCurveClone(curve);
  // Replace each curve's control point by its projection
  GSetIterForward iter =
    GSetIterForwardCreateStatic(SCurveCtrls(ret));
  do {
    VecFloat* ctrl = (VecFloat*)GSetIterGet(&iter);
    VecFloat* v = GBEyeGetProjectedPoint(that, ctrl);
    VecCopy(ctrl ,v);
    VecFree(&v);
  } while (GSetIterStep(&iter));
  // Return the projected curve
  return ret;
}

// Return the projection through the GBEye 'that' of the Shapoid 'shap'
Shapoid* GBEyeGetProjectedShapoid(const GBEye* const that,
  const Shapoid* const shap) {
#if BUILDMODE == 0
```

```
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (shap == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'shap' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Clone the shapoid
  Shapoid* ret = ShapoidClone(shap);
  // Project the origin of the shapoid
  VecFloat* proj = GBEyeGetProjectedPoint(that, ShapoidPos(ret));
  ShapoidSetPos(ret, proj);
  VecFree(&proj);
  // Project each axis
  GSetVecFloat* set = GSetVecFloatCreate();
  for (int iAxis = ShapoidGetDim(ret); iAxis--;) {
    proj = GBEyeGetProjectedPoint(that, ShapoidAxis(ret, iAxis));
    GSetPush(set, proj);
  }
  ShapoidSetAllAxis(ret, set);
  while (GSetNbElem(set) > 0) {
    proj = GSetPop(set);
    VecFree(&proj);
  }
  GSetFree(&set);
  // Return the new shapoid
  return ret;
}

// ---------------- GBEyeOrtho -------------------------

// Return a new GBEyeOrtho with orientation 'view'
// scale is initialized to (1,1), trans to (0,0) and rot to 0
GBEyeOrtho* GBEyeOrthoCreate(const GBEyeOrthoView view) {
  // Allocate memory
  GBEyeOrtho* that = PBErrMalloc(GenBrushErr, sizeof(GBEyeOrtho));
  // Set properties
  that->_view = view;
  that->_eye = GBEyeCreateStatic(GBEyeTypeOrtho);
  GBEyeUpdateProj((GBEye*)that);
  // Return the new GBEyeOrtho
  return that;
}

// Free the memory used by the GBEyeOrho
void GBEyeOrthoFree(GBEyeOrtho** that) {
  if (that == NULL || *that == NULL)
    return;
  // Free memory
  GBEyeFreeStatic((GBEye*)*that);
  free(*that);
  *that = NULL;
}

// Get the value for the projection matrix of a GBEyeOrtho
void GBEyeOrthoGetProjVal(const GBEyeOrtho* const that,
  float* const val) {
#if BUILDMODE == 0
```

```
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (val == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'val' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Declare variable for optimization
  float cosTheta = cos(GBEyeGetRot(that));
  float sinTheta = sin(GBEyeGetRot(that));
  float scaleX = VecGet(GBEyeScale(that), 0);
  float scaleY = VecGet(GBEyeScale(that), 1);
  float scaleZ = VecGet(GBEyeScale(that), 2);
  // Set the values according to the orientation
  switch (that->_view) {
    case GBEyeOrthoViewFront:
      val[0] = scaleX * cosTheta;
      val[1] = scaleX * sinTheta;
      val[2] = 0.0;
      val[3] = scaleY * -sinTheta;
      val[4] = scaleY * cosTheta;
      val[5] = 0.0;
      val[6] = 0.0;
      val[7] = 0.0;
      val[8] = scaleZ;
      break;
    case GBEyeOrthoViewRear:
      val[0] = scaleX * -cosTheta;
      val[1] = scaleX * -sinTheta;
      val[2] = 0.0;
      val[3] = scaleY * -sinTheta;
      val[4] = scaleY * cosTheta;
      val[5] = 0.0;
      val[6] = 0.0;
      val[7] = 0.0;
      val[8] = -scaleZ;
      break;
    case GBEyeOrthoViewTop:
      val[0] = scaleX * cosTheta;
      val[1] = scaleX * sinTheta;
      val[2] = 0.0;
      val[3] = 0.0;
      val[4] = 0.0;
      val[5] = -scaleZ;
      val[6] = scaleY * -sinTheta;
      val[7] = scaleY * cosTheta;
      val[8] = 0.0;
      break;
    case GBEyeOrthoViewBottom:
      val[0] = scaleX * cosTheta;
      val[1] = scaleX * sinTheta;
      val[2] = 0.0;
      val[3] = 0.0;
      val[4] = 0.0;
      val[5] = scaleZ;
      val[6] = scaleY * sinTheta;
      val[7] = scaleY * -cosTheta;
      val[8] = 0.0;
```

```
      break;
    case GBEyeOrthoViewLeft:
      val[0] = 0.0;
      val[1] = 0.0;
      val[2] = scaleZ;
      val[3] = scaleY * -sinTheta;
      val[4] = scaleY * cosTheta;
      val[5] = 0.0;
      val[6] = scaleX * -cosTheta;
      val[7] = scaleX * -sinTheta;
      val[8] = 0.0;
      break;
    case GBEyeOrthoViewRight:
      val[0] = 0.0;
      val[1] = 0.0;
      val[2] = -scaleZ;
      val[3] = scaleY * -sinTheta;
      val[4] = scaleY * cosTheta;
      val[5] = 0.0;
      val[6] = scaleX * cosTheta;
      val[7] = scaleX * sinTheta;
      val[8] = 0.0;
      break;
    default:
      break;
  }
}

// Process the object of the GBObjPod 'pod' to update the viewed object
// through the GBEyeOrtho 'that'
void GBEyeOrthoProcess(const GBEyeOrtho* const that,
  GBObjPod* const pod) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pod == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pod' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  VecFloat* point = NULL;
  SCurve* curve = NULL;
  Shapoid* shap = NULL;
  switch (GBObjPodGetType(pod)) {
    case GBObjTypePoint:
      point = GBEyeGetProjectedPoint((GBEye*)that,
        GBObjPodGetObjAsPoint(pod));
      GBObjPodSetEyePoint(pod, point);
      break;
    case GBObjTypeSCurve:
      curve = GBEyeGetProjectedCurve((GBEye*)that,
        GBObjPodGetObjAsSCurve(pod));
      GBObjPodSetEyeSCurve(pod, curve);
      break;
    case GBObjTypeShapoid:
      shap = GBEyeGetProjectedShapoid((GBEye*)that,
        GBObjPodGetObjAsShapoid(pod));
      GBObjPodSetEyeShapoid(pod,shap);
```

```
      break;
    default:
      break;
  }
}

// ---------------- GBEyeIsometric -------------------------

// Return a new GBEyeIsometric with orientation 'view'
// scale is initialized to (1,1), trans to (0,0) and rot to 0
// thetaY is initialized to pi/4 and thetaRight to pi/4
GBEyeIsometric* GBEyeIsometricCreate() {
  // Allocate memory
  GBEyeIsometric* that = PBErrMalloc(GenBrushErr,
    sizeof(GBEyeIsometric));
  // Set properties
  that->_thetaY = PBMATH_QUARTERPI;
  that->_thetaRight = PBMATH_QUARTERPI;
  that->_eye = GBEyeCreateStatic(GBEyeTypeIsometric);
  GBEyeUpdateProj((GBEye*)that);
  // Return the new GBEyeIsometric
  return that;
}

// Free the memory used by the GBEyeIsometric 'that'
void GBEyeIsometricFree(GBEyeIsometric** that) {
  if (that == NULL || *that == NULL)
    return;
  // Free memory
  GBEyeFreeStatic((GBEye*)*that);
  free(*that);
  *that = NULL;
}

// Process the object of the GBObjPod 'pod' to update the viewed object
// through the GBEyeIsometric 'that'
void GBEyeIsometricProcess(const GBEyeIsometric* const that,
  GBObjPod* const pod) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pod == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pod' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  VecFloat* point = NULL;
  SCurve* curve = NULL;
  Shapoid* shap = NULL;
  switch (GBObjPodGetType(pod)) {
    case GBObjTypePoint:
      point = GBEyeGetProjectedPoint((GBEye*)that,
        GBObjPodGetObjAsPoint(pod));
      GBObjPodSetEyePoint(pod, point);
      break;
    case GBObjTypeSCurve:
      curve = GBEyeGetProjectedCurve((GBEye*)that,
        GBObjPodGetObjAsSCurve(pod));
```

```
      GBObjPodSetEyeSCurve(pod, curve);
      break;
    case GBObjTypeShapoid:
      shap = GBEyeGetProjectedShapoid((GBEye*)that,
        GBObjPodGetObjAsShapoid(pod));
      GBObjPodSetEyeShapoid(pod,shap);
      break;
    default:
      break;
  }
}

// Get the value for the projection matrix of a GBEyeIsometric
void GBEyeIsometricGetProjVal(const GBEyeIsometric* const that,
  float* val) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (val == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'val' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Declare variables for optimization
  float scaleX = VecGet(GBEyeScale(that), 0);
  float scaleY = VecGet(GBEyeScale(that), 1);
  float scaleZ = VecGet(GBEyeScale(that), 2);
  float cosTheta = cos(GBEyeGetRot(that));
  float sinTheta = sin(GBEyeGetRot(that));
  float cosThetaY = cos(GBEyeIsometricGetRotY(that));
  float sinThetaY = sin(GBEyeIsometricGetRotY(that));
  float cosThetaR = cos(GBEyeIsometricGetRotRight(that));
  float sinThetaR = sin(GBEyeIsometricGetRotRight(that));
  // Set the values
  val[0] = scaleX * cosTheta * cosThetaY -
    scaleY * sinTheta * sinThetaY * sinThetaR;
  val[1] = scaleX * sinTheta * cosThetaY +
    scaleY * cosTheta * sinThetaY * sinThetaR;
  val[2] = scaleZ * sinThetaY * cosThetaR;

  val[3] = -1.0 * scaleY * sinTheta * cosThetaR;
  val[4] = scaleY * cosTheta * cosThetaR;
  val[5] = -scaleZ * sinThetaR;

  val[6] = -1.0 * (scaleX * cosTheta * sinThetaY +
    scaleY * sinTheta * cosThetaY * sinThetaR);
  val[7] = -1.0 * scaleX * sinTheta * sinThetaY +
    scaleY * cosTheta * cosThetaY * sinThetaR;
  val[8] = scaleZ * cosThetaY * cosThetaR;
}

// ---------------- GBHand -------------------------

// Create a new GBHand with type 'type'
GBHand GBHandCreateStatic(const GBHandType type) {
  // Declare the new hand
  GBHand hand;
  // Set properties
```

```
  hand._type = type;
  // Return the new hand
  return hand;
}

// Free the memory used by the GBHand 'that'
void GBHandFreeStatic(GBHand* const that) {
  // Nothing to do
  (void)that;
}

// ---------------- GBHandDefault -------------------------

// Create a new GBHandDefault
GBHandDefault* GBHandDefaultCreate() {
  // Declare the new hand
  GBHandDefault* hand = PBErrMalloc(GenBrushErr, sizeof(GBHandDefault));
  // Set properties
  hand->_hand = GBHandCreateStatic(GBHandTypeDefault);
  // Return the new hand
  return hand;
}

// Free the memory used by the GBHandDefault 'that'
void GBHandDefaultFree(GBHandDefault** that) {
  // Check argument
  if (that == NULL || *that == NULL)
    return;
  // Free memory
  GBHandFreeStatic((GBHand*)(*that));
  free(*that);
  *that = NULL;
}

// Process the viewed projection of the object in GBObjPod 'pod' into
// its handed projection through the GBHandDefault 'that'
void GBHandDefaultProcess(const GBHandDefault* const that,
  GBObjPod* const pod) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pod == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pod' is null");
    PBErrCatch(GenBrushErr);
  }
  if (GBObjPodEyeObj(pod) == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "Viewed object of 'pod' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  (void)that;
  // Empty all the sets
  GSetVecFloat* setPoints = GBObjPodGetHandObjAsPoints(pod);
  while (GSetNbElem(setPoints) > 0) {
    VecFloat* point = GSetPop(setPoints);
    VecFree(&point);
  }
```

```
  GSetShapoid* setShapoids = GBObjPodGetHandObjAsShapoids(pod);
  while (GSetNbElem(setShapoids) > 0) {
    Shapoid* shap = GSetPop(setShapoids);
    ShapoidFree(&shap);
  }
  GSetSCurve* setSCurves = GBObjPodGetHandObjAsSCurves(pod);
  while (GSetNbElem(setPoints) > 0) {
    SCurve* curve = GSetPop(setSCurves);
    SCurveFree(&curve);
  }
  // Simply copy the viewed object as it is according to its type
  switch (GBObjPodGetType(pod)) {
    case GBObjTypePoint:
      // Add a copy of the viewed point
      GSetAppend(setPoints, VecClone(GBObjPodGetEyeObjAsPoint(pod)));
      break;
    case GBObjTypeShapoid:
      // Add a copy of the viewed shapoid
      GSetAppend(setShapoids,
        ShapoidClone(GBObjPodGetEyeObjAsShapoid(pod)));
      break;
    case GBObjTypeSCurve:
      // Add a copy of the viewed scurve
      GSetAppend(setSCurves,
        SCurveClone(GBObjPodGetEyeObjAsSCurve(pod)));
      break;
    default:
      break;
  }
}

// ---------------- GBTool -------------------------

// Create a static GBTool with GBToolType 'type'
GBTool GBToolCreateStatic(const GBToolType type) {
  // Declare the GBTool
  GBTool that;
  // Set properties
  that._type = type;
  // Return the tool
  return that;
}

// Free the memory used by the GBTool 'that'
void GBToolFreeStatic(GBTool* const that) {
  // Nothing to do
  (void)that;
}

// ---------------- GBToolPlotter -------------------------

// Create a new GBToolPlotter
GBToolPlotter* GBToolPlotterCreate() {
  // Declare the new GBToolPlotter
  GBToolPlotter* that = PBErrMalloc(GenBrushErr, sizeof(GBToolPlotter));
  // Set properties
  that->_tool = GBToolCreateStatic(GBToolTypePlotter);
  // Return the new tool
  return that;
}

// Free the memory used by the GBToolPlotter 'that'
```

```
void GBToolPlotterFree(GBToolPlotter** that) {
  // Check argument
  if (that == NULL || *that == NULL)
    // Nothing to do
    return;
  // Free memory
  GBToolFreeStatic(&((*that)->_tool));
  free(*that);
  *that = NULL;
}

// Draw the object in the GBObjPod 'pod' with the GBToolPlotter 'that'
void GBToolPlotterDraw(const GBToolPlotter* const that,
  const GBObjPod* const pod) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pod == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pod' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Loop on the Points drawn by hand
  if (GSetNbElem(&(pod->_handPoints)) > 0) {
    GSetIterForward iter =
      GSetIterForwardCreateStatic(&(pod->_handPoints));
    do {
      // Get the point
      VecFloat* point = GSetIterGet(&iter);
      // Draw the point
      GBToolPlotterDrawPoint(that, point, pod);
    } while (GSetIterStep(&iter));
  }
  // Loop on the Shapoids drawn by hand
  if (GSetNbElem(&(pod->_handShapoids)) > 0) {
    GSetIterForward iter =
      GSetIterForwardCreateStatic(&(pod->_handShapoids));
    do {
      // Get the shapoid
      Shapoid* shap = GSetIterGet(&iter);
      // Draw the shapoid
      GBToolPlotterDrawShapoid(that, shap, pod);
    } while (GSetIterStep(&iter));
  }
  // Loop on the SCurves drawn by hand
  if (GSetNbElem(&(pod->_handSCurves)) > 0) {
    GSetIterForward iter =
      GSetIterForwardCreateStatic(&(pod->_handSCurves));
    do {
      // Get the curve
      SCurve* curve = GSetIterGet(&iter);
      // Draw the curve
      GBToolPlotterDrawSCurve(that, curve, pod);
    } while (GSetIterStep(&iter));
  }
}

// Draw the Point 'point' in the GBObjPod 'pod' with the
```

```
// GBToolPlotter 'that'
void GBToolPlotterDrawPoint(const GBToolPlotter* const that,
  const VecFloat*  const point, const GBObjPod*  const pod) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pod == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pod' is null");
    PBErrCatch(GenBrushErr);
  }
  if (point == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'point' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Get the position in layer
  VecShort2D posLayer = VecShortCreateStatic2D();
  for (int i = 2; i--;)
    VecSet(&posLayer, i, (short)round(VecGet(point, i)));
  // Get the color from the ink
  // As the point as no internal parameters create a null 3d vector
  // instead
  VecFloat3D null = VecFloatCreateStatic3D();
  GBPixel pixColor = GBInkGet(GBObjPodInk(pod), that, pod, &null,
    point, &posLayer);
  // Get the depth
  float depth = 0.0;
  if (VecGetDim(point) > 2)
    depth = VecGet(point, 2);
  // Add the pixel at the point position in the layer
  GBLayerAddPixelSafe(GBObjPodLayer(pod), &posLayer,
    &pixColor, depth);
}

// Draw the Shapoid 'shap' in the GBObjPod 'pod' with the
// GBToolPlotter 'that'
void GBToolPlotterDrawShapoid(const GBToolPlotter* const that,
  const Shapoid* const shap, const GBObjPod* const pod) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pod == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pod' is null");
    PBErrCatch(GenBrushErr);
  }
  if (shap == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'shap' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Get the bounding box of the shapoid in layer
  Facoid* bound = ShapoidGetBoundingBox(shap);
```

```
  // Declare two vectors for the VecShiftStep
  VecShort* from = VecShortCreate(ShapoidGetDim(bound));
  VecShort* to = VecShortCreate(ShapoidGetDim(bound));
  // Initialise the values of the vectors for the VecShiftStep
  for (int iAxis = ShapoidGetDim(bound); iAxis--;) {
    if (iAxis < 2) {
      VecSet(from, iAxis,
        (short)round(MAX(ShapoidPosGet(bound, iAxis), 0.0)));
      short v = (short)round(ShapoidPosGet(bound, iAxis) +
        ShapoidAxisGet(bound, iAxis, iAxis)) + 1;
      VecSet(to, iAxis,
        MIN(v, VecGet(GBLayerDim(GBObjPodLayer(pod)),iAxis)));
    } else {
      VecSet(from, iAxis,
        (short)round(ShapoidPosGet(bound, iAxis)));
      short v = (short)round(ShapoidPosGet(bound, iAxis) +
        ShapoidAxisGet(bound, iAxis, iAxis)) + 1;
      VecSet(to, iAxis, v);
    }
  }
  // Loop on pixels in layers inside the bounding box
  VecShort* posLayer = VecClone(from);
  VecFloat* posLayerFloat = VecFloatCreate(VecGetDim(posLayer));
  do {
    for (long iAxis = VecGetDim(posLayer); iAxis--;)
      VecSet(posLayerFloat, iAxis,
        (float)VecGet(posLayer, iAxis) + 0.5);
    // If this pixel is inside the Shapoid
    if (ShapoidIsPosInside(shap, posLayerFloat)) {
      // Get the current internal coordinates
      VecFloat* posIn = ShapoidImportCoord(shap, posLayerFloat);
      // Get the current external coordinates
      VecFloat* posExt =
        ShapoidExportCoord(GBObjPodGetObjAsShapoid(pod), posIn);
      // Get the ink at this position
      GBPixel pixColor = GBInkGet(GBObjPodInk(pod), that, pod,
        posIn, posExt, posLayer);
      // Get the depth
      float depth = 0.0;
      if (VecGetDim(posLayerFloat) > 2)
        depth = VecGet(posLayerFloat, 2);
      // Add the pixel to the layer
      GBLayerAddPixelSafe(GBObjPodLayer(pod), (VecShort2D*)posLayer,
        &pixColor, depth);
      // Free memory
      VecFree(&posIn);
      VecFree(&posExt);
    }
  } while (VecShiftStep(posLayer, from, to));
  // Free memory
  VecFree(&from);
  VecFree(&to);
  VecFree(&posLayer);
  VecFree(&posLayerFloat);
  ShapoidFree(&bound);
}

// Draw the SCurve 'curve' in the GBObjPod 'pod' with the
// GBToolPlotter 'that'
void GBToolPlotterDrawSCurve(const GBToolPlotter* const that,
  const SCurve* const curve, const GBObjPod* const pod) {
#if BUILDMODE == 0
```

```
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pod == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pod' is null");
    PBErrCatch(GenBrushErr);
  }
  if (curve == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'curve' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Det the approximate length of the curve
  float length = SCurveGetApproxLen(curve);
  // Calculate the delta step based on teh apporximate length
  float delta = 0.5 / length;
  // Create an iterator on the curve
  SCurveIter iter = SCurveIterCreateStatic(curve, delta);
  // Declare a vector to store the internal position as a vector
  VecFloat* posIn = VecFloatCreate(1);
  // Declare a vector to memorize the position in layer as short
  VecShort* posLayer = VecShortCreate(SCurveGetDim(curve));
  // Declare a vector to memorize the
  VecShort* prevPosLayer = VecShortCreate(SCurveGetDim(curve));
  // Loop on the curve internal position
  do {
    // Get the internal position
    float p = SCurveIterGetPos(&iter);
    // Get the position in layer
    VecFloat* posLayerFloat = SCurveIterGet(&iter);
    for (long iAxis = VecGetDim(posLayer); iAxis--;)
      VecSet(posLayer, iAxis,
        (short)round(VecGet(posLayerFloat, iAxis)));
    // Ensure the position is different (at pixel level) with the
    // previous one, except for the first step (p==0.0)
    if (ISEQUALF(p, 0.0) == true ||
      VecIsEqual(posLayer, prevPosLayer) == false) {
      // Get the internal position as a vector
      VecSet(posIn, 0, p);
      // Get the external position
      VecFloat* posExt = SCurveGet(GBObjPodGetObjAsSCurve(pod), p);
      // Get the ink at this position
      GBPixel pixColor = GBInkGet(GBObjPodInk(pod), that, pod,
        posIn, posExt, posLayer);
      // Get the depth
      float depth = 0.0;
      if (VecGetDim(posLayerFloat) > 2)
        depth = VecGet(posLayerFloat, 2);
      // Add the pixel to the layer
      GBLayerAddPixelSafe(GBObjPodLayer(pod), (VecShort2D*)posLayer,
        &pixColor, depth);
      // Free memory
      VecFree(&posExt);
      // Set the previous position
      VecCopy(prevPosLayer, posLayer);
    }
    // Free memory
    VecFree(&posLayerFloat);
```

```
  } while (SCurveIterStep(&iter));
  // Free memory
  VecFree(&posIn);
  VecFree(&posLayer);
  VecFree(&prevPosLayer);
}

// ---------------- GBInk -------------------------

// Entry point for the GBTool<>Draw function to get the color of the
// appropriate GBInk according to the type of 'that'
// posInternal represents the position in the object internal space
// posExternal represents the position in the global coordinates system
// posLayer represents the position in the destination layer
GBPixel _GBInkGet(const GBInk* const that, const GBTool* const tool,
  const GBObjPod* const pod, const VecFloat* const posInternal,
  const VecFloat* const posExternal, const VecShort* const posLayer) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Currently unused, voided and left for forward compatibility
  (void)tool; (void)pod;
  (void)posInternal; (void)posExternal; (void)posLayer;
  // Declare the result pixel
  GBPixel pix = GBColorTransparent;
  // Call the appropriate function according to the type of ink
  switch (GBInkGetType(that)) {
    case GBInkTypeSolid:
      pix = GBInkSolidGet((GBInkSolid*)that);
      break;
    default:
      break;
  }
  // Return the result pixel
  return pix;
}

// ---------------- GBInk -------------------------

// Free the memory used by the GBInk 'that'
void GBInkFree(GBInk* const that) {
  // Nothing to do
  (void)that;
}

// ---------------- GBInkSolid -------------------------

// Create a new GBInkSolid with color 'col'
GBInkSolid* GBInkSolidCreate(const GBPixel* const col) {
#if BUILDMODE == 0
  if (col == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'col' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Declare the new GBInkSolid
  GBInkSolid* ink = PBErrMalloc(GenBrushErr, sizeof(GBInkSolid));
```

```
  // Set properties
  ink->_ink._type = GBInkTypeSolid;
  ink->_color = *col;
  // Return the new ink
  return ink;
}

// Free the memory used by the GBInkSolid 'that'
void GBInkSolidFree(GBInkSolid** that) {
  // Check argument
  if (that == NULL || *that == NULL)
    // Nothing to do
    return;
  // Free memory
  GBInkFree(&((*that)->_ink));
  free(*that);
  *that = NULL;
}

// ---------------- GBObjPod -------------------------

// Create a new GBObjPod for a Point at position 'pos'
// drawn with 'eye', 'hand', 'tool' and 'ink' in layer 'layer'
// 'pos' must be a vector of 2 or more dimensions
// If 'eye', 'hand, 'tool', 'ink' or 'layer' is null return null
GBObjPod* _GBObjPodCreatePoint(VecFloat* const pos, GBEye* const eye,
  GBHand* const hand, GBTool* const tool, GBInk* const ink,
  GBLayer* const layer) {
#if BUILDMODE == 0
  if (pos == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pos' is null");
    PBErrCatch(GenBrushErr);
  }
  if (VecGetDim(pos) < 2) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg,
    "'pos' 's dimension is invalid (%ld>=2)",
    VecGetDim(pos));
    PBErrCatch(GenBrushErr);
  }
#endif
  // Check that the parameters are not null
  if (eye == NULL || hand == NULL || tool == NULL ||
    ink == NULL || layer == NULL)
    return NULL;
  // Declare the new GBObjPod
  GBObjPod* pod = PBErrMalloc(GenBrushErr, sizeof(GBObjPod));
  // Set properties
  pod->_type = GBObjTypePoint;
  pod->_srcPoint = pos;
  pod->_eyePoint = NULL;
  pod->_handPoints = GSetVecFloatCreateStatic();
  pod->_handShapoids = GSetShapoidCreateStatic();
  pod->_handSCurves = GSetSCurveCreateStatic();
  pod->_eye = eye;
  pod->_hand = hand;
  pod->_tool = tool;
  pod->_ink = ink;
  pod->_layer = layer;
  // Process the Point through eye and hand
  GBEyeProcess(eye, pod);
```

```
  GBHandProcess(hand, pod);
  // Return the new pod
  return pod;
}

// Create a new GBObjPod for the Shapoid 'shap'
// drawn with 'eye', 'hand', 'tool' and 'ink' in layer 'layer'
// 'shap' 's dimension must be 2 or more
// If 'eye', 'hand, 'tool', 'ink' or 'layer' is null return null
GBObjPod* _GBObjPodCreateShapoid(Shapoid* const shap, GBEye* const eye,
  GBHand* const hand, GBTool* const tool, GBInk* const ink,
  GBLayer* const layer) {
#if BUILDMODE == 0
  if (shap == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'shap' is null");
    PBErrCatch(GenBrushErr);
  }
  if (ShapoidGetDim(shap) < 2) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg,
    "'shap' 's dimension is invalid (%d>=2)",
    ShapoidGetDim(shap));
    PBErrCatch(GenBrushErr);
  }
#endif
  // Check that the parameters are not null
  if (eye == NULL || hand == NULL || tool == NULL ||
    ink == NULL || layer == NULL)
    return NULL;
  // Declare the new GBObjPod
  GBObjPod* pod = PBErrMalloc(GenBrushErr, sizeof(GBObjPod));
  // Set properties
  pod->_type = GBObjTypeShapoid;
  pod->_srcShapoid = shap;
  pod->_eyeShapoid = NULL;
  pod->_handPoints = GSetVecFloatCreateStatic();
  pod->_handShapoids = GSetShapoidCreateStatic();
  pod->_handSCurves = GSetSCurveCreateStatic();
  pod->_eye = eye;
  pod->_hand = hand;
  pod->_tool = tool;
  pod->_ink = ink;
  pod->_layer = layer;
  // Process the Shapoid through eye and hand
  GBEyeProcess(eye, pod);
  GBHandProcess(hand, pod);
 // Return the new pod
  return pod;
}

// Create a new GBObjPod for the SCurve 'curve'
// drawn with 'eye', 'hand', 'tool' and 'ink' in layer 'layer'
// 'curve' 's dimension must be 2 or more
// If 'eye', 'hand, 'tool', 'ink' or 'layer' is null return null
GBObjPod* _GBObjPodCreateSCurve(SCurve* const curve, GBEye* const eye,
  GBHand* const hand, GBTool* const tool, GBInk* const ink,
  GBLayer* const layer) {
#if BUILDMODE == 0
  if (curve == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'curve' is null");
```

```
    PBErrCatch(GenBrushErr);
  }
  if (SCurveGetDim(curve) < 2) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg,
    "'curve' 's dimension is invalid (%d>=2)",
    SCurveGetDim(curve));
    PBErrCatch(GenBrushErr);
  }
#endif
  // Check that the parameters are not null
  if (eye == NULL || hand == NULL || tool == NULL ||
    ink == NULL || layer == NULL)
    return NULL;
  // Declare the new GBObjPod
  GBObjPod* pod = PBErrMalloc(GenBrushErr, sizeof(GBObjPod));
  // Set properties
  pod->_type = GBObjTypeSCurve;
  pod->_srcSCurve = curve;
  pod->_eyeSCurve = NULL;
  pod->_handPoints = GSetVecFloatCreateStatic();
  pod->_handShapoids = GSetShapoidCreateStatic();
  pod->_handSCurves = GSetSCurveCreateStatic();
  pod->_eye = eye;
  pod->_hand = hand;
  pod->_tool = tool;
  pod->_ink = ink;
  pod->_layer = layer;
  // Process the SCurve through eye and hand
  GBEyeProcess(eye, pod);
  GBHandProcess(hand, pod);
  // Return the new pod
  return pod;
}

// Free the memory used by the GBObjPod 'that'
void GBObjPodFree(GBObjPod** that) {
  // Check argument
  if (that == NULL || *that == NULL)
    // Nothing to do
    return;
  // Free memory
  switch (GBObjPodGetType(*that)) {
    case GBObjTypePoint:
      VecFree(&((*that)->_eyePoint));
      break;
    case GBObjTypeShapoid:
      ShapoidFree(&((*that)->_eyeShapoid));
      break;
    case GBObjTypeSCurve:
      SCurveFree(&((*that)->_eyeSCurve));
      break;
    default:
      break;
  }
  while (GSetNbElem(&((*that)->_handPoints)) > 0) {
    VecFloat* point = GSetPop(&((*that)->_handPoints));
    VecFree(&point);
  }
  while (GSetNbElem(&((*that)->_handShapoids)) > 0) {
    Shapoid* shap = GSetPop(&((*that)->_handShapoids));
    ShapoidFree(&shap);
```

```
  }
  while (GSetNbElem(&((*that)->_handSCurves)) > 0) {
    SCurve* curve = GSetPop(&((*that)->_handSCurves));
    SCurveFree(&curve);
  }
  free(*that);
  *that = NULL;
}

// ---------------- GenBrush -------------------------

// Create a new GenBrush with a GBSurface of type GBSurfaceTypeImage
// and dimensions 'dim'
GenBrush* GBCreateImage(const VecShort2D* const dim) {
#if BUILDMODE == 0
  if (dim == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'dim' is null");
    PBErrCatch(GenBrushErr);
  }
  if (VecGet(dim, 0) <= 0 || VecGet(dim, 1) <= 0) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'dim' is invalid (%d>0,%d>0)",
      VecGet(dim, 0), VecGet(dim, 1));
    PBErrCatch(GenBrushErr);
  }
#endif
  // Declare the new GenBrush
  GenBrush* ret = PBErrMalloc(GenBrushErr, sizeof(GenBrush));
  // Set properties
  ret->_surf = (GBSurface*)GBSurfaceImageCreate(dim);
  ret->_pods = GSetCreateStatic();
  ret->_postProcs = GSetCreateStatic();
  // Return the new GenBrush
  return ret;
}

// Create a new GenBrush with one layer containing the content
// of the image located at 'fileName' and dimensions equal to the
// dimensions of the image
// If the image couldn't be loaded return NULL
GenBrush* GBCreateFromFile(const char* const fileName) {
  // Declare the new GenBrush
  GenBrush* ret = NULL;
  // Load the image in a surface
  GBSurfaceImage *img = GBSurfaceImageCreateFromFile(fileName);
  if (img != NULL) {
    // Declare the new GenBrush
    ret = PBErrMalloc(GenBrushErr, sizeof(GenBrush));
    // Set properties
    ret->_surf = (GBSurface*)img;
    ret->_pods = GSetCreateStatic();
    ret->_postProcs = GSetCreateStatic();
    GBSetFileName(ret, fileName);
  }
  // Return the new GenBrush
  return ret;

}

// Free memory used by the GenBrush 'that'
void GBFree(GenBrush** that) {
```

```
  // If the pointer is null
  if (that == NULL || *that == NULL)
    // Nothing to do
    return;
  // Free memory
  switch (GBGetType(*that)) {
    case GBSurfaceTypeDefault:
      GBSurfaceFree(&((*that)->_surf));
      break;
    case GBSurfaceTypeImage:
      GBSurfaceImageFree((GBSurfaceImage**)&((*that)->_surf));
      break;
    default:
      break;
  }
  GBRemoveAllPod(*that);
  GBRemoveAllPostProcess(*that);
  free(*that);
  *that = NULL;
}

// Get the dimensions of the GenBrush 'that'
VecShort2D* GBDim(const GenBrush* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return GBSurfaceDim(that->_surf);
}

// Update the GBSurface of the GenBrush 'that'
void GBUpdate(GenBrush* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Refresh the layers that have been modified
  // If there is layers
  if (GBGetNbLayer(that) > 0) {
    // Declare an iterator on the layers
    GSetIterForward iter =
      GSetIterForwardCreateStatic(GBSurfaceLayers(GBSurf(that)));
    // Loop on the layers
    do {
      // Get the current layer
      GBLayer* layer = GSetIterGet(&iter);
      // If this layer has been modified
      if (GBLayerIsModified(layer))
        // Refresh the layer content
        GBUpdateLayer(that, layer);
    } while (GSetIterStep(&iter));
  }
  // Request the update of the surface
  GBSurfaceUpdate(GBSurf(that));
  // Apply the post processing
  if (GSetNbElem(GBPostProcs(that)) > 0) {
```

```
    GSetIterForward iter =
      GSetIterForwardCreateStatic(GBPostProcs(that));
    do {
      GBPostProcessing* post = GSetIterGet(&iter);
      GBSurfacePostProcess(GBSurf(that), post);
    } while (GSetIterStep(&iter));
  }
}

// Update the content of the layer 'layer' of the GenBrush 'that'
// Flush the content of the layer and redraw all the pod attached to it
void GBUpdateLayer(GenBrush* const that, GBLayer* const layer) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (layer == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'layer' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Flush the content of the layer
  GBLayerFlush(layer);
  // If there is no pods
  if (GBGetNbPod(that) == 0)
    // Nothing to do
    return;
  // Declare an iterator on the set of pods
  GSetIterForward iter = GSetIterForwardCreateStatic(&(that->_pods));
  // Loop on pods
  do {
    // Get the current pod
    GBObjPod* pod = GSetIterGet(&iter);
    // If the pod is attahced ot the requested layer
    if (pod->_layer == layer)
      // Redraw the pod
      GBToolDraw(GBObjPodTool(pod), pod);
  } while (GSetIterStep(&iter));
}

// Render the GBSurface (save on disk, display on screen, ...) of
// the GenBrush 'that'
bool GBRender(GenBrush* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Declare a variable to memorize the success of rendering
  bool status = false;
  switch (GBSurfaceGetType(that->_surf)) {
    case GBSurfaceTypeImage:
      status = GBSurfaceImageSave((GBSurfaceImage*)(that->_surf));
      break;
#if BUILDWITHGRAPHICLIB == 1
    case GBSurfaceTypeWidget:
      GBSurfaceWidgetRender((GBSurfaceWidget*)(that->_surf));
```

```
      status = true;
      break;
    case GBSurfaceTypeApp:
      status = GBSurfaceAppRender((GBSurfaceApp*)(that->_surf));
      break;
#endif
    default:
      break;
  }
  // Return the status of rendering
  return status;
}

// Remove from the list of pods of the GenBrush 'that' those who
// match the 'obj', 'eye', 'hand', 'tool', 'ink' and 'layer'
// Null arguments are ignored. For example:
// GBRemovePod(that, elemA, NULL, NULL, NULL, NULL, NULL) removes all
// the pods related to the object 'elemA'
// GBRemovePod(that, elemA, NULL, handA, NULL, NULL, NULL) removes
// all the pods related to both the object 'elemA' AND 'handA'
// If all the filters are null it removes all the pods
void _GBRemovePod(GenBrush* const that, const void* const obj,
  const GBEye* const eye, const GBHand* const hand,
  const GBTool* const tool, const GBInk* const ink,
  const GBLayer* const layer) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // If there is no pods
  if (GBGetNbPod(that) == 0)
    // Nothing to do
    return;
  // Declare an iterator on the set of pods
  GSetIterForward iter = GSetIterForwardCreateStatic(&(that->_pods));
  // Declare a variable for the end condition of the loop
  bool flag = true;
  // Loop on pods
  while (flag) {
    // Get the current pod
    GBObjPod* pod = GSetIterGet(&iter);
    // If the pod matches the filters
    if ((obj == NULL || (void*)(pod->_srcPoint) == obj) &&
      (eye == NULL || pod->_eye == eye) &&
      (hand == NULL || pod->_hand == hand) &&
      (tool == NULL || pod->_tool == tool) &&
      (ink == NULL || pod->_ink == ink) &&
      (layer == NULL || pod->_layer == layer)) {
      // Remove the pod and move to the next one
      GBObjPodFree(&pod);
      flag = GSetIterRemoveElem(&iter);
    // Else the pod doesn't match the filters
    } else {
      // Move to the next pod
      flag = GSetIterStep(&iter);
    }
  }
}
```

```
// Set the eye to 'toEye' in the pods of the GenBrush 'that' who
// match the 'obj', 'eye', 'hand', 'tool', 'ink' and 'layer'
// Null arguments are ignored. For example:
// GBSetPodEye(that, toEye, elemA, NULL, NULL, NULL, NULL, NULL)
// affects all the pods related to the object 'elemA'
// GBSetPodEye(that, toEye, elemA, NULL, handA, NULL, NULL, NULL)
// affects all the pods related to both the object 'elemA' AND 'handA'
// If all the filters are null it affects all the pods
// If 'toEye' is null, do nothing
void _GBSetPodEye(GenBrush* const that, GBEye* const toEye,
  const void* const obj, const GBEye* const eye,
  const GBHand* const hand, const GBTool* const tool,
  const GBInk* const ink, const GBLayer* const layer) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // If 'toEye' is null or there is no pods
  if (toEye == NULL || GBGetNbPod(that) == 0)
    // Nothing to do
    return;
  // Declare an iterator on the set of pods
  GSetIterForward iter = GSetIterForwardCreateStatic(&(that->_pods));
  // Loop on pods
  do {
    // Get the current pod
    GBObjPod* pod = GSetIterGet(&iter);
    // If the pod matches the filters
    if ((obj == NULL || (void*)(pod->_srcPoint) == obj) &&
      (eye == NULL || pod->_eye == eye) &&
      (hand == NULL || pod->_hand == hand) &&
      (tool == NULL || pod->_tool == tool) &&
      (ink == NULL || pod->_ink == ink) &&
      (layer == NULL || pod->_layer == layer))
      // Set the eye of the pod
      pod->_eye = toEye;
  } while (GSetIterStep(&iter));
}

// Set the hand to 'toHand' in the pods of the GenBrush 'that' who
// match the 'obj', 'eye', 'hand', 'tool', 'ink' and 'layer'
// Null arguments are ignored. For example:
// GBSetPodEye(that, toHand, elemA, NULL, NULL, NULL, NULL, NULL)
// affects all the pods related to the object 'elemA'
// GBSetPodEye(that, toHand, elemA, NULL, handA, NULL, NULL, NULL)
// affects all the pods related to both the object 'elemA' AND 'handA'
// If all the filters are null it affects all the pods
// If 'toHand' is null, do nothing
void _GBSetPodHand(GenBrush* const that, GBHand* const toHand,
  const void* const obj, const GBEye* const eye,
  const GBHand* const hand, const GBTool* const tool,
  const GBInk* const ink, const GBLayer* const layer) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
```

```
  // If 'toHand' is null or there is no pods
  if (toHand == NULL || GBGetNbPod(that) == 0)
    // Nothing to do
    return;
  // Declare an iterator on the set of pods
  GSetIterForward iter = GSetIterForwardCreateStatic(&(that->_pods));
  // Loop on pods
  do {
    // Get the current pod
    GBObjPod* pod = GSetIterGet(&iter);
    // If the pod matches the filters
    if ((obj == NULL || (void*)(pod->_srcPoint) == obj) &&
      (eye == NULL || pod->_eye == eye) &&
      (hand == NULL || pod->_hand == hand) &&
      (tool == NULL || pod->_tool == tool) &&
      (ink == NULL || pod->_ink == ink) &&
      (layer == NULL || pod->_layer == layer))
      // Set the hand of the pod
      pod->_hand = toHand;
  } while (GSetIterStep(&iter));
}

// Set the tool to 'toTool' in the pods of the GenBrush 'that' who
// match the 'obj', 'eye', 'hand', 'tool', 'ink' and 'layer'
// Null arguments are ignored. For example:
// GBSetPodTool(that, toTool, elemA, NULL, NULL, NULL, NULL) affects
// all the pods related to the object 'elemA'
// GBSetPodTool(that, toTool, elemA, NULL, handA, NULL, NULL) affects
// all the pods related to both the object 'elemA' AND 'handA'
// If all the filters are null it affects all the pods
// If 'toTool' is null, do nothing
void _GBSetPodTool(GenBrush* const that, GBTool* const toTool,
  const void* const obj, const GBEye* const eye,
  const GBHand* const hand, const GBTool* const tool,
  const GBInk* const ink, const GBLayer* const layer) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // If 'toTool' is null or there is no pods
  if (toTool == NULL || GBGetNbPod(that) == 0)
    // Nothing to do
    return;
  // Declare an iterator on the set of pods
  GSetIterForward iter = GSetIterForwardCreateStatic(&(that->_pods));
  // Loop on pods
  do {
    // Get the current pod
    GBObjPod* pod = GSetIterGet(&iter);
    // If the pod matches the filters
    if ((obj == NULL || (void*)(pod->_srcPoint) == obj) &&
      (eye == NULL || pod->_eye == eye) &&
      (hand == NULL || pod->_hand == hand) &&
      (tool == NULL || pod->_tool == tool) &&
      (ink == NULL || pod->_ink == ink) &&
      (layer == NULL || pod->_layer == layer))
      // Set the tool of the pod
      pod->_tool = toTool;
  } while (GSetIterStep(&iter));
```

```
}

// Set the ink to 'toInk' in the pods of the GenBrush 'that' who
// match the 'obj', 'eye', 'hand', 'tool', 'ink' and 'layer'
// Null arguments are ignored. For example:
// GBSetPodTool(that, toTool, elemA, NULL, NULL, NULL, NULL) affects
// all the pods related to the object 'elemA'
// GBSetPodTool(that, toTool, elemA, NULL, handA, NULL, NULL) affects
// all the pods related to both the object 'elemA' AND 'handA'
// If all the filters are null it affects all the pods
// If 'toInk' is null, do nothing
void _GBSetPodInk(GenBrush* const that, GBInk* const toInk,
  const void* const obj, const GBEye* const eye,
  const GBHand* const hand, const GBTool* const tool,
  const GBInk* const ink, const GBLayer* const layer) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // If 'toInk' is null or there is no pods
  if (toInk == NULL || GBGetNbPod(that) == 0)
    // Nothing to do
    return;
  // Declare an iterator on the set of pods
  GSetIterForward iter = GSetIterForwardCreateStatic(&(that->_pods));
  // Loop on pods
  do {
    // Get the current pod
    GBObjPod* pod = GSetIterGet(&iter);
    // If the pod matches the filters
    if ((obj == NULL || (void*)(pod->_srcPoint) == obj) &&
      (eye == NULL || pod->_eye == eye) &&
      (hand == NULL || pod->_hand == hand) &&
      (tool == NULL || pod->_tool == tool) &&
      (ink == NULL || pod->_ink == ink) &&
      (layer == NULL || pod->_layer == layer))
      // Set the tool of the pod
      pod->_ink = toInk;
  } while (GSetIterStep(&iter));
}

// Set the layer to 'toLayer' in the pods of the GenBrush 'that' who
// match the 'obj', 'eye', 'hand', 'tool', 'ink' and 'layer'
// Null arguments are ignored. For example:
// GBSetPodLayer(that, toLayer, elemA, NULL, NULL, NULL, NULL, NULL)
// affects all the pods related to the object 'elemA'
// GBSetPodLayer(that, toLayer, elemA, NULL, handA, NULL, NULL, NULL)
// affects all the pods related to both the object 'elemA' AND 'handA'
// If all the filters are null it affects all the pods
// If 'toLayer' is null, do nothing
void _GBSetPodLayer(GenBrush* const that, GBLayer* const toLayer,
  const void* const obj, const GBEye* const eye,
  const GBHand* const hand, const GBTool* const tool,
  const GBInk* const ink, const GBLayer* const layer) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
```

```
  }
#endif
  // If 'toLayer' is null or there is no pods
  if (toLayer == NULL || GBGetNbPod(that) == 0)
    // Nothing to do
    return;
  // Declare an iterator on the set of pods
  GSetIterForward iter = GSetIterForwardCreateStatic(&(that->_pods));
  // Loop on pods
  do {
    // Get the current pod
    GBObjPod* pod = GSetIterGet(&iter);
    // If the pod matches the filters
    if ((obj == NULL || (void*)(pod->_srcPoint) == obj) &&
      (eye == NULL || pod->_eye == eye) &&
      (hand == NULL || pod->_hand == hand) &&
      (tool == NULL || pod->_tool == tool) &&
      (ink == NULL || pod->_ink == ink) &&
      (layer == NULL || pod->_layer == layer))
      // Set the layer of the pod
      pod->_layer = toLayer;
  } while (GSetIterStep(&iter));
}

// Set to true the modified flag of the layers of pods attached to the
// object 'obj' in the list of pods of the GenBrush 'that'
void _GBNotifyChangeFromObj(GenBrush* const that,
  const void* const obj) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (obj == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'obj' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // If there is no pods
  if (GBGetNbPod(that) == 0)
    // Nothing to do
    return;
  // Declare an iterator on the set of pods
  GSetIterForward iter = GSetIterForwardCreateStatic(&(that->_pods));
  // Loop on pods
  do {
    // Get the current pod
    GBObjPod* pod = GSetIterGet(&iter);
    // If the pod matches the filter
    if (GBObjPodObj(pod) == obj) {
      // Reprocess the object
      GBEyeProcess(GBObjPodEye(pod), pod);
      GBHandProcess(GBObjPodHand(pod), pod);
      // Set the layer flag
      GBLayerSetModified(pod->_layer, true);
    }
  } while (GSetIterStep(&iter));
}

// Set to true the modified flag of the layers of pods attached to the
```

```
// GBEye 'eye' in the list of pods of the GenBrush 'that'
void _GBNotifyChangeFromEye(GenBrush* const that,
  const GBEye* const eye) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (eye == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'eye' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // If there is no pods
  if (GBGetNbPod(that) == 0)
    // Nothing to do
    return;
  // Declare an iterator on the set of pods
  GSetIterForward iter = GSetIterForwardCreateStatic(&(that->_pods));
  // Loop on pods
  do {
    // Get the current pod
    GBObjPod* pod = GSetIterGet(&iter);
    // If the pod matches the filter
    if (GBObjPodEye(pod) == eye) {
      // Reprocess the object
      GBEyeProcess(GBObjPodEye(pod), pod);
      GBHandProcess(GBObjPodHand(pod), pod);
      // Set the layer flag
      GBLayerSetModified(pod->_layer, true);
    }
  } while (GSetIterStep(&iter));
}

// Set to true the modified flag of the layers of pods attached to the
// GBInk 'ink' in the list of pods of the GenBrush 'that'
void _GBNotifyChangeFromInk(GenBrush* const that,
  const GBInk* const ink) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (ink == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'ink' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // If there is no pods
  if (GBGetNbPod(that) == 0)
    // Nothing to do
    return;
  // Declare an iterator on the set of pods
  GSetIterForward iter = GSetIterForwardCreateStatic(&(that->_pods));
  // Loop on pods
  do {
    // Get the current pod
    GBObjPod* pod = GSetIterGet(&iter);
```

```
    // If the pod matches the filter
    if (pod->_ink == ink)
      // Set the layer flag
      GBLayerSetModified(pod->_layer, true);
  } while (GSetIterStep(&iter));
}

// Set to true the modified flag of the layers of pods attached to the
// GBHand 'hand' in the list of pods of the GenBrush 'that'
void _GBNotifyChangeFromHand(GenBrush* const that,
  const GBHand* const hand) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (hand == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'hand' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // If there is no pods
  if (GBGetNbPod(that) == 0)
    // Nothing to do
    return;
  // Declare an iterator on the set of pods
  GSetIterForward iter = GSetIterForwardCreateStatic(&(that->_pods));
  // Loop on pods
  do {
    // Get the current pod
    GBObjPod* pod = GSetIterGet(&iter);
    // If the pod matches the filter
    if (GBObjPodHand(pod) == hand) {
      GBHandProcess(GBObjPodHand(pod), pod);
      // Set the layer flag
      GBLayerSetModified(pod->_layer, true);
    }
  } while (GSetIterStep(&iter));
}

// Set to true the modified flag of the layers of pods attached to the
// GBTool 'tool' in the list of pods of the GenBrush 'that'
void _GBNotifyChangeFromTool(GenBrush* const that,
  const GBTool* const tool) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (tool == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'tool' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // If there is no pods
  if (GBGetNbPod(that) == 0)
    // Nothing to do
    return;
```

```
  // Declare an iterator on the set of pods
  GSetIterForward iter = GSetIterForwardCreateStatic(&(that->_pods));
  // Loop on pods
  do {
    // Get the current pod
    GBObjPod* pod = GSetIterGet(&iter);
    // If the pod matches the filter
    if (pod->_tool == tool)
      // Set the layer flag
      GBLayerSetModified(pod->_layer, true);
  } while (GSetIterStep(&iter));
}

// Return a clone of the GenBrush 'that' with its final surface scaled
// to the dimensions 'dim' according to the scaling method 'scaleMethod'
GenBrush* GBScale(const GenBrush* const that,
  const VecShort2D* const dim, const GBScaleMethod scaleMethod) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (dim == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'dim' is null");
    PBErrCatch(GenBrushErr);
  }
  if (VecGet(dim, 0) <= 0 || VecGet(dim, 1) <= 0) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'dim' is invalid (%d>0,%d>0)",
      VecGet(dim, 0), VecGet(dim, 1));
    PBErrCatch(GenBrushErr);
  }
#endif
  // Declare the scaled version of the GenBrush
  GenBrush* scaledGB = NULL;
  // Call the appropriate scaling method
  switch (scaleMethod) {
    case GBScaleMethod_AvgNeighbour:
      scaledGB = GBScaleAvgNeighbour(that, dim);
      break;
    default:
      break;
  }
  // Return the scaled version of the GenBrush
  return scaledGB;
}

// Return a clone of the GenBrush 'that' with its final surface scaled
// to the dimensions 'dim' according to the scaling method AvgNeighbour
GenBrush* GBScaleAvgNeighbour(const GenBrush* const that,
  const VecShort2D* const dim) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (dim == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'dim' is null");
```

```
    PBErrCatch(GenBrushErr);
  }
  if (VecGet(dim, 0) <= 0 || VecGet(dim, 1) <= 0) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'dim' is invalid (%d>0,%d>0)",
      VecGet(dim, 0), VecGet(dim, 1));
    PBErrCatch(GenBrushErr);
  }
#endif
  // Declare the scaled version of the GenBrush
  GenBrush* scaledGB = GBCreateImage(dim);
  // Calculate the scale factors along each axis
  VecFloat2D scaleFactor = VecFloatCreateStatic2D();
  VecSet(&scaleFactor, 0,
    (float)VecGet(dim, 0) / (float)VecGet(GBDim(that), 0));
  VecSet(&scaleFactor, 1,
    (float)VecGet(dim, 1) / (float)VecGet(GBDim(that), 1));
  // Declare variables to calculate the average of pixels in the
  // original image
  int nbPix = 0;
  VecFloat* avgPix = VecFloatCreate(4);
  // Declare a variable to loop on the scaled image
  VecShort2D posScaled = VecShortCreateStatic2D();
  // Loop on pixels of the scaled image
  do {
    // Get the floating point position in the original image of
    // the lower left and upper right of the 3x3 cell around for this
    // pixel
    VecFloat2D posLLFloat = VecFloatCreateStatic2D();
    VecSet(&posLLFloat, 0,
      (float)(VecGet(&posScaled, 0) - 1) / VecGet(&scaleFactor, 0));
    VecSet(&posLLFloat, 1,
      (float)(VecGet(&posScaled, 1) - 1) / VecGet(&scaleFactor, 1));
    VecFloat2D posURFloat = VecFloatCreateStatic2D();
    VecSet(&posURFloat, 0,
      (float)(VecGet(&posScaled, 0) + 1) / VecGet(&scaleFactor, 0));
    VecSet(&posURFloat, 1,
      (float)(VecGet(&posScaled, 1) + 1) / VecGet(&scaleFactor, 1));
    // Get the integer position in the original image of
    // the lower left and upper right of the 3x3 cell around for this
    // pixel
    // Ensure the positions are inside the original image
    VecShort2D posLL = VecShortCreateStatic2D();
    VecSet(&posLL, 0, MAX(0, (short)floor(VecGet(&posLLFloat, 0))));
    VecSet(&posLL, 1, MAX(0, (short)floor(VecGet(&posLLFloat, 1))));
    VecShort2D posUR = VecShortCreateStatic2D();
    VecSet(&posUR, 0,
      MIN(VecGet(GBDim(that), 0), (short)floor(VecGet(&posURFloat, 0))));
    VecSet(&posUR, 1,
      MIN(VecGet(GBDim(that), 1), (short)floor(VecGet(&posURFloat, 1))));
    // Init the variables to calculate the average of pixels in the
    // original image
    nbPix = 0;
    VecSetNull(avgPix);
    // Declare a variable to loop on the original image
    VecShort2D posOrig = posLL;
    // Loop on the pixels of the original image
    do {
      // Get the pixel in the original image
      const GBPixel* pix = GBSurfaceFinalPixel(GBSurf(that), &posOrig);
      // Calculate the average pixel
      ++nbPix;
```

```
      for (int i = 4; i--;)
        VecSet(avgPix, i, VecGet(avgPix, i) + (float)(pix->_rgba[i]));
    } while (VecShiftStep(&posOrig, &posLL, &posUR));
    // Calculate the average pixel
    VecScale(avgPix, 1.0 / (float)nbPix);
    // Get the pixel in the original image
    GBPixel* pixScaled =
      GBSurfaceFinalPixel(GBSurf(scaledGB), &posScaled);
    // Update the pixel in the scaled image with the average pixel
    for (int i = 4; i--;)
      pixScaled->_rgba[i] = (unsigned char)VecGet(avgPix, i);
  } while (VecStep(&posScaled, dim));
  // Free memory
  VecFree(&avgPix);
  // Return the scaled version of the GenBrush
  return scaledGB;
}

// Return a clone of the GenBrush 'that' with its final surface cropped
// to the dimensions 'dim' from the lower right position 'posLR'
// If the cropping area is partially or totally outside of the
// original image, pixels outside of the image are filled with
// 'fillPix' or left to their default value (cf GBSurfaceCreate) if
// 'fillPix is NULL
GenBrush* GBCrop(const GenBrush* const that,
  const VecShort2D* const posLR, const VecShort2D* const dim,
  const GBPixel* const fillPix) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (dim == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'dim' is null");
    PBErrCatch(GenBrushErr);
  }
  if (VecGet(dim, 0) <= 0 || VecGet(dim, 1) <= 0) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'dim' is invalid (%d>0,%d>0)",
      VecGet(dim, 0), VecGet(dim, 1));
    PBErrCatch(GenBrushErr);
  }
#endif
  // Declare the cropped version of the GenBrush
  GenBrush* croppedGB = GBCreateImage(dim);
  // Declare a variable to loop on the cropped image
  VecShort2D posCropped = VecShortCreateStatic2D();
  // Loop on pixels of the scaled image
  do {
    // Get the position in the original image
    VecShort2D posOrig = VecGetOp(posLR, 1, &posCropped, 1);
    // Get the pixel in the original image
    const GBPixel* pixOrig =
      GBSurfaceFinalPixelSafe(GBSurf(that), &posOrig);
    // If the pixel is inside the image
    if (pixOrig != NULL) {
      // Copy the pixel in the cropped image
      GBSurfaceSetFinalPixel(GBSurf(croppedGB), &posCropped, pixOrig);
    } else if (fillPix != NULL) {
      // Copy the filling pixel in the cropped image
```

```
      GBSurfaceSetFinalPixel(GBSurf(croppedGB), &posCropped, fillPix);
    }
  } while (VecStep(&posCropped, dim));
  // Return the cropped version of the GenBrush
  return croppedGB;
}

// Duplicate the final pixels of the GenBrush 'src' to the
// GenBrush 'dest' for the area starting at 'posSrc' in 'src' and
// 'posDest' in 'dest' and having dimension 'dim'
// The fragment must be fully included in both 'src' and 'dest'
void GBCopyFragment(const GenBrush* const src, GenBrush* const dest,
  const VecShort2D* const posSrc, const VecShort2D* const posDest,
  const VecShort2D* const dim) {
#if BUILDMODE == 0
  if (src == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'src' is null");
    PBErrCatch(GenBrushErr);
  }
  if (dest == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'dest' is null");
    PBErrCatch(GenBrushErr);
  }
  if (posSrc == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'posSrc' is null");
    PBErrCatch(GenBrushErr);
  }
  if (posDest == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'posDest' is null");
    PBErrCatch(GenBrushErr);
  }
  if (dim == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'dim' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Declare a variable to loop on pixels
  VecShort2D pos = VecShortCreateStatic2D();

  // Loop on pixels
  do {

    // Get the position in the source
    VecShort2D pSrc = VecGetOp(&pos, 1, posSrc, 1);

    // Get the position in the destination
    VecShort2D pDest = VecGetOp(&pos, 1, posDest, 1);

    // Get the pixel from the source
    GBPixel pix = GBGetFinalPixel(src, &pSrc);

    // Set the pixel in the destination
    GBSetFinalPixel(dest, &pDest, &pix);

  } while (VecStep(&pos, dim));
}
```

```
// ================ GTK Functions ====================
#if BUILDWITHGRAPHICLIB == 1
  #include "genbrush-GTK.c"
#endif
```

3.2 genbrush-inline.c

```
// ============ GENBRUSH-INLINE.C ================

// ================ Functions implementation ====================

// ---------------- GBPixel --------------------------

// Return true if the GBPixel 'that' and 'tho' are the same, else false.
#if BUILDMODE != 0
inline
#endif
bool GBPixelIsSame(const GBPixel* const that, const GBPixel* const tho) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (tho == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'tho' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return (memcmp(that, tho, sizeof(GBPixel)) == 0);
}

// ---------------- GBLayer --------------------------

// Get the area of the layer (width * height)
#if BUILDMODE != 0
inline
#endif
int GBLayerArea(const GBLayer* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return (int)VecGet(&(that->_dim), 0) *
    (int)VecGet(&(that->_dim), 1);
}

// Get the position of the GBLayer 'that'
#if BUILDMODE != 0
inline
#endif
VecShort2D* GBLayerPos(const GBLayer* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
```

```
    PBErrCatch(GenBrushErr);
  }
#endif
  return (VecShort2D*)&(that->_pos);
}

// Get a copy of the position of the GBLayer 'that'
#if BUILDMODE != 0
inline
#endif
VecShort2D GBLayerGetPos(const GBLayer* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_pos;
}

// Set the position of the GBLayer 'that' to 'pos'
// If the flag _modified==false _prevPos is first set to _pos
// and _modified is set to true
#if BUILDMODE != 0
inline
#endif
void GBLayerSetPos(GBLayer* const that, const VecShort2D* const pos) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pos == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pos' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  if (!(that->_modified)) {
    that->_modified = true;
    that->_prevPos = that->_pos;
  }
  that->_pos = *pos;
}

// Get the previous position of the GBLayer 'that'
#if BUILDMODE != 0
inline
#endif
VecShort2D* GBLayerPrevPos(const GBLayer* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return (VecShort2D*)&(that->_prevPos);
}
```

```
// Get a copy of the previous position of the GBLayer 'that'
#if BUILDMODE != 0
inline
#endif
VecShort2D GBLayerGetPrevPos(const GBLayer* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_prevPos;
}

// Get the scale of the GBLayer 'that'
#if BUILDMODE != 0
inline
#endif
VecFloat2D* GBLayerScale(const GBLayer* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return (VecFloat2D*)&(that->_scale);
}

// Get a copy of the scale of the GBLayer 'that'
#if BUILDMODE != 0
inline
#endif
VecFloat2D GBLayerGetScale(const GBLayer* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_scale;
}

// Set the scale of the GBLayer 'that' to 'scale'
// If the flag _modified==false _prevScale is first set to _scale
// and _modified is set to true
#if BUILDMODE != 0
inline
#endif
void GBLayerSetScale(GBLayer* const that, const VecFloat2D* const scale) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (scale == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'scale' is null");
    PBErrCatch(GenBrushErr);
```

```
  }
#endif
  if (!(that->_modified)) {
    that->_modified = true;
    that->_prevScale = that->_scale;
  }
  that->_scale = *scale;
}

// Get the previous scale of the GBLayer 'that'
#if BUILDMODE != 0
inline
#endif
VecFloat2D* GBLayerPrevScale(const GBLayer* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return (VecFloat2D*)&(that->_prevScale);
}

// Get a copy of the previous scale of the GBLayer 'that'
#if BUILDMODE != 0
inline
#endif
VecFloat2D GBLayerGetPrevScale(const GBLayer* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_prevScale;
}

// Get the dimensions of the GBLayer 'that'
#if BUILDMODE != 0
inline
#endif
VecShort2D* GBLayerDim(const GBLayer* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return (VecShort2D*)&(that->_dim);
}

// Get a copy of the dimensions of the GBLayer 'that'
#if BUILDMODE != 0
inline
#endif
VecShort2D GBLayerGetDim(const GBLayer* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
```

```
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_dim;
}

// Get a copy of the blend mode of the GBLayer 'that'
#if BUILDMODE != 0
inline
#endif
GBLayerBlendMode GBLayerGetBlendMode(const GBLayer* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_blendMode;
}

// Set the blend mode of the GBLayer 'that' to 'blend'
// Set the flag _modified to true
#if BUILDMODE != 0
inline
#endif
void GBLayerSetBlendMode(GBLayer* const that,
  const GBLayerBlendMode blend) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  that->_modified = true;
  that->_blendMode = blend;
}

// Get a copy of the modified flag of the GBLayer 'that'
#if BUILDMODE != 0
inline
#endif
bool GBLayerIsModified(const GBLayer* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_modified;
}

// Set the modified flag of the GBLayer 'that' to 'flag'
#if BUILDMODE != 0
inline
#endif
void GBLayerSetModified(GBLayer* const that, const bool flag) {
#if BUILDMODE == 0
  if (that == NULL) {
```

```
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  that->_modified = flag;
}

// Get a copy of the stack position of the GBLayer 'that'
#if BUILDMODE != 0
inline
#endif
GBLayerStackPosition GBLayerGetStackPos(const GBLayer* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_stackPos;
}

// Set the stack position of the GBLayer 'that' to 'pos'
// Set the flag _modified to true
#if BUILDMODE != 0
inline
#endif
void GBLayerSetStackPos(GBLayer* const that,
  const GBLayerStackPosition pos) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  that->_modified = true;
  that->_stackPos = pos;
}

// Get the stacked pixels of the GBLayer 'that'
#if BUILDMODE != 0
inline
#endif
GSet* GBLayerPixels(const GBLayer* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_pix;
}

// Get the stacked pixels of the GBLayer 'that' at position 'pos'
// 'pos' must be inside the layer
#if BUILDMODE != 0
inline
#endif
GSet* GBLayerPixel(const GBLayer* const that,
```

```
  const VecShort2D* const pos) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pos == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pos' is null");
    PBErrCatch(GenBrushErr);
  }
  if (!GBLayerIsPosInside(that, pos)) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'pos' is out of the layer (%d,%d)",
      VecGet(pos, 0), VecGet(pos, 1));
    PBErrCatch(GenBrushErr);
  }
#endif
  int iPix = GBPosIndex(pos, GBLayerDim(that));
  return that->_pix + iPix;
}

// Get the stacked pixels of the GBLayer 'that' at position 'pos'
// If 'pos' is out of the layer return NULL
#if BUILDMODE != 0
inline
#endif
GSet* GBLayerPixelSafe(const GBLayer* const that,
  const VecShort2D* const pos) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pos == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pos' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  if (!GBLayerIsPosInside(that, pos))
    return NULL;
  else
    return GBLayerPixel(that, pos);
}

// Add the pixel 'pix' with depth 'depth' on top of the stack at
// position 'pos' of GBLayer 'that'
// Set the flag _modified to true
// 'pos' must be inside the layer
// If the pixel is completely transparent (_rgba[GBPixelAlpha]==0)
// do nothing
#if BUILDMODE != 0
inline
#endif
void GBLayerAddPixel(GBLayer* const that, const VecShort2D* const pos,
  const GBPixel* const pix, const float depth) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
```

```
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pos == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pos' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pix == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pix' is null");
    PBErrCatch(GenBrushErr);
  }
  if (!GBLayerIsPosInside(that, pos)) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'pos' is out of the layer (%d,%d)",
      VecGet(pos, 0), VecGet(pos, 1));
    PBErrCatch(GenBrushErr);
  }
#endif
  // If the pixel is transparent
  if (pix->_rgba[GBPixelAlpha] == 0)
    // Do nothing
    return;
  int iPix = GBPosIndex(pos, GBLayerDim(that));
  GBStackedPixel* clone = PBErrMalloc(GenBrushErr,
    sizeof(GBStackedPixel));
  clone->_val = *pix;
  clone->_depth = depth;
  clone->_blendMode = GBLayerGetBlendMode(that);
  GSetAppend(that->_pix + iPix, clone);
}

// Add the pixel 'pix' with depth 'depth' on top of the stack at
// position 'pos' of GBLayer 'that'
// Set the flag _modified to true
// If 'pos' is out of the layer do nothing
// If the pixel is completely transparent (_rgba[GBPixelAlpha]==0)
// do nothing
#if BUILDMODE != 0
inline
#endif
void GBLayerAddPixelSafe(GBLayer* const that,
  const VecShort2D* const pos, const GBPixel* const pix,
  const float depth) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pos == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pos' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pix == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pix' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
```

```
  if (GBLayerIsPosInside(that, pos))
    GBLayerAddPixel(that, pos, pix, depth);
}

// Return true if the position 'pos' is inside the layer 'that'
// boundary, false else
#if BUILDMODE != 0
inline
#endif
bool GBLayerIsPosInside(const GBLayer* const that,
  const VecShort2D* const pos) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pos == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pos' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  if (VecGet(pos, 0) >= 0 &&
    VecGet(pos, 1) >= 0 &&
    VecGet(pos, 0) < VecGet(GBLayerDim(that), 0) &&
    VecGet(pos, 1) < VecGet(GBLayerDim(that), 1))
    return true;
  else
    return false;
}

// Delete all the stacked pixels in the GBLayer 'that'
#if BUILDMODE != 0
inline
#endif
void GBLayerFlush(GBLayer* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  for (int iPix = GBLayerArea(that); iPix--;) {
    GSet *stack = that->_pix + iPix;
    while (GSetNbElem(stack) > 0) {
      GBStackedPixel *pix = GSetPop(stack);
      free(pix);
    }
  }
}

// ---------------- GBPostProcessing -------------------------

// Return the type of the GBPostProcessing 'that'
#if BUILDMODE != 0
inline
#endif
GBPPType GBPostProcessingGetType(const GBPostProcessing* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
```

```
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_type;
}

// ---------------- GBSurface --------------------------

// Return true if the GBSurface 'that' has same dimension and same
// values for _finalPix as GBSurface 'surf'
// Else, return false
#if BUILDMODE != 0
inline
#endif
bool GBSurfaceIsSameAs(const GBSurface* const that,
  const GBSurface* const surf) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (surf == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'surf' is null");
    PBErrCatch(GenBrushErr);
  }
#endif

  // Display different pixels, for debugging purpose
  /*VecShort2D p = VecShortCreateStatic2D();
  do {
    GBPixel* pA = GBSurfaceFinalPixel(that, &p);
    GBPixel* pB = GBSurfaceFinalPixel(surf, &p);
    if (pA->_rgba[0] != pB->_rgba[0] ||
      pA->_rgba[1] != pB->_rgba[1] ||
      pA->_rgba[2] != pB->_rgba[2] ||
      pA->_rgba[3] != pB->_rgba[3]) {
      VecPrint(&p, stdout);
      printf(" %d,%d,%d,%d %d,%d,%d,%d\n",
        pA->_rgba[0], pA->_rgba[1], pA->_rgba[2], pA->_rgba[3],
        pB->_rgba[0], pB->_rgba[1], pB->_rgba[2], pB->_rgba[3]);
    }
  } while (VecStep(&p, GBSurfaceDim(that)));*/

  if (VecIsEqual(GBSurfaceDim(that), GBSurfaceDim(surf)) &&
    memcmp(GBSurfaceFinalPixels(that), GBSurfaceFinalPixels(surf),
    sizeof(GBPixel) * VecGet(GBSurfaceDim(that), 0) *
    VecGet(GBSurfaceDim(that), 1)) == 0)
    return true;
  else
    return false;
}

// Get the type of the GBSurface 'that'
#if BUILDMODE != 0
inline
#endif
GBSurfaceType GBSurfaceGetType(const GBSurface* const that) {
#if BUILDMODE == 0
```

```
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_type;
}

// Get a copy of the dimensions of the GBSurface 'that'
#if BUILDMODE != 0
inline
#endif
VecShort2D GBSurfaceGetDim(const GBSurface* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_dim;
}

// Get the dimensions of the GBSurface 'that'
#if BUILDMODE != 0
inline
#endif
VecShort2D* GBSurfaceDim(const GBSurface* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return (VecShort2D*)&(that->_dim);
}

// Get the final pixels of the GBSurface 'that'
#if BUILDMODE != 0
inline
#endif
GBPixel* GBSurfaceFinalPixels(const GBSurface* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_finalPix;
}

// Get the final pixel at position 'pos' of the GBSurface 'that'
// 'pos' must be in the surface
#if BUILDMODE != 0
inline
#endif
GBPixel* GBSurfaceFinalPixel(const GBSurface* const that,
  const VecShort2D* const pos) {
#if BUILDMODE == 0
```

```
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pos == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pos' is null");
    PBErrCatch(GenBrushErr);
  }
  if (!GBSurfaceIsPosInside(that, pos)) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'pos' is out of the surface (%d,%d)",
      VecGet(pos, 0),VecGet(pos, 1));
    PBErrCatch(GenBrushErr);
  }
#endif
  int iPix = GBPosIndex(pos, GBSurfaceDim(that));
  return that->_finalPix + iPix;
}

// Get a copy of the final pixel at position 'pos' of the GBSurface
// 'that'
// 'pos' must be in the surface
#if BUILDMODE != 0
inline
#endif
GBPixel GBSurfaceGetFinalPixel(const GBSurface* const that,
  const VecShort2D* const pos) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pos == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pos' is null");
    PBErrCatch(GenBrushErr);
  }
  if (!GBSurfaceIsPosInside(that, pos)) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'pos' is out of the surface (%d,%d)",
      VecGet(pos, 0),VecGet(pos, 1));
    PBErrCatch(GenBrushErr);
  }
#endif
  int iPix = GBPosIndex(pos, GBSurfaceDim(that));
  return that->_finalPix[iPix];
}

// Set the final pixel at position 'pos' of the GBSurface 'that' to
// the pixel 'pix'
// 'pos' must be in the surface
#if BUILDMODE != 0
inline
#endif
void GBSurfaceSetFinalPixel(GBSurface* const that,
  const VecShort2D* const pos, const GBPixel* const pix) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
```

```
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pos == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pos' is null");
    PBErrCatch(GenBrushErr);
  }
  if (!GBSurfaceIsPosInside(that, pos)) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'pos' is out of the surface (%d,%d)",
      VecGet(pos, 0),VecGet(pos, 1));
    PBErrCatch(GenBrushErr);
  }
#endif
  int iPix = GBPosIndex(pos, GBSurfaceDim(that));
  that->_finalPix[iPix] = *pix;
}

// Get the final pixel at position 'pos' of the GBSurface 'that'
// If 'pos' is out of the surface return NULL
#if BUILDMODE != 0
inline
#endif
GBPixel* GBSurfaceFinalPixelSafe(const GBSurface* const that,
  const VecShort2D* const pos) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pos == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pos' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  if (GBSurfaceIsPosInside(that, pos))
    return GBSurfaceFinalPixel(that, pos);
  else
    return NULL;
}

// Get a copy of the final pixel at position 'pos' of the GBSurface
// 'that'
// If 'pos' is out of the surface return a transparent pixel
#if BUILDMODE != 0
inline
#endif
GBPixel GBSurfaceGetFinalPixelSafe(const GBSurface* const that,
  const VecShort2D* const pos) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pos == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pos' is null");
    PBErrCatch(GenBrushErr);
```

```
  }
#endif
  if (GBSurfaceIsPosInside(that, pos))
    return GBSurfaceGetFinalPixel(that, pos);
  else
    return GBColorTransparent;
}

// Set the final pixel at position 'pos' of the GBSurface 'that' to
// the pixel 'pix'
// If 'pos' is out of the surface do nothing
#if BUILDMODE != 0
inline
#endif
void GBSurfaceSetFinalPixelSafe(GBSurface* const that,
  const VecShort2D* const pos, const GBPixel* const pix) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pos == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pos' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pix == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pix' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  if (GBSurfaceIsPosInside(that, pos))
    GBSurfaceSetFinalPixel(that, pos, pix);
}

// Get the area of the GBSurface 'that'
#if BUILDMODE != 0
inline
#endif
long GBSurfaceArea(const GBSurface* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return VecGet(&(that->_dim), 0) * VecGet(&(that->_dim), 1);
}

// Get the background color of the GBSurface 'that'
#if BUILDMODE != 0
inline
#endif
GBPixel* GBSurfaceBgColor(const GBSurface* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
```

```
  }
#endif
  return (GBPixel*)&(that->_bgColor);
}

// Get a copy of the background color of the GBSurface 'that'
#if BUILDMODE != 0
inline
#endif
GBPixel GBSurfaceGetBgColor(const GBSurface* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_bgColor;
}

// Set the background color of the GBSurface 'that' to 'col'
#if BUILDMODE != 0
inline
#endif
void GBSurfaceSetBgColor(GBSurface* const that,
  const GBPixel* const col) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (col == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'col' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  that->_bgColor = *col;
}

// Return true if the position 'pos' is inside the GBSurface 'that'
// boundary, false else
#if BUILDMODE != 0
inline
#endif
bool GBSurfaceIsPosInside(const GBSurface* const that,
  const VecShort2D* const pos) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pos == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pos' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  if (VecGet(pos, 0) >= 0 &&
    VecGet(pos, 1) >= 0 &&
```

```
    VecGet(pos, 0) < VecGet(GBSurfaceDim(that), 0) &&
    VecGet(pos, 1) < VecGet(GBSurfaceDim(that), 1))
    return true;
  else
    return false;
}

// Get the seet of layers of the GBSurface 'that'
#if BUILDMODE != 0
inline
#endif
GSet* GBSurfaceLayers(const GBSurface* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return (GSet*)&(that->_layers);
}

// Add a new GBLayer with dimensions 'dim' to the top of the stack
// of layers of the GBSurface 'that'
// Return the new GBLayer
#if BUILDMODE != 0
inline
#endif
GBLayer* GBSurfaceAddLayer(GBSurface* const that,
  const VecShort2D* const dim) {
#if BUILDMODE == 0
  if (dim == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'dim' is null");
    PBErrCatch(GenBrushErr);
  }
  if (VecGet(dim, 0) <= 0 || VecGet(dim, 1) <= 0) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'dim' is invalid (%d>0,%d>0)",
      VecGet(dim, 0), VecGet(dim, 1));
    PBErrCatch(GenBrushErr);
  }
#endif
  // Create the layer
  GBLayer* layer = GBLayerCreate(dim);
  // Add the new layer to the set of layers
  GSetAppend(&(that->_layers), layer);
  // Return the new layer
  return layer;
}

// 'fileName' to the top of the stack of layers of the GBSurface
// 'that'
// Return the new GBLayer
#if BUILDMODE != 0
inline
#endif
GBLayer* GBSurfaceAddLayerFromFile(GBSurface* const that,
  const char* const fileName) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
```

```
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (fileName == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'fileName' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Create the layer from the file
  GBLayer* layer = GBLayerCreateFromFile(fileName);
  // If we could create the layer
  if (layer != NULL)
    // Add the layer to the surface
    GSetAppend(&(that->_layers), layer);
  // Return the new layer
  return layer;
}

// Get the 'iLayer'-th layer of the GBSurface 'that'
// 'iLayer' must be valid
#if BUILDMODE != 0
inline
#endif
GBLayer* GBSurfaceLayer(const GBSurface* const that, const int iLayer) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (iLayer < 0 || iLayer >= GSetNbElem(&(that->_layers))) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'iLayer' is invalid (0<=%d<%ld)",
      iLayer, GSetNbElem(&(that->_layers)));
    PBErrCatch(GenBrushErr);
  }
#endif
  return (GBLayer*)GSetGet(&(that->_layers), iLayer);
}

// Get the number of layer of the GBSurface 'that'
#if BUILDMODE != 0
inline
#endif
int GBSurfaceNbLayer(const GBSurface* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return GSetNbElem(&(that->_layers));
}

// Set the _modified flag of all layers of the GBSurface 'that'
// to 'flag'
#if BUILDMODE != 0
inline
#endif
void GBSurfaceSetLayersModified(GBSurface* const that, const bool flag) {
```

```
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // If there are layers
  if (GBSurfaceNbLayer(that) > 0) {
    // Declare an iterator on the set of layers
    GSetIterForward iter =
      GSetIterForwardCreateStatic(GBSurfaceLayers(that));
    do {
      GBLayer* layer = GSetIterGet(&iter);
      GBLayerSetModified(layer, flag);
    } while (GSetIterStep(&iter));
  }
}

// Set the stack position of the GBLayer 'layer' into the set of
// layers of the GBSurface 'that' to 'pos'
// If 'layer' can't be found in the surface do nothing
// 'pos' must be valid (0<='pos'<nbLayers)
#if BUILDMODE != 0
inline
#endif
void GBSurfaceSetLayerStackPos(GBSurface* const that,
  GBLayer* const layer, const int pos) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (layer == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'layer' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pos < 0 || pos >= GSetNbElem(&(that->_layers))) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'pos' is invalid (0<=%d<%ld)",
      pos, GSetNbElem(&(that->_layers)));
    PBErrCatch(GenBrushErr);
  }
#endif
  // Get the current index of the layer to move
  int curPos = GSetGetIndexFirst(&(that->_layers), layer);
  // If we could find the layer
  if (curPos != -1) {
    // Move the layer
    GSetMoveElem(&(that->_layers), curPos, pos);
    // Set the _modified flag
    GBLayerSetModified(layer, true);
  }
}

// Remove the GBLayer 'layer' from the set of layers of the
// GBSurface 'that'
// The memory used by 'layer' is freed
#if BUILDMODE != 0
inline
```

```
#endif
void GBSurfaceRemoveLayer(GBSurface* const that, GBLayer* layer) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (layer == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'layer' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Remove the layer from the set
  GSetRemoveAll(&(that->_layers), layer);
  // Free the memory
  GBLayerFree(&layer);
}

// ---------------- GBSurfaceImage --------------------------

// Get the filename of the GBSurfaceImage 'that'
#if BUILDMODE != 0
inline
#endif
char* GBSurfaceImageFileName(const GBSurfaceImage* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_fileName;
}

// Set the filename of the GBSurfaceImage 'that' to 'fileName'
#if BUILDMODE != 0
inline
#endif
void GBSurfaceImageSetFileName(GBSurfaceImage* const that,
  const char* const fileName) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // If the filename is already allocated, free memory
  if (that->_fileName != NULL) {
    free(that->_fileName);
  }
  // If the new filename is not null
  if (fileName != NULL) {
    // Allocate memory and copy the new filename
    that->_fileName = PBErrMalloc(GenBrushErr,
      sizeof(char) * (strlen(fileName) + 1));
    strcpy(that->_fileName, fileName);
  }
}
```

```
// ---------------- GBEye -------------------------

// Return the type of the GBEye 'that'
#if BUILDMODE != 0
inline
#endif
GBEyeType _GBEyeGetType(const GBEye* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_type;
}

// Get the scale of the GBEye
#if BUILDMODE != 0
inline
#endif
VecFloat3D* _GBEyeScale(const GBEye* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return (VecFloat3D*)&(that->_scale);
}

// Get a copy of the scale of the GBEye
#if BUILDMODE != 0
inline
#endif
VecFloat3D _GBEyeGetScale(const GBEye* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_scale;
}


// Get the translation of the GBEye
#if BUILDMODE != 0
inline
#endif
VecFloat2D* _GBEyeOrig(const GBEye* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return (VecFloat2D*)&(that->_orig);
```

```
}


// Get a copy of the translation of the GBEye
#if BUILDMODE != 0
inline
#endif
VecFloat2D _GBEyeGetOrig(const GBEye* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_orig;
}


// Get the rotation of the GBEye (in radians)
#if BUILDMODE != 0
inline
#endif
float _GBEyeGetRot(const GBEye* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_theta;
}

// Set the scale of the GBEye
#if BUILDMODE != 0
inline
#endif
void GBEyeSetScaleVec(GBEye* const that, const VecFloat3D* const scale) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (scale == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'scale' is null");
    PBErrCatch(GenBrushErr);
  }
  if (ISEQUALF(VecGet(scale, 0), 0.0) == true ||
    ISEQUALF(VecGet(scale, 1), 0.0) == true) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'scale' is invalid (%f!=0 && %f!=0)",
      VecGet(scale, 0), VecGet(scale, 1));
    PBErrCatch(GenBrushErr);
  }
#endif
  VecCopy(&(that->_scale), scale);
  // Update the projection matrix
  GBEyeUpdateProj(that);
}
```

```
#if BUILDMODE != 0
inline
#endif
void GBEyeSetScaleFloat(GBEye* const that, const float scale) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (ISEQUALF(scale, 0.0) == true) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'scale' is invalid (%f!=0)", scale);
    PBErrCatch(GenBrushErr);
  }
#endif
  for (int i = 3; i--;)
    VecSet(&(that->_scale), i, scale);
  // Update the projection matrix
  GBEyeUpdateProj(that);
}

// Set the origin of the GBEye
#if BUILDMODE != 0
inline
#endif
void _GBEyeSetOrig(GBEye* const that, const VecFloat2D* const orig) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (orig == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'orig' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  that->_orig = *orig;
  // Update the projection matrix
  GBEyeUpdateProj(that);
}


// Set the rotation of the GBEye (in radians)
#if BUILDMODE != 0
inline
#endif
void _GBEyeSetRot(GBEye* const that, const float theta) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  that->_theta = theta;
  // Update the projection matrix
  GBEyeUpdateProj(that);
}
```

```
// Get the matrix projection of the eye
#if BUILDMODE != 0
inline
#endif
MatFloat* _GBEyeProj(const GBEye* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_proj;
}

// Call the appropriate GBEye<>Process according to the type of the
// GBEye 'that'
#if BUILDMODE != 0
inline
#endif
void _GBEyeProcess(const GBEye* const that, GBObjPod* const pod) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pod == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pod' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Call the appropriate function according to the type of eye
  switch (that->_type) {
    case GBEyeTypeOrtho:
      GBEyeOrthoProcess((GBEyeOrtho*)that, pod);
      break;
    case GBEyeTypeIsometric:
      GBEyeIsometricProcess((GBEyeIsometric*)that, pod);
      break;
    default:
      switch (GBObjPodGetType(pod)) {
        case GBObjTypePoint:
          GBObjPodSetEyePoint(pod,
            VecClone(GBObjPodGetObjAsPoint(pod)));
          break;
        case GBObjTypeSCurve:
          GBObjPodSetEyeSCurve(pod,
            SCurveClone(GBObjPodGetObjAsSCurve(pod)));
          break;
        case GBObjTypeShapoid:
          GBObjPodSetEyeShapoid(pod,
            ShapoidClone(GBObjPodGetObjAsShapoid(pod)));
          break;
        default:
          break;
      }
      break;
  }
}
```

```
// ---------------- GBEyeOrtho -------------------------

// Set the orientation the GBEyeOrtho
#if BUILDMODE != 0
inline
#endif
void GBEyeOrthoSetView(GBEyeOrtho* const that,
  const GBEyeOrthoView view) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  that->_view = view;
  // Update the projection matrix
  GBEyeUpdateProj((GBEye*)that);
}

// ---------------- GBEyeIsometric -------------------------

// Set the angle around Y of the GBEyeOrtho to 'theta' (in radians)
#if BUILDMODE != 0
inline
#endif
void GBEyeIsometricSetRotY(GBEyeIsometric* const that,
  const float theta) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  that->_thetaY = theta;
  GBEyeUpdateProj((GBEye*)that);
}

// Set the angle around Right of the GBEyeOrtho to 'theta'
// (in radians, in [-pi/2, pi/2])
// If 'theta' is out of range it is automatically bounded
// (ex: pi -> pi/2)
#if BUILDMODE != 0
inline
#endif
void GBEyeIsometricSetRotRight(GBEyeIsometric* const that,
  const float theta) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Ensure 'theta' is in bounds
  float safeTheta = theta;
  if (safeTheta > PBMATH_HALFPI)
    safeTheta = PBMATH_HALFPI;
  else if (safeTheta < -PBMATH_HALFPI)
    safeTheta = -PBMATH_HALFPI;
  that->_thetaRight = safeTheta;
```

```
  GBEyeUpdateProj((GBEye*)that);
}

// Get the angle around Y of the GBEyeOrtho 'that'
#if BUILDMODE != 0
inline
#endif
float GBEyeIsometricGetRotY(const GBEyeIsometric* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_thetaY;
}

// Get the angle around Right of the GBEyeOrtho 'that'
#if BUILDMODE != 0
inline
#endif
float GBEyeIsometricGetRotRight(const GBEyeIsometric* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_thetaRight;
}

// ---------------- GBHand -------------------------

// Return the type of the GBHand 'that'
#if BUILDMODE != 0
inline
#endif
GBHandType _GBHandGetType(const GBHand* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_type;
}

// Call the appropriate GBHand<>Process according to the type of the
// GBHand 'that'
#if BUILDMODE != 0
inline
#endif
void _GBHandProcess(const GBHand* const that, GBObjPod* const pod) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
```

```
#endif
  // If 'pod' has no viewed object do nothing
  if (GBObjPodEyeObj(pod) == NULL)
    return;
  // Call the appropriate function depending on the type of hand
  switch (that->_type) {
    case GBHandTypeDefault:
      GBHandDefaultProcess((GBHandDefault*)that, pod);
      break;
    default:
      break;
  }
}

// ---------------- GBTool -------------------------

// Return a copy of the type of the GBTool 'that'
#if BUILDMODE != 0
inline
#endif
GBToolType GBToolGetType(const GBTool* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_type;
}

// ---------------- GBInkSolid -------------------------

// Return the type of the GBInk 'that'
#if BUILDMODE != 0
inline
#endif
GBInkType _GBInkGetType(const GBInk* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_type;
}

// ---------------- GInkSolid -------------------------

// Get the color of the GBInkSolid 'that'
#if BUILDMODE != 0
inline
#endif
GBPixel GBInkSolidGet(const GBInkSolid* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
```

```
  return that->_color;
}

// Set the color of the GBInkSolid 'that' to 'col'
#if BUILDMODE != 0
inline
#endif
void GBInkSolidSet(GBInkSolid* const that, const GBPixel* const col) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (col == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'col' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  that->_color = *col;
}


// ---------------- GBTool -------------------------

// Function to call the appropriate GBTool<>Draw function according to
// type of GBTool 'that'
#if BUILDMODE != 0
inline
#endif
void _GBToolDraw(const GBTool* const that, GBObjPod* const pod) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pod == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pod' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  switch (GBToolGetType(that)) {
    case GBToolTypePlotter:
      GBToolPlotterDraw((GBToolPlotter*)that, pod);
      break;
    default:
      break;
  }
}

// ---------------- GBObjPod -------------------------

// Return the type of the object in the GBObjPod 'that'
#if BUILDMODE != 0
inline
#endif
GBObjType GBObjPodGetType(const GBObjPod* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
```

```
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_type;
}

// Return the object in the GBObjPod 'that'
#if BUILDMODE != 0
inline
#endif
void* GBObjPodObj(const GBObjPod* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_srcPoint;
}

// Return the object viewed by its attached eye in the GBObjPod 'that'
#if BUILDMODE != 0
inline
#endif
void* GBObjPodEyeObj(const GBObjPod* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_eyePoint;
}

// Return the object processed as Points by its attached hand in the
// GBObjPod 'that'
#if BUILDMODE != 0
inline
#endif
GSetVecFloat* GBObjPodGetHandObjAsPoints(const GBObjPod* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return (GSetVecFloat*)&(that->_handPoints);
}

// Return the object processed as Shapoids by its attached hand in the
// GBObjPod 'that'
#if BUILDMODE != 0
inline
#endif
GSetShapoid* GBObjPodGetHandObjAsShapoids(const GBObjPod* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
```

```
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return (GSetShapoid*)&(that->_handShapoids);
}

// Return the object processed as SCurves by its attached hand in the
// GBObjPod 'that'
#if BUILDMODE != 0
inline
#endif
GSetSCurve* GBObjPodGetHandObjAsSCurves(const GBObjPod* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return (GSetSCurve*)&(that->_handSCurves);
}

// Return the eye in the GBObjPod 'that'
#if BUILDMODE != 0
inline
#endif
GBEye* GBObjPodEye(const GBObjPod* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_eye;
}

// Return the hand in the GBObjPod 'that'
#if BUILDMODE != 0
inline
#endif
GBHand* GBObjPodHand(const GBObjPod* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_hand;
}

// Return the tool in the GBObjPod 'that'
#if BUILDMODE != 0
inline
#endif
GBTool* GBObjPodTool(const GBObjPod* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
```

```
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_tool;
}

// Return the ink in the GBObjPod 'that'
#if BUILDMODE != 0
inline
#endif
GBInk* GBObjPodInk(const GBObjPod* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_ink;
}

// Return the layer in the GBObjPod 'that'
#if BUILDMODE != 0
inline
#endif
GBLayer* GBObjPodLayer(const GBObjPod* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_layer;
}

// Set the Point viewed by its attached eye in the GBObjPod 'that'
// to 'point'
// If 'point' is null do nothing
#if BUILDMODE != 0
inline
#endif
void _GBObjPodSetEyePoint(GBObjPod* const that, VecFloat* const point) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  if (point != NULL) {
    if (that->_eyePoint != NULL)
      VecFree(&(that->_eyePoint));
    that->_eyePoint = point;
  }
}

// Set the Shapoid viewed by its attached eye in the GBObjPod 'that'
// to 'shap'
// If 'shap' is null do nothing
#if BUILDMODE != 0
```

```
inline
#endif
void _GBObjPodSetEyeShapoid(GBObjPod* const that, Shapoid* const shap) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  if (shap != NULL) {
    if (that->_eyeShapoid != NULL)
      ShapoidFree(&(that->_eyeShapoid));
    that->_eyeShapoid = shap;
  }
}

// Set the SCurve viewed by its attached eye in the GBObjPod 'that'
// to 'curve'
// If 'curve' is null do nothing
#if BUILDMODE != 0
inline
#endif
void _GBObjPodSetEyeSCurve(GBObjPod* const that, SCurve* const curve) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  if (curve != NULL) {
    if (that->_eyeSCurve != NULL)
      SCurveFree(&(that->_eyeSCurve));
    that->_eyeSCurve = curve;
  }
}

// Set the eye in the GBObjPod 'that' to 'eye'
// If 'eye' is null do nothing
#if BUILDMODE != 0
inline
#endif
void _GBObjPodSetEye(GBObjPod* const that, GBEye* const eye) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  if (eye != NULL)
    that->_eye = eye;
}

// Set the hand in the GBObjPod 'that' to 'hand'
// If 'hand' is null do nothing
#if BUILDMODE != 0
inline
#endif
void _GBObjPodSetHand(GBObjPod* const that, GBHand* const hand) {
#if BUILDMODE == 0
```

```
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  if (hand != NULL)
    that->_hand = hand;
}

// Set the tool in the GBObjPod 'that' to 'tool'
// If 'tool' is null do nothing
#if BUILDMODE != 0
inline
#endif
void _GBObjPodSetTool(GBObjPod* const that, GBTool* const tool) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  if (tool != NULL)
    that->_tool = tool;
}

// Set the ink in the GBObjPod 'that' to 'ink'
// If 'ink' is null do nothing
#if BUILDMODE != 0
inline
#endif
void _GBObjPodSetInk(GBObjPod* const that, GBInk* const ink) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  if (ink != NULL)
    that->_ink = ink;
}

// Set the layer in the GBObjPod 'that' to 'layer'
// If 'layer' is null do nothing
#if BUILDMODE != 0
inline
#endif
void GBObjPodSetLayer(GBObjPod* const that, GBLayer* const layer) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  if (layer != NULL)
    that->_layer = layer;
}

// ---------------- GenBrush -------------------------
```

```
// Get the GBSurface of the GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
GBSurface* GBSurf(const GenBrush* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_surf;
}

// Get the set of pods of the GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
GSet* GBPods(const GenBrush* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return (GSet*)&(that->_pods);
}

// Get a copy of the dimensions of the GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
VecShort2D GBGetDim(const GenBrush* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return GBSurfaceGetDim(that->_surf);
}

// Get the final pixels of the GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
GBPixel* GBFinalPixels(const GenBrush* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return GBSurfaceFinalPixels(that->_surf);
}

// Get the final pixel at position 'pos' of the GBSurface of the GB
```

```
// 'that'
// 'pos' must be in the surface
#if BUILDMODE != 0
inline
#endif
GBPixel* GBFinalPixel(const GenBrush* const that,
  const VecShort2D* const pos) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pos == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pos' is null");
    PBErrCatch(GenBrushErr);
  }
  if (!GBIsPosInside(that, pos)) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'pos' is out of the surface (%d,%d)",
      VecGet(pos, 0), VecGet(pos, 1));
    PBErrCatch(GenBrushErr);
  }
#endif
  return GBSurfaceFinalPixel(GBSurf(that), pos);
}

// Get a copy of the final pixel at position 'pos' of the GBSurface
// of the GB 'that'
// 'pos' must be in the surface
#if BUILDMODE != 0
inline
#endif
GBPixel GBGetFinalPixel(const GenBrush* const that,
  const VecShort2D* const pos) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pos == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pos' is null");
    PBErrCatch(GenBrushErr);
  }
  if (!GBIsPosInside(that, pos)) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'pos' is out of the surface (%d,%d)",
      VecGet(pos, 0), VecGet(pos, 1));
    PBErrCatch(GenBrushErr);
  }
#endif
  return GBSurfaceGetFinalPixel(GBSurf(that), pos);
}

// Set the final pixel at position 'pos' of the GBSurface of the GB
// 'that' to the pixel 'pix'
// 'pos' must be in the surface
#if BUILDMODE != 0
inline
```

```
#endif
void GBSetFinalPixel(GenBrush* const that, const VecShort2D* const pos,
  const GBPixel* const pix) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pos == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pos' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pix == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pix' is null");
    PBErrCatch(GenBrushErr);
  }
  if (!GBIsPosInside(that, pos)) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'pos' is out of the surface (%d,%d)",
      VecGet(pos, 0), VecGet(pos, 1));
    PBErrCatch(GenBrushErr);
  }
#endif
  GBSurfaceSetFinalPixel(GBSurf(that), pos, pix);
}

// Get the final pixel at position 'pos' of the GBSurface of the GB
// 'that'
// If 'pos' is out of the surface return NULL
#if BUILDMODE != 0
inline
#endif
GBPixel* GBFinalPixelSafe(const GenBrush* const that,
  const VecShort2D* const pos) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pos == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pos' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  if (GBIsPosInside(that, pos))
    return GBSurfaceFinalPixel(GBSurf(that), pos);
  else
    return NULL;
}

// Get a copy of the final pixel at position 'pos' of the GBSurface
// of the GB 'that'
// If 'pos' is out of the surface return a transparent pixel
#if BUILDMODE != 0
inline
#endif
GBPixel GBGetFinalPixelSafe(const GenBrush* const that,
```

```
  const VecShort2D* const pos) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pos == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pos' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  if (GBIsPosInside(that, pos))
    return GBSurfaceGetFinalPixel(GBSurf(that), pos);
  else
    return GBColorTransparent;
}

// Set the final pixel at position 'pos' of the GBSurface of the GB
// 'that' to the pixel 'pix'
// If 'pos' is out of the surface do nothing
#if BUILDMODE != 0
inline
#endif
void GBSetFinalPixelSafe(GenBrush* const that,
  const VecShort2D* const pos, const GBPixel* const pix) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pos == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pos' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pix == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pix' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  if (GBIsPosInside(that, pos))
    GBSurfaceSetFinalPixel(GBSurf(that), pos, pix);
}

// Get the type of the GBSurface of the GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
GBSurfaceType GBGetType(const GenBrush* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return GBSurfaceGetType(that->_surf);
}
```

```
// Get the background color of the GBSurface of the GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
GBPixel* GBBgColor(const GenBrush* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return GBSurfaceBgColor(GBSurf(that));
}

// Get a copy of the background color of the GBSurface of the
// GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
GBPixel GBGetBgColor(const GenBrush* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return GBSurfaceGetBgColor(GBSurf(that));
}

// Set the background color of the GBSurface of the GenBrush
//  'that' to 'col'
#if BUILDMODE != 0
inline
#endif
void GBSetBgColor(GenBrush* const that, const GBPixel* const col) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (col == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'col' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  GBSurfaceSetBgColor(GBSurf(that), col);
}

// Get the filename of the GBSurfaceImage of the GenBrush 'that'
// Return NULL if the surface is not a GBSurfaceImage
#if BUILDMODE != 0
inline
#endif
char* GBFileName(const GenBrush* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
```

```
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  if (GBGetType(that) == GBSurfaceTypeImage)
    return GBSurfaceImageFileName((GBSurfaceImage*)GBSurf(that));
  else
    return NULL;
}

// Set the filename of the GBSurfaceImage of the GenBrush 'that'
// to 'fileName'
// Do nothing if the surface is not a GBSurfaceImage
#if BUILDMODE != 0
inline
#endif
void GBSetFileName(GenBrush* const that, const char* const fileName) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  if (GBGetType(that) == GBSurfaceTypeImage)
    GBSurfaceImageSetFileName((GBSurfaceImage*)GBSurf(that), fileName);
}

// Get the area of the GBSurface of the Genbrush 'that'
#if BUILDMODE != 0
inline
#endif
int GBArea(const GenBrush* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return GBSurfaceArea(GBSurf(that));
}

// Return true if the position 'pos' is inside the GBSurface of the
// GenBrush 'that'
// boundary, false else
#if BUILDMODE != 0
inline
#endif
bool GBIsPosInside(const GenBrush* const that,
  const VecShort2D* const pos) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pos == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'pos' is null");
    PBErrCatch(GenBrushErr);
  }
```

```
#endif
  return GBSurfaceIsPosInside(GBSurf(that), pos);
}

// Return the layers of the surface of the GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
GSet* GBLayers(const GenBrush* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return GBSurfaceLayers(GBSurf(that));
}

// Add a new GBLayer with dimensions 'dim' to the top of the stack
// of layers of the GBSurface of the GenBrush' that'
// Return the new GBLayer
#if BUILDMODE != 0
inline
#endif
GBLayer* GBAddLayer(GenBrush* const that, const VecShort2D* const dim) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (dim == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'dim' is null");
    PBErrCatch(GenBrushErr);
  }
  if (VecGet(dim, 0) <= 0 || VecGet(dim, 1) <= 0) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'dim' is invalid (%d>0,%d>0)",
      VecGet(dim, 0), VecGet(dim, 1));
    PBErrCatch(GenBrushErr);
  }
#endif
  return GBSurfaceAddLayer(GBSurf(that), dim);
}

// Add a new GBLayer with content equals to the image located at
// 'fileName' to the top of the stack
// of layers of the GBSurface of the GenBrush' that'
// Return the new GBLayer
#if BUILDMODE != 0
inline
#endif
GBLayer* GBAddLayerFromFile(GenBrush* const that,
  const char* const fileName) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
```

```
  if (fileName == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'fileName' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return GBSurfaceAddLayerFromFile(GBSurf(that), fileName);
}

// Get the 'iLayer'-th layer of the GBSurface of the GenBrush 'that'
// 'iLayer' must be valid
#if BUILDMODE != 0
inline
#endif
GBLayer* GBLay(const GenBrush* const that, const int iLayer) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (iLayer < 0 ||
    iLayer >= GSetNbElem(GBSurfaceLayers(GBSurf(that)))) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'iLayer' is invalid (0<=%d<%ld)",
      iLayer, GSetNbElem(GBSurfaceLayers(GBSurf(that))));
    PBErrCatch(GenBrushErr);
  }
#endif
  return GBSurfaceLayer(GBSurf(that), iLayer);
}

// Get the number of layer of the GBSurface of the GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
int GBGetNbLayer(const GenBrush* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return GBSurfaceNbLayer(GBSurf(that));
}

// Set the stack position of the GBLayer 'layer' into the set of
// layers of the GBSurface of the GenBrush'that' to 'pos'
// If 'layer' can't be found in the surface do nothing
// 'pos' must be valid (0<='pos'<nbLayers)
#if BUILDMODE != 0
inline
#endif
void GBSetLayerStackPos(GenBrush* const that, GBLayer* const layer,
  const int pos) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
```

```
  if (layer == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'layer' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pos < 0 || pos >= GBGetNbLayer(that)) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'pos' is invalid (0<=%d<%d)",
      pos, GBGetNbLayer(that));
    PBErrCatch(GenBrushErr);
  }
#endif
  GBSurfaceSetLayerStackPos(GBSurf(that), layer, pos);
}

// Remove the GBLayer 'layer' from the set of layers of the
// GBSurface of the GenBrush 'that'
// The memory used by 'layer' is freed
#if BUILDMODE != 0
inline
#endif
void GBRemoveLayer(GenBrush* const that, GBLayer* layer) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (layer == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'layer' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Remove the graphical elements bounded to this layer
  GBRemovePod(that, NULL, NULL, NULL, NULL, NULL, layer);
  // Remove the layer from the surface
  GBSurfaceRemoveLayer(GBSurf(that), layer);
}

// Get the number of pod in the GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
int GBGetNbPod(const GenBrush* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return GSetNbElem(&(that->_pods));
}

// Add a GBObjPod for the Point at position 'pos' to the GenBrush 'that'
// drawn with 'eye', 'hand' and 'tool' in layer 'layer'
// 'pos' must be a vector of 2 or more dimensions
#if BUILDMODE != 0
inline
#endif
void _GBAddPoint(GenBrush* const that, VecFloat* const pos,
```

```
  GBEye* const eye, GBHand* const hand, GBTool* const tool,
  GBInk* const ink, GBLayer* const layer) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (pos == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'pos' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  GSetAppend(GBPods(that),
    GBObjPodCreatePoint(pos, eye, hand, tool, ink, layer));
}

// Add a GBObjPod for the Shapoid 'shap' to the GenBrush 'that'
// drawn with 'eye', 'hand' and 'tool' in layer 'layer'
// 'shap' 's dimension must be 2 or more
#if BUILDMODE != 0
inline
#endif
void _GBAddShapoid(GenBrush* const that, Shapoid* const shap,
  GBEye* const eye, GBHand* const hand, GBTool* const tool,
  GBInk* const ink, GBLayer* const layer) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (shap == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'shap' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  GSetAppend(&(that->_pods),
    GBObjPodCreateShapoid(shap, eye, hand, tool, ink, layer));
}

// Add a GBObjPod for the SCurve 'curve' to the GenBrush 'that'
// drawn with 'eye', 'hand' and 'tool' in layer 'layer'
// 'curve' 's dimension must be 2 or more
#if BUILDMODE != 0
inline
#endif
void _GBAddSCurve(GenBrush* const that, SCurve* const curve,
  GBEye* const eye, GBHand* const hand, GBTool* const tool,
  GBInk* const ink, GBLayer* const layer) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (curve == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'curve' is null");
    PBErrCatch(GenBrushErr);
```

```
  }
#endif
  GSetAppend(&(that->_pods),
    GBObjPodCreateSCurve(curve, eye, hand, tool, ink, layer));
}

// Reset all the final pix of the surface of the GenBrush 'that' to its
// background color, and reset all the modified flag of layers to true
#if BUILDMODE != 0
inline
#endif
void GBFlush(GenBrush* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  GBSurfaceFlush(GBSurf(that));
}

// Return true if the surface of the GenBrush 'that' is same as the
// surface of the GenBrush 'gb'
// Else, return false
#if BUILDMODE != 0
inline
#endif
bool GBIsSameAs(const GenBrush* const that, const GenBrush* const gb) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (gb == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'gb' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return GBSurfaceIsSameAs(GBSurf(that), GBSurf(gb));
}

// Add a GBPostProcessing of type 'type' to the GenBrush 'that'
// Return the GBPostProcessing
#if BUILDMODE != 0
inline
#endif
GBPostProcessing* GBAddPostProcess(GenBrush* const that,
  const GBPPType type) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  GBPostProcessing* post = GBPostProcessingCreate(type);
  GSetAppend(&(that->_postProcs), post);
  return post;
}
```

```
// Remove the GBPostProcessing 'post' from the GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
void GBRemovePostProcess(GenBrush* const that,
  const GBPostProcessing* const post) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  if (GBGetNbPostProcs(that) > 0) {
    GSetIterForward iter =
      GSetIterForwardCreateStatic(GBPostProcs(that));
    bool flag = true;
    do {
      GBPostProcessing* p = GSetIterGet(&iter);
      if (post == p) {
        GBPostProcessingFree(&p);
        GSetIterRemoveElem(&iter);
      }
    } while (flag == true && GSetIterStep(&iter));
  }
  GSetRemoveFirst(&(that->_postProcs), post);
}

// Remove all the GBPostProcessing from the GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
void GBRemoveAllPostProcess(GenBrush* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  while (GBGetNbPostProcs(that) > 0) {
    GBPostProcessing* post = GSetPop(&(that->_postProcs));
    GBPostProcessingFree(&post);
  }
}

// Get the 'iPost'-th post process of the GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
GBPostProcessing* GBPostProcess(const GenBrush* const that,
  const int iPost) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return GSetGet(&(that->_postProcs), iPost);
}
```

```
// Get the GSet of GBPostProcessing of the GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
GSet* GBPostProcs(const GenBrush* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return (GSet*)&(that->_postProcs);
}

// Get the number of GBPostProcessing of the GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
int GBGetNbPostProcs(const GenBrush* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return GSetNbElem(&(that->_postProcs));
}

// Remove all the GBObjPods from the GenBrush 'that'
#if BUILDMODE != 0
inline
#endif
void GBRemoveAllPod(GenBrush* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeInvalidArg;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  while (GBGetNbPod(that) > 0) {
    GBObjPod* pod = GSetPop(&(that->_pods));
    GBObjPodFree(&pod);
  }
}


// ================ GTK Functions ====================

#if BUILDWITHGRAPHICLIB == 1
  #include "genbrush-inline-GTK.c"
#endif
```

3.3 genbrush-GTK.c

```
// ============ GENBRUSH-GTK.C ================
```

```
// ================ Functions declaration ====================

// Callback for the 'activate' event on a GBSurfaceApp
void GBSurfaceAppCallbackActivate(GtkApplication* app,
  gpointer data);

// Callback for the 'draw' event on a GBSurfaceApp
gboolean GBSurfaceAppCallbackDraw(GtkWidget *widget, cairo_t *cr,
  gpointer data);

// Callback for the 'config' event on a GBSurfaceApp
gboolean GBSurfaceAppCallbackConfigEvt (GtkWidget *widget,
  GdkEventConfigure *event, gpointer data);

// Callback for the 'draw' event on a GBSurfaceWidget
gboolean GBSurfaceWidgetCallbackDraw(GtkWidget *widget, cairo_t *cr,
  gpointer data);

// Callback for the 'config' event on a GBSurfaceWidget
gboolean GBSurfaceWidgetCallbackConfigEvt(GtkWidget *widget,
  GdkEventConfigure *event, gpointer data);

// ================ Functions implementation ====================

// Callback for the 'draw' event on a GBSurfaceApp
gboolean GBSurfaceAppCallbackDraw(GtkWidget *widget, cairo_t *cr,
  gpointer data) {
  (void)widget;
  // Declare a variable to convert the data into the GBSurfaceApp
  GBSurfaceApp* GBApp = (GBSurfaceApp*)data;
  // Paint the final pixels of the GBSurface on the Cairo surface
  // The data in GenBrush are flipped horizontally relatively to
  // the Cairo coordinates system. Thus we need to flip them
  // horizontally.

  // Terrible patch. The code below should do the flipping but
  // instead it splits only half of the surface (???). Can't find
  // the problem, then give up and create a flipped copy of the data
  // and us it instead.
  //cairo_scale(cr, 1.0, -1.0);
  //cairo_translate(cr, 0, -1 * gtk_widget_get_allocated_height(GBApp->_drawingArea));
  //cairo_set_source_surface(cr, GBApp->_cairoSurf, 0, 0);

  const VecShort2D* const dim = GBSurfaceDim(&(GBApp->_surf));
  unsigned char* origData =
    (unsigned char*)GBSurfaceFinalPixels(&(GBApp->_surf));
  for (int iLine = 0; iLine < VecGet(dim, 1); ++iLine) {
    memcpy(GBApp->_flippedData +
      (VecGet(dim, 1) - iLine - 1) * VecGet(dim, 0) * 4,
      origData + iLine * VecGet(dim, 0) * 4,
      sizeof(unsigned char) * VecGet(dim, 0) * 4);
  }
  cairo_set_source_surface(cr, GBApp->_cairoSurf, 0, 0);

  cairo_paint(cr);
  return FALSE;
}

// Callback for the 'config' event on a GBSurfaceApp
gboolean GBSurfaceAppCallbackConfigEvt(GtkWidget *widget,
  GdkEventConfigure *event, gpointer data) {
  (void)event;
```

```
  // Declare a variable to convert the data into the GBSurfaceApp
  GBSurfaceApp* GBApp = (GBSurfaceApp*)data;
  // Attach the GBPixel to the cairo surface
  GBApp->_cairoSurf = cairo_image_surface_create_for_data(
    //(unsigned char* )GBSurfaceFinalPixels(&(GBWidget->_surf)),

    // cf GBSurfaceAppCallbackDraw
    GBApp->_flippedData,

    CAIRO_FORMAT_ARGB32,
    gtk_widget_get_allocated_width(widget),
    gtk_widget_get_allocated_height(widget),
    cairo_format_stride_for_width(CAIRO_FORMAT_ARGB32,
      gtk_widget_get_allocated_width(widget)));
  // Draw the surface
  cairo_t *cr = cairo_create(GBApp->_cairoSurf);
  GBSurfaceAppCallbackDraw(widget, cr, GBApp);
  cairo_destroy (cr);
  return TRUE;
}

// Callback for the activate event on a GBSurfaceApp
void GBSurfaceAppCallbackActivate(GtkApplication* app,
  gpointer data) {
  // Declare a variable to convert the data into the GBSurfaceApp
  GBSurfaceApp* GBApp = (GBSurfaceApp*)data;
  // Create the window
  GBApp->_window = gtk_application_window_new(app);
  // Set the title of the window
  gtk_window_set_title(GTK_WINDOW(GBApp->_window), GBApp->_title);
  // Set the size of the window
  gtk_window_set_default_size(GTK_WINDOW(GBApp->_window),
    VecGet(GBSurfaceDim(&(GBApp->_surf)), 0),
    VecGet(GBSurfaceDim(&(GBApp->_surf)), 1));
  // Set the window as non resizable
  gtk_window_set_resizable(GTK_WINDOW(GBApp->_window), false);
  // Center the window on the screen
  gtk_window_set_position(GTK_WINDOW(GBApp->_window), GTK_WIN_POS_CENTER);
  // Create the drawing area
  GBApp->_drawingArea = gtk_drawing_area_new();
  // Set the size of the drawing area
  gtk_widget_set_size_request(GBApp->_drawingArea,
    VecGet(GBSurfaceDim(&(GBApp->_surf)), 0),
    VecGet(GBSurfaceDim(&(GBApp->_surf)), 1));
  // Insert the drawing area into the window
  gtk_container_add(GTK_CONTAINER(GBApp->_window), GBApp->_drawingArea);
  // Connect the events
  g_signal_connect(GBApp->_drawingArea, "draw",
    G_CALLBACK (GBSurfaceAppCallbackDraw), GBApp);
  g_signal_connect(GBApp->_drawingArea,"configure-event",
    G_CALLBACK (GBSurfaceAppCallbackConfigEvt), GBApp);
  if (GBApp->_idleFun != NULL)
    g_timeout_add(GBApp->_idleMs, GBApp->_idleFun, GBApp);
  // Display the window
  gtk_widget_show_all(GBApp->_window);
}

// Create a new GBSurfaceApp with title 'title' and
// dimensions 'dim'
// The surface is initialized with one layer of white pixels
// (rgba = {255})
GBSurfaceApp* GBSurfaceAppCreate(const VecShort2D* const dim,
```

```
  const char* const title) {
#if BUILDMODE == 0
  if (dim == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'dim' is null");
    PBErrCatch(GenBrushErr);
  }
  if (title == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'title' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Allocate memory
  GBSurfaceApp* that = PBErrMalloc(GenBrushErr, sizeof(GBSurfaceApp));
  // Set the title of the application
  that->_title = PBErrMalloc(GenBrushErr,
    sizeof(char) * (strlen(title) + 1));
  strcpy(that->_title, title);
  // Create the surface
  that->_surf = GBSurfaceCreateStatic(GBSurfaceTypeApp, dim);
  // Create the application
  that->_app = gtk_application_new(NULL, G_APPLICATION_FLAGS_NONE);
  // Set the idle properties
  that->_idleFun = NULL;
  that->_idleMs = 0;
  // Set the return status
  that->_returnStatus = 0;
  // Connect the 'activate' event
  // Other properties will be set up by the activate event
  g_signal_connect (that->_app, "activate",
    G_CALLBACK (GBSurfaceAppCallbackActivate), that);

  // cf GBSurfaceAppCallbackDraw.
  // Allocate memory for the flipped data
  that->_flippedData = malloc(sizeof(unsigned char) * 4 *
    VecGet(dim, 0) * VecGet(dim, 0));

  // Return the GBSurfaceApp
  return that;
}

// Set the idle function of the GBSurfaceApp 'that' to 'idleFun'
// with a timeout of 'idleMs'
// The interface of the 'idleFun' is
// gint tick(gpointer data)
// the argument of 'idleFun' is a pointer to GBSurfaceApp
void GBSurfaceSetIdle(GBSurfaceApp* const that,
  gint (*idleFun)(gpointer), int idleMs) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (idleFun == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'idleFun' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Memorize the idle properties
```

```
  that->_idleFun = idleFun;
  that->_idleMs = idleMs;
}

// Render the GBSurfaceApp 'that'
// This function block the execution until the app is killed
// Return true if the status of the app when closed was 0, false else
bool GBSurfaceAppRender(GBSurfaceApp* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Run the application
  int argc = 0;
  char* *argv = NULL;
  that->_returnStatus =
    g_application_run(G_APPLICATION(that->_app), argc, argv);
  // After the application has been killed
  // Return the success code
  return (that->_returnStatus == 0 ? true : false);
}

// Free the GBSurfaceApp 'that'
void GBSurfaceAppFree(GBSurfaceApp** that) {
  if (that == NULL || *that == NULL)
    return;
  // Free memory
  g_object_unref((*that)->_app);
  free((*that)->_title);

  // cf GBSurfaceAppCallbackDraw
  free((*that)->_flippedData);

}

// Free the GBSurfaceWidget 'that'
void GBSurfaceWidgetFree(GBSurfaceWidget** that) {
  (void)that;

  // cf GBSurfaceAppCallbackDraw
  free((*that)->_flippedData);

}

// Create a GenBrush with a blank GBSurfaceApp
GenBrush* GBCreateApp(const VecShort2D* const dim,
  const char* const title) {
#if BUILDMODE == 0
  if (dim == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'dim' is null");
    PBErrCatch(GenBrushErr);
  }
  if (title == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'title' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
```

```
  // Allocate memory
  GenBrush* that = PBErrMalloc(GenBrushErr, sizeof(GenBrush));
  // Set properties
  that->_surf = (GBSurface*)GBSurfaceAppCreate(dim, title);
  that->_pods = GSetCreateStatic();
  that->_postProcs = GSetCreateStatic();
  // Return the new GenBrush
  return that;
}

// Set the idle function of the GBSurfaceApp of the GenBrush 'that'
// to 'idleFun' with a timeout of 'idleMs'
// The interface of the 'idleFun' is
// gint tick(gpointer data)
// the argument of 'idleFun' is a pointer to GBSurfaceApp
// If the surface of the app is not a GBSurfaceTypeApp, do nothing
void GBSetIdle(GenBrush* that, gint (*idleFun)(gpointer),
  const int idleMs) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (idleFun == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'idleFun' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  if (GBSurfaceGetType(that->_surf) == GBSurfaceTypeApp)
    GBSurfaceSetIdle((GBSurfaceApp*)(that->_surf), idleFun, idleMs);
}

// Create a GenBrush with a blank GBSurfaceWidget and an eye
// of type 'eyeType'
// If 'eyeType' is GBEyeTypeOrtho the view is front
GenBrush* GBCreateWidget(const VecShort2D* const dim) {
#if BUILDMODE == 0
  if (dim == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'dim' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Allocate memory
  GenBrush* that = PBErrMalloc(GenBrushErr, sizeof(GenBrush));
  // Set properties
  that->_surf = (GBSurface*)GBSurfaceWidgetCreate(dim);
  that->_pods = GSetCreateStatic();
  that->_postProcs = GSetCreateStatic();
  // Return the new GenBrush
  return that;
}

// Create a new GBSurfaceWidget with dimensions 'dim'
GBSurfaceWidget* GBSurfaceWidgetCreate(const VecShort2D* const dim) {
#if BUILDMODE == 0
  if (dim == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'dim' is null");
    PBErrCatch(GenBrushErr);
```

```
  }
#endif
  // Allocate memory
  GBSurfaceWidget* that = PBErrMalloc(GenBrushErr,
    sizeof(GBSurfaceWidget));
  // Create the surface
  that->_surf = GBSurfaceCreateStatic(GBSurfaceTypeWidget, dim);
  // Create the drawing area
  that->_drawingArea = gtk_drawing_area_new();
  // Set the size of the drawing area
  gtk_widget_set_size_request(that->_drawingArea,
    VecGet(dim, 0), VecGet(dim, 1));
  // Connect to the draw event
  g_signal_connect(that->_drawingArea, "draw",
    G_CALLBACK (GBSurfaceWidgetCallbackDraw), that);
  // Connect to the configure event
  g_signal_connect(that->_drawingArea,"configure-event",
    G_CALLBACK (GBSurfaceWidgetCallbackConfigEvt), that);

  // cf GBSurfaceAppCallbackDraw.
  // Allocate memory for the flipped data
  that->_flippedData = malloc(sizeof(unsigned char) * 4 *
    VecGet(dim, 0) * VecGet(dim, 0));

  // Return the GBSurfaceWidget
  return that;
}

// Callback for the 'draw' event on a GBSurfaceWidget
gboolean GBSurfaceWidgetCallbackDraw(GtkWidget *widget, cairo_t *cr,
  gpointer data) {
  (void)widget;
  // Declare a variable to convert the data into the GBSurfaceApp
  GBSurfaceWidget* GBWidget = (GBSurfaceWidget*)data;
  // Paint the final pixels of the GBSurface on the Cairo surface
  // The data in GenBrush are flipped horizontally relatively to
  // the Cairo coordinates system. Thus we need to flip them
  // horizontally.

  // Terrible patch. The code below should do the flipping but
  // instead it splits only half of the surface (???). Can't find
  // the problem, then give up and create a flipped copy of the data
  // and use it instead.
  //cairo_scale(cr, 1.0, -1.0);
  //cairo_translate(cr, 0, -1 * gtk_widget_get_allocated_height(GBWidget->_drawingArea));
  //cairo_set_source_surface(cr, GBWidget->_cairoSurf, 0, 0);

  const VecShort2D* const dim = GBSurfaceDim(&(GBWidget->_surf));
  unsigned char* origData =
    (unsigned char*)GBSurfaceFinalPixels(&(GBWidget->_surf));
  for (int iLine = 0; iLine < VecGet(dim, 1); ++iLine) {
    memcpy(GBWidget->_flippedData +
      (VecGet(dim, 1) - iLine - 1) * VecGet(dim, 0) * 4,
      origData + iLine * VecGet(dim, 0) * 4,
      sizeof(unsigned char) * VecGet(dim, 0) * 4);
  }

  cairo_set_source_surface(cr, GBWidget->_cairoSurf, 0, 0);

  cairo_paint (cr);
  return FALSE;
}
```

```
// Render the GBSurfaceWidget 'that'
void GBSurfaceWidgetRender(const GBSurfaceWidget* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Request the update of the widget area
  gtk_widget_queue_draw_area(that->_drawingArea, 0.0, 0.0,
    gtk_widget_get_allocated_width(that->_drawingArea),
    gtk_widget_get_allocated_height(that->_drawingArea));
}

// Callback for the 'config' event on a GBSurfaceWidget
gboolean GBSurfaceWidgetCallbackConfigEvt(GtkWidget *widget,
  GdkEventConfigure *event, gpointer data) {
  (void)event;
  // Declare a variable to convert the data into the GBSurfaceApp
  GBSurfaceWidget* GBWidget = (GBSurfaceWidget*)data;
  // Attach the GBPixel to the cairo surface
  GBWidget->_cairoSurf = cairo_image_surface_create_for_data(
    //(unsigned char* )GBSurfaceFinalPixels(&(GBWidget->_surf)),

    // cf GBSurfaceAppCallbackDraw
    GBWidget->_flippedData,

    CAIRO_FORMAT_ARGB32,
    gtk_widget_get_allocated_width(widget),
    gtk_widget_get_allocated_height(widget),
    cairo_format_stride_for_width(CAIRO_FORMAT_ARGB32,
      gtk_widget_get_allocated_width(widget)));
  // Draw the surface
  cairo_t *cr = cairo_create(GBWidget->_cairoSurf);
  GBSurfaceWidgetCallbackDraw(widget, cr, GBWidget);
  cairo_destroy (cr);
  return TRUE;
}

// Take a snapshot of the GBSurfaceApp 'that' and save it to 'fileName'
// Return true if successful, false else
bool GBSurfaceAppScreenshot(
  const GBSurfaceApp* const that,
              const char* const fileName) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (fileName == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'fileName' is null");
    PBErrCatch(GenBrushErr);
  }
#endif

  // Create a temporary GBSurfaceImage from the GBSurface of the
  // GBSurfaceApp
  GBSurfaceImage surf;
```

```
  memcpy(&surf, &(that->_surf), sizeof(GBSurface));
  surf._fileName = (char*)fileName;

  // Save the GBSurface as an image
  bool flag = GBSurfaceImageSave(&surf);

  // Return the success flag
  return flag;
}

// Take a snapshot of the GBSurfaceWidget 'that' and save it to 'fileName'
// Return true if successfull, flase else
bool GBSurfaceWidgetScreenshot(
  const GBSurfaceWidget* const that,
             const char* const fileName) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
  if (fileName == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'fileName' is null");
    PBErrCatch(GenBrushErr);
  }
#endif

  // Create a temporary GBSurfaceImage from the GBSurface of the
  // GBSurfaceWidget
  GBSurfaceImage surf;
  memcpy(&surf, &(that->_surf), sizeof(GBSurface));
  surf._fileName = (char*)fileName;

  // Save the GBSurface as an image
  bool flag = GBSurfaceImageSave(&surf);

  // Return the success flag
  return flag;
}
```

3.4 genbrush-inline-GTK.c

```
// ============ GENBRUSH-INLINE-GTK.C ================

// ================ Functions implementation ====================

// Close the GBSurfaceApp 'that'
#if BUILDMODE != 0
inline
#endif
void GBSurfaceAppClose(const GBSurfaceApp* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  // Request the killing of the drawing area
```

```
  gtk_window_close(GTK_WINDOW(that->_window));
}

// Refresh the content of the GBSurfaceApp 'that'
#if BUILDMODE != 0
inline
#endif
void GBSurfaceAppRefresh(const GBSurfaceApp* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  gtk_widget_queue_draw_area(that->_drawingArea, 0.0, 0.0,
    gtk_widget_get_allocated_width(that->_drawingArea),
    gtk_widget_get_allocated_height(that->_drawingArea));
}

// Return the GtkWidget of the GBSurfaceWidget 'that'
#if BUILDMODE != 0
inline
#endif
GtkWidget* GBSurfaceWidgetGtkWidget(const GBSurfaceWidget* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_drawingArea;
}

// Return the GtkWidget of the GBSurfaceApp 'that'
#if BUILDMODE != 0
inline
#endif
GtkWidget* GBSurfaceAppGtkWidget(const GBSurfaceApp* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
#endif
  return that->_drawingArea;
}

// Return the GtkWidget of the GenBrush 'that', or NULL if the surface
// of the GenBursh is not a GBSurfaceWidget
#if BUILDMODE != 0
inline
#endif
GtkWidget* GBGetGtkWidget(const GenBrush* const that) {
#if BUILDMODE == 0
  if (that == NULL) {
    GenBrushErr->_type = PBErrTypeNullPointer;
    sprintf(GenBrushErr->_msg, "'that' is null");
    PBErrCatch(GenBrushErr);
  }
```

```
#endif
  if (GBSurfaceGetType(that->_surf) == GBSurfaceTypeWidget)
    return GBSurfaceWidgetGtkWidget((GBSurfaceWidget*)(that->_surf));
  else
    return NULL;
}
```

4 Makefile

```
# Build mode
# 0: development (max safety, no optimisation)
# 1: release (min safety, optimisation)
# 2: fast and furious (no safety, optimisation)
BUILD_MODE?=0

all: pbmake_wget main

# Automatic installation of the repository PBMake in the parent folder
pbmake_wget:
if [ ! -d ../PBMake ]; then wget https://github.com/BayashiPascal/PBMake/archive/master.zip; unzip master.zip; rm -f

# 0: monolith version, the GBSurface is rendered toward a TGA image
# 1: GTK version, the GBSurface is rendered toward a TGA image or
#    a GtkWidget
BUILDWITHGRAPHICLIB=1

# Makefile definitions
MAKEFILE_INC=../PBMake/Makefile.inc
include $(MAKEFILE_INC)

# Rules to make the executable
repo=genbrush
$($(repo)_EXENAME): \
$($(repo)_EXENAME).o \
$($(repo)_EXE_DEP) \
$($(repo)_DEP)
$(COMPILER) `echo "$($(repo)_EXE_DEP) $($(repo)_EXENAME).o" | tr ' ' '\n' | sort -u` $(LINK_ARG) $($(repo)_LINK_ARG)

$($(repo)_EXENAME).o: \
$($(repo)_DIR)/$($(repo)_EXENAME).c \
$($(repo)_INC_H_EXE) \
$($(repo)_EXE_DEP)
$(COMPILER) $(BUILD_ARG) $($(repo)_BUILD_ARG) `echo "$($(repo)_INC_DIR)" | tr ' ' '\n' | sort -u` -c $($(repo)_DIR)/$
```

5 Unit tests

```
#include <stdlib.h>
#include <stdio.h>
#include <time.h>
#include <string.h>
#include <time.h>
#include <unistd.h>
#include <sys/time.h>
#include "genbrush.h"

#define RANDOMSEED 0
```

```
void UnitTestGBPixelBlendNormal() {
  GBPixel pixA;
  GBPixel pixB;
  pixA = (GBPixel){._rgba[GBPixelRed]=100, ._rgba[GBPixelGreen]=0,
    ._rgba[GBPixelBlue]=0, ._rgba[GBPixelAlpha]=100};
  pixB = (GBPixel){._rgba[GBPixelRed]=0, ._rgba[GBPixelGreen]=100,
    ._rgba[GBPixelBlue]=0, ._rgba[GBPixelAlpha]=100};
  GBPixelBlendNormal(&pixA, &pixB);
  if (pixA._rgba[GBPixelRed] != 50 ||
    pixA._rgba[GBPixelGreen] != 50 ||
    pixA._rgba[GBPixelBlue] != 0 ||
    pixA._rgba[GBPixelAlpha] != 200) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBPixelBlendNormal failed");
    PBErrCatch(GenBrushErr);
  }
  pixA = (GBPixel){._rgba[GBPixelRed]=100, ._rgba[GBPixelGreen]=0,
    ._rgba[GBPixelBlue]=0, ._rgba[GBPixelAlpha]=255};
  pixB = (GBPixel){._rgba[GBPixelRed]=0, ._rgba[GBPixelGreen]=100,
    ._rgba[GBPixelBlue]=0, ._rgba[GBPixelAlpha]=255};
  GBPixelBlendNormal(&pixA, &pixB);
  if (pixA._rgba[GBPixelRed] != 50 ||
    pixA._rgba[GBPixelGreen] != 50 ||
    pixA._rgba[GBPixelBlue] != 0 ||
    pixA._rgba[GBPixelAlpha] != 255) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBPixelBlendNormal failed");
    PBErrCatch(GenBrushErr);
  }
  pixA = (GBPixel){._rgba[GBPixelRed]=100, ._rgba[GBPixelGreen]=0,
    ._rgba[GBPixelBlue]=0, ._rgba[GBPixelAlpha]=255};
  pixB = (GBPixel){._rgba[GBPixelRed]=0, ._rgba[GBPixelGreen]=100,
    ._rgba[GBPixelBlue]=0, ._rgba[GBPixelAlpha]=25};
  GBPixelBlendNormal(&pixA, &pixB);
  if (pixA._rgba[GBPixelRed] != 5 ||
    pixA._rgba[GBPixelGreen] != 95 ||
    pixA._rgba[GBPixelBlue] != 0 ||
    pixA._rgba[GBPixelAlpha] != 255) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBPixelBlendNormal failed");
    PBErrCatch(GenBrushErr);
  }
  printf("UnitTestGBPixelBlendNormal OK\n");
}

void UnitTestGBPixelBlendOver() {
  GBPixel pixA;
  GBPixel pixB;
  pixA = (GBPixel){._rgba[GBPixelRed]=100, ._rgba[GBPixelGreen]=0,
    ._rgba[GBPixelBlue]=0, ._rgba[GBPixelAlpha]=100};
  pixB = (GBPixel){._rgba[GBPixelRed]=0, ._rgba[GBPixelGreen]=100,
    ._rgba[GBPixelBlue]=0, ._rgba[GBPixelAlpha]=25};
  GBPixelBlendOver(&pixA, &pixB);
  if (pixA._rgba[GBPixelRed] != 61 ||
    pixA._rgba[GBPixelGreen] != 39 ||
    pixA._rgba[GBPixelBlue] != 0 ||
    pixA._rgba[GBPixelAlpha] != 125) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBPixelBlendOver failed");
    PBErrCatch(GenBrushErr);
  }
```

```
  pixA = (GBPixel){._rgba[GBPixelRed]=100, ._rgba[GBPixelGreen]=0,
    ._rgba[GBPixelBlue]=0, ._rgba[GBPixelAlpha]=255};
  pixB = (GBPixel){._rgba[GBPixelRed]=0, ._rgba[GBPixelGreen]=100,
    ._rgba[GBPixelBlue]=0, ._rgba[GBPixelAlpha]=255};
  GBPixelBlendOver(&pixA, &pixB);
  if (pixA._rgba[GBPixelRed] != 0 ||
    pixA._rgba[GBPixelGreen] != 100 ||
    pixA._rgba[GBPixelBlue] != 0 ||
    pixA._rgba[GBPixelAlpha] != 255) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBPixelBlendOver failed");
    PBErrCatch(GenBrushErr);
  }
  printf("UnitTestGBPixelBlendOver OK\n");
}

void UnitTestGBPixelIsSame() {
  GBPixel blue = GBColorBlue;
  GBPixel red = GBColorRed;
  GBPixel rouge = GBColorRed;
  if (GBPixelIsSame(&blue, &red) ||
    !GBPixelIsSame(&rouge, &red)) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBPixelIsSame failed");
    PBErrCatch(GenBrushErr);
  }
  printf("UnitTestGBPixelIsSame OK\n");
}

void UnitTestGBPixelConvertRGBHSV() {
  GBPixel blue = GBColorBlue;
  GBPixel red = GBColorRed;
  GBPixel green = GBColorGreen;
  GBPixel white = GBColorWhite;
  GBPixel black = GBColorBlack;
  GBPixel hsv = GBPixelRGB2HSV(&blue);
  if (hsv._hsva[GBPixelAlpha] != 255 ||
    hsv._hsva[GBPixelHue] != 170 ||
    hsv._hsva[GBPixelSaturation] != 255 ||
    hsv._hsva[GBPixelValue] != 255) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBPixelRGB2HSV failed");
    PBErrCatch(GenBrushErr);
  }
  GBPixel rgb = GBPixelHSV2RGB(&hsv);
  if (rgb._rgba[GBPixelAlpha] != 255 ||
    rgb._rgba[GBPixelRed] != 0 ||
    rgb._rgba[GBPixelGreen] != 0 ||
    rgb._rgba[GBPixelBlue] != 255) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBPixelHSV2RGB failed");
    PBErrCatch(GenBrushErr);
  }
  hsv = GBPixelRGB2HSV(&red);
  if (hsv._hsva[GBPixelAlpha] != 255 ||
    hsv._hsva[GBPixelHue] != 0 ||
    hsv._hsva[GBPixelSaturation] != 255 ||
    hsv._hsva[GBPixelValue] != 255) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBPixelRGB2HSV failed");
    PBErrCatch(GenBrushErr);
  }
```

```
rgb = GBPixelHSV2RGB(&hsv);
if (rgb._rgba[GBPixelAlpha] != 255 ||
  rgb._rgba[GBPixelRed] != 255 ||
  rgb._rgba[GBPixelGreen] != 0 ||
  rgb._rgba[GBPixelBlue] != 0) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBPixelHSV2RGB failed");
  PBErrCatch(GenBrushErr);
}
hsv = GBPixelRGB2HSV(&green);
if (hsv._hsva[GBPixelAlpha] != 255 ||
  hsv._hsva[GBPixelHue] != 85 ||
  hsv._hsva[GBPixelSaturation] != 255 ||
  hsv._hsva[GBPixelValue] != 255) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBPixelRGB2HSV failed");
  PBErrCatch(GenBrushErr);
}
rgb = GBPixelHSV2RGB(&hsv);
if (rgb._rgba[GBPixelAlpha] != 255 ||
  rgb._rgba[GBPixelRed] != 0 ||
  rgb._rgba[GBPixelGreen] != 255 ||
  rgb._rgba[GBPixelBlue] != 0) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBPixelHSV2RGB failed");
  PBErrCatch(GenBrushErr);
}
hsv = GBPixelRGB2HSV(&white);
if (hsv._hsva[GBPixelAlpha] != 255 ||
  hsv._hsva[GBPixelHue] != 0 ||
  hsv._hsva[GBPixelSaturation] != 0 ||
  hsv._hsva[GBPixelValue] != 255) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBPixelRGB2HSV failed");
  PBErrCatch(GenBrushErr);
}
rgb = GBPixelHSV2RGB(&hsv);
if (rgb._rgba[GBPixelAlpha] != 255 ||
  rgb._rgba[GBPixelRed] != 255 ||
  rgb._rgba[GBPixelGreen] != 255 ||
  rgb._rgba[GBPixelBlue] != 255) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBPixelHSV2RGB failed");
  PBErrCatch(GenBrushErr);
}
hsv = GBPixelRGB2HSV(&black);
if (hsv._hsva[GBPixelAlpha] != 255 ||
  hsv._hsva[GBPixelHue] != 0 ||
  hsv._hsva[GBPixelSaturation] != 0 ||
  hsv._hsva[GBPixelValue] != 0) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBPixelRGB2HSV failed");
  PBErrCatch(GenBrushErr);
}
rgb = GBPixelHSV2RGB(&hsv);
if (rgb._rgba[GBPixelAlpha] != 255 ||
  rgb._rgba[GBPixelRed] != 0 ||
  rgb._rgba[GBPixelGreen] != 0 ||
  rgb._rgba[GBPixelBlue] != 0) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBPixelHSV2RGB failed");
  PBErrCatch(GenBrushErr);
```

```
  }
  printf("UnitTestGBPixelConvertRGBHSV OK\n");
}

void UnitTestGBPixel() {
  UnitTestGBPixelBlendNormal();
  UnitTestGBPixelBlendOver();
  UnitTestGBPixelIsSame();
  UnitTestGBPixelConvertRGBHSV();
  printf("UnitTestGBPixel OK\n");
}

void UnitTestGBLayerCreateFree() {
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 4); VecSet(&dim, 1, 3);
  GBLayer* layer = GBLayerCreate(&dim);
  VecShort2D v = VecShortCreateStatic2D();
  if (VecIsEqual(&(layer->_pos), &v) == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBLayerCreate failed");
    PBErrCatch(GenBrushErr);
  }
  if (VecIsEqual(&(layer->_prevPos), &v) == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBLayerCreate failed");
    PBErrCatch(GenBrushErr);
  }
  if (VecIsEqual(&(layer->_dim), &dim) == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBLayerCreate failed");
    PBErrCatch(GenBrushErr);
  }
  if (layer->_pix == NULL) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBLayerCreate failed");
    PBErrCatch(GenBrushErr);
  }
  if (layer->_blendMode != GBLayerBlendModeDefault) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBLayerCreate failed");
    PBErrCatch(GenBrushErr);
  }
  if (layer->_modified == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBLayerCreate failed");
    PBErrCatch(GenBrushErr);
  }
  if (layer->_stackPos != GBLayerStackPosBg) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBLayerCreate failed");
    PBErrCatch(GenBrushErr);
  }
  GBLayerFree(&layer);
  printf("UnitTestGBLayerCreateFree OK\n");
}

void UnitTestGBLayerArea() {
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 4); VecSet(&dim, 1, 3);
  GBLayer* layer = GBLayerCreate(&dim);
  if (GBLayerArea(layer) != 12) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
```

```
    sprintf(GenBrushErr->_msg, "GBLayerArea failed");
    PBErrCatch(GenBrushErr);
  }
  GBLayerFree(&layer);
  printf("UnitTestGBLayerArea OK\n");
}

void UnitTestGBLayerGetSet() {
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 4); VecSet(&dim, 1, 3);
  GBLayer* layer = GBLayerCreate(&dim);
  if (GBLayerPos(layer) != &(layer->_pos)) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBLayerPos failed");
    PBErrCatch(GenBrushErr);
  }
  VecShort2D p = VecShortCreateStatic2D();
  VecSet(&p, 0, 1); VecSet(&p, 1, 2);
  GBLayerSetPos(layer, &p);
  if (VecIsEqual(GBLayerPos(layer), &p) == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBLayerSetPos failed");
    PBErrCatch(GenBrushErr);
  }
  VecSet(&p, 0, 0); VecSet(&p, 1, 0);
  if (VecIsEqual(&(layer->_prevPos), &p) == false ||
    layer->_modified == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBLayerSetPos failed");
    PBErrCatch(GenBrushErr);
  }
  layer->_modified = false;
  VecSet(&p, 0, 3); VecSet(&p, 1, 4);
  GBLayerSetPos(layer, &p);
  VecSet(&p, 0, 1); VecSet(&p, 1, 2);
  if (VecIsEqual(&(layer->_prevPos), &p) == false ||
    layer->_modified == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBLayerSetPos failed");
    PBErrCatch(GenBrushErr);
  }
  p = GBLayerGetPos(layer);
  if (VecIsEqual(GBLayerPos(layer), &p) == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBLayerGetPos failed");
    PBErrCatch(GenBrushErr);
  }
  if (GBLayerPrevPos(layer) != &(layer->_prevPos)) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBLayerPrevPos failed");
    PBErrCatch(GenBrushErr);
  }
  p = GBLayerGetPrevPos(layer);
  if (VecIsEqual(GBLayerPrevPos(layer), &p) == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBLayerGetPrevPos failed");
    PBErrCatch(GenBrushErr);
  }
  if (GBLayerDim(layer) != &(layer->_dim)) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBLayerDim failed");
    PBErrCatch(GenBrushErr);
```

```
}
p = GBLayerGetDim(layer);
if (VecIsEqual(GBLayerDim(layer), &p) == false) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBLayerGetDim failed");
  PBErrCatch(GenBrushErr);
}
if (GBLayerGetBlendMode(layer) != layer->_blendMode) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBLayerGetBlendMode failed");
  PBErrCatch(GenBrushErr);
}
GBLayerSetBlendMode(layer, GBLayerBlendModeNormal);
if (GBLayerGetBlendMode(layer) != GBLayerBlendModeNormal) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBLayerSetBlendMode failed");
  PBErrCatch(GenBrushErr);
}
if (GBLayerIsModified(layer) != true) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBLayerIsModified failed");
  PBErrCatch(GenBrushErr);
}
GBLayerSetModified(layer, false);
if (GBLayerIsModified(layer) != false) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBLayerSetModified failed");
  PBErrCatch(GenBrushErr);
}
if (GBLayerGetStackPos(layer) != GBLayerStackPosBg) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBLayerGetStackPos failed");
  PBErrCatch(GenBrushErr);
}
GBLayerSetStackPos(layer, GBLayerStackPosFg);
if (GBLayerGetStackPos(layer) != GBLayerStackPosFg ||
  GBLayerIsModified(layer) == false) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBLayerSetStackPos failed");
  PBErrCatch(GenBrushErr);
}
if (GBLayerPixels(layer) != layer->_pix) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBLayerPixels failed");
  PBErrCatch(GenBrushErr);
}
VecSet(&p, 0, -1); VecSet(&p, 1, 2);
if (GBLayerPixelSafe(layer, &p) != NULL) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBLayerPixelSafe failed");
  PBErrCatch(GenBrushErr);
}
VecSet(&p, 0, 1); VecSet(&p, 1, 2);
if (GBLayerPixel(layer, &p) != layer->_pix + 9) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBLayerPixel failed");
  PBErrCatch(GenBrushErr);
}
if (GBLayerPixelSafe(layer, &p) != layer->_pix + 9) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBLayerPixelSafe failed");
  PBErrCatch(GenBrushErr);
```

```
  }
  GBPixel pix = GBColorWhite;
  float depth = 1.0;
  GBLayerAddPixel(layer, &p, &pix, depth);
  if (GSetNbElem(GBLayerPixel(layer, &p)) != 1) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBLayerAddPixel failed");
    PBErrCatch(GenBrushErr);
  }
  VecSet(&p, 0, -1); VecSet(&p, 1, 2);
  GBLayerAddPixelSafe(layer, &p, &pix, depth);
  VecSet(&p, 0, 1); VecSet(&p, 1, 2);
  GBLayerAddPixelSafe(layer, &p, &pix, depth);
  if (GSetNbElem(GBLayerPixel(layer, &p)) != 2) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBLayerAddPixelSafe failed");
    PBErrCatch(GenBrushErr);
  }
  if (GBLayerIsPosInside(layer, &p) == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBLayerIsPosInside failed");
    PBErrCatch(GenBrushErr);
  }
  VecSet(&p, 0, 10); VecSet(&p, 1, 2);
  if (GBLayerIsPosInside(layer, &p) == true) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBLayerIsPosInside failed");
    PBErrCatch(GenBrushErr);
  }
  VecSet(&p, 0, 1); VecSet(&p, 1, -2);
  if (GBLayerIsPosInside(layer, &p) == true) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBLayerIsPosInside failed");
    PBErrCatch(GenBrushErr);
  }
  GBLayerFlush(layer);
  VecSet(&p, 0, 1); VecSet(&p, 1, 2);
  if (GSetNbElem(GBLayerPixel(layer, &p)) != 0) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBLayerFlush failed");
    PBErrCatch(GenBrushErr);
  }
  GBLayerFree(&layer);
  printf("UnitTestGBLayerGetSet OK\n");
}

void UnitTestGBLayerCreateFromFile() {
  GBLayer* layer = GBLayerCreateFromFile("./testBottomLeft.tga");
  if (layer == NULL) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBLayerCreateFromFile failed");
    PBErrCatch(GenBrushErr);
  }
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 3); VecSet(&dim, 1, 4);
  if (VecIsEqual(&dim, GBLayerDim(layer)) == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBLayerCreateFromFile failed");
    PBErrCatch(GenBrushErr);
  }
  unsigned char check[48] = {
    91,0,163,192, 52,0,202,194, 23,0,231,205,
```

```
    153,0,102,200, 106,0,148,192, 64,0,190,193,
    211,0,43,221, 168,0,86,204, 121,0,133,193,
    255,0,0,255, 226,0,28,230, 184,0,70,209
  };
  for (int iPix = 0; iPix < 12; iPix++) {
    GBPixel pix =
      ((GBStackedPixel*)GSetGet(layer->_pix + iPix, 0))->_val;
    if (pix._rgba[GBPixelRed] != check[4 * iPix] ||
      pix._rgba[GBPixelGreen] != check[4 * iPix + 1] ||
      pix._rgba[GBPixelBlue] != check[4 * iPix + 2] ||
      pix._rgba[GBPixelAlpha] != check[4 * iPix + 3]) {
      GenBrushErr->_type = PBErrTypeUnitTestFailed;
      sprintf(GenBrushErr->_msg, "GBLayerCreateFromFile1 failed");
      PBErrCatch(GenBrushErr);
    }
  }
  GBLayerFree(&layer);
  layer = GBLayerCreateFromFile("./testTopLeft.tga");
  if (layer == NULL) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBLayerCreateFromFile failed");
    PBErrCatch(GenBrushErr);
  }
  if (VecIsEqual(&dim, GBLayerDim(layer)) == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBLayerCreateFromFile failed");
    PBErrCatch(GenBrushErr);
  }
  for (int iPix = 0; iPix < 12; iPix++) {
    GBPixel pix =
      ((GBStackedPixel*)GSetGet(layer->_pix + iPix, 0))->_val;
    if (pix._rgba[GBPixelRed] != check[4 * iPix] ||
      pix._rgba[GBPixelGreen] != check[4 * iPix + 1] ||
      pix._rgba[GBPixelBlue] != check[4 * iPix + 2] ||
      pix._rgba[GBPixelAlpha] != check[4 * iPix + 3]) {
      GenBrushErr->_type = PBErrTypeUnitTestFailed;
      sprintf(GenBrushErr->_msg, "GBLayerCreateFromFile2 failed");
      PBErrCatch(GenBrushErr);
    }
  }
  GBLayerFree(&layer);
  printf("UnitTestGBLayerCreateFromFile OK\n");
}

void UnitTestGBLayerGetBoundaryInSurface() {
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 800); VecSet(&dim, 1, 600);
  GBSurface* surf = GBSurfaceCreate(GBSurfaceTypeImage, &dim);
  VecSet(&dim, 0, 200); VecSet(&dim, 1, 100);
  GBLayer* layer = GBLayerCreate(&dim);
  VecShort2D pos = VecShortCreateStatic2D();
  VecSet(&pos, 0, 10); VecSet(&pos, 1, 10);
  GBLayerSetPos(layer, &pos);
  Facoid* bound = GBLayerGetBoundaryInSurface(layer, surf, false);
  VecFloat2D p = VecFloatCreateStatic2D();
  VecFloat2D u = VecFloatCreateStatic2D();
  VecFloat2D v = VecFloatCreateStatic2D();
  VecSet(&p, 0, 10); VecSet(&p, 1, 10);
  VecSet(&u, 0, 200); VecSet(&u, 1, 0);
  VecSet(&v, 0, 0); VecSet(&v, 1, 100);
  if (VecIsEqual(ShapoidPos(bound), &p) == false ||
    VecIsEqual(ShapoidAxis(bound, 0), &u) == false ||
```

```
  VecIsEqual(ShapoidAxis(bound, 1), &v) == false) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBLayerGetBoundaryInSurface failed");
  PBErrCatch(GenBrushErr);
}
ShapoidFree(&bound);
VecSet(&pos, 0, 700); VecSet(&pos, 1, 10);
GBLayerSetPos(layer, &pos);
bound = GBLayerGetBoundaryInSurface(layer, surf, false);
VecSet(&p, 0, 700); VecSet(&p, 1, 10);
VecSet(&u, 0, 100); VecSet(&u, 1, 0);
VecSet(&v, 0, 0); VecSet(&v, 1, 100);
if (VecIsEqual(ShapoidPos(bound), &p) == false ||
  VecIsEqual(ShapoidAxis(bound, 0), &u) == false ||
  VecIsEqual(ShapoidAxis(bound, 1), &v) == false) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBLayerGetBoundaryInSurface failed");
  PBErrCatch(GenBrushErr);
}
ShapoidFree(&bound);
VecSet(&pos, 0, -100); VecSet(&pos, 1, 10);
GBLayerSetPos(layer, &pos);
bound = GBLayerGetBoundaryInSurface(layer, surf, false);
VecSet(&p, 0, 0); VecSet(&p, 1, 10);
VecSet(&u, 0, 100); VecSet(&u, 1, 0);
VecSet(&v, 0, 0); VecSet(&v, 1, 100);
if (VecIsEqual(ShapoidPos(bound), &p) == false ||
  VecIsEqual(ShapoidAxis(bound, 0), &u) == false ||
  VecIsEqual(ShapoidAxis(bound, 1), &v) == false) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBLayerGetBoundaryInSurface failed");
  PBErrCatch(GenBrushErr);
}
ShapoidFree(&bound);
VecSet(&pos, 0, 10); VecSet(&pos, 1, 550);
GBLayerSetPos(layer, &pos);
bound = GBLayerGetBoundaryInSurface(layer, surf, false);
VecSet(&p, 0, 10); VecSet(&p, 1, 550);
VecSet(&u, 0, 200); VecSet(&u, 1, 0);
VecSet(&v, 0, 0); VecSet(&v, 1, 50);
if (VecIsEqual(ShapoidPos(bound), &p) == false ||
  VecIsEqual(ShapoidAxis(bound, 0), &u) == false ||
  VecIsEqual(ShapoidAxis(bound, 1), &v) == false) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBLayerGetBoundaryInSurface failed");
  PBErrCatch(GenBrushErr);
}
ShapoidFree(&bound);
VecSet(&pos, 0, 10); VecSet(&pos, 1, -50);
GBLayerSetPos(layer, &pos);
bound = GBLayerGetBoundaryInSurface(layer, surf, false);
VecSet(&p, 0, 10); VecSet(&p, 1, 0);
VecSet(&u, 0, 200); VecSet(&u, 1, 0);
VecSet(&v, 0, 0); VecSet(&v, 1, 50);
if (VecIsEqual(ShapoidPos(bound), &p) == false ||
  VecIsEqual(ShapoidAxis(bound, 0), &u) == false ||
  VecIsEqual(ShapoidAxis(bound, 1), &v) == false) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBLayerGetBoundaryInSurface failed");
  PBErrCatch(GenBrushErr);
}
ShapoidFree(&bound);
```

```
  VecSet(&pos, 0, -300); VecSet(&pos, 1, -150);
  GBLayerSetPos(layer, &pos);
  bound = GBLayerGetBoundaryInSurface(layer, surf, false);
  if (bound != NULL) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBLayerGetBoundaryInSurface failed");
    PBErrCatch(GenBrushErr);
  }
  VecSet(&pos, 0, 1000); VecSet(&pos, 1, 1000);
  GBLayerSetPos(layer, &pos);
  bound = GBLayerGetBoundaryInSurface(layer, surf, false);
  if (bound != NULL) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBLayerGetBoundaryInSurface failed");
    PBErrCatch(GenBrushErr);
  }
  VecSet(&pos, 0, 0); VecSet(&pos, 1, 1000);
  GBLayerSetPos(layer, &pos);
  bound = GBLayerGetBoundaryInSurface(layer, surf, false);
  if (bound != NULL) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBLayerGetBoundaryInSurface failed");
    PBErrCatch(GenBrushErr);
  }
  VecSet(&pos, 0, 1000); VecSet(&pos, 1, 0);
  GBLayerSetPos(layer, &pos);
  bound = GBLayerGetBoundaryInSurface(layer, surf, false);
  if (bound != NULL) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBLayerGetBoundaryInSurface failed");
    PBErrCatch(GenBrushErr);
  }
  GBLayerFree(&layer);
  GBSurfaceFree(&surf);
  printf("UnitTestGBLayerGetBoundaryInSurface OK\n");
}

void UnitTestGBLayer() {
  UnitTestGBLayerCreateFree();
  UnitTestGBLayerArea();
  UnitTestGBLayerGetSet();
  UnitTestGBLayerCreateFromFile();
  UnitTestGBLayerGetBoundaryInSurface();

  printf("UnitTestGBLayer OK\n");
}

void UnitTestGBPostProcessingCreateFree() {
  GBPostProcessing pp =
    GBPostProcessingCreateStatic(GBPPTypeNormalizeHue);
  if (pp._type != GBPPTypeNormalizeHue) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBPostProcessingCreateStatic failed");
    PBErrCatch(GenBrushErr);
  }
  GBPostProcessing* pp2 =
    GBPostProcessingCreate(GBPPTypeNormalizeHue);
  if (pp2->_type != GBPPTypeNormalizeHue) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBPostProcessingCreate failed");
    PBErrCatch(GenBrushErr);
  }
```

```
  GBPostProcessingFree(&pp2);
  if (pp2 != NULL) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBPostProcessingFree failed");
    PBErrCatch(GenBrushErr);
  }
  printf("UnitTestGBPostProcessingCreateFree OK\n");
}

void UnitTestGBPostProcessingGetSet() {
  GBPostProcessing pp =
    GBPostProcessingCreateStatic(GBPPTypeNormalizeHue);
  if (GBPostProcessingGetType(&pp) != GBPPTypeNormalizeHue) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBPostProcessingGetType failed");
    PBErrCatch(GenBrushErr);
  }
  printf("UnitTestGBPostProcessingGetSet OK\n");
}

void UnitTestGBPostProcessing() {
  UnitTestGBPostProcessingCreateFree();
  UnitTestGBPostProcessingGetSet();

  printf("UnitTestGBPostProcessing OK\n");
}

void UnitTestGBSurfaceCreateFree() {
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 800); VecSet(&dim, 1, 600);
  GBSurface* surf = GBSurfaceCreate(GBSurfaceTypeImage, &dim);
  if (surf->_type != GBSurfaceTypeImage) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceCreate failed");
    PBErrCatch(GenBrushErr);
  }
  if (VecIsEqual(&(surf->_dim), &dim) == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceCreate failed");
    PBErrCatch(GenBrushErr);
  }
  GBPixel white = GBColorWhite;
  if (memcmp(&(surf->_bgColor), &white, sizeof(GBPixel)) != 0) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceCreate failed");
    PBErrCatch(GenBrushErr);
  }
  if (surf->_finalPix == NULL) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceCreate failed");
    PBErrCatch(GenBrushErr);
  }
  if (GSetNbElem(&(surf->_layers)) != 0) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceCreate failed");
    PBErrCatch(GenBrushErr);
  }
  GBSurfaceFree(&surf);
  printf("UnitTestGBSurfaceCreateFree OK\n");
}

void UnitTestGBSurfaceGetSet() {
```

```
VecShort2D dim = VecShortCreateStatic2D();
VecSet(&dim, 0, 4); VecSet(&dim, 1, 3);
GBSurface surf = GBSurfaceCreateStatic(GBSurfaceTypeImage, &dim);
if (GBSurfaceGetType(&surf) != GBSurfaceTypeImage) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBSurfaceGetType failed");
  PBErrCatch(GenBrushErr);
}
VecShort2D d = GBSurfaceGetDim(&surf);
if (VecIsEqual(&d, &dim) == false) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBSurfaceGetDim failed");
  PBErrCatch(GenBrushErr);
}
if (VecIsEqual(GBSurfaceDim(&surf), &dim) == false) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBSurfaceDim failed");
  PBErrCatch(GenBrushErr);
}
if (GBSurfaceFinalPixels(&surf) != surf._finalPix) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBSurfaceFinalPix failed");
  PBErrCatch(GenBrushErr);
}
GBPixel black = GBColorBlack;
GBSurfaceSetBgColor(&surf, &black);
if (memcmp(&(surf._bgColor), &black, sizeof(GBPixel)) != 0) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBSurfaceSetBgColor failed");
  PBErrCatch(GenBrushErr);
}
if (memcmp(GBSurfaceBgColor(&surf), &black, sizeof(GBPixel)) != 0) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBSurfaceBgColor failed");
  PBErrCatch(GenBrushErr);
}
GBPixel bgCol = GBSurfaceGetBgColor(&surf);
if (memcmp(&(surf._bgColor), &bgCol, sizeof(GBPixel)) != 0) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBSurfaceGetBgColor failed");
  PBErrCatch(GenBrushErr);
}
VecShort2D p = VecShortCreateStatic2D();
VecSet(&p, 0, 1); VecSet(&p, 1, 2);
if (GBSurfaceFinalPixel(&surf, &p) != surf._finalPix + 9) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBSurfaceFinalPixel failed");
  PBErrCatch(GenBrushErr);
}
if (GBSurfaceFinalPixelSafe(&surf, &p) != surf._finalPix + 9) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBSurfaceFinalPixelSafe failed");
  PBErrCatch(GenBrushErr);
}
GBPixel white = GBColorWhite;
GBSurfaceSetFinalPixel(&surf, &p, &white);
if (memcmp(GBSurfaceFinalPixel(&surf, &p), &white,
  sizeof(GBPixel)) != 0) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBSurfaceSetFinalPixel failed");
  PBErrCatch(GenBrushErr);
}
```

```
  GBPixel pix = GBSurfaceGetFinalPixel(&surf, &p);
  if (memcmp(&pix, &white, sizeof(GBPixel)) != 0) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceGetFinalPixel failed");
    PBErrCatch(GenBrushErr);
  }
  if (GBSurfaceIsPosInside(&surf, &p) == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceIsPosInside failed");
    PBErrCatch(GenBrushErr);
  }
  VecSet(&p, 0, -1); VecSet(&p, 1, 2);
  if (GBSurfaceIsPosInside(&surf, &p) == true) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceIsPosInside failed");
    PBErrCatch(GenBrushErr);
  }
  GBPixel transparent = GBColorTransparent;
  pix = GBSurfaceGetFinalPixelSafe(&surf, &p);
  if (memcmp(&pix, &transparent, sizeof(GBPixel)) != 0) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceGetFinalPixelSafe failed");
    PBErrCatch(GenBrushErr);
  }
  if (GBSurfaceFinalPixelSafe(&surf, &p) != NULL) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceFinalPixelSafe failed");
    PBErrCatch(GenBrushErr);
  }
  VecSet(&p, 0, 1); VecSet(&p, 1, 10);
  if (GBSurfaceIsPosInside(&surf, &p) == true) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceIsPosInside failed");
    PBErrCatch(GenBrushErr);
  }
  GBSurfaceSetFinalPixelSafe(&surf, &p, &white);
  VecSet(&p, 0, 2); VecSet(&p, 1, 1);
  GBPixel blue = GBColorBlue;
  GBSurfaceSetFinalPixelSafe(&surf, &p, &blue);
  if (memcmp(GBSurfaceFinalPixel(&surf, &p), &blue,
    sizeof(GBPixel)) != 0) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceSetFinalPixelSafe failed");
    PBErrCatch(GenBrushErr);
  }
  if (GBSurfaceLayers(&surf) != &(surf._layers)) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceLayers failed");
    PBErrCatch(GenBrushErr);
  }
  GBSurfaceFreeStatic(&surf);
  printf("UnitTestGBSurfaceGetSet OK\n");
}

void UnitTestGBSurfaceArea() {
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 4); VecSet(&dim, 1, 3);
  GBSurface surf = GBSurfaceCreateStatic(GBSurfaceTypeImage, &dim);
  if (GBSurfaceArea(&surf) != 12) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceArea failed");
    PBErrCatch(GenBrushErr);
```

```
  }
  GBSurfaceFreeStatic(&surf);
  printf("UnitTestGBSurfaceArea OK\n");
}

void UnitTestGBSurfaceClone() {
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 4); VecSet(&dim, 1, 3);
  GBSurface surf = GBSurfaceCreateStatic(GBSurfaceTypeImage, &dim);
  GBSurface clone = GBSurfaceClone(&surf);
  if (GBSurfaceGetType(&surf) != GBSurfaceGetType(&clone)) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceClone failed");
    PBErrCatch(GenBrushErr);
  }
  if (VecIsEqual(GBSurfaceDim(&surf), GBSurfaceDim(&clone)) == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceClone failed");
    PBErrCatch(GenBrushErr);
  }
  if (memcmp(&(surf._bgColor), &(clone._bgColor),
    sizeof(GBPixel)) != 0) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceClone failed");
    PBErrCatch(GenBrushErr);
  }
  if (surf._finalPix == clone._finalPix) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceClone failed");
    PBErrCatch(GenBrushErr);
  }
  if (memcmp(surf._finalPix, clone._finalPix,
    sizeof(GBPixel) * GBSurfaceArea(&surf)) != 0) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceClone failed");
    PBErrCatch(GenBrushErr);
  }
  GBSurfaceFreeStatic(&surf);
  GBSurfaceFreeStatic(&clone);
  printf("UnitTestGBSurfaceClone OK\n");
}

void UnitTestGBSurfaceAddRemoveLayer() {
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 4); VecSet(&dim, 1, 3);
  GBSurface surf = GBSurfaceCreateStatic(GBSurfaceTypeImage, &dim);
  GBLayer* layerA = GBSurfaceAddLayer(&surf, &dim);
  if (layerA == NULL) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceAddLayer failed");
    PBErrCatch(GenBrushErr);
  }
  if (GSetNbElem(GBSurfaceLayers(&surf)) != 1) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceAddLayer failed");
    PBErrCatch(GenBrushErr);
  }
  if (VecIsEqual(GBLayerDim(layerA), &dim) == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceAddLayer failed");
    PBErrCatch(GenBrushErr);
  }
```

```
  GBLayer* layerB = GBSurfaceAddLayer(&surf, &dim);
  GBSurfaceRemoveLayer(&surf, layerA);
  if ((GBLayer*)(surf._layers._head->_data) != layerB) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceRemoveLayer failed");
    PBErrCatch(GenBrushErr);
  }
  GBSurfaceFreeStatic(&surf);
  printf("UnitTestGBSurfaceAddRemoveLayer OK\n");
}

void UnitTestGBSurfaceGetLayerNbLayer() {
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 4); VecSet(&dim, 1, 3);
  GBSurface surf = GBSurfaceCreateStatic(GBSurfaceTypeImage, &dim);
  GBLayer* layers[3] = {NULL};
  for (int iLayer = 0; iLayer< 3; ++iLayer)
    layers[iLayer] = GBSurfaceAddLayer(&surf, &dim);
  if (GBSurfaceNbLayer(&surf) != 3) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceNbLayer failed");
    PBErrCatch(GenBrushErr);
  }
  for (int iLayer = 0; iLayer< 3; ++iLayer) {
    if (GBSurfaceLayer(&surf, iLayer) != layers[iLayer]) {
      GenBrushErr->_type = PBErrTypeUnitTestFailed;
      sprintf(GenBrushErr->_msg, "GBSurfaceGetLayer failed");
      PBErrCatch(GenBrushErr);
    }
  }
  GBSurfaceFreeStatic(&surf);
  printf("UnitTestGBSurfaceGetLayer OK\n");
}

void UnitTestGBSurfaceSetLayersModified() {
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 4); VecSet(&dim, 1, 3);
  GBSurface surf = GBSurfaceCreateStatic(GBSurfaceTypeImage, &dim);
  GBLayer* layers[3] = {NULL};
  for (int iLayer = 0; iLayer< 3; ++iLayer)
    layers[iLayer] = GBSurfaceAddLayer(&surf, &dim);
  GBSurfaceSetLayersModified(&surf, false);
  for (int iLayer = 0; iLayer< 3; ++iLayer) {
    if (GBLayerIsModified(layers[iLayer]) != false) {
      GenBrushErr->_type = PBErrTypeUnitTestFailed;
      sprintf(GenBrushErr->_msg, "GBSurfaceSetLayersModified failed");
      PBErrCatch(GenBrushErr);
    }
  }
  GBSurfaceSetLayersModified(&surf, true);
  for (int iLayer = 0; iLayer< 3; ++iLayer) {
    if (GBLayerIsModified(layers[iLayer]) != true) {
      GenBrushErr->_type = PBErrTypeUnitTestFailed;
      sprintf(GenBrushErr->_msg, "GBSurfaceSetLayersModified failed");
      PBErrCatch(GenBrushErr);
    }
  }
  GBSurfaceFreeStatic(&surf);
  printf("UnitTestGBSurfaceSetLayersModified OK\n");
}

void UnitTestGBSurfaceSetLayerStackPos() {
```

```
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 4); VecSet(&dim, 1, 3);
  GBSurface surf = GBSurfaceCreateStatic(GBSurfaceTypeImage, &dim);
  GBLayer* layers[3] = {NULL};
  for (int iLayer = 0; iLayer< 3; ++iLayer)
    layers[iLayer] = GBSurfaceAddLayer(&surf, &dim);
  GBSurfaceSetLayerStackPos(&surf, layers[2], 0);
  GBSurfaceSetLayerStackPos(&surf, layers[0], 2);
  if (GBSurfaceLayer(&surf, 0) != layers[2] ||
    GBSurfaceLayer(&surf, 1) != layers[1] ||
    GBSurfaceLayer(&surf, 2) != layers[0] ||
    GBLayerIsModified(layers[0]) != true ||
    GBLayerIsModified(layers[1]) != true ||
    GBLayerIsModified(layers[2]) != true) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceSetLayerPos failed");
    PBErrCatch(GenBrushErr);
  }
  GBSurfaceFreeStatic(&surf);
  printf("UnitTestGBSurfaceSetLayerPos OK\n");
}

void UnitTestGBSurfaceGetModifiedArea() {
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 100); VecSet(&dim, 1, 100);
  GBSurface surf = GBSurfaceCreateStatic(GBSurfaceTypeImage, &dim);
  GBLayer* layers[4] = {NULL};
  VecSet(&dim, 0, 10); VecSet(&dim, 1, 10);
  for (int iLayer = 0; iLayer < 4; ++iLayer)
    layers[iLayer] = GBSurfaceAddLayer(&surf, &dim);
  VecShort2D pos = VecShortCreateStatic2D();
  VecSet(&pos, 0, -2); VecSet(&pos, 1, 5);
  GBLayerSetPos(layers[0], &pos);
  VecSet(&pos, 0, 5); VecSet(&pos, 1, 5);
  GBLayerSetPos(layers[1], &pos);
  VecSet(&pos, 0, 10); VecSet(&pos, 1, 8);
  GBLayerSetPos(layers[2], &pos);
  VecSet(&pos, 0, 20); VecSet(&pos, 1, 20);
  GBLayerSetPos(layers[3], &pos);
  GBLayerSetModified(layers[3], false);
  GSetShapoid* set = GBSurfaceGetModifiedArea(&surf);
  if (GSetNbElem(set) != 5) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg,
      "GBSurfaceGetModifiedArea failed");
    PBErrCatch(ShapoidErr);
  }
  int iCheck = 0;
  float checkp[10] = {
      0.0, 5.0, 0.0, 0.0, 8.0, 5.0, 10.0, 15.0, 15.0, 8.0};
  float checku[5] = {8.0, 10.0, 7.0, 10.0, 5.0};
  float checkv[5] = {10.0, 5.0, 10.0, 3.0, 7.0};
  VecFloat2D p = VecFloatCreateStatic2D();
  VecFloat2D u = VecFloatCreateStatic2D();
  VecFloat2D v = VecFloatCreateStatic2D();
  do {
    Facoid* fac = (Facoid*)GSetPop(set);
    VecSet(&p, 0, checkp[2 * iCheck]);
    VecSet(&p, 1, checkp[2 * iCheck + 1]);
    VecSet(&u, 0, checku[iCheck]); VecSet(&v, 1, checkv[iCheck]);
    if (VecIsEqual(ShapoidPos(fac), &p) == false ||
      VecIsEqual(ShapoidAxis(fac, 0), &u) == false ||
```

```
      VecIsEqual(ShapoidAxis(fac, 1), &v) == false) {
      ShapoidErr->_type = PBErrTypeUnitTestFailed;
      sprintf(ShapoidErr->_msg,
        "GBSurfaceGetModifiedArea failed");
      PBErrCatch(ShapoidErr);
    }
    ShapoidFree(&fac);
    ++iCheck;
  } while(GSetNbElem(set) > 0);
  GSetFree(&set);
  GBSurfaceFreeStatic(&surf);
  printf("UnitTestGBSurfaceGetModifiedArea OK\n");
}

void UnitTestGBSurfaceUpdate() {
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 10); VecSet(&dim, 1, 10);
  GBSurface* surf = GBSurfaceCreate(GBSurfaceTypeImage, &dim);
  GBLayer* layers[4] = {NULL};
  VecSet(&dim, 0, 5); VecSet(&dim, 1, 5);
  for (int iLayer = 0; iLayer < 4; ++iLayer) {
    layers[iLayer] = GBSurfaceAddLayer((GBSurface*)surf, &dim);
    GBLayerSetBlendMode(layers[iLayer], GBLayerBlendModeOver);
  }
  GBLayerSetStackPos(layers[1], GBLayerStackPosInside);
  GBLayerSetStackPos(layers[2], GBLayerStackPosInside);
  GBLayerSetStackPos(layers[3], GBLayerStackPosFg);
  VecShort2D pos = VecShortCreateStatic2D();
  VecSet(&pos, 0, 1); VecSet(&pos, 1, 1);
  GBLayerSetPos(layers[0], &pos);
  VecSet(&pos, 0, 3); VecSet(&pos, 1, 3);
  GBLayerSetPos(layers[1], &pos);
  VecSet(&pos, 0, 4); VecSet(&pos, 1, 4);
  GBLayerSetPos(layers[2], &pos);
  VecSet(&pos, 0, 7); VecSet(&pos, 1, 7);
  GBLayerSetPos(layers[3], &pos);
  VecSetNull(&pos);
  GBPixel col;
  float depth;
  do {
    col = GBColorGreen;
    depth = 0.0;
    GBLayerAddPixel(layers[0], &pos, &col, depth);
    col._rgba[GBPixelRed] = VecGet(&pos, 1) * 30;
    col._rgba[GBPixelGreen] = VecGet(&pos, 0) * 30;
    col._rgba[GBPixelBlue] = 0;
    col._rgba[GBPixelAlpha] = 255 - VecGet(&pos, 1) * 30;
    depth = VecGet(&pos, 0);
    GBLayerAddPixel(layers[1], &pos, &col, depth);
    col._rgba[GBPixelRed] = 0;
    col._rgba[GBPixelGreen] = VecGet(&pos, 0) * 30;
    col._rgba[GBPixelBlue] = VecGet(&pos, 1) * 30;
    col._rgba[GBPixelAlpha] = 255 - VecGet(&pos, 0) * 30;
    depth = VecGet(&pos, 1);
    GBLayerAddPixel(layers[2], &pos, &col, depth);
    col = GBColorBlue;
    depth = 0.0;
    GBLayerAddPixel(layers[3], &pos, &col, depth);
  } while (VecStep(&pos, &dim));
  GBSurfaceUpdate(surf);
  unsigned char check[400] = {
    255,255,255,255, 255,255,255,255, 255,255,255,255, 255,255,255,
```

```
    255, 255,255,255,255, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 255,255,255,255, 0,255,0,255, 0,255,0,255, 0,255,0,255,
    0,255,0,255, 0,255,0,255, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    255,255,255,255, 0,255,0,255, 0,255,0,255, 0,255,0,255,
    0,255,0,255, 0,255,0,255, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    255,255,255,255, 0,255,0,255, 0,255,0,255, 0,0,0,255, 0,30,0,255,
    0,60,0,255, 0,90,0,255, 0,120,0,255, 0,0,0,0, 0,0,0,0,
    255,255,255,255, 0,255,0,255, 0,255,0,255, 26,30,0,255,
    0,0,0,255, 4,34,0,255, 7,67,0,255, 11,101,0,255, 120,184,120,255,
    0,0,0,0, 0,0,0,0, 0,255,0,255, 0,255,0,255, 46,60,0,255,
    0,0,30,255, 7,34,26,255, 14,67,23,255, 21,101,19,255,
    120,184,136,255, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    148,90,90,255, 0,0,60,255, 11,34,53,255, 21,67,46,255,
    32,101,39,255, 120,184,152,255, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 184,120,120,255, 0,0,90,255, 14,34,79,255, 28,67,69,255,
    0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,120,255, 30,56,136,255, 60,106,152,255, 0,0,255,255,
    0,0,255,255, 0,0,255,255, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,255,255, 0,0,255,255, 0,0,255,255
    };
  for (int iPix = 0; iPix < GBSurfaceArea(surf); ++iPix) {
    if (surf->_finalPix[iPix]._rgba[GBPixelRed] !=
      check[iPix * 4] ||
      surf->_finalPix[iPix]._rgba[GBPixelGreen] !=
      check[iPix * 4 + 1] ||
      surf->_finalPix[iPix]._rgba[GBPixelBlue] !=
      check[iPix * 4 + 2] ||
      surf->_finalPix[iPix]._rgba[GBPixelAlpha] !=
      check[iPix * 4 + 3]) {
      ShapoidErr->_type = PBErrTypeUnitTestFailed;
      sprintf(ShapoidErr->_msg, "GBSurfaceUpdate failed");
      //PBErrCatch(ShapoidErr);
    }
  }
  GBSurfaceFree(&surf);

  printf("UnitTestGBSurfaceUpdate OK\n");
}

void UnitTestGBSurfaceAddLayerFromFile() {
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 10); VecSet(&dim, 1, 10);
  GBSurface* surf = GBSurfaceCreate(GBSurfaceTypeImage, &dim);
  GBLayer* layer = GBSurfaceAddLayerFromFile(surf, "./ImageRef.tga");
  (void)layer;
  GBPixel transparent = GBColorTransparent;
  GBSurfaceSetBgColor(surf, &transparent);
  GBSurfaceUpdate(surf);
  unsigned char check[400] = {
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,255,0,255, 0,255,0,255,
    0,255,0,255, 0,255,0,255, 0,255,0,255, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,255,0,255, 0,255,0,255, 0,255,0,255,
    0,255,0,255, 0,255,0,255, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,255,0,255, 0,255,0,255, 0,0,0,255, 0,30,0,255,
    0,60,0,255, 0,90,0,255, 0,120,0,255, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,255,0,255, 0,255,0,255, 26,30,0,255, 0,0,0,255, 4,34,0,255,
    7,67,0,255, 11,101,0,255, 120,184,120,255, 0,0,0,0, 0,0,0,0,
    0,255,0,255, 0,255,0,255, 46,60,0,255, 0,0,30,255, 7,34,26,255,
    14,67,23,255, 21,101,19,255, 120,184,136,255, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 148,90,90,255, 0,0,60,255, 11,34,53,255,
    21,67,46,255, 32,101,39,255, 120,184,152,255, 0,0,0,0, 0,0,0,0,
```

```
    0,0,0,0, 0,0,0,0, 184,120,120,255, 0,0,90,255, 14,34,79,255,
    28,67,69,255, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,120,255, 30,56,136,255,
    60,106,152,255, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,255,255, 0,0,255,255, 0,0,255,255
    };
  for (int iPix = 0; iPix < GBSurfaceArea(surf); ++iPix) {
    if (surf->_finalPix[iPix]._rgba[GBPixelRed] !=
      check[iPix * 4] ||
      surf->_finalPix[iPix]._rgba[GBPixelGreen] !=
      check[iPix * 4 + 1] ||
      surf->_finalPix[iPix]._rgba[GBPixelBlue] !=
      check[iPix * 4 + 2] ||
      surf->_finalPix[iPix]._rgba[GBPixelAlpha] !=
      check[iPix * 4 + 3]) {
      ShapoidErr->_type = PBErrTypeUnitTestFailed;
      sprintf(ShapoidErr->_msg, "GBSurfaceAddLayerFromFile failed");
      PBErrCatch(ShapoidErr);
    }
  }
  GBSurfaceFree(&surf);
  printf("UnitTestGBSurfaceAddLayerFromFile OK\n");
}

void UnitTestGBSurfaceFlush() {
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 10); VecSet(&dim, 1, 10);
  GBSurface* surf = GBSurfaceCreate(GBSurfaceTypeImage, &dim);
  GBLayer* layer = GBSurfaceAddLayer(surf, &dim);
  GBLayerSetModified(layer, false);
  GBPixel blue = GBColorBlue;
  GBSurfaceSetBgColor(surf, &blue);
  GBSurfaceFlush(surf);
  if (GBLayerIsModified(layer) == false) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBSurfaceFlush failed");
    PBErrCatch(ShapoidErr);
  }
  for (int iPix = GBSurfaceArea(surf); iPix--;)
    if (memcmp(surf->_finalPix + iPix, &blue, sizeof(GBPixel)) != 0) {
      ShapoidErr->_type = PBErrTypeUnitTestFailed;
      sprintf(ShapoidErr->_msg, "GBSurfaceFlush failed");
      PBErrCatch(ShapoidErr);
    }
  GBSurfaceFree(&surf);
  printf("UnitTestGBSurfaceFlush OK\n");
}

void UnitTestGBSurfaceIsSameAs() {
  char* fileName = "./ImageRef.tga";
  GBSurface* surfA = (GBSurface*)GBSurfaceImageCreateFromFile(fileName);
  GBSurface* surfB = (GBSurface*)GBSurfaceImageCreateFromFile(fileName);
  if (GBSurfaceIsSameAs(surfA, surfB) == false) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBSurfaceIsSameAs failed");
    PBErrCatch(ShapoidErr);
  }
  VecSet(GBSurfaceDim(surfA), 0, 0);
  if (GBSurfaceIsSameAs(surfA, surfB) == true) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBSurfaceIsSameAs failed");
```

```
    PBErrCatch(ShapoidErr);
  }
  VecSet(GBSurfaceDim(surfA), 0, 10);
  GBSurfaceFinalPixels(surfA)->_rgba[GBPixelAlpha] = 255;
  if (GBSurfaceIsSameAs(surfA, surfB) == true) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBSurfaceIsSameAs failed");
    PBErrCatch(ShapoidErr);
  }
  GBSurfaceFree(&surfA);
  GBSurfaceFree(&surfB);
  printf("UnitTestGBSurfaceIsSameAs OK\n");
}

void UnitTestGBSurfaceNormalizeHue() {
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 3); VecSet(&dim, 1, 3);
  GBSurface* surf = GBSurfaceCreate(GBSurfaceTypeImage, &dim);
  unsigned char in[27] = {
    20,20,20, 10,20,30, 60,50,40,
    30,30,30, 20,30,40, 50,40,30,
    40,40,40, 30,40,50, 40,30,20
    };
  VecShort2D p = VecShortCreateStatic2D();
  int iPix = 0;
  do {
    GBPixel* pix = GBSurfaceFinalPixel(surf, &p);
    pix->_rgba[GBPixelRed] = in[iPix * 3];
    pix->_rgba[GBPixelGreen] = in[iPix * 3 + 1];
    pix->_rgba[GBPixelBlue] = in[iPix * 3 + 2];
    ++iPix;
  } while (VecStep(&p, GBSurfaceDim(surf)));
  GBPostProcessing post =
    GBPostProcessingCreateStatic(GBPPTypeNormalizeHue);
  GBSurfacePostProcess(surf, &post);
  VecSetNull(&p);
  iPix = 0;
  unsigned char out[27] = {
    51,51,51, 0,51,102, 255,204,153,
    102,102,102, 51,102,153, 204,153,102,
    153,153,153, 102,153,204, 153,102,51
    };
  do {
    GBPixel* pix = GBSurfaceFinalPixel(surf, &p);
    if (pix->_rgba[GBPixelRed] != out[iPix * 3] ||
      pix->_rgba[GBPixelGreen] != out[iPix * 3 + 1] ||
      pix->_rgba[GBPixelBlue] != out[iPix * 3 + 2]) {
      ShapoidErr->_type = PBErrTypeUnitTestFailed;
      sprintf(ShapoidErr->_msg, "UnitTestGBSurfaceNormalizeHue failed");
      PBErrCatch(ShapoidErr);
    }
    ++iPix;
  } while (VecStep(&p, GBSurfaceDim(surf)));
  GBSurfaceFree(&surf);
  GBSurfaceImage* img = GBSurfaceImageCreateFromFile(
    "./GBSurfaceNormalizeHueTest.tga");
  GBSurfacePostProcess((GBSurface*)img, &post);
  GBSurfaceImage* ref = GBSurfaceImageCreateFromFile(
    "./GBSurfaceNormalizeHueRef.tga");
  if (GBSurfaceIsSameAs((GBSurface*)img, (GBSurface*)ref) == false) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "UnitTestGBSurfaceNormalizeHue failed");
```

```
    PBErrCatch(ShapoidErr);
  }
  GBSurfaceFree(&surf);
  GBSurfaceImageFree(&img);
  GBSurfaceImageFree(&ref);
  printf("UnitTestGBSurfaceNormalizeHue OK\n");
}

void UnitTestGBSurface() {
  UnitTestGBSurfaceCreateFree();
  UnitTestGBSurfaceGetSet();
  UnitTestGBSurfaceArea();
  UnitTestGBSurfaceClone();
  UnitTestGBSurfaceAddRemoveLayer();
  UnitTestGBSurfaceGetLayerNbLayer();
  UnitTestGBSurfaceSetLayersModified();
  UnitTestGBSurfaceSetLayerStackPos();
  UnitTestGBSurfaceGetModifiedArea();
  UnitTestGBSurfaceUpdate();
  UnitTestGBSurfaceAddLayerFromFile();
  UnitTestGBSurfaceFlush();
  UnitTestGBSurfaceIsSameAs();
  UnitTestGBSurfaceNormalizeHue();
  printf("UnitTestGBSurface OK\n");
}

void UnitTestGBSurfaceImageCreateFree() {
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 800); VecSet(&dim, 1, 600);
  GBSurfaceImage* surf = GBSurfaceImageCreate(&dim);
  if (GBSurfaceGetType((GBSurface*)surf) != GBSurfaceTypeImage) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceImageCreate failed");
    PBErrCatch(GenBrushErr);
  }
  if (VecIsEqual(GBSurfaceDim((GBSurface*)surf), &dim) == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceImageCreate failed");
    PBErrCatch(GenBrushErr);
  }
  if (surf->_fileName != NULL) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceImageCreate failed");
    PBErrCatch(GenBrushErr);
  }
  GBSurfaceImageFree(&surf);
  printf("UnitTestGBSurfaceImageCreateFree OK\n");
}

void UnitTestGBSurfaceImageGetSet() {
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 800); VecSet(&dim, 1, 600);
  GBSurfaceImage* surf = GBSurfaceImageCreate(&dim);
  if (GBSurfaceImageFileName(surf) != surf->_fileName) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceImageFileName failed");
    PBErrCatch(GenBrushErr);
  }
  char* fileName = "./";
  GBSurfaceImageSetFileName(surf, fileName);
  if (strcmp(surf->_fileName, fileName) != 0) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
```

```
    sprintf(GenBrushErr->_msg, "GBSurfaceImageSetFileName failed");
    PBErrCatch(GenBrushErr);
  }
  GBSurfaceImageFree(&surf);
  printf("UnitTestGBSurfaceImageGetSet OK\n");
}

void UnitTestGBSurfaceImageClone() {
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 800); VecSet(&dim, 1, 600);
  GBSurfaceImage* surf = GBSurfaceImageCreate(&dim);
  char* fileName = "./";
  GBSurfaceImageSetFileName(surf, fileName);
  GBSurfaceImage* clone = GBSurfaceImageClone(surf);
  if (GBSurfaceGetType((GBSurface*)clone) != GBSurfaceTypeImage) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceImageCreate failed");
    PBErrCatch(GenBrushErr);
  }
  if (VecIsEqual(GBSurfaceDim((GBSurface*)clone), &dim) == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceImageCreate failed");
    PBErrCatch(GenBrushErr);
  }
  if (strcmp(clone->_fileName, fileName) != 0) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceImageClone failed");
    PBErrCatch(GenBrushErr);
  }
  GBSurfaceImageFree(&surf);
  GBSurfaceImageFree(&clone);
  printf("UnitTestGBSurfaceImageClone OK\n");
}

void UnitTestGBSurfaceImageSave() {
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 10); VecSet(&dim, 1, 10);
  GBSurfaceImage* surfImage = GBSurfaceImageCreate(&dim);
  GBSurface* surf = (GBSurface*)surfImage;

GBPixel t = GBColorTransparent;
GBSurfaceSetBgColor(surf, &t);
GBSurfaceFlush(surf);

  GBLayer* layers[4] = {NULL};
  VecSet(&dim, 0, 5); VecSet(&dim, 1, 5);
  for (int iLayer = 0; iLayer < 4; ++iLayer) {
    layers[iLayer] = GBSurfaceAddLayer(surf, &dim);
    GBLayerSetBlendMode(layers[iLayer], GBLayerBlendModeOver);
  }
  GBLayerSetStackPos(layers[0], GBLayerStackPosBg);
  GBLayerSetStackPos(layers[1], GBLayerStackPosInside);
  GBLayerSetStackPos(layers[2], GBLayerStackPosInside);
  GBLayerSetStackPos(layers[3], GBLayerStackPosFg);
  VecShort2D pos = VecShortCreateStatic2D();
  VecSet(&pos, 0, 1); VecSet(&pos, 1, 1);
  GBLayerSetPos(layers[0], &pos);
  VecSet(&pos, 0, 3); VecSet(&pos, 1, 3);
  GBLayerSetPos(layers[1], &pos);
  VecSet(&pos, 0, 4); VecSet(&pos, 1, 4);
  GBLayerSetPos(layers[2], &pos);
  VecSet(&pos, 0, 7); VecSet(&pos, 1, 7);
```

```
  GBLayerSetPos(layers[3], &pos);
  VecSetNull(&pos);
  GBPixel col;
  float depth;
  do {
    col = GBColorGreen;
    depth = 0.0;
    GBLayerAddPixel(layers[0], &pos, &col, depth);
    col._rgba[GBPixelRed] = VecGet(&pos, 1) * 30;
    col._rgba[GBPixelGreen] = VecGet(&pos, 0) * 30;
    col._rgba[GBPixelBlue] = 0;
    col._rgba[GBPixelAlpha] = 255 - VecGet(&pos, 1) * 30;
    depth = VecGet(&pos, 0);
    GBLayerAddPixel(layers[1], &pos, &col, depth);
    col._rgba[GBPixelRed] = 0;
    col._rgba[GBPixelGreen] = VecGet(&pos, 0) * 30;
    col._rgba[GBPixelBlue] = VecGet(&pos, 1) * 30;
    col._rgba[GBPixelAlpha] = 255 - VecGet(&pos, 0) * 30;
    depth = VecGet(&pos, 1);
    GBLayerAddPixel(layers[2], &pos, &col, depth);
    col = GBColorBlue;
    depth = 0.0;
    GBLayerAddPixel(layers[3], &pos, &col, depth);
  } while (VecStep(&pos, &dim));
  GBSurfaceUpdate(surf);
  GBSurfaceImageSetFileName(surfImage, "./GBSurfaceImageSave.tga");
  if (GBSurfaceImageSave(surfImage) == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceImageSave failed");
    PBErrCatch(GenBrushErr);
  }
  GBSurfaceImageFree(&surfImage);
  printf("UnitTestGBSurfaceImageSave OK\n");
}

void UnitTestGBSurfaceImageCreateFromFile() {
  char* fileName = "./ImageRef.tga";
  GBSurfaceImage* surfImage = GBSurfaceImageCreateFromFile(fileName);
  if (surfImage == NULL) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceImageCreateFromFile failed");
    PBErrCatch(GenBrushErr);
  }
  GBSurface* surf = (GBSurface*)surfImage;
  unsigned char check[400] = {
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,255,0,255, 0,255,0,255,
    0,255,0,255, 0,255,0,255, 0,255,0,255, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,255,0,255, 0,255,0,255, 0,255,0,255,
    0,255,0,255, 0,255,0,255, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,255,0,255, 0,255,0,255, 0,0,0,255, 0,30,0,255,
    0,60,0,255, 0,90,0,255, 0,120,0,255, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,255,0,255, 0,255,0,255, 26,30,0,255, 0,0,0,255, 4,34,0,255,
    7,67,0,255, 11,101,0,255, 120,184,120,255, 0,0,0,0, 0,0,0,0,
    0,255,0,255, 0,255,0,255, 46,60,0,255, 0,0,30,255, 7,34,26,255,
    14,67,23,255, 21,101,19,255, 120,184,136,255, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 148,90,90,255, 0,0,60,255, 11,34,53,255,
    21,67,46,255, 32,101,39,255, 120,184,152,255, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 184,120,120,255, 0,0,90,255, 14,34,79,255,
    28,67,69,255, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,120,255, 30,56,136,255,
    60,106,152,255, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,0,0,
```

```
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,255,255, 0,0,255,255, 0,0,255,255
    };
  for (int iPix = 0; iPix < GBSurfaceArea(surf); ++iPix) {
    if (surf->_finalPix[iPix]._rgba[GBPixelRed] !=
      check[iPix * 4] ||
      surf->_finalPix[iPix]._rgba[GBPixelGreen] !=
      check[iPix * 4 + 1] ||
      surf->_finalPix[iPix]._rgba[GBPixelBlue] !=
      check[iPix * 4 + 2] ||
      surf->_finalPix[iPix]._rgba[GBPixelAlpha] !=
      check[iPix * 4 + 3]) {
      ShapoidErr->_type = PBErrTypeUnitTestFailed;
      sprintf(ShapoidErr->_msg, "GBSurfaceCreateFromFile failed");
      PBErrCatch(ShapoidErr);
    }
  }
  GBSurfaceImageFree(&surfImage);
  printf("UnitTestGBSurfaceImageCreateFromFile OK\n");
}

void UnitTestGBSurfaceImage() {
  UnitTestGBSurfaceImageCreateFree();
  UnitTestGBSurfaceImageGetSet();
  UnitTestGBSurfaceImageClone();
  UnitTestGBSurfaceImageSave();
  UnitTestGBSurfaceImageCreateFromFile();
  printf("UnitTestGBSurfaceImage OK\n");
}

void UnitTestGBEyeOrthoCreateFree() {
  GBEyeOrthoView view = GBEyeOrthoViewFront;
  GBEyeOrtho* eye = GBEyeOrthoCreate(view);
  if (eye->_view != GBEyeOrthoViewFront) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBEyeOrthoCreate failed");
    PBErrCatch(GenBrushErr);
  }
  float check[9] = {1.0, 0.0, 0.0, 0.0, 1.0, 0.0, 0.0, 0.0, 1.0};
  VecShort2D index = VecShortCreateStatic2D();
  VecShort2D dim = MatGetDim(GBEyeProj(eye));
  int iCheck = 0;
  do {
    if (ISEQUALF(MatGet(GBEyeProj(eye), &index),
      check[iCheck]) == false) {
      GenBrushErr->_type = PBErrTypeUnitTestFailed;
      sprintf(GenBrushErr->_msg, "GBEyeOrthoCreate failed");
      PBErrCatch(GenBrushErr);
    }
    ++iCheck;
  } while (VecStep(&index, &dim));
  GBEyeFree(&eye);
  if (eye != NULL) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBEyeOrthoFree failed");
    PBErrCatch(GenBrushErr);
  }
  printf("UnitTestGBEyeOrthoCreateFree OK\n");
}

void UnitTestGBEyeOrthoGetSet() {
  GBEyeOrthoView view = GBEyeOrthoViewFront;
```

```
  GBEyeOrtho* eye = GBEyeOrthoCreate(view);
  VecShort2D index = VecShortCreateStatic2D();
  VecFloat3D scale = VecFloatCreateStatic3D();
  VecSet(&scale, 0, 2.0); VecSet(&scale, 1, 3.0);
  VecSet(&scale, 2, 1.0);
  GBEyeSetScale(eye, &scale);
  VecFloat2D orig = VecFloatCreateStatic2D();
  VecSet(&orig, 0, 4.0); VecSet(&orig, 1, 5.0);
  GBEyeSetOrig(eye, &orig);
  float theta = PBMATH_QUARTERPI;
  GBEyeSetRot(eye, theta);
  VecShort2D dim = MatGetDim(GBEyeProj(eye));
  float check[6][9] = {
    {1.414214, 1.414214, 0.0, -2.121320, 2.121320, 0.0, 0.0,
      0.0, 1.0},
    {-1.414214, -1.414214, 0.0, -2.121320, 2.121320, 0.0, 0.0,
      0.0, -1.0},
    {1.414214, 1.414214, 0.0, 0.0, 0.0, -1.0, -2.121320, 2.121320,
      0.0},
    {1.414214, 1.414214, 0.0, 0.0, 0.0, 1.0, 2.121320, -2.121320,
      0.0},
    {0.0, 0.0, 1.0, -2.121320, 2.121320, 0.0, -1.414214, -1.414214,
      0.0},
    {0.0, 0.0, -1.0, -2.121320, 2.121320, 0.0, 1.414214, 1.414214,
      0.0}
    };
  for (int iView = 6; iView--;) {
    int iCheck = 0;
    VecSetNull(&index);
    GBEyeOrthoSetView(eye, (GBEyeOrthoView)iView);
    do {
      if (ISEQUALF(MatGet(GBEyeProj(eye), &index),
        check[iView][iCheck]) == false) {
        GenBrushErr->_type = PBErrTypeUnitTestFailed;
        sprintf(GenBrushErr->_msg, "GBEyeOrthoSetView failed");
        PBErrCatch(GenBrushErr);
      }
      ++iCheck;
    } while (VecStep(&index, &dim));
  }
  GBEyeFree(&eye);
  printf("UnitTestGBEyeOrthoGetSet OK\n");
}

void UnitTestGBEyeOrthoProcessPoint() {
  VecFloat2D v2d = VecFloatCreateStatic2D();
  VecSet(&v2d, 0, 0.0); VecSet(&v2d, 1, 1.0);
  VecFloat3D v3d = VecFloatCreateStatic3D();
  VecSet(&v3d, 0, 1.0); VecSet(&v3d, 1, 0.0); VecSet(&v3d, 2, 1.0);
  VecFloat* v4d = VecFloatCreate(4);
  VecSet(v4d, 0, 1.0); VecSet(v4d, 1, 2.0);
  VecSet(v4d, 2, 3.0); VecSet(v4d, 3, 4.0);
  float check2d[6][2] = {
    {1.0,5.0},
    {1.0,5.0},
    {4.0,5.0},
    {4.0,5.0},
    {1.0,5.0},
    {1.0,5.0}};
  float check3d[6][3] = {
    {4.0,7.0,1.0},
    {4.0,3.0,-1.0},
```

```
  {1.0,7.0,0.0},
  {7.0,7.0,0.0},
  {4.0,3.0,1.0},
  {4.0,7.0,-1.0}};
float check4d[6][4] = {
  {-2.0,7.0,3.0,4.0},
  {-2.0,3.0,-3.0,4.0},
  {-5.0,7.0,-2.0,4.0},
  {13.0,7.0,2.0,4.0},
  {-2.0,-1.0,1.0,4.0},
  {-2.0,11.0,-1.0,4.0}};
GBHandDefault* hand = GBHandDefaultCreate();
for (int iView = 6; iView--;) {
  GBEyeOrthoView view = (GBEyeOrthoView)iView;
  GBEyeOrtho* eye = GBEyeOrthoCreate(view);
  VecFloat3D scale = VecFloatCreateStatic3D();
  VecSet(&scale, 0, 2.0); VecSet(&scale, 1, 3.0);
  VecSet(&scale, 2, 1.0);
  GBEyeSetScale(eye, &scale);
  VecFloat2D orig = VecFloatCreateStatic2D();
  VecSet(&orig, 0, 4.0); VecSet(&orig, 1, 5.0);
  GBEyeSetOrig(eye, &orig);
  float theta = PBMATH_HALFPI;
  GBEyeSetRot(eye, theta);
  GBLayer layer;
  GBInk ink;
  GBTool tool;
  GBObjPod* pod = GBObjPodCreatePoint((VecFloat*)&v2d, eye,
    hand, &tool, &ink, &layer);
  VecFloat* proj = GBObjPodGetEyeObjAsPoint(pod);
  if (VecGetDim(proj) != VecGetDim(pod->_srcPoint)) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBEyeOrthoProcess failed");
    PBErrCatch(GenBrushErr);
  }
  for (int i = VecGetDim(proj); i--;) {
    if (ISEQUALF(VecGet(proj, i), check2d[iView][i]) == false) {
      GenBrushErr->_type = PBErrTypeUnitTestFailed;
      sprintf(GenBrushErr->_msg, "GBEyeOrthoProcess failed");
      PBErrCatch(GenBrushErr);
    }
  }
  pod->_srcPoint = (VecFloat*)&v3d;
  GBEyeProcess((GBEye*)eye, pod);
  proj = GBObjPodGetEyeObjAsPoint(pod);
  if (VecGetDim(proj) != 3) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBEyeOrthoProcess failed");
    PBErrCatch(GenBrushErr);
  }
  for (int i = VecGetDim(proj); i--;) {
    if (ISEQUALF(VecGet(proj, i), check3d[iView][i]) == false) {
      GenBrushErr->_type = PBErrTypeUnitTestFailed;
      sprintf(GenBrushErr->_msg, "GBEyeOrthoProcess failed");
      PBErrCatch(GenBrushErr);
    }
  }
  pod->_srcPoint = v4d;
  GBEyeProcess((GBEye*)eye, pod);
  proj = GBObjPodGetEyeObjAsPoint(pod);
  if (VecGetDim(proj) != 4) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
```

```
      sprintf(GenBrushErr->_msg, "GBEyeOrthoProcess failed");
      PBErrCatch(GenBrushErr);
    }
    for (int i = VecGetDim(proj); i--;) {
      if (ISEQUALF(VecGet(proj, i), check4d[iView][i]) == false) {
        GenBrushErr->_type = PBErrTypeUnitTestFailed;
        sprintf(GenBrushErr->_msg, "GBEyeOrthoProcess failed");
        PBErrCatch(GenBrushErr);
      }
    }
    GBEyeFree(&eye);
    GBObjPodFree(&pod);
  }
  GBHandDefaultFree(&hand);
  VecFree(&v4d);
  printf("UnitTestGBEyeOrthoProcessPoint OK\n");
}

void UnitTestGBEyeOrthoProcessCurve() {
  SCurve* curve = SCurveCreate(1, 2, 2);
  for (int iCtrl = SCurveGetNbCtrl(curve); iCtrl--;) {
    SCurveCtrlSet(curve, iCtrl, 0, (float)iCtrl);
    SCurveCtrlSet(curve, iCtrl, 1, (float)iCtrl * 2.0);
  }
  GBEyeOrtho* eye = GBEyeOrthoCreate(GBEyeOrthoViewFront);
  float theta = PBMATH_HALFPI;
  GBEyeSetRot((GBEye*)eye, theta);
  SCurve* projCurve = GBEyeGetProjectedCurve((GBEye*)eye, curve);
  if (SCurveGetDim(projCurve) != SCurveGetDim(curve)) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBEyeOrthoGetProjectedCurve failed");
    PBErrCatch(GenBrushErr);
  }
  for (int iCtrl = SCurveGetNbCtrl(curve); iCtrl--;) {
    if (ISEQUALF(SCurveCtrlGet(projCurve, iCtrl, 0),
      (float)iCtrl * -2.0) == false) {
      GenBrushErr->_type = PBErrTypeUnitTestFailed;
      sprintf(GenBrushErr->_msg, "GBEyeOrthoGetProjectedCurve failed");
      PBErrCatch(GenBrushErr);
    }
    if (ISEQUALF(SCurveCtrlGet(projCurve, iCtrl, 1),
      (float)iCtrl) == false) {
      GenBrushErr->_type = PBErrTypeUnitTestFailed;
      sprintf(GenBrushErr->_msg, "GBEyeOrthoGetProjectedCurve failed");
      PBErrCatch(GenBrushErr);
    }
  }
  GBEyeFree(&eye);
  SCurveFree(&curve);
  SCurveFree(&projCurve);
  printf("UnitTestGBEyeOrthoProcessCurve OK\n");
}

void UnitTestGBEyeOrthoProcessShapoid() {
  Facoid* facoid = FacoidCreate(2);
  VecFloat2D v = VecFloatCreateStatic2D();
  VecSet(&v, 0, 1.0); VecSet(&v, 1, 2.0);
  ShapoidTranslate(facoid, &v);
  VecSet(&v, 0, 2.0); VecSet(&v, 1, 3.0);
  ShapoidScale(facoid, (VecFloat*)&v);
  GBEyeOrtho* eye = GBEyeOrthoCreate(GBEyeOrthoViewFront);
  Shapoid* shap =
```

```
  GBEyeGetProjectedShapoid((GBEye*)eye, (Shapoid*)facoid);
VecFloat2D checka = VecFloatCreateStatic2D();
VecSet(&checka, 0, 1.0); VecSet(&checka, 1, 2.0);
VecFloat2D checkb = VecFloatCreateStatic2D();
VecSet(&checkb, 0, 2.0); VecSet(&checkb, 1, 0.0);
VecFloat2D checkc = VecFloatCreateStatic2D();
VecSet(&checkc, 0, 0.0); VecSet(&checkc, 1, 3.0);
if (VecIsEqual(ShapoidPos(shap), &checka) == false ||
  VecIsEqual(ShapoidAxis(shap, 0), &checkb) == false ||
  VecIsEqual(ShapoidAxis(shap, 1), &checkc) == false) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBEyeOrthoGetProjectedShapoid failed");
  PBErrCatch(GenBrushErr);
}
ShapoidFree(&shap);
GBEyeFree(&eye);
ShapoidFree(&facoid);

Spheroid* spheroid = SpheroidCreate(3);
VecFloat3D u = VecFloatCreateStatic3D();
VecSet(&u, 0, 1.0); VecSet(&u, 1, 2.0); VecSet(&u, 2, 3.0);
ShapoidTranslate(spheroid, &u);
VecSet(&u, 0, 2.0); VecSet(&u, 1, 3.0); VecSet(&u, 1, 4.0);
ShapoidScale(spheroid, (VecFloat*)&u);
VecFloat3D checkd[6];
VecFloat3D checke[6];
VecFloat3D checkf[6];
VecFloat3D checkg[6];
for (int iView = 6; iView--;) {
  checkd[iView] = VecFloatCreateStatic3D();
  checke[iView] = VecFloatCreateStatic3D();
  checkf[iView] = VecFloatCreateStatic3D();
  checkg[iView] = VecFloatCreateStatic3D();
}
VecSet(checkd, 0, 3.0); VecSet(checkd, 1, 2.0);
VecSet(checkd, 2, -1.0);
VecSet(checke, 0, 0.0); VecSet(checke, 1, 0.0);
VecSet(checke, 2, -2.0);
VecSet(checkf, 0, 0.0); VecSet(checkf, 1, 4.0);
VecSet(checkf, 2, 0.0);
VecSet(checkg, 0, 3.0); VecSet(checkg, 1, 0.0);
VecSet(checkg, 2, 0.0);
VecSet(checkd + 1, 0, -3.0); VecSet(checkd + 1, 1, 2.0);
VecSet(checkd + 1, 2, 1.0);
VecSet(checke + 1, 0, 0.0); VecSet(checke + 1, 1, 0.0);
VecSet(checke + 1, 2, 2.0);
VecSet(checkf + 1, 0, 0.0); VecSet(checkf + 1, 1, 4.0);
VecSet(checkf + 1, 2, 0.0);
VecSet(checkg + 1, 0, -3.0); VecSet(checkg + 1, 1, 0.0);
VecSet(checkg + 1, 2, 0.0);
VecSet(checkd + 2, 0, 1.0); VecSet(checkd + 2, 1, -3.0);
VecSet(checkd + 2, 2, 2.0);
VecSet(checke + 2, 0, 2.0); VecSet(checke + 2, 1, 0.0);
VecSet(checke + 2, 2, 0.0);
VecSet(checkf + 2, 0, 0.0); VecSet(checkf + 2, 1, 0.0);
VecSet(checkf + 2, 2, 4.0);
VecSet(checkg + 2, 0, 0.0); VecSet(checkg + 2, 1, -3.0);
VecSet(checkg + 2, 2, 0.0);
VecSet(checkd + 3, 0, 1.0); VecSet(checkd + 3, 1, 3.0);
VecSet(checkd + 3, 2, -2.0);
VecSet(checke + 3, 0, 2.0); VecSet(checke + 3, 1, 0.0);
VecSet(checke + 3, 2, 0.0);
```

```
  VecSet(checkf + 3, 0, 0.0); VecSet(checkf + 3, 1, 0.0);
  VecSet(checkf + 3, 2, -4.0);
  VecSet(checkg + 3, 0, 0.0); VecSet(checkg + 3, 1, 3.0);
  VecSet(checkg + 3, 2, 0.0);
  VecSet(checkd + 4, 0, -1.0); VecSet(checkd + 4, 1, 2.0);
  VecSet(checkd + 4, 2, -3.0);
  VecSet(checke + 4, 0, -2.0); VecSet(checke + 4, 1, 0.0);
  VecSet(checke + 4, 2, 0.0);
  VecSet(checkf + 4, 0, 0.0); VecSet(checkf + 4, 1, 4.0);
  VecSet(checkf + 4, 2, 0.0);
  VecSet(checkg + 4, 0, 0.0); VecSet(checkg + 4, 1, 0.0);
  VecSet(checkg + 4, 2, -3.0);
  VecSet(checkd + 5, 0, 1.0); VecSet(checkd + 5, 1, 2.0);
  VecSet(checkd + 5, 2, 3.0);
  VecSet(checke + 5, 0, 2.0); VecSet(checke + 5, 1, 0.0);
  VecSet(checke + 5, 2, 0.0);
  VecSet(checkf + 5, 0, 0.0); VecSet(checkf + 5, 1, 4.0);
  VecSet(checkf + 5, 2, 0.0);
  VecSet(checkg + 5, 0, 0.0); VecSet(checkg + 5, 1, 0.0);
  VecSet(checkg + 5, 2, 3.0);
  for (int iView = 6; iView--;) {
    GBEyeOrthoView view = (GBEyeOrthoView)iView;
    GBEyeOrtho* eye = GBEyeOrthoCreate(view);
    Shapoid* shap =
      GBEyeGetProjectedShapoid((GBEye*)eye, (Shapoid*)spheroid);
    if (VecIsEqual(ShapoidPos(shap), checkd + 5 - iView) == false ||
      VecIsEqual(ShapoidAxis(shap, 0), checke + 5 - iView) == false ||
      VecIsEqual(ShapoidAxis(shap, 1), checkf + 5 - iView) == false ||
      VecIsEqual(ShapoidAxis(shap, 2), checkg + 5 - iView) == false) {
      GenBrushErr->_type = PBErrTypeUnitTestFailed;
      sprintf(GenBrushErr->_msg,
        "GBEyeOrthoGetProjectedShapoid failed");
      PBErrCatch(GenBrushErr);
    }
    ShapoidFree(&shap);
    GBEyeFree(&eye);
  }
  ShapoidFree(&spheroid);
  printf("UnitTestGBEyeOrthoProcessShapoid OK\n");
}

void UnitTestGBEyeOrtho() {
  UnitTestGBEyeOrthoCreateFree();
  UnitTestGBEyeOrthoGetSet();
  UnitTestGBEyeOrthoProcessPoint();
  UnitTestGBEyeOrthoProcessCurve();
  UnitTestGBEyeOrthoProcessShapoid();
  printf("UnitTestGBEyeOrtho OK\n");
}

void UnitTestGBEyeIsometricCreateFree() {
  GBEyeIsometric* eye = GBEyeIsometricCreate();
  if (GBEyeGetType(eye) != GBEyeTypeIsometric ||
    ISEQUALF(eye->_thetaRight, PBMATH_QUARTERPI) == false ||
    ISEQUALF(eye->_thetaY, PBMATH_QUARTERPI) == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBEyeIsometricCreate failed");
    PBErrCatch(GenBrushErr);
  }
  float check[9] = {
    0.707107, -0.00000, -0.707107,
    0.50000, 0.707107, 0.50000,
```

```
    0.50000, -0.707107, 0.50000
    };
  for (int iVal = 9; iVal--;) {
    if (ISEQUALF(eye->_eye._proj->_val[iVal], check[iVal]) == false) {
      GenBrushErr->_type = PBErrTypeUnitTestFailed;
      sprintf(GenBrushErr->_msg, "GBEyeIsometricCreate failed");
      PBErrCatch(GenBrushErr);
    }
  }
  GBEyeFree(&eye);
  if (eye != NULL) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBEyeIsometricFree failed");
    PBErrCatch(GenBrushErr);
  }
  printf("UnitTestGBEyeIsometricCreateFree OK\n");
}

void UnitTestGBEyeIsometricGetSet() {
  GBEyeIsometric* eye = GBEyeIsometricCreate();
  if (ISEQUALF(GBEyeIsometricGetRotY(eye), eye->_thetaY) == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBEyeIsometricGetRotY failed");
    PBErrCatch(GenBrushErr);
  }
  if (ISEQUALF(GBEyeIsometricGetRotRight(eye),
    eye->_thetaRight) == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBEyeIsometricGetRotRight failed");
    PBErrCatch(GenBrushErr);
  }
  GBEyeIsometricSetRotRight(eye, 0.5 * PBMATH_QUARTERPI);
  if (ISEQUALF(GBEyeIsometricGetRotRight(eye),
    0.5 * PBMATH_QUARTERPI) == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBEyeIsometricSetRotRight failed");
    PBErrCatch(GenBrushErr);
  }
  float checka[9] = {
    0.707107, -0.000000, -0.707107,
    0.270598, 0.923880, 0.270598,
    0.653282, -0.382683, 0.653281
    };
  for (int iVal = 9; iVal--;) {
    if (ISEQUALF(eye->_eye._proj->_val[iVal], checka[iVal]) == false) {
      GenBrushErr->_type = PBErrTypeUnitTestFailed;
      sprintf(GenBrushErr->_msg, "GBEyeIsometricSetRotRight failed");
      PBErrCatch(GenBrushErr);
    }
  }
  GBEyeIsometricSetRotY(eye, 0.5 * PBMATH_QUARTERPI);
  float checkb[9] = {
    0.923880, -0.000000, -0.382683,
    0.146447, 0.923880, 0.353553,
    0.353553, -0.382683, 0.853553
    };
  if (ISEQUALF(GBEyeIsometricGetRotY(eye),
    0.5 * PBMATH_QUARTERPI) == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBEyeIsometricSetRotY failed");
    PBErrCatch(GenBrushErr);
  }
```

```
  for (int iVal = 9; iVal--;) {
    if (ISEQUALF(eye->_eye._proj->_val[iVal], checkb[iVal]) == false) {
      GenBrushErr->_type = PBErrTypeUnitTestFailed;
      sprintf(GenBrushErr->_msg, "GBEyeIsometricSetRotY failed");
      PBErrCatch(GenBrushErr);
    }
  }
  GBEyeFree(&eye);
  printf("UnitTestGBEyeIsometricGetSet OK\n");
}

void UnitTestGBEyeIsometricProcessPoint() {
  VecFloat2D v2d = VecFloatCreateStatic2D();
  VecSet(&v2d, 0, 0.0); VecSet(&v2d, 1, 1.0);
  VecFloat3D v3d = VecFloatCreateStatic3D();
  VecSet(&v3d, 0, 1.0); VecSet(&v3d, 1, 0.0); VecSet(&v3d, 2, 1.0);
  VecFloat* v4d = VecFloatCreate(4);
  VecSet(v4d, 0, 1.0); VecSet(v4d, 1, 2.0);
  VecSet(v4d, 2, 3.0); VecSet(v4d, 3, 4.0);
  float check2d[2] = {1.878680,5.0};
  float check3d[3] = {1.0,5.0,1.0};
  float check4d[4] = {-6.242640,2.171572,0.585786,4.0};
  GBHandDefault* hand = GBHandDefaultCreate();
  GBEyeIsometric* eye = GBEyeIsometricCreate();
  VecFloat3D scale = VecFloatCreateStatic3D();
  VecSet(&scale, 0, 2.0); VecSet(&scale, 1, 3.0);
  VecSet(&scale, 2, 1.0);
  GBEyeSetScale(eye, &scale);
  VecFloat2D orig = VecFloatCreateStatic2D();
  VecSet(&orig, 0, 4.0); VecSet(&orig, 1, 5.0);
  GBEyeSetOrig(eye, &orig);
  float theta = PBMATH_HALFPI;
  GBEyeSetRot(eye, theta);
  GBLayer layer;
  GBInk ink;
  GBTool tool;
  GBObjPod* pod = GBObjPodCreatePoint((VecFloat*)&v2d, eye,
    hand, &tool, &ink, &layer);
  VecFloat* proj = GBObjPodGetEyeObjAsPoint(pod);
  if (VecGetDim(proj) != VecGetDim(pod->_srcPoint)) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBEyeIsometricProcess failed");
    PBErrCatch(GenBrushErr);
  }
  for (int i = VecGetDim(proj); i--;) {
    if (ISEQUALF(VecGet(proj, i), check2d[i]) == false) {
      GenBrushErr->_type = PBErrTypeUnitTestFailed;
      sprintf(GenBrushErr->_msg, "GBEyeIsometricProcess failed");
      PBErrCatch(GenBrushErr);
    }
  }
  pod->_srcPoint = (VecFloat*)&v3d;
  GBEyeProcess((GBEye*)eye, pod);
  proj = GBObjPodGetEyeObjAsPoint(pod);
  if (VecGetDim(proj) != 3) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBEyeIsometricProcess failed");
    PBErrCatch(GenBrushErr);
  }
  for (int i = VecGetDim(proj); i--;) {
    if (ISEQUALF(VecGet(proj, i), check3d[i]) == false) {
      GenBrushErr->_type = PBErrTypeUnitTestFailed;
```

```
      sprintf(GenBrushErr->_msg, "GBEyeIsometricProcess failed");
      PBErrCatch(GenBrushErr);
    }
  }
  pod->_srcPoint = v4d;
  GBEyeProcess((GBEye*)eye, pod);
  proj = GBObjPodGetEyeObjAsPoint(pod);
  if (VecGetDim(proj) != 4) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBEyeIsometricProcess failed");
    PBErrCatch(GenBrushErr);
  }
  for (int i = VecGetDim(proj); i--;) {
    if (ISEQUALF(VecGet(proj, i), check4d[i]) == false) {
      GenBrushErr->_type = PBErrTypeUnitTestFailed;
      sprintf(GenBrushErr->_msg, "GBEyeIsometricProcess failed");
      PBErrCatch(GenBrushErr);
    }
  }
  GBEyeFree(&eye);
  GBObjPodFree(&pod);
  GBHandDefaultFree(&hand);
  VecFree(&v4d);
  printf("UnitTestGBEyeIsometricProcessPoint OK\n");
}

void UnitTestGBEyeIsometricProcessCurve() {
  SCurve* curve = SCurveCreate(1, 2, 2);
  for (int iCtrl = SCurveGetNbCtrl(curve); iCtrl--;) {
    SCurveCtrlSet(curve, iCtrl, 0, (float)iCtrl);
    SCurveCtrlSet(curve, iCtrl, 1, (float)iCtrl * 2.0);
  }
  GBEyeIsometric* eye = GBEyeIsometricCreate();
  SCurve* projCurve = GBEyeGetProjectedCurve((GBEye*)eye, curve);
  if (SCurveGetDim(projCurve) != SCurveGetDim(curve)) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg,
      "GBEyeIsometricGetProjectedCurve failed");
    PBErrCatch(GenBrushErr);
  }
  float check[3][2]={
    {0.0,0.0},
    {0.707107,1.914214},
    {1.414214,3.828427}
    };
  for (int iCtrl = SCurveGetNbCtrl(curve); iCtrl--;) {
    if (ISEQUALF(SCurveCtrlGet(projCurve, iCtrl, 0),
      check[iCtrl][0]) == false ||
      ISEQUALF(SCurveCtrlGet(projCurve, iCtrl, 1),
      check[iCtrl][1]) == false) {
      GenBrushErr->_type = PBErrTypeUnitTestFailed;
      sprintf(GenBrushErr->_msg,
        "GBEyeIsometricGetProjectedCurve failed");
      PBErrCatch(GenBrushErr);
    }
  }
  GBEyeFree(&eye);
  SCurveFree(&curve);
  SCurveFree(&projCurve);
  printf("UnitTestGBEyeIsometricProcessCurve OK\n");
}
```

```
void UnitTestGBEyeIsometricProcessShapoid() {
  Facoid* facoid = FacoidCreate(3);
  VecFloat3D v = VecFloatCreateStatic3D();
  VecSet(&v, 0, 1.0); VecSet(&v, 1, 2.0); VecSet(&v, 2, 3.0);
  ShapoidTranslate(facoid, &v);
  VecSet(&v, 0, 3.0); VecSet(&v, 1, 2.0); VecSet(&v, 2, 1.0);
  ShapoidScale(facoid, (VecFloat*)&v);
  GBEyeIsometric* eye = GBEyeIsometricCreate();
  Shapoid* shap =
    GBEyeGetProjectedShapoid((GBEye*)eye, (Shapoid*)facoid);
  VecFloat3D checka = VecFloatCreateStatic3D();
  VecSet(&checka, 0, -1.414214); VecSet(&checka, 1, 3.414214);
  VecSet(&checka, 2, 0.585786);
  VecFloat3D checkb = VecFloatCreateStatic3D();
  VecSet(&checkb, 0, 2.121320); VecSet(&checkb, 1, 1.500000);
  VecSet(&checkb, 2, 1.500000);
  VecFloat3D checkc = VecFloatCreateStatic3D();
  VecSet(&checkc, 0, 0.000000); VecSet(&checkc, 1, 1.414214);
  VecSet(&checkc, 2, -1.414214);
  VecFloat3D checkd = VecFloatCreateStatic3D();
  VecSet(&checkd, 0, -0.707107); VecSet(&checkd, 1, 0.500000);
  VecSet(&checkd, 2, 0.500000);
  if (VecIsEqual(ShapoidPos(shap), &checka) == false ||
    VecIsEqual(ShapoidAxis(shap, 0), &checkb) == false ||
    VecIsEqual(ShapoidAxis(shap, 1), &checkc) == false ||
    VecIsEqual(ShapoidAxis(shap, 2), &checkd) == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg,
      "GBEyeIsometricGetProjectedShapoid failed");
    PBErrCatch(GenBrushErr);
  }
  ShapoidFree(&shap);
  GBEyeFree(&eye);
  ShapoidFree(&facoid);
  printf("UnitTestGBEyeIsometricProcessShapoid OK\n");
}

void UnitTestGBEyeIsometric() {
  UnitTestGBEyeIsometricCreateFree();
  UnitTestGBEyeIsometricGetSet();
  UnitTestGBEyeIsometricProcessPoint();
  UnitTestGBEyeIsometricProcessCurve();
  UnitTestGBEyeIsometricProcessShapoid();
  printf("UnitTestGBEyeIsometric OK\n");
}

void UnitTestGBEyeCreateFree() {
  VecFloat3D v = VecFloatCreateStatic3D();
  VecSet(&v, 0, 1.0); VecSet(&v, 1, 1.0); VecSet(&v, 2, 1.0);
  VecFloat2D w = VecFloatCreateStatic2D();
  GBEye eye = GBEyeCreateStatic(GBEyeTypeOrtho);
  if (eye._type != GBEyeTypeOrtho ||
    VecIsEqual(&(eye._scale), &v) == false ||
    VecIsEqual(&(eye._orig), &w) == false ||
    eye._proj == NULL) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBEyeCreateStatic failed");
    PBErrCatch(ShapoidErr);
  }
  GBEyeFreeStatic(&eye);
  if (eye._proj != NULL) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
```

```
    sprintf(ShapoidErr->_msg, "GBEyeFreeStatic failed");
    PBErrCatch(ShapoidErr);
  }
  printf("UnitTestGBEyeCreateFree OK\n");
}

void UnitTestGBEyeGetSet() {
  GBEye eye = GBEyeCreateStatic(GBEyeTypeOrtho);
  if (GBEyeGetType(&eye) != GBEyeTypeOrtho) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBEyeGetType failed");
    PBErrCatch(ShapoidErr);
  }
  if (GBEyeScale(&eye) != &(eye._scale)) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBEyeScale failed");
    PBErrCatch(ShapoidErr);
  }
  VecFloat3D v = GBEyeGetScale(&eye);
  if (VecIsEqual(&v, &(eye._scale)) == false) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBEyeGetScale failed");
    PBErrCatch(ShapoidErr);
  }
  if (GBEyeOrig(&eye) != &(eye._orig)) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBEyeOrig failed");
    PBErrCatch(ShapoidErr);
  }
  VecFloat2D w = GBEyeGetOrig(&eye);
  if (VecIsEqual(&w, &(eye._orig)) == false) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBEyeGetOrig failed");
    PBErrCatch(ShapoidErr);
  }
  if (GBEyeGetRot(&eye) != eye._theta) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBEyeGetRot failed");
    PBErrCatch(ShapoidErr);
  }
  VecSet(&v, 0, 2.0); VecSet(&v, 1, 3.0); VecSet(&v, 2, 4.0);
  GBEyeSetScale(&eye, &v);
  if (VecIsEqual(&v, &(eye._scale)) == false) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBEyeSetScale failed");
    PBErrCatch(ShapoidErr);
  }
  VecSet(&v, 0, 3.0); VecSet(&v, 1, 3.0); VecSet(&v, 2, 3.0);
  GBEyeSetScale(&eye, (float)3.0);
  if (VecIsEqual(&v, &(eye._scale)) == false) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBEyeSetScale failed");
    PBErrCatch(ShapoidErr);
  }
  GBEyeSetOrig(&eye, &w);
  if (VecIsEqual(&w, &(eye._orig)) == false) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBEyeSetOrig failed");
    PBErrCatch(ShapoidErr);
  }
  float theta = 1.0;
  GBEyeSetRot(&eye, theta);
```

```
  if (ISEQUALF(eye._theta, theta) == false) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBEyeSetRot failed");
    PBErrCatch(ShapoidErr);
  }
  if (GBEyeProj(&eye) != eye._proj) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBEyeProj failed");
    PBErrCatch(ShapoidErr);
  }
  GBEyeFreeStatic(&eye);
  printf("UnitTestGBEyeGetSet OK\n");
}

void UnitTestGBEye() {
  UnitTestGBEyeCreateFree();
  UnitTestGBEyeGetSet();
  UnitTestGBEyeOrtho();
  UnitTestGBEyeIsometric();
  printf("UnitTestGBEye OK\n");
}

void UnitTestGBHandDefaultCreateFree() {
  GBHandDefault* hand = GBHandDefaultCreate();
  if (GBHandGetType(hand) != GBHandTypeDefault) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBHandDefaultCreate failed");
    PBErrCatch(ShapoidErr);
  }
  GBHandDefaultFree(&hand);
  if (hand != NULL) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBHandDefaultFree failed");
    PBErrCatch(ShapoidErr);
  }
  printf("UnitTestGBHandDefaultCreateFree OK\n");
}

void UnitTestGBHandDefaultProcess() {
  VecFloat3D point = VecFloatCreateStatic3D();
  VecSet(&point, 0, 1.0); VecSet(&point, 1, 2.0);
  VecSet(&point, 2, 3.0);
  GBEyeOrtho* eye = GBEyeOrthoCreate(GBEyeOrthoViewFront);
  GBHandDefault* hand = GBHandDefaultCreate();
  GBTool tool;
  GBInk ink;
  GBLayer layer;
  GBObjPod* pod =
    GBObjPodCreatePoint(&point, &eye, hand, &tool, &ink, &layer);
  GBHandProcess(hand, pod);
  if (GSetNbElem(&(pod->_handPoints)) == 0 ||
    VecIsEqual(GSetHead(&(pod->_handPoints)),
      &point) == false) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBHandDefaultProcess failed");
    PBErrCatch(ShapoidErr);
  }
  GBEyeOrthoFree(&eye);
  GBObjPodFree(&pod);
  GBHandDefaultFree(&hand);
  printf("UnitTestGBHandDefaultProcess OK\n");
}
```

```
void UnitTestGBHandDefault() {
  UnitTestGBHandDefaultCreateFree();
  UnitTestGBHandDefaultProcess();
  printf("UnitTestGBHandDefault OK\n");
}

void UnitTestGBHandCreateFree() {
  GBHand hand = GBHandCreateStatic(GBHandTypeDefault);
  if (hand._type != GBHandTypeDefault) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBHandCreateStatic failed");
    PBErrCatch(ShapoidErr);
  }
  GBHandFreeStatic(&hand);
  printf("UnitTestGBHandCreateFree OK\n");
}

void UnitTestGBHandGetSet() {
  GBHand hand = GBHandCreateStatic(GBHandTypeDefault);
  if (GBHandGetType(&hand) != GBHandTypeDefault) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBHandGetType failed");
    PBErrCatch(ShapoidErr);
  }
  GBHandFreeStatic(&hand);
  printf("UnitTestGBHandCreateFree OK\n");
}

void UnitTestGBHand() {
  UnitTestGBHandCreateFree();
  UnitTestGBHandGetSet();
  UnitTestGBHandDefault();
  printf("UnitTestGBHand OK\n");
}

void UnitTestGBToolPlotterCreateFree() {
  GBToolPlotter* tool = GBToolPlotterCreate();
  if (tool->_tool._type != GBToolTypePlotter) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBToolPlotterCreate failed");
    PBErrCatch(GenBrushErr);
  }
  GBToolPlotterFree(&tool);
  if (tool != NULL) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBToolPlotterFree failed");
    PBErrCatch(GenBrushErr);
  }
  printf("UnitTestGBToolPlotterCreateFree OK\n");
}

void UnitTestGBToolPlotterDrawPoint() {
  GBToolPlotter* tool = GBToolPlotterCreate();
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 10); VecSet(&dim, 1, 10);
  GBSurface* surf = (GBSurface*)GBSurfaceImageCreate(&dim);
  GBPixel transparent = GBColorTransparent;
  GBSurfaceSetBgColor(surf, &transparent);
  GBLayer* layer = GBSurfaceAddLayer(surf, &dim);
  GBPixel red = GBColorRed;
  GBInkSolid* ink = GBInkSolidCreate(&red);
```

```
  VecFloat* pos = VecFloatCreate(3);
  VecSet(pos, 0, 4.0); VecSet(pos, 1, 4.0); VecSet(pos, 2, 0.0);
  GBEyeOrtho* eye = GBEyeOrthoCreate(GBEyeOrthoViewFront);
  GBHand hand = GBHandCreateStatic(GBHandTypeDefault);
  GBObjPod* pod =
    GBObjPodCreatePoint(pos, &eye, &hand, tool, ink, layer);
  GSetAppend(&(pod->_handPoints), VecClone(pos));
  GBToolPlotterDraw(tool, pod);
  GBSurfaceUpdate(surf);
  unsigned char check[400] = {
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 255,0,0,255,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0
    };
  for (int iPix = 0; iPix < GBSurfaceArea(surf); ++iPix) {
    if (surf->_finalPix[iPix]._rgba[GBPixelRed] !=
      check[iPix * 4] ||
      surf->_finalPix[iPix]._rgba[GBPixelGreen] !=
      check[iPix * 4 + 1] ||
      surf->_finalPix[iPix]._rgba[GBPixelBlue] !=
      check[iPix * 4 + 2] ||
      surf->_finalPix[iPix]._rgba[GBPixelAlpha] !=
      check[iPix * 4 + 3]) {
      ShapoidErr->_type = PBErrTypeUnitTestFailed;
      sprintf(ShapoidErr->_msg, "GBToolPlotterDraw failed");
      PBErrCatch(ShapoidErr);
    }
  }
  GBSurfaceImageSetFileName((GBSurfaceImage*)surf,
    "./GBToolPlotterDrawPoint.tga");
  GBSurfaceImageSave((GBSurfaceImage*)surf);
  GBObjPodFree(&pod);
  GBToolPlotterFree(&tool);
  GBSurfaceImageFree((GBSurfaceImage**)&surf);
  GBInkSolidFree(&ink);
  GBEyeOrthoFree(&eye);
  VecFree(&pos);
  printf("UnitTestGBToolPlotterDrawPoint OK\n");
}

void UnitTestGBToolPlotterDrawFacoid() {
  GBToolPlotter* tool = GBToolPlotterCreate();
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 10); VecSet(&dim, 1, 10);
  GBSurface* surf = (GBSurface*)GBSurfaceImageCreate(&dim);
```

```
  GBPixel transparent = GBColorTransparent;
  GBSurfaceSetBgColor(surf, &transparent);
  GBLayer* layer = GBSurfaceAddLayer(surf, &dim);
  GBPixel blue = GBColorBlue;
  GBInkSolid* ink = GBInkSolidCreate(&blue);
  Facoid* facoid = FacoidCreate(2);
  Shapoid* shap = (Shapoid*)facoid;
  VecFloat2D v = VecFloatCreateStatic2D();
  VecSet(&v, 0, 7.0); VecSet(&v, 1, 4.0);
  ShapoidScale(shap, (VecFloat*)&v);
  VecSet(&v, 0, 2.0); VecSet(&v, 1, 4.0);
  ShapoidTranslate(shap, (VecFloat*)&v);
  ShapoidRotStart(shap, PBMATH_QUARTERPI);
  GBEyeOrtho* eye = GBEyeOrthoCreate(GBEyeOrthoViewFront);
  GBHand hand = GBHandCreateStatic(GBHandTypeDefault);
  GBObjPod* pod =
    GBObjPodCreateShapoid(shap, &eye, &hand, tool, ink, layer);
  GBToolPlotterDraw(tool, pod);
  GBSurfaceUpdate(surf);
#if BUILDMODE == 0
  unsigned char check[400] = {
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,255,255, 0,0,255,255, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255,
    0,0,255,255, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255,
    0,0,255,255, 0,0,255,255, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,255,255, 0,0,255,255, 0,0,255,255,
    0,0,255,255, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0
    };
#else
  unsigned char check[400] = {
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,255,255, 0,0,255,255, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255,
    0,0,255,255, 0,0,255,255, 0,0,0,0, 0,0,0,0, 0,0,0,0,
```

```
    0,0,0,0, 0,0,0,0, 0,0,255,255, 0,0,255,255, 0,0,255,255,
    0,0,255,255, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0
    };
#endif
  for (int iPix = 0; iPix < GBSurfaceArea(surf); ++iPix) {
    if (surf->_finalPix[iPix]._rgba[GBPixelRed] !=
      check[iPix * 4] ||
      surf->_finalPix[iPix]._rgba[GBPixelGreen] !=
      check[iPix * 4 + 1] ||
      surf->_finalPix[iPix]._rgba[GBPixelBlue] !=
      check[iPix * 4 + 2] ||
      surf->_finalPix[iPix]._rgba[GBPixelAlpha] !=
      check[iPix * 4 + 3]) {
      ShapoidErr->_type = PBErrTypeUnitTestFailed;
      sprintf(ShapoidErr->_msg, "GBToolPlotterDraw failed");
      PBErrCatch(ShapoidErr);
    }
  }
  GBSurfaceImageSetFileName((GBSurfaceImage*)surf,
    "./GBToolPlotterDrawFacoid.tga");
  GBSurfaceImageSave((GBSurfaceImage*)surf);
  GBObjPodFree(&pod);
  GBToolPlotterFree(&tool);
  GBSurfaceImageFree((GBSurfaceImage**)&surf);
  GBInkSolidFree(&ink);
  ShapoidFree(&facoid);
  GBEyeOrthoFree(&eye);
  printf("UnitTestGBToolPlotterDrawFacoid OK\n");
}

void UnitTestGBToolPlotterDrawPyramidoid() {
  GBToolPlotter* tool = GBToolPlotterCreate();
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 10); VecSet(&dim, 1, 10);
  GBSurface* surf = (GBSurface*)GBSurfaceImageCreate(&dim);
  GBPixel transparent = GBColorTransparent;
  GBSurfaceSetBgColor(surf, &transparent);
  GBLayer* layer = GBSurfaceAddLayer(surf, &dim);
  GBPixel blue = GBColorBlue;
  GBInkSolid* ink = GBInkSolidCreate(&blue);
  Pyramidoid* pyramidoid = PyramidoidCreate(2);
  Shapoid* shap = (Shapoid*)pyramidoid;
  VecFloat2D v = VecFloatCreateStatic2D();
  VecSet(&v, 0, 7.0); VecSet(&v, 1, 4.0);
  ShapoidScale(shap, (VecFloat*)&v);
  VecSet(&v, 0, 2.0); VecSet(&v, 1, 4.0);
  ShapoidTranslate(shap, (VecFloat*)&v);
  GBEyeOrtho* eye = GBEyeOrthoCreate(GBEyeOrthoViewFront);
  GBHand hand = GBHandCreateStatic(GBHandTypeDefault);
  GBObjPod* pod =
    GBObjPodCreateShapoid(shap, &eye, &hand, tool, ink, layer);
  GSetAppend(&(pod->_handShapoids), shap);
  GBToolPlotterDraw(tool, pod);
  GBSurfaceUpdate(surf);
  unsigned char checka[400] = {
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
```

```
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,255,255, 0,0,255,255, 0,0,255,255,
    0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,255,255, 0,0,255,255, 0,0,255,255,
    0,0,255,255, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,255,255, 0,0,255,255, 0,0,255,255,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,255,255, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0
    };
  for (int iPix = 0; iPix < GBSurfaceArea(surf); ++iPix) {
    if (surf->_finalPix[iPix]._rgba[GBPixelRed] !=
      checka[iPix * 4] ||
      surf->_finalPix[iPix]._rgba[GBPixelGreen] !=
      checka[iPix * 4 + 1] ||
      surf->_finalPix[iPix]._rgba[GBPixelBlue] !=
      checka[iPix * 4 + 2] ||
      surf->_finalPix[iPix]._rgba[GBPixelAlpha] !=
      checka[iPix * 4 + 3]) {
      ShapoidErr->_type = PBErrTypeUnitTestFailed;
      sprintf(ShapoidErr->_msg, "GBToolPlotterDraw failed");
      PBErrCatch(ShapoidErr);
    }
  }
  GBSurfaceImageSetFileName((GBSurfaceImage*)surf,
    "./GBToolPlotterDrawPyramidoid.tga");
  GBSurfaceImageSave((GBSurfaceImage*)surf);
  GBObjPodFree(&pod);
  GBToolPlotterFree(&tool);
  GBSurfaceImageFree((GBSurfaceImage**)&surf);
  GBInkSolidFree(&ink);
  GBEyeOrthoFree(&eye);
  printf("UnitTestGBToolPlotterDrawPyramidoid OK\n");
}

void UnitTestGBToolPlotterDrawSpheroid() {
  GBToolPlotter* tool = GBToolPlotterCreate();
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 10); VecSet(&dim, 1, 10);
  GBSurface* surf = (GBSurface*)GBSurfaceImageCreate(&dim);
  GBPixel transparent = GBColorTransparent;
  GBSurfaceSetBgColor(surf, &transparent);
  GBLayer* layer = GBSurfaceAddLayer(surf, &dim);
  GBPixel blue = GBColorBlue;
  GBInkSolid* ink = GBInkSolidCreate(&blue);
  Spheroid* spheroid = SpheroidCreate(2);
  Shapoid* shap = (Shapoid*)spheroid;
  VecFloat2D v = VecFloatCreateStatic2D();
  VecSet(&v, 0, 10.0); VecSet(&v, 1, 8.0);
  ShapoidScale(shap, (VecFloat*)&v);
  VecSet(&v, 0, 5.0); VecSet(&v, 1, 5.0);
  ShapoidTranslate(shap, (VecFloat*)&v);
  GBEyeOrtho* eye = GBEyeOrthoCreate(GBEyeOrthoViewFront);
  GBHand hand = GBHandCreateStatic(GBHandTypeDefault);
  GBObjPod* pod =
    GBObjPodCreateShapoid(shap, &eye, &hand, tool, ink, layer);
  GSetAppend(&(pod->_handShapoids), shap);
  GBToolPlotterDraw(tool, pod);
```

```
  GBSurfaceUpdate(surf);
  unsigned char checka[400] = {
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,255,255, 0,0,255,255,
    0,0,255,255, 0,0,255,255, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255,
    0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,0,0,
    0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255,
    0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255,
    0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255,
    0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255,
    0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255,
    0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255,
    0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255,
    0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255,
    0,0,0,0, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255,
    0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,255,255, 0,0,255,255,
    0,0,255,255, 0,0,255,255, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0
    };
  for (int iPix = 0; iPix < GBSurfaceArea(surf); ++iPix) {
    if (surf->_finalPix[iPix]._rgba[GBPixelRed] !=
      checka[iPix * 4] ||
      surf->_finalPix[iPix]._rgba[GBPixelGreen] !=
      checka[iPix * 4 + 1] ||
      surf->_finalPix[iPix]._rgba[GBPixelBlue] !=
      checka[iPix * 4 + 2] ||
      surf->_finalPix[iPix]._rgba[GBPixelAlpha] !=
      checka[iPix * 4 + 3]) {
      ShapoidErr->_type = PBErrTypeUnitTestFailed;
      sprintf(ShapoidErr->_msg, "GBToolPlotterDraw failed");
      PBErrCatch(ShapoidErr);
    }
  }
  GBSurfaceImageSetFileName((GBSurfaceImage*)surf,
    "./GBToolPlotterDrawSpheroid.tga");
  GBSurfaceImageSave((GBSurfaceImage*)surf);
  GBObjPodFree(&pod);
  GBToolPlotterFree(&tool);
  GBSurfaceImageFree((GBSurfaceImage**)&surf);
  GBInkSolidFree(&ink);
  GBEyeOrthoFree(&eye);
  printf("UnitTestGBToolPlotterDrawSpheroid OK\n");
}

void UnitTestGBToolPlotterDrawFacoid3D() {
  GBToolPlotter* tool = GBToolPlotterCreate();
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 10); VecSet(&dim, 1, 10);
  GBSurface* surf = (GBSurface*)GBSurfaceImageCreate(&dim);
  GBPixel transparent = GBColorTransparent;
  GBSurfaceSetBgColor(surf, &transparent);
  GBLayer* layer = GBSurfaceAddLayer(surf, &dim);
  GBLayerSetStackPos(layer, GBLayerStackPosInside);
  GBLayerSetBlendMode(layer, GBLayerBlendModeOver);
  GBPixel blue = GBColorBlue;
  blue._rgba[GBPixelAlpha] = 10;
  GBInkSolid* ink = GBInkSolidCreate(&blue);
  Facoid* facoid = FacoidCreate(3);
```

```
  Shapoid* shap = (Shapoid*)facoid;
  VecFloat3D v = VecFloatCreateStatic3D();
  VecSet(&v, 0, 7.0); VecSet(&v, 1, 4.0); VecSet(&v, 2, 4.0);
  ShapoidScale(shap, (VecFloat*)&v);
  VecSet(&v, 0, 2.0); VecSet(&v, 1, 4.0); VecSet(&v, 2, 0.0);
  ShapoidTranslate(shap, (VecFloat*)&v);
  ShapoidRotYStart(shap, PBMATH_QUARTERPI);
  GBEyeOrtho* eye = GBEyeOrthoCreate(GBEyeOrthoViewFront);
  GBHand hand = GBHandCreateStatic(GBHandTypeDefault);
  GBObjPod* pod =
    GBObjPodCreateShapoid(shap, &eye, &hand, tool, ink, layer);
  GBToolPlotterDraw(tool, pod);
  GBSurfaceUpdate(surf);
#if BUILDMODE==0
  unsigned char checka[400] = {
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,235,20, 0,0,215,40, 0,0,195,60,
    0,0,195,60, 0,0,195,60, 0,0,215,40, 0,0,235,20, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,235,20, 0,0,215,40, 0,0,195,60,
    0,0,195,60, 0,0,195,60, 0,0,215,40, 0,0,235,20, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,235,20, 0,0,215,40, 0,0,195,60,
    0,0,195,60, 0,0,195,60, 0,0,215,40, 0,0,235,20, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,235,20, 0,0,215,40, 0,0,195,60,
    0,0,195,60, 0,0,195,60, 0,0,215,40, 0,0,235,20, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0
    };
#else
  unsigned char checka[400] = {
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,235,20, 0,0,235,20, 0,0,195,60,
    0,0,195,60, 0,0,205,50, 0,0,215,40, 0,0,235,20, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,235,20, 0,0,235,20, 0,0,195,60,
    0,0,195,60, 0,0,205,50, 0,0,215,40, 0,0,235,20, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,235,20, 0,0,235,20, 0,0,195,60,
    0,0,195,60, 0,0,205,50, 0,0,215,40, 0,0,235,20, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,235,20, 0,0,235,20, 0,0,195,60,
    0,0,195,60, 0,0,205,50, 0,0,215,40, 0,0,235,20, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0
    };
#endif
  for (int iPix = 0; iPix < GBSurfaceArea(surf); ++iPix) {
    if (surf->_finalPix[iPix]._rgba[GBPixelRed] !=
```

```
      checka[iPix * 4] ||
      surf->_finalPix[iPix]._rgba[GBPixelGreen] !=
      checka[iPix * 4 + 1] ||
      surf->_finalPix[iPix]._rgba[GBPixelBlue] !=
      checka[iPix * 4 + 2] ||
      surf->_finalPix[iPix]._rgba[GBPixelAlpha] !=
      checka[iPix * 4 + 3]) {
      ShapoidErr->_type = PBErrTypeUnitTestFailed;
      sprintf(ShapoidErr->_msg, "GBToolPlotterDraw failed");
      PBErrCatch(ShapoidErr);
    }
  }
  GBSurfaceImageSetFileName((GBSurfaceImage*)surf,
    "./GBToolPlotterDrawFacoid3D.tga");
  GBSurfaceImageSave((GBSurfaceImage*)surf);
  GBObjPodFree(&pod);
  GBToolPlotterFree(&tool);
  GBSurfaceImageFree((GBSurfaceImage**)&surf);
  GBInkSolidFree(&ink);
  ShapoidFree(&facoid);
  GBEyeOrthoFree(&eye);
  printf("UnitTestGBToolPlotterDrawFacoid3D OK\n");
}

void UnitTestGBToolPlotterDrawSCurve() {
  GBToolPlotter* tool = GBToolPlotterCreate();
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 10); VecSet(&dim, 1, 10);
  GBSurface* surf = (GBSurface*)GBSurfaceImageCreate(&dim);
  GBPixel transparent = GBColorTransparent;
  GBSurfaceSetBgColor(surf, &transparent);
  GBLayer* layer = GBSurfaceAddLayer(surf, &dim);
  GBLayerSetStackPos(layer, GBLayerStackPosInside);
  GBLayerSetBlendMode(layer, GBLayerBlendModeOver);
  GBPixel blue = GBColorBlue;
  blue._rgba[GBPixelAlpha] = 10;
  GBInkSolid* ink = GBInkSolidCreate(&blue);
  SCurve* curve = SCurveCreate(3, 3, 1);
  VecFloat3D v = VecFloatCreateStatic3D();
  SCurveSetCtrl(curve, 0, (VecFloat*)&v);
  VecSet(&v, 0, 10.0); VecSet(&v, 1, 10.0); VecSet(&v, 2, 10.0);
  SCurveSetCtrl(curve, 1, (VecFloat*)&v);
  VecSet(&v, 0, 10.0); VecSet(&v, 1, 0.0); VecSet(&v, 2, -10.0);
  SCurveSetCtrl(curve, 2, (VecFloat*)&v);
  VecSet(&v, 0, 0.0); VecSet(&v, 1, 10.0); VecSet(&v, 2, 0.0);
  SCurveSetCtrl(curve, 3, (VecFloat*)&v);
  GBEyeOrtho* eye = GBEyeOrthoCreate(GBEyeOrthoViewFront);
  GBHand hand = GBHandCreateStatic(GBHandTypeDefault);
  GBObjPod* pod =
    GBObjPodCreateSCurve(curve, &eye, &hand, tool, ink, layer);
  GBToolPlotterDraw(tool, pod);
  GBSurfaceUpdate(surf);
  unsigned char checka[400] = {
    0,0,245,10, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,235,20, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,245,10, 0,0,245,10, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,235,20, 0,0,245,10,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,245,10,
```

```
    0,0,245,10, 0,0,245,10, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,215,40, 0,0,195,60, 0,0,245,10, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,245,10,
    0,0,245,10, 0,0,245,10, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,235,20, 0,0,245,10,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,245,10, 0,0,245,10, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,235,20, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0
    };
  for (int iPix = 0; iPix < GBSurfaceArea(surf); ++iPix) {
    if (surf->_finalPix[iPix]._rgba[GBPixelRed] !=
      checka[iPix * 4] ||
      surf->_finalPix[iPix]._rgba[GBPixelGreen] !=
      checka[iPix * 4 + 1] ||
      surf->_finalPix[iPix]._rgba[GBPixelBlue] !=
      checka[iPix * 4 + 2] ||
      surf->_finalPix[iPix]._rgba[GBPixelAlpha] !=
      checka[iPix * 4 + 3]) {
      ShapoidErr->_type = PBErrTypeUnitTestFailed;
      sprintf(ShapoidErr->_msg, "GBToolPlotterDraw failed");
      PBErrCatch(ShapoidErr);
    }
  }
  GBSurfaceImageSetFileName((GBSurfaceImage*)surf,
    "./GBToolPlotterDrawSCurve.tga");
  GBSurfaceImageSave((GBSurfaceImage*)surf);
  GBObjPodFree(&pod);
  GBToolPlotterFree(&tool);
  GBSurfaceImageFree((GBSurfaceImage**)&surf);
  GBInkSolidFree(&ink);
  SCurveFree(&curve);
  GBEyeOrthoFree(&eye);
  printf("UnitTestGBToolPlotterDrawSCurve OK\n");
}

void UnitTestGBToolPlotter() {
  UnitTestGBToolPlotterCreateFree();
  UnitTestGBToolPlotterDrawPoint();
  UnitTestGBToolPlotterDrawFacoid();
  UnitTestGBToolPlotterDrawPyramidoid();
  UnitTestGBToolPlotterDrawSpheroid();
  UnitTestGBToolPlotterDrawFacoid3D();
  UnitTestGBToolPlotterDrawSCurve();

  printf("UnitTestGBToolPlotter OK\n");
}

void UnitTestGBToolCreateFree() {
  GBTool tool = GBToolCreateStatic(GBToolTypePlotter);
  if (tool._type != GBToolTypePlotter) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBToolCreateStatic failed");
    PBErrCatch(GenBrushErr);
  }
  GBToolFreeStatic(&tool);
  printf("UnitTestGBToolCreateFree OK\n");
}

void UnitTestGBToolGetSet() {
```

```
  GBTool tool = GBToolCreateStatic(GBToolTypePlotter);
  if (GBToolGetType(&tool) != GBToolTypePlotter) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBToolGetType failed");
    PBErrCatch(GenBrushErr);
  }
  GBToolFreeStatic(&tool);
  printf("UnitTestGBToolGetSet OK\n");
}

void UnitTestGBTool() {
  UnitTestGBToolCreateFree();
  UnitTestGBToolGetSet();
  UnitTestGBToolPlotter();
  printf("UnitTestGBTool OK\n");
}

void UnitTestGBInkSolidCreateFree() {
  GBPixel green = GBColorGreen;
  GBInkSolid* ink = GBInkSolidCreate(&green);
  if (memcmp(&(ink->_color), &green, sizeof(GBPixel)) != 0) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBInkSolidCreate failed");
    PBErrCatch(GenBrushErr);
  }
  if (ink->_ink._type != GBInkTypeSolid) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBInkSolidCreate failed");
    PBErrCatch(GenBrushErr);
  }
  GBInkSolidFree(&ink);
  if (ink != NULL) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBInkSolidFree failed");
    PBErrCatch(GenBrushErr);
  }
  printf("UnitTestGBInkSolidCreateFree OK\n");
}

void UnitTestGBInkSolidGetSet() {
  GBPixel green = GBColorGreen;
  GBInkSolid* ink = GBInkSolidCreate(&green);
  GBPixel col = GBInkSolidGet(ink);
  if (memcmp(&col, &green, sizeof(GBPixel)) != 0) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBInkSolidGet failed");
    PBErrCatch(GenBrushErr);
  }
  GBPixel blue = GBColorBlue;
  GBInkSolidSet(ink, &blue);
  if (memcmp(&(ink->_color), &blue, sizeof(GBPixel)) != 0) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBInkSolidSet failed");
    PBErrCatch(GenBrushErr);
  }
  col = GBInkGet(ink, NULL, NULL, NULL, NULL, NULL);
  if (memcmp(&col, &blue, sizeof(GBPixel)) != 0) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBInkGet failed");
    PBErrCatch(GenBrushErr);
  }
  if (GBInkGetType(ink) != GBInkTypeSolid) {
```

```
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBInkGetType failed");
    PBErrCatch(GenBrushErr);
  }
  GBInkSolidFree(&ink);
  printf("UnitTestGBInkSolidGetSet OK\n");
}

void UnitTestGBInkSolid() {
  UnitTestGBInkSolidCreateFree();
  UnitTestGBInkSolidGetSet();
  printf("UnitTestGBInkSolid OK\n");
}

void UnitTestGBInk() {
  UnitTestGBInkSolid();
  printf("UnitTestGBInk OK\n");
}

void UnitTestGBObjPodCreateFree() {
  GBEyeOrtho* eye = GBEyeOrthoCreate(GBEyeOrthoViewFront);
  GBHand hand = GBHandCreateStatic(GBHandTypeDefault);
  GBTool tool;
  GBLayer layer;
  GBInk ink;
  VecFloat3D pos = VecFloatCreateStatic3D();
  GBObjPod* pod =
    GBObjPodCreatePoint(&pos, eye, &hand, &tool, &ink, &layer);
  if (pod->_type != GBObjTypePoint ||
    pod->_srcPoint != (VecFloat*)&pos ||
    pod->_eyePoint == NULL ||
    GSetNbElem(&(pod->_handPoints)) != 1 ||
    GSetNbElem(&(pod->_handShapoids)) != 0 ||
    GSetNbElem(&(pod->_handSCurves)) != 0 ||
    pod->_eye != (GBEye*)eye ||
    pod->_hand != &hand ||
    pod->_tool != &tool ||
    pod->_ink != &ink ||
    pod->_layer != &layer) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBObjPodCreatePoint failed");
    PBErrCatch(GenBrushErr);
  }
  GBObjPodFree(&pod);
  if (pod != NULL) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBObjPodFree failed");
    PBErrCatch(GenBrushErr);
  }
  Facoid* facoid = FacoidCreate(2);
  pod = GBObjPodCreateShapoid(facoid, eye, &hand, &tool, &ink, &layer);
  if (pod->_type != GBObjTypeShapoid ||
    pod->_srcShapoid != (Shapoid*)facoid ||
    pod->_eyeShapoid == NULL ||
    GSetNbElem(&(pod->_handPoints)) != 0 ||
    GSetNbElem(&(pod->_handShapoids)) != 1 ||
    GSetNbElem(&(pod->_handSCurves)) != 0 ||
    pod->_eye != (GBEye*)eye ||
    pod->_hand != &hand ||
    pod->_tool != &tool ||
    pod->_ink != &ink ||
    pod->_layer != &layer) {
```

```
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBObjPodCreateShapoid failed");
    PBErrCatch(GenBrushErr);
  }
  GBObjPodFree(&pod);
  SCurve* curve = SCurveCreate(2, 2, 1);
  pod = GBObjPodCreateSCurve(curve, eye, &hand, &tool, &ink, &layer);
  if (pod->_type != GBObjTypeSCurve ||
    pod->_srcSCurve != curve ||
    pod->_eyeSCurve == NULL ||
    GSetNbElem(&(pod->_handPoints)) != 0 ||
    GSetNbElem(&(pod->_handShapoids)) != 0 ||
    GSetNbElem(&(pod->_handSCurves)) != 1 ||
    pod->_eye != (GBEye*)eye ||
    pod->_hand != &hand ||
    pod->_tool != &tool ||
    pod->_ink != &ink ||
    pod->_layer != &layer) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBObjPodCreateSCurve failed");
    PBErrCatch(GenBrushErr);
  }
  GBObjPodFree(&pod);
  SCurveFree(&curve);
  ShapoidFree(&facoid);
  GBEyeOrthoFree(&eye);
  printf("UnitTestGBObjPodCreateFree OK\n");
}

void UnitTestGBObjPodGetSet() {
  GBEyeOrtho* eye = GBEyeOrthoCreate(GBEyeOrthoViewFront);
  GBHandDefault* hand = GBHandDefaultCreate();
  GBTool* tool = PBErrMalloc(GenBrushErr, sizeof(GBTool));
  GBLayer* layer = PBErrMalloc(GenBrushErr, sizeof(GBLayer));
  GBInk* ink = PBErrMalloc(GenBrushErr, sizeof(GBInk));
  VecFloat2D pos = VecFloatCreateStatic2D();
  GBObjPod* pod =
    GBObjPodCreatePoint(&pos, eye, hand, tool, ink, layer);
  if (GBObjPodGetType(pod) != GBObjTypePoint) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBObjPodGetType failed");
    PBErrCatch(GenBrushErr);
  }
  if (GBObjPodGetObjAsPoint(pod) != (VecFloat*)&pos) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBObjPodGetObjAsPoint failed");
    PBErrCatch(GenBrushErr);
  }
  if (GBObjPodGetHandObjAsPoints(pod) != &(pod->_handPoints)) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBObjPodGetHandObjAsPoints failed");
    PBErrCatch(GenBrushErr);
  }
  if (GBObjPodGetHandObjAsShapoids(pod) != &(pod->_handShapoids)) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBObjPodGetHandObjAsShapoids failed");
    PBErrCatch(GenBrushErr);
  }
  if (GBObjPodGetHandObjAsSCurves(pod) != &(pod->_handSCurves)) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBObjPodGetHandObjAsSCurves failed");
    PBErrCatch(GenBrushErr);
```

```
}
if (GBObjPodGetEyeObjAsPoint(pod) != pod->_eyePoint) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBObjPodGetEyeObjAsPoint failed");
  PBErrCatch(GenBrushErr);
}
VecFloat* posEyeB = VecFloatCreate(2);
GBObjPodSetEyePoint(pod, posEyeB);
if (GBObjPodGetEyeObjAsPoint(pod) != posEyeB) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBObjPodSetEyePoint failed");
  PBErrCatch(GenBrushErr);
}
GBObjPodFree(&pod);
Facoid* shap = FacoidCreate(2);
pod = GBObjPodCreateShapoid(shap, eye, hand, tool, ink, layer);
if (GBObjPodGetType(pod) != GBObjTypeShapoid) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBObjPodGetType failed");
  PBErrCatch(GenBrushErr);
}
if (GBObjPodGetObjAsShapoid(pod) != (Shapoid*)shap) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBObjPodGetObjAsShapoid failed");
  PBErrCatch(GenBrushErr);
}
if (GBObjPodGetEyeObjAsShapoid(pod) != pod->_eyeShapoid) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBObjPodGetEyeObjAsShapoid failed");
  PBErrCatch(GenBrushErr);
}
if (GBObjPodEye(pod) != (GBEye*)eye) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBObjPodGetEye failed");
  PBErrCatch(GenBrushErr);
}
if (GBObjPodHand(pod) != (GBHand*)hand) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBObjPodGetHand failed");
  PBErrCatch(GenBrushErr);
}
if (GBObjPodTool(pod) != tool) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBObjPodGetTool failed");
  PBErrCatch(GenBrushErr);
}
if (GBObjPodInk(pod) != ink) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBObjPodGetInk failed");
  PBErrCatch(GenBrushErr);
}
if (GBObjPodLayer(pod) != layer) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBObjPodGetLayer failed");
  PBErrCatch(GenBrushErr);
}
Facoid* shapEyeB = FacoidCreate(2);
GBEyeOrtho* eyeB = GBEyeOrthoCreate(GBEyeOrthoViewFront);
GBHandDefault* handB = GBHandDefaultCreate();
GBTool* toolB = PBErrMalloc(GenBrushErr, sizeof(GBTool));
GBLayer* layerB = PBErrMalloc(GenBrushErr, sizeof(GBLayer));
GBInk* inkB = PBErrMalloc(GenBrushErr, sizeof(GBInk));
```

```
  GBObjPodSetEyeShapoid(pod, shapEyeB);
  if (GBObjPodGetEyeObjAsShapoid(pod) != (Shapoid*)shapEyeB) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBObjPodSetEyeShap failed");
    PBErrCatch(GenBrushErr);
  }
  GBObjPodSetEye(pod, eyeB);
  GBObjPodSetHand(pod, handB);
  GBObjPodSetTool(pod, toolB);
  GBObjPodSetInk(pod, inkB);
  GBObjPodSetLayer(pod, layerB);
  if (GBObjPodEye(pod) != (GBEye*)eyeB) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBObjPodSetEye failed");
    PBErrCatch(GenBrushErr);
  }
  if (GBObjPodHand(pod) != (GBHand*)handB) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBObjPodSetHand failed");
    PBErrCatch(GenBrushErr);
  }
  if (GBObjPodTool(pod) != toolB) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBObjPodSetTool failed");
    PBErrCatch(GenBrushErr);
  }
  if (GBObjPodInk(pod) != inkB) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBObjPodSetInk failed");
    PBErrCatch(GenBrushErr);
  }
  if (GBObjPodLayer(pod) != layerB) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBObjPodSetLayer failed");
    PBErrCatch(GenBrushErr);
  }
  GBEyeOrthoFree(&eye);
  GBHandDefaultFree(&hand);
  free(tool);
  free(ink);
  free(layer);
  GBEyeOrthoFree(&eyeB);
  GBHandDefaultFree(&handB);
  free(toolB);
  free(inkB);
  free(layerB);
  ShapoidFree(&shap);
  GBObjPodFree(&pod);
  printf("UnitTestGBObjPodGetSet OK\n");
}

void UnitTestGBObjPod() {
  UnitTestGBObjPodCreateFree();
  UnitTestGBObjPodGetSet();

  printf("UnitTestGBObjPod OK\n");
}

void UnitTestGenBrushCreateFree() {
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 800); VecSet(&dim, 1, 600);
  GenBrush* gb = GBCreateImage(&dim);
```

```
  if (VecIsEqual(GBSurfaceDim(gb->_surf), &dim) == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBCreateImage failed");
    PBErrCatch(GenBrushErr);
  }
  if (GBSurfaceGetType(gb->_surf) != GBSurfaceTypeImage) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBCreateImage failed");
    PBErrCatch(GenBrushErr);
  }
  if (GSetNbElem(&(gb->_pods)) != 0) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBCreateImage failed");
    PBErrCatch(GenBrushErr);
  }
  GBFree(&gb);
  if (gb != NULL) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBFree failed");
    PBErrCatch(GenBrushErr);
  }
  printf("UnitTestGenBrushCreateFree OK\n");
}

void UnitTestGenBrushGetSet() {
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 4); VecSet(&dim, 1, 3);
  GenBrush* gb = GBCreateImage(&dim);
  if (VecIsEqual(GBDim(gb), &dim) == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBDim failed");
    PBErrCatch(GenBrushErr);
  }
  VecShort2D d = GBGetDim(gb);
  if (VecIsEqual(&d, &dim) == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBGetDim failed");
    PBErrCatch(GenBrushErr);
  }
  if (GBSurf(gb) != gb->_surf) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurf failed");
    PBErrCatch(GenBrushErr);
  }
  if (GBFinalPixels(gb) != gb->_surf->_finalPix) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBFinalPix failed");
    PBErrCatch(GenBrushErr);
  }
  if (GBGetType(gb) != GBSurfaceTypeImage) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBGetType failed");
    PBErrCatch(GenBrushErr);
  }
  VecFloat2D v = VecFloatCreateStatic2D();
  GBEyeOrtho* eye = GBEyeOrthoCreate(GBEyeOrthoViewFront);
  GBHand hand = GBHandCreateStatic(GBHandTypeDefault);
  GBTool tool;
  GBLayer layer;
  GBInk ink;
  GSetAppend(&(gb->_pods), GBObjPodCreatePoint(&v, &eye, &hand,
    &tool, &ink, &layer));
```

```
if (GBGetNbPod(gb) != 1) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBGetNbPod failed");
  PBErrCatch(GenBrushErr);
}
GBPixel black = GBColorBlack;
GBSetBgColor(gb, &black);
if (memcmp(&(gb->_surf->_bgColor), &black, sizeof(GBPixel)) != 0) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBSetBgColor failed");
  PBErrCatch(GenBrushErr);
}
if (memcmp(GBBgColor(gb), &black, sizeof(GBPixel)) != 0) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBBgColor failed");
  PBErrCatch(GenBrushErr);
}
GBPixel bgCol = GBGetBgColor(gb);
if (memcmp(&(gb->_surf->_bgColor), &bgCol, sizeof(GBPixel)) != 0) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBGetBgColor failed");
  PBErrCatch(GenBrushErr);
}
char* fileName = "./";
GBSetFileName(gb, fileName);
if (strcmp(((GBSurfaceImage*)(gb->_surf))->_fileName,
  fileName) != 0) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBSetFileName failed");
  PBErrCatch(GenBrushErr);
}
if (strcmp(GBFileName(gb), fileName) != 0) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBFileName failed");
  PBErrCatch(GenBrushErr);
}
VecShort2D p = VecShortCreateStatic2D();
VecSet(&p, 0, 1); VecSet(&p, 1, 2);
if (GBFinalPixel(gb, &p) != gb->_surf->_finalPix + 9) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBFinalPixel failed");
  PBErrCatch(GenBrushErr);
}
if (GBFinalPixelSafe(gb, &p) != gb->_surf->_finalPix + 9) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBFinalPixelSafe failed");
  PBErrCatch(GenBrushErr);
}
VecSet(&p, 0, 1); VecSet(&p, 1, -2);
if (GBFinalPixelSafe(gb, &p) != NULL) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBFinalPixelSafe failed");
  PBErrCatch(GenBrushErr);
}
VecSet(&p, 0, 1); VecSet(&p, 1, 2);
GBPixel white = GBColorWhite;
GBSetFinalPixel(gb, &p, &white);
if (memcmp(GBFinalPixel(gb, &p), &white,
  sizeof(GBPixel)) != 0) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBSetFinalPixel failed");
  PBErrCatch(GenBrushErr);
```

```
  }
  GBPixel pix = GBGetFinalPixel(gb, &p);
  if (memcmp(&pix, &white, sizeof(GBPixel)) != 0) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBGetFinalPixel failed");
    PBErrCatch(GenBrushErr);
  }
  GBPixel blue = GBColorBlue;
  GBSetFinalPixelSafe(gb, &p, &blue);
  pix = GBGetFinalPixel(gb, &p);
  if (memcmp(&pix, &blue, sizeof(GBPixel)) != 0) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSetFinalPixelSafe failed");
    PBErrCatch(GenBrushErr);
  }
  VecSet(&p, 0, 1); VecSet(&p, 1, -2);
  GBSetFinalPixelSafe(gb, &p, &white);
  pix = GBGetFinalPixelSafe(gb, &p);
  GBPixel transparent = GBColorTransparent;
  if (memcmp(&pix, &transparent, sizeof(GBPixel)) != 0) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBGetFinalPixelSafe failed");
    PBErrCatch(GenBrushErr);
  }
  if (GBArea(gb) != 12) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBArea failed");
    PBErrCatch(GenBrushErr);
  }
  VecSet(&p, 0, 1); VecSet(&p, 1, 2);
  if (GBIsPosInside(gb, &p) == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBIsPosInside failed");
    PBErrCatch(GenBrushErr);
  }
  VecSet(&p, 0, 10); VecSet(&p, 1, 2);
  if (GBIsPosInside(gb, &p) == true) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBIsPosInside failed");
    PBErrCatch(GenBrushErr);
  }
  VecSet(&p, 0, 1); VecSet(&p, 1, -2);
  if (GBIsPosInside(gb, &p) == true) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBIsPosInside failed");
    PBErrCatch(GenBrushErr);
  }
  if (GBLayers(gb) != &(gb->_surf->_layers)) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceLayers failed");
    PBErrCatch(GenBrushErr);
  }
  GBEyeOrthoFree(&eye);
  GBFree(&gb);
  printf("UnitTestGenBrushGetSet OK\n");
}

void UnitTestGenBrushUpdate() {
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 10); VecSet(&dim, 1, 10);
  GenBrush* gb = GBCreateImage(&dim);
  GBSurface* surf = GBSurf(gb);
```

```
  GBLayer* layer = GBAddLayer(gb, &dim);
  GBToolPlotter* tool = GBToolPlotterCreate();
  GBPixel transparent = GBColorTransparent;
  GBSurfaceSetBgColor(surf, &transparent);
  GBPixel blue = GBColorBlue;
  GBInkSolid* ink = GBInkSolidCreate(&blue);
  Facoid* facoid = FacoidCreate(2);
  Shapoid* shap = (Shapoid*)facoid;
  VecFloat2D v = VecFloatCreateStatic2D();
  VecSet(&v, 0, 7.0); VecSet(&v, 1, 4.0);
  ShapoidScale(shap, (VecFloat*)&v);
  VecSet(&v, 0, 2.0); VecSet(&v, 1, 4.0);
  ShapoidTranslate(shap, (VecFloat*)&v);
  GBEyeOrtho* eye = GBEyeOrthoCreate(GBEyeOrthoViewFront);
  GBHand hand = GBHandCreateStatic(GBHandTypeDefault);
  GBAddShapoid(gb, shap, &eye, &hand, tool, ink, layer);
  GBUpdate(gb);
  unsigned char check[400] = {
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,255,255, 0,0,255,255, 0,0,255,255,
    0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,255,255, 0,0,255,255, 0,0,255,255,
    0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,255,255, 0,0,255,255, 0,0,255,255,
    0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,255,255, 0,0,255,255, 0,0,255,255,
    0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0
    };
  for (int iPix = 0; iPix < GBSurfaceArea(surf); ++iPix) {
    if (surf->_finalPix[iPix]._rgba[GBPixelRed] !=
      check[iPix * 4] ||
      surf->_finalPix[iPix]._rgba[GBPixelGreen] !=
      check[iPix * 4 + 1] ||
      surf->_finalPix[iPix]._rgba[GBPixelBlue] !=
      check[iPix * 4 + 2] ||
      surf->_finalPix[iPix]._rgba[GBPixelAlpha] !=
      check[iPix * 4 + 3]) {
      ShapoidErr->_type = PBErrTypeUnitTestFailed;
      sprintf(ShapoidErr->_msg, "GBUpdate failed");
      PBErrCatch(ShapoidErr);
    }
  }
  GBToolPlotterFree(&tool);
  GBInkSolidFree(&ink);
  ShapoidFree(&shap);
  GBEyeOrthoFree(&eye);
  GBFree(&gb);
  printf("UnitTestGenBrushUpdate OK\n");
}

void UnitTestGenBrushRender() {
```

```
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 10); VecSet(&dim, 1, 10);
  GenBrush* gb = GBCreateImage(&dim);
  GBSurface* surf = GBSurf(gb);
  GBLayer* layers[4] = {NULL};
  VecSet(&dim, 0, 5); VecSet(&dim, 1, 5);
  for (int iLayer = 0; iLayer < 4; ++iLayer) {
    layers[iLayer] = GBSurfaceAddLayer(surf, &dim);
    GBLayerSetBlendMode(layers[iLayer], GBLayerBlendModeOver);
  }
  GBLayerSetStackPos(layers[1], GBLayerStackPosInside);
  GBLayerSetStackPos(layers[2], GBLayerStackPosInside);
  GBLayerSetStackPos(layers[3], GBLayerStackPosFg);
  VecShort2D pos = VecShortCreateStatic2D();
  VecSet(&pos, 0, 1); VecSet(&pos, 1, 1);
  GBLayerSetPos(layers[0], &pos);
  VecSet(&pos, 0, 3); VecSet(&pos, 1, 3);
  GBLayerSetPos(layers[1], &pos);
  VecSet(&pos, 0, 4); VecSet(&pos, 1, 4);
  GBLayerSetPos(layers[2], &pos);
  VecSet(&pos, 0, 7); VecSet(&pos, 1, 7);
  GBLayerSetPos(layers[3], &pos);
  VecSetNull(&pos);
  GBPixel col;
  float depth;
  do {
    col = GBColorGreen;
    depth = 0.0;
    GBLayerAddPixel(layers[0], &pos, &col, depth);
    col._rgba[GBPixelRed] = VecGet(&pos, 1) * 30;
    col._rgba[GBPixelGreen] = VecGet(&pos, 0) * 30;
    col._rgba[GBPixelBlue] = 0;
    col._rgba[GBPixelAlpha] = 255 - VecGet(&pos, 1) * 30;
    depth = VecGet(&pos, 0);
    GBLayerAddPixel(layers[1], &pos, &col, depth);
    col._rgba[GBPixelRed] = 0;
    col._rgba[GBPixelGreen] = VecGet(&pos, 0) * 30;
    col._rgba[GBPixelBlue] = VecGet(&pos, 1) * 30;
    col._rgba[GBPixelAlpha] = 255 - VecGet(&pos, 0) * 30;
    depth = VecGet(&pos, 1);
    GBLayerAddPixel(layers[2], &pos, &col, depth);
    col = GBColorBlue;
    depth = 0.0;
    GBLayerAddPixel(layers[3], &pos, &col, depth);
  } while (VecStep(&pos, &dim));
  GBUpdate(gb);
  GBSetFileName(gb, "./UnitTestGenBrushRender.tga");
  GBRender(gb);
  GBFree(&gb);
  printf("UnitTestGenBrushRender OK\n");
}

void UnitTestGenBrushAddRemoveLayer() {
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 4); VecSet(&dim, 1, 3);
  GenBrush* gb = GBCreateImage(&dim);
  GBLayer* layerA = GBAddLayer(gb, &dim);
  if (layerA == NULL) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBAddLayer failed");
    PBErrCatch(GenBrushErr);
  }
```

```
  if (GSetNbElem(GBSurfaceLayers(GBSurf(gb))) != 1) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBAddLayer failed");
    PBErrCatch(GenBrushErr);
  }
  if (VecIsEqual(GBLayerDim(layerA), &dim) == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBAddLayer failed");
    PBErrCatch(GenBrushErr);
  }
  GBLayer* layerB = GBAddLayer(gb, &dim);
  GBRemoveLayer(gb, layerA);
  if ((GBLayer*)(GBSurf(gb)->_layers._head->_data) != layerB) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBRemoveLayer failed");
    PBErrCatch(GenBrushErr);
  }
  GBFree(&gb);
  printf("UnitTestGenBrushAddRemoveLayer OK\n");
}

void UnitTestGenBrushGetLayerNbLayer() {
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 4); VecSet(&dim, 1, 3);
  GenBrush* gb = GBCreateImage(&dim);
  GBLayer* layers[3] = {NULL};
  for (int iLayer = 0; iLayer< 3; ++iLayer)
    layers[iLayer] = GBAddLayer(gb, &dim);
  if (GBGetNbLayer(gb) != 3) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBGetNbLayer failed");
    PBErrCatch(GenBrushErr);
  }
  for (int iLayer = 0; iLayer< 3; ++iLayer) {
    if (GBLay(gb, iLayer) != layers[iLayer]) {
      GenBrushErr->_type = PBErrTypeUnitTestFailed;
      sprintf(GenBrushErr->_msg, "GBGetLayer failed");
      PBErrCatch(GenBrushErr);
    }
  }
  GBFree(&gb);
  printf("UnitTestGenBrushGetLayer OK\n");
}

void UnitTestGenBrushSetLayerPos() {
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 4); VecSet(&dim, 1, 3);
  GenBrush* gb = GBCreateImage(&dim);
  GBLayer* layers[3] = {NULL};
  for (int iLayer = 0; iLayer< 3; ++iLayer)
    layers[iLayer] = GBAddLayer(gb, &dim);
  GBSetLayerStackPos(gb, layers[2], 0);
  GBSetLayerStackPos(gb, layers[0], 2);
  if (GBLay(gb, 0) != layers[2] ||
    GBLay(gb, 1) != layers[1] ||
    GBLay(gb, 2) != layers[0] ||
    GBLayerIsModified(layers[0]) != true ||
    GBLayerIsModified(layers[1]) != true ||
    GBLayerIsModified(layers[2]) != true) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSetLayerPos failed");
    PBErrCatch(GenBrushErr);
```

```
  }
  GBFree(&gb);
  printf("UnitTestGenBrushSetLayerPos OK\n");
}

void UnitTestGenBrushAddLayerFromFile() {
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 10); VecSet(&dim, 1, 10);
  GenBrush* gb = GBCreateImage(&dim);
  GBSurface* surf = GBSurf(gb);
  GBLayer* layer = GBAddLayerFromFile(gb, "./ImageRef.tga");
  (void)layer;
  GBPixel transparent = GBColorTransparent;
  GBSurfaceSetBgColor(surf, &transparent);
  GBSurfaceUpdate(surf);
  unsigned char check[400] = {
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,255,0,255, 0,255,0,255,
    0,255,0,255, 0,255,0,255, 0,255,0,255, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,255,0,255, 0,255,0,255, 0,255,0,255,
    0,255,0,255, 0,255,0,255, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,255,0,255, 0,255,0,255, 0,0,0,255, 0,30,0,255,
    0,60,0,255, 0,90,0,255, 0,120,0,255, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,255,0,255, 0,255,0,255, 26,30,0,255, 0,0,0,255, 4,34,0,255,
    7,67,0,255, 11,101,0,255, 120,184,120,255, 0,0,0,0, 0,0,0,0,
    0,255,0,255, 0,255,0,255, 46,60,0,255, 0,0,30,255, 7,34,26,255,
    14,67,23,255, 21,101,19,255, 120,184,136,255, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 148,90,90,255, 0,0,60,255, 11,34,53,255,
    21,67,46,255, 32,101,39,255, 120,184,152,255, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 184,120,120,255, 0,0,90,255, 14,34,79,255,
    28,67,69,255, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,120,255, 30,56,136,255,
    60,106,152,255, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,255,255, 0,0,255,255, 0,0,255,255
    };
  for (int iPix = 0; iPix < GBSurfaceArea(surf); ++iPix) {
    if (surf->_finalPix[iPix]._rgba[GBPixelRed] !=
      check[iPix * 4] ||
      surf->_finalPix[iPix]._rgba[GBPixelGreen] !=
      check[iPix * 4 + 1] ||
      surf->_finalPix[iPix]._rgba[GBPixelBlue] !=
      check[iPix * 4 + 2] ||
      surf->_finalPix[iPix]._rgba[GBPixelAlpha] !=
      check[iPix * 4 + 3]) {
      ShapoidErr->_type = PBErrTypeUnitTestFailed;
      sprintf(ShapoidErr->_msg, "GBAddLayerFromFile failed");
      PBErrCatch(ShapoidErr);
    }
  }
  GBFree(&gb);
  printf("UnitTestGenBrushAddLayerFromFile OK\n");
}

void UnitTestGenBrushAddRemoveObj() {
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 10); VecSet(&dim, 1, 10);
  GenBrush* gb = GBCreateImage(&dim);
  VecFloat2D posA = VecFloatCreateStatic2D();
  VecFloat2D posB = VecFloatCreateStatic2D();
  GBEye eyeA = GBEyeCreateStatic(GBEyeTypeOrtho);
  GBEye eyeB = GBEyeCreateStatic(GBEyeTypeOrtho);
```

```
GBHand handA = GBHandCreateStatic(GBHandTypeDefault);
GBHand handB = GBHandCreateStatic(GBHandTypeDefault);
GBTool toolA;
GBTool toolB;
GBLayer layerA;
GBLayer layerB;
GBInk inkA;
GBInk inkB;
GBAddPoint(gb, &posA, &eyeA, &handA, &toolA, &inkA, &layerA);
GBAddPoint(gb, &posB, &eyeA, &handA, &toolA, &inkB, &layerA);
if (GBGetNbPod(gb) != 2 ||
  ((GBObjPod*)(gb->_pods._head->_data))->_srcPoint !=
  (VecFloat*)&posA ||
  ((GBObjPod*)(gb->_pods._head->_next->_data))->_srcPoint !=
  (VecFloat*)&posB) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBAddPoint failed");
  PBErrCatch(GenBrushErr);
}
GBRemovePod(gb, &posA, NULL, NULL, NULL, NULL, NULL);
if (GBGetNbPod(gb) != 1 ||
  ((GBObjPod*)(gb->_pods._head->_data))->_srcPoint !=
    (VecFloat*)&posB) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBRemovePod failed");
  PBErrCatch(GenBrushErr);
}
GBAddPoint(gb, &posA, &eyeA, &handA, &toolA, &inkA, &layerA);
GBRemovePod(gb, NULL, &eyeA, NULL, NULL, NULL, NULL);
if (GBGetNbPod(gb) != 0) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBRemovePod failed");
  PBErrCatch(GenBrushErr);
}
GBAddPoint(gb, &posA, &eyeA, &handA, &toolA, &inkA, &layerA);
GBAddPoint(gb, &posB, &eyeB, &handA, &toolA, &inkA, &layerA);
GBRemovePod(gb, NULL, &eyeA, &handA, NULL, NULL, NULL);
if (GBGetNbPod(gb) != 1 ||
  ((GBObjPod*)(gb->_pods._head->_data))->_srcPoint !=
    (VecFloat*)&posB) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBRemovePod failed");
  PBErrCatch(GenBrushErr);
}
GBAddPoint(gb, &posA, &eyeA, &handA, &toolB, &inkA, &layerA);
GBRemovePod(gb, NULL, NULL, NULL, &toolB, NULL, NULL);
if (GBGetNbPod(gb) != 1 ||
  ((GBObjPod*)(gb->_pods._head->_data))->_srcPoint !=
    (VecFloat*)&posB) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBRemovePod failed");
  PBErrCatch(GenBrushErr);
}
GBAddPoint(gb, &posA, &eyeA, &handB, &toolB, &inkA, &layerB);
GBRemovePod(gb, NULL, NULL, NULL, NULL, NULL, &layerB);
if (GBGetNbPod(gb) != 1 ||
  ((GBObjPod*)(gb->_pods._head->_data))->_srcPoint !=
    (VecFloat*)&posB) {
  GenBrushErr->_type = PBErrTypeUnitTestFailed;
  sprintf(GenBrushErr->_msg, "GBRemovePod failed");
  PBErrCatch(GenBrushErr);
}
```

```
  GBRemovePod(gb, NULL, NULL, NULL, NULL, NULL, NULL);
  if (GBGetNbPod(gb) != 0) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBRemovePod failed");
    PBErrCatch(GenBrushErr);
  }
  GBAddPoint(gb, &posA, &eyeA, &handB, &toolB, &inkA, &layerA);
  GBAddPoint(gb, &posB, &eyeB, &handB, &toolB, &inkB, &layerB);
  GBRemovePod(gb, NULL, NULL, NULL, NULL, &inkB, NULL);
  if (GBGetNbPod(gb) != 1 ||
    ((GBObjPod*)(gb->_pods._head->_data))->_srcPoint !=
      (VecFloat*)&posA) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBRemovePod failed");
    PBErrCatch(GenBrushErr);
  }
  GBFree(&gb);
  GBEyeFreeStatic(&eyeA);
  GBEyeFreeStatic(&eyeB);
  printf("UnitTestGenBrushAddRemoveObj OK\n");
}

void UnitTestGenBrushSetPod() {
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 10); VecSet(&dim, 1, 10);
  GenBrush* gb = GBCreateImage(&dim);
  VecFloat2D posA = VecFloatCreateStatic2D();
  VecFloat2D posB = VecFloatCreateStatic2D();
  GBEye eyeA = GBEyeCreateStatic(GBEyeTypeOrtho);
  GBEye eyeB = GBEyeCreateStatic(GBEyeTypeOrtho);
  GBHand handA = GBHandCreateStatic(GBHandTypeDefault);
  GBHand handB = GBHandCreateStatic(GBHandTypeDefault);
  GBTool toolA;
  GBTool toolB;
  GBLayer layerA;
  GBLayer layerB;
  GBInk inkA;
  GBInk inkB;
  GBAddPoint(gb, &posA, &eyeA, &handA, &toolA, &inkA, &layerA);
  GBAddPoint(gb, &posB, &eyeA, &handB, &toolB, &inkA, &layerB);
  GBSetPodEye(gb, &eyeB, &posA, NULL, NULL, NULL, NULL, NULL);
  if (((GBObjPod*)(gb->_pods._head->_data))->_eye != &eyeB) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSetPodEye failed");
    PBErrCatch(GenBrushErr);
  }
  GBSetPodHand(gb, &handA, NULL, NULL, NULL, NULL, NULL, &layerB);
  if (((GBObjPod*)(gb->_pods._head->_next->_data))->_hand != &handA) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSetPodHand failed");
    PBErrCatch(GenBrushErr);
  }
  GBSetPodTool(gb, &toolA, NULL, NULL, &handA, NULL, NULL, NULL);
  if (((GBObjPod*)(gb->_pods._head->_data))->_tool != &toolA ||
    ((GBObjPod*)(gb->_pods._head->_next->_data))->_tool != &toolA) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSetPodTool failed");
    PBErrCatch(GenBrushErr);
  }
  GBSetPodInk(gb, &inkA, NULL, NULL, NULL, NULL, &inkB, NULL);
  if (((GBObjPod*)(gb->_pods._head->_data))->_ink != &inkA ||
    ((GBObjPod*)(gb->_pods._head->_next->_data))->_ink != &inkA) {
```

```
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSetPodTool failed");
    PBErrCatch(GenBrushErr);
  }
  GBSetPodLayer(gb, &layerA, &posB, NULL, NULL, &toolA, NULL, NULL);
  if (((GBObjPod*)(gb->_pods._head->_next->_data))->_layer != &layerA) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSetPodLayer failed");
    PBErrCatch(GenBrushErr);
  }
  GBFree(&gb);
  GBEyeFreeStatic(&eyeA);
  GBEyeFreeStatic(&eyeB);
  printf("UnitTestGenBrushSetPod OK\n");
}

void UnitTestGenBrushFlush() {
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 10); VecSet(&dim, 1, 10);
  GenBrush* gb = GBCreateImage(&dim);
  GBSurface* surf = GBSurf(gb);
  GBLayer* layer = GBSurfaceAddLayer(surf, &dim);
  GBLayerSetModified(layer, false);
  GBPixel blue = GBColorBlue;
  GBSurfaceSetBgColor(surf, &blue);
  GBFlush(gb);
  if (GBLayerIsModified(layer) == false) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBSurfaceFlush failed");
    PBErrCatch(ShapoidErr);
  }
  for (int iPix = GBSurfaceArea(surf); iPix--;)
    if (memcmp(surf->_finalPix + iPix, &blue, sizeof(GBPixel)) != 0) {
      ShapoidErr->_type = PBErrTypeUnitTestFailed;
      sprintf(ShapoidErr->_msg, "GBSurfaceFlush failed");
      PBErrCatch(ShapoidErr);
    }
  GBFree(&gb);
  printf("UnitTestGenBrushFlush OK\n");
}

void UnitTestGenBrushTouchLayers() {
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 10); VecSet(&dim, 1, 10);
  GenBrush* gb = GBCreateImage(&dim);
  VecFloat2D posA = VecFloatCreateStatic2D();
  VecFloat2D posB = VecFloatCreateStatic2D();
  GBEye eyeA = GBEyeCreateStatic(GBEyeTypeOrtho);
  GBHand handA = GBHandCreateStatic(GBHandTypeDefault);
  GBHand handB = GBHandCreateStatic(GBHandTypeDefault);
  GBTool toolA;
  GBTool toolB;
  GBLayer* layerA = GBAddLayer(gb, &dim);
  GBLayer* layerB = GBAddLayer(gb, &dim);
  GBInk inkA;
  GBAddPoint(gb, &posA, &eyeA, &handA, &toolA, &inkA, layerA);
  GBAddPoint(gb, &posB, &eyeA, &handB, &toolB, &inkA, layerB);
  GBSurfaceSetLayersModified(GBSurf(gb), false);
  GBNotifyChangeFromObj(gb, &posA);
  if (GBLayerIsModified(layerA) == false ||
    GBLayerIsModified(layerB) == true) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
```

```
    sprintf(GenBrushErr->_msg, "GBNotifyChangeFromObj failed");
    PBErrCatch(GenBrushErr);
  }
  GBSurfaceSetLayersModified(GBSurf(gb), false);
  GBNotifyChangeFromEye(gb, &eyeA);
  if (GBLayerIsModified(layerA) == false ||
    GBLayerIsModified(layerB) == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBNotifyChangeFromEye failed");
    PBErrCatch(GenBrushErr);
  }
  GBSurfaceSetLayersModified(GBSurf(gb), false);
  GBNotifyChangeFromHand(gb, &handA);
  if (GBLayerIsModified(layerA) == false ||
    GBLayerIsModified(layerB) == true) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBNotifyChangeFromHand failed");
    PBErrCatch(GenBrushErr);
  }
  GBSurfaceSetLayersModified(GBSurf(gb), false);
  GBNotifyChangeFromTool(gb, &toolA);
  if (GBLayerIsModified(layerA) == false ||
    GBLayerIsModified(layerB) == true) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBNotifyChangeFromTool failed");
    PBErrCatch(GenBrushErr);
  }
  GBSurfaceSetLayersModified(GBSurf(gb), false);
  GBNotifyChangeFromInk(gb, &inkA);
  if (GBLayerIsModified(layerA) == false ||
    GBLayerIsModified(layerB) == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBNotifyChangeFromInk failed");
    PBErrCatch(GenBrushErr);
  }
  GBFree(&gb);
  GBEyeFreeStatic(&eyeA);
  printf("UnitTestGenBrushTouchLayers OK\n");
}

void UnitTestGenBrushCreateFromFile() {
  char* fileName = "./ImageRef.tga";
  GenBrush* gb = GBCreateFromFile(fileName);
  if (gb == NULL) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBCreateFromFile failed");
    PBErrCatch(GenBrushErr);
  }
  GBSurface* surf = GBSurf(gb);
  unsigned char check[400] = {
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,255,0,255, 0,255,0,255,
    0,255,0,255, 0,255,0,255, 0,255,0,255, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,255,0,255, 0,255,0,255, 0,255,0,255,
    0,255,0,255, 0,255,0,255, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,255,0,255, 0,255,0,255, 0,0,0,255, 0,30,0,255,
    0,60,0,255, 0,90,0,255, 0,120,0,255, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,255,0,255, 0,255,0,255, 26,30,0,255, 0,0,0,255, 4,34,0,255,
    7,67,0,255, 11,101,0,255, 120,184,120,255, 0,0,0,0, 0,0,0,0,
    0,255,0,255, 0,255,0,255, 46,60,0,255, 0,0,30,255, 7,34,26,255,
    14,67,23,255, 21,101,19,255, 120,184,136,255, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 148,90,90,255, 0,0,60,255, 11,34,53,255,
```

```
    21,67,46,255, 32,101,39,255, 120,184,152,255, 0,0,0,0, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 184,120,120,255, 0,0,90,255, 14,34,79,255,
    28,67,69,255, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,120,255, 30,56,136,255,
    60,106,152,255, 0,0,255,255, 0,0,255,255, 0,0,255,255, 0,0,0,0,
    0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0, 0,0,0,0,
    0,0,255,255, 0,0,255,255, 0,0,255,255
    };
  for (int iPix = 0; iPix < GBSurfaceArea(surf); ++iPix) {
    if (surf->_finalPix[iPix]._rgba[GBPixelRed] !=
      check[iPix * 4] ||
      surf->_finalPix[iPix]._rgba[GBPixelGreen] !=
      check[iPix * 4 + 1] ||
      surf->_finalPix[iPix]._rgba[GBPixelBlue] !=
      check[iPix * 4 + 2] ||
      surf->_finalPix[iPix]._rgba[GBPixelAlpha] !=
      check[iPix * 4 + 3]) {
      ShapoidErr->_type = PBErrTypeUnitTestFailed;
      sprintf(ShapoidErr->_msg, "GBCreateFromFile failed");
      PBErrCatch(ShapoidErr);
    }
  }
  GBFree(&gb);
  printf("UnitTestGenBrushCreateFromFile OK\n");
}

void UnitTestGenBrushIsSameAs() {
  char* fileName = "./ImageRef.tga";
  GenBrush* gbA = GBCreateFromFile(fileName);
  GenBrush* gbB = GBCreateFromFile(fileName);
  if (GBIsSameAs(gbA, gbB) == false) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBIsSameAs failed");
    PBErrCatch(ShapoidErr);
  }
  VecSet(GBSurfaceDim(GBSurf(gbA)), 0, 0);
  if (GBIsSameAs(gbA, gbB) == true) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBIsSameAs failed");
    PBErrCatch(ShapoidErr);
  }
  VecSet(GBSurfaceDim(GBSurf(gbA)), 0, 10);
  GBSurfaceFinalPixels(GBSurf(gbA))->_rgba[GBPixelAlpha] = 255;
  if (GBIsSameAs(gbA, gbB) == true) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBIsSameAs failed");
    PBErrCatch(ShapoidErr);
  }
  GBFree(&gbA);
  GBFree(&gbB);
  printf("UnitTestGenBrushIsSameAs OK\n");
}

void UnitTestGenBrushAddRemovePostProcessing() {
  GenBrush* gb = GBCreateFromFile("./GBSurfaceNormalizeHueTest.tga");
  if (GBPostProcs(gb) != &(gb->_postProcs)) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBPostProcs failed");
    PBErrCatch(ShapoidErr);
  }
  GBPostProcessing* postA = GBAddPostProcess(gb, GBPPTypeNormalizeHue);
  if (gb->_postProcs._head->_data != (void*)postA) {
```

```
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBAddPostProcess failed");
    PBErrCatch(ShapoidErr);
  }
  if (GBPostProcess(gb, 0) != (void*)postA) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBGetPostProcess failed");
    PBErrCatch(ShapoidErr);
  }
  GBUpdate(gb);
  GBSurfaceImage* ref = GBSurfaceImageCreateFromFile(
    "./GBSurfaceNormalizeHueRef.tga");
  if (GBSurfaceIsSameAs(GBSurf(gb), (GBSurface*)ref) == false) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBUpdate failed");
    PBErrCatch(ShapoidErr);
  }
  GBRemovePostProcess(gb, postA);
  if (GSetNbElem(GBPostProcs(gb)) != 0) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBRemovePostProcess failed");
    PBErrCatch(ShapoidErr);
  }
  postA = GBAddPostProcess(gb, GBPPTypeNormalizeHue);
  postA = GBAddPostProcess(gb, GBPPTypeNormalizeHue);
  if (GBGetNbPostProcs(gb) != 2) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBGetNbPostProcs failed");
    PBErrCatch(ShapoidErr);
  }
  GBRemoveAllPostProcess(gb);
  if (GSetNbElem(GBPostProcs(gb)) != 0) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBRemoveAllPostProcess failed");
    PBErrCatch(ShapoidErr);
  }
  postA = GBAddPostProcess(gb, GBPPTypeNormalizeHue);
  GBFree(&gb);
  GBSurfaceImageFree(&ref);
  printf("UnitTestGenBrushAddRemovePostProcessing\n");
}

void UnitTestGenBrushScaleCropCopyFragment() {
  GenBrush* gb = GBCreateFromFile("./GBScaleCropTest.tga");
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 100); VecSet(&dim, 1, 50);
  GenBrush* gbScaled = GBScale(gb, &dim, GBScaleMethod_AvgNeighbour);
#if BUILDMODE == 0
  GenBrush* gbRef = GBCreateFromFile(
    "./GBScaleTestAvgNeighbourRef01.tga");
#else
  GenBrush* gbRef = GBCreateFromFile(
    "./GBScaleTestAvgNeighbourRef02.tga");
#endif
  if (!GBSurfaceIsSameAs(GBSurf(gbScaled), GBSurf(gbRef))) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBScaleAvgNeighbour failed");
    PBErrCatch(ShapoidErr);
  }
  GBFree(&gbScaled);
  GBFree(&gbRef);
  VecShort2D pos = VecShortCreateStatic2D();
```

```
  VecSet(&pos, 0, -5); VecSet(&pos, 1, -5);
  VecSet(&dim, 0, 50); VecSet(&dim, 1, 50);
  GenBrush* gbCropped = GBCrop(gb, &pos, &dim, NULL);
  gbRef = GBCreateFromFile("./GBCropTestRef01.tga");
  if (!GBSurfaceIsSameAs(GBSurf(gbCropped), GBSurf(gbRef))) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBCrop failed (1)");
    PBErrCatch(ShapoidErr);
  }
  GBFree(&gbRef);
  GBFree(&gbCropped);
  VecSet(&pos, 0, 30); VecSet(&pos, 1, 30);
  VecSet(&dim, 0, 50); VecSet(&dim, 1, 50);
  GBPixel fillPix = GBColorBlue;
  gbCropped = GBCrop(gb, &pos, &dim, &fillPix);
  gbRef = GBCreateFromFile("./GBCropTestRef02.tga");
  if (!GBSurfaceIsSameAs(GBSurf(gbCropped), GBSurf(gbRef))) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBCrop failed (2)");
    PBErrCatch(ShapoidErr);
  }

  VecSet(&pos, 0, 5); VecSet(&pos, 1, 15);
  VecShort2D posDest = VecShortCreateStatic2D();
  VecSet(&posDest, 0, 40); VecSet(&posDest, 1, 30);
  VecSet(&dim, 0, 10); VecSet(&dim, 1, 20);
  GBCopyFragment(gbRef, gb, &pos, &posDest, &dim);
  GBFree(&gbRef);
  gbRef = GBCreateFromFile("./GBCopyFragmentTestRef.tga");
  if (!GBSurfaceIsSameAs(GBSurf(gb), GBSurf(gbRef))) {
    ShapoidErr->_type = PBErrTypeUnitTestFailed;
    sprintf(ShapoidErr->_msg, "GBCopyFragment failed (2)");
    PBErrCatch(ShapoidErr);
  }


  GBFree(&gbRef);
  GBFree(&gbCropped);
  GBFree(&gb);
  printf("UnitTestGenBrushScaleCropCopyFragment OK\n");
}

void UnitTestGenBrush() {
  UnitTestGenBrushCreateFree();
  UnitTestGenBrushGetSet();
  UnitTestGenBrushUpdate();
  UnitTestGenBrushRender();
  UnitTestGenBrushAddRemoveLayer();
  UnitTestGenBrushGetLayerNbLayer();
  UnitTestGenBrushSetLayerPos();
  UnitTestGenBrushUpdate();
  UnitTestGenBrushAddLayerFromFile();
  UnitTestGenBrushAddRemoveObj();
  UnitTestGenBrushSetPod();
  UnitTestGenBrushFlush();
  UnitTestGenBrushTouchLayers();
  UnitTestGenBrushCreateFromFile();
  UnitTestGenBrushIsSameAs();
  UnitTestGenBrushAddRemovePostProcessing();
  UnitTestGenBrushScaleCropCopyFragment();

  printf("UnitTestGenBrush OK\n");
```

```
}

void UnitTestAll() {
  UnitTestGBPixel();
  UnitTestGBLayer();
  UnitTestGBPostProcessing();
  UnitTestGBSurface();
  UnitTestGBSurfaceImage();
  UnitTestGBEye();
  UnitTestGBHand();
  UnitTestGBTool();
  UnitTestGBInk();
  UnitTestGBObjPod();
  UnitTestGenBrush();
  printf("UnitTestAll OK\n");
}

#if BUILDWITHGRAPHICLIB == 0

  int main() {
    UnitTestAll();
    // Return success code
    return 0;
  }

#elif BUILDWITHGRAPHICLIB == 1

  void UnitTestPaintSurface(GBSurface* const surf,
    VecShort2D* dim,
    int green) {
    // Declare a vector to memorize position in the surface
    VecShort2D pos = VecShortCreateStatic2D();
    // Set the surface to a shade of red and blue
    do {
      GBPixel pixel;
      pixel._rgba[GBPixelAlpha] = 255;
      pixel._rgba[GBPixelRed] = MIN(255, VecGet(&pos, 0));
      pixel._rgba[GBPixelGreen] = MIN(255, green);
      pixel._rgba[GBPixelBlue] = MIN(255, VecGet(&pos, 1));
      GBSurfaceSetFinalPixel(surf, &pos, &pixel);
    } while (VecStep(&pos, dim));
  }

  gint UnitTestGBSurfaceAppCB(gpointer data) {
    // Declare a variable to convert the data into the GBSurfaceApp
    GBSurfaceApp* GBApp = (GBSurfaceApp*)data;
    // Paint again the surface
    UnitTestPaintSurface((GBSurface*)GBApp,
      GBSurfaceDim((GBSurface*)GBApp), 0);
    // Refresh the displayed surface
    GBSurfaceAppRefresh(GBApp);
    // Take a screenshot before closing
    bool ret = GBScreenshot(
      GBApp, "./screenshotGBSurfaceApp.tga");
    if (ret == false) {
      GenBrushErr->_type = PBErrTypeUnitTestFailed;
      sprintf(GenBrushErr->_msg, "GBSurfaceAppScreenshot failed");
      PBErrCatch(GenBrushErr);
    }
    // Kill the app
    GBSurfaceAppClose(GBApp);
    // Return false to continue the callback chain
```

```
  return FALSE;
}

void UnitTestGBSurfaceApp() {
  // Declare variable ot memorize the parameters of the app
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 300); VecSet(&dim, 1, 200);
  char* title = "UnitTestGBSurfaceApp";
  // Create the app
  GenBrush* app = GBCreateApp(&dim, title);
  // Set the idle function of the surface
  GBSetIdle(app, &UnitTestGBSurfaceAppCB, 1000);
  // Paint some content on the surface
  UnitTestPaintSurface(app->_surf, &dim, 0);
  // Render the app
  bool status = GBRender(app);
  // If the render of the app failed
  if (status == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceAppCreate failed");
    PBErrCatch(GenBrushErr);
  }
  // Free the memory used by the app
  GBFree(&app);
  printf("UnitTestGBSurfaceApp OK\n");
}

GtkWidget* UnitTestGBSurfaceWidgetWindow;
gint UnitTestGBSurfaceWidgetCB(gpointer data) {
  static int green = 0;
  // Declare a variable to convert the data into the GenBrush
  GenBrush* GBWidget = (GenBrush*)data;
  // Paint again the surface
  UnitTestPaintSurface(GBWidget->_surf,
    GBSurfaceDim(GBWidget->_surf), green);
  ++green;
  // Refresh the displayed surface
  GBRender(GBWidget);
  if (green == 255) {
    gtk_window_close(GTK_WINDOW(UnitTestGBSurfaceWidgetWindow));
  }
  // Return true to stop the callback chain
  return TRUE;
}

gboolean UnitTestGBSurfaceWidgetCloseCB(GtkWidget* widget,
  GdkEventConfigure* event, gpointer data) {
    (void)widget;(void)event;
  // Declare a variable to convert the data into the GenBrush
  GenBrush* GBWidget = (GenBrush*)data;
  // Take a screenshot before closing
  bool ret = GBScreenshot(
    (GBSurfaceWidget*)(GBWidget->_surf),
    "./screenshotGBSurfaceWidget.tga");
  if (ret == false) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "GBSurfaceWidgetScreenshot failed");
    PBErrCatch(GenBrushErr);
  }
  // Free memory
  GBFree(&GBWidget);
  // Return false to continue the callback chain
```

```
  return FALSE;
}

void UnitTestGBSurfaceWidgetActivateCB(GtkApplication* app,
  gpointer user_data) {
  (void)user_data;
  // Create a GTK application
  GtkWidget* window = gtk_application_window_new(app);
  UnitTestGBSurfaceWidgetWindow = window;
  // Set the title
  gtk_window_set_title(GTK_WINDOW(window), "UnitTestGBSurfaceWidget");
  // Declare a variable to memorize the size
  VecShort2D dim = VecShortCreateStatic2D();
  VecSet(&dim, 0, 300); VecSet(&dim, 1, 200);
  // Set the size
  gtk_window_set_default_size(GTK_WINDOW(window), VecGet(&dim, 0),
    VecGet(&dim, 1));
  // Avoid window resizing
  gtk_window_set_resizable(GTK_WINDOW(window), false);
  // Create the GenBrush with a GBSurfaceWidget
  GenBrush* GBWidget = GBCreateWidget(&dim);
  // Get the widget of the drawing area
  GtkWidget* drawingArea = GBGetGtkWidget(GBWidget);
  // Add the widget to the window
  gtk_container_add(GTK_CONTAINER(window), drawingArea);
  // Connect to the delete event
  g_signal_connect(window, "delete-event",
    G_CALLBACK(UnitTestGBSurfaceWidgetCloseCB), GBWidget);
  // Connect the idle function
  g_timeout_add(40, UnitTestGBSurfaceWidgetCB, GBWidget);
  // Display the window
  gtk_widget_show_all(window);
}

void UnitTestGBSurfaceWidget(int argc, char** argv) {
  // Create a GTK application
  GtkApplication* app =
    gtk_application_new(NULL, G_APPLICATION_FLAGS_NONE);
  // Connect the activate callback
  g_signal_connect(app, "activate",
    G_CALLBACK(UnitTestGBSurfaceWidgetActivateCB), NULL);
  // Run the application
  int status = g_application_run(G_APPLICATION(app), argc, argv);
  // If the application failed
  if (status != 0) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GenBrushErr->_msg, "Application failed");
    PBErrCatch(GenBrushErr);
  }
  // Unreference the application
  g_object_unref(app);
  printf("UnitTestGBSurfaceWidget OK\n");
}

void UnitTestAllGTK(int argc, char** argv) {
  UnitTestGBSurfaceApp();
  UnitTestGBSurfaceWidget(argc, argv);
  printf("UnitTestAllGTK OK\n");
}

int main(int argc, char** argv) {
  UnitTestAll();
```

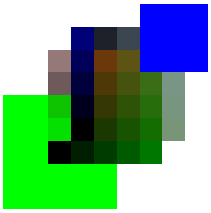
```
    UnitTestAllGTK(argc, argv);
    // Return success code
    return 0;
  }

#endif
```

6 Unit tests output

```
UnitTestGBPixelBlendNormal OK
UnitTestGBPixelBlendOver OK
UnitTestGBPixelIsSame OK
UnitTestGBPixelConvertRGBHSV OK
UnitTestGBPixel OK
UnitTestGBLayerCreateFree OK
UnitTestGBLayerArea OK
UnitTestGBLayerGetSet OK
UnitTestGBLayerCreateFromFile OK
UnitTestGBLayerGetBoundaryInSurface OK
UnitTestGBLayer OK
UnitTestGBPostProcessingCreateFree OK
UnitTestGBPostProcessingGetSet OK
UnitTestGBPostProcessing OK
UnitTestGBSurfaceCreateFree OK
UnitTestGBSurfaceGetSet OK
UnitTestGBSurfaceArea OK
UnitTestGBSurfaceClone OK
UnitTestGBSurfaceAddRemoveLayer OK
UnitTestGBSurfaceGetLayer OK
UnitTestGBSurfaceSetLayersModified OK
UnitTestGBSurfaceSetLayerPos OK
UnitTestGBSurfaceGetModifiedArea OK
UnitTestGBSurfaceUpdate OK
UnitTestGBSurfaceAddLayerFromFile OK
UnitTestGBSurfaceFlush OK
UnitTestGBSurfaceIsSameAs OK
UnitTestGBSurfaceNormalizeHue OK
UnitTestGBSurface OK
UnitTestGBSurfaceImageCreateFree OK
UnitTestGBSurfaceImageGetSet OK
UnitTestGBSurfaceImageClone OK
UnitTestGBSurfaceImageSave OK
UnitTestGBSurfaceImageCreateFromFile OK
UnitTestGBSurfaceImage OK
UnitTestGBEyeCreateFree OK
UnitTestGBEyeGetSet OK
UnitTestGBEyeOrthoCreateFree OK
UnitTestGBEyeOrthoGetSet OK
UnitTestGBEyeOrthoProcessPoint OK
UnitTestGBEyeOrthoProcessCurve OK
UnitTestGBEyeOrthoProcessShapoid OK
UnitTestGBEyeOrtho OK
UnitTestGBEyeIsometricCreateFree OK
UnitTestGBEyeIsometricGetSet OK
UnitTestGBEyeIsometricProcessPoint OK
UnitTestGBEyeIsometricProcessCurve OK
UnitTestGBEyeIsometricProcessShapoid OK
UnitTestGBEyeIsometric OK
```

```
UnitTestGBEye OK
UnitTestGBHandCreateFree OK
UnitTestGBHandCreateFree OK
UnitTestGBHandDefaultCreateFree OK
UnitTestGBHandDefaultProcess OK
UnitTestGBHandDefault OK
UnitTestGBHand OK
UnitTestGBToolCreateFree OK
UnitTestGBToolGetSet OK
UnitTestGBToolPlotterCreateFree OK
UnitTestGBToolPlotterDrawPoint OK
UnitTestGBToolPlotterDrawFacoid OK
UnitTestGBToolPlotterDrawPyramidoid OK
UnitTestGBToolPlotterDrawSpheroid OK
UnitTestGBToolPlotterDrawFacoid3D OK
UnitTestGBToolPlotterDrawSCurve OK
UnitTestGBToolPlotter OK
UnitTestGBTool OK
UnitTestGBInkSolidCreateFree OK
UnitTestGBInkSolidGetSet OK
UnitTestGBInkSolid OK
UnitTestGBInk OK
UnitTestGBObjPodCreateFree OK
UnitTestGBObjPodGetSet OK
UnitTestGBObjPod OK
UnitTestGenBrushCreateFree OK
UnitTestGenBrushGetSet OK
UnitTestGenBrushUpdate OK
UnitTestGenBrushRender OK
UnitTestGenBrushAddRemoveLayer OK
UnitTestGenBrushGetLayer OK
UnitTestGenBrushSetLayerPos OK
UnitTestGenBrushUpdate OK
UnitTestGenBrushAddLayerFromFile OK
UnitTestGenBrushAddRemoveObj OK
UnitTestGenBrushSetPod OK
UnitTestGenBrushFlush OK
UnitTestGenBrushTouchLayers OK
UnitTestGenBrushCreateFromFile OK
UnitTestGenBrushIsSameAs OK
UnitTestGenBrushAddRemovePostProcessing
UnitTestGenBrushScaleCrop OK
UnitTestGenBrush OK
UnitTestAll OK
UnitTestGBSurfaceApp OK
UnitTestGBSurfaceWidget OK
UnitTestAllGTK OK
```

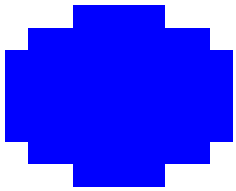
GBSurfaceImageSave.tga:



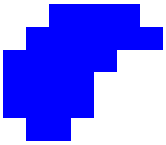
GBToolPlotterDrawSCurve.tga:

GBToolPlotterDrawFacoid3D.tga:

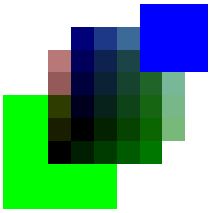
GBToolPlotterDrawSpheroid.tga:



GBToolPlotterDrawFacoid.tga:



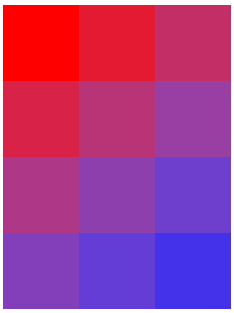
ImageRef.tga:



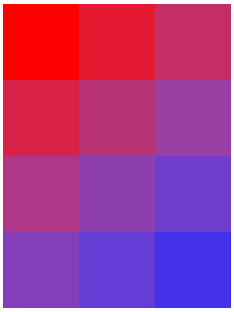
GBToolPlotterDrawPoint.tga:

GBToolPlotterDrawPyramidoid.tga:

testBottomLeft.tga:



testTopLeft.tga:

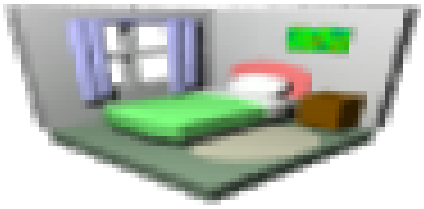


GBSurfaceNormalizeHueTest.tga:

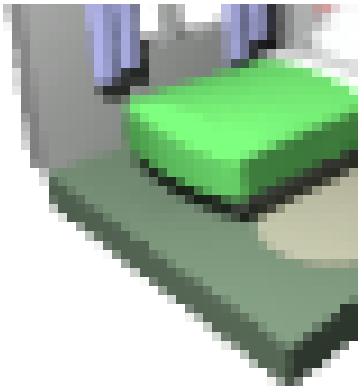
GBSurfaceNormalizeHueRef.tga:

GBScaleCropTest.tga:

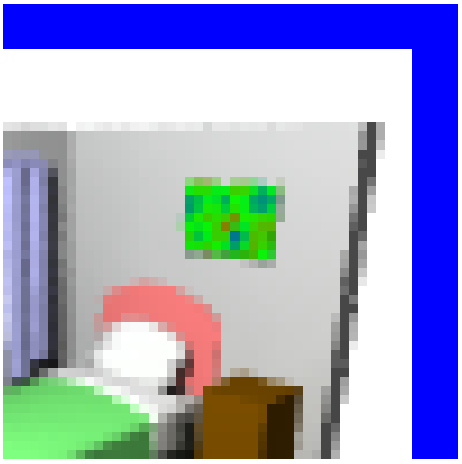
GBScaleTestAvgNeighbourRef.tga:



GBCropTestRef01.tga:



GBCropTestRef02.tga:



screenshotGBSurfaceApp.tga:

screenshotGBSurfaceWidget.tga:

7 Demo

7.1 ImageViewer

7.1.1 main.c

```
#include <stdlib.h>
#include <stdio.h>
#include <time.h>
#include <string.h>
#include <time.h>
#include <unistd.h>
#include <sys/time.h>
#include "genbrush.h"

int main(int argc, char** argv) {
  // Check if one argument has been given
  if (argc != 2) {
    printf("No file name given in argument.\n");
    return 1;
  }
```

```
  // Load the image as a GBSurfaceImage to get its dimensions
  GBSurfaceImage* image = GBSurfaceImageCreateFromFile(argv[1]);
  // If we couldn't load the image
  if (image == NULL) {
    printf("Couldn't load the image %s.\n", argv[1]);
    return 1;
  }
  // Declare variable to memorize the title of the app
  char* title = "GenBrush: Image viewer";
  // Create the app with same dimensions as the image
  GenBrush* app = GBCreateApp(GBSurfaceDim((GBSurface*)image), title);
  // Steal the image content from the GBSurfaceImage to avoid
  // reloading it
  GBPixel* tmp = ((GBSurface*)image)->_finalPix;
  ((GBSurface*)image)->_finalPix = GBSurf(app)->_finalPix;
  GBSurf(app)->_finalPix = tmp;
  // Render the app
  bool status = GBRender(app);
  // If the render of the app failed
  if (status == false) {
    printf("Couldn't create the application.\n");
    return 1;
  }
  // Free the memory used by the app
  GBFree(&app);
  // Free the memory used by the image
  GBSurfaceImageFree(&image);
  // Return success code
  return 0;
}
```

7.1.2 Makefile

```
# Build mode
# 0: development (max safety, no optimisation)
# 1: release (min safety, optimisation)
# 2: fast and furious (no safety, optimisation)
BUILD_MODE?=1

all: main

# 0: monolith version, the GBSurface is rendered toward a TGA image
# 1: GTK version, the GBSurface is rendered toward a TGA image or
#    a GtkWidget
BUILDWITHGRAPHICLIB=1

# Makefile definitions
MAKEFILE_INC=../../../PBMake/Makefile.inc
include $(MAKEFILE_INC)

# Rules to make the executable
repo=genbrush
$($(repo)_EXENAME): \
$($(repo)_EXENAME).o \
$($(repo)_EXE_DEP) \
$($(repo)_DEP)
$(COMPILER) `echo "$($(repo)_EXE_DEP) $($(repo)_EXENAME).o" | tr ' ' '\n' | sort -u` $(LINK_ARG) $($(repo)_LINK_ARG)

$($(repo)_EXENAME).o: \
main.c \
```

```
$($(repo)_INC_H_EXE) \
$($(repo)_EXE_DEP)
$(COMPILER) $(BUILD_ARG) $($(repo)_BUILD_ARG) `echo "$($(repo)_INC_DIR)" | tr ' ' '\n' | sort -u` -c main.c
```

7.2 Glade

This example shows how to use a GenBrush widget within a GUI designed using Glade.

7.2.1 main.c

```
#include <gtk/gtk.h>
#include "pbmath.h"
#include "genbrush.h"

// Main structure of the application
typedef struct {
  char* gladeFilePath;
  GtkApplication* gtkApp;
  GApplication* gApp;
  GtkWidget* mainWindow;
  GenBrush* gbWidget;
  int green;
} DemoApp;

// Declare a global instance of the application
DemoApp app;

// Callback function for the 'activate' event on the GTK application
// 'data' is the DemoApp application
void GtkAppActivate(
  GtkApplication* gtkApp,
  gpointer user_data);

// Callback function for the 'delete-event' event on the GTK application
// window
// 'user_data' is the DemoApp application
gboolean ApplicationWindowDeleteEvent(
  GtkWidget* widget,
  GdkEventConfigure* event,
  gpointer user_data);

// Callback function for the 'delete-event' event on the GTK application
// window
// 'user_data' is the DemoApp application
gboolean ButtonClicked(
  gpointer user_data);

// Paint the GenBrush surface
void PaintSurface(
  GBSurface* const surf,
       VecShort2D* dim,
               int green);

// Create an instance of the application
DemoApp DemoAppCreate(
     int argc,
```

```
  char** argv) {

  // Unused arguments
  (void)argc;
  (void)argv;

  // Init the variable to paint the GenBrush widget
  app.green = 0;

  // Set the UI definition file path
  app.gladeFilePath = strdup("./test.glade");

  // Create a GTK application
  app.gtkApp = gtk_application_new(
    NULL,
    G_APPLICATION_FLAGS_NONE);
  app.gApp = G_APPLICATION(app.gtkApp);

  // Connect the callback function on the 'activate' event of the GTK
  // application
  g_signal_connect(
    app.gtkApp,
    "activate",
    G_CALLBACK(GtkAppActivate),
    NULL);

  // Return the instance of the application
  return app;
}

// Main function of the application
int DemoAppMain(
  DemoApp* that,
       int argc,
    char** argv) {

  // Run the application at the G level
  int status = g_application_run(
    that->gApp,
    argc,
    argv);

  // If the application failed
  if (status != 0) {
    GenBrushErr->_type = PBErrTypeUnitTestFailed;
    sprintf(
      GenBrushErr->_msg,
      "g_application_run failed (%d)",
      status);
    PBErrCatch(GenBrushErr);
  }

  // Unreference the GTK application
  g_object_unref(that->gtkApp);

  // Return the status code
  return status;
}

// Callback function for the 'activate' event on the GTK application
// 'user_data' is the DemoApp application
void GtkAppActivate(
```

```
GtkApplication* gtkApp,
gpointer user_data) {

// Unused arguments
(void)gtkApp;
(void)user_data;

// Create a GTK builder with the UI definition file
GtkBuilder* gtkBuilder = gtk_builder_new_from_file(app.gladeFilePath);

// Set the GTK application in the GTK builder
gtk_builder_set_application(gtkBuilder, app.gtkApp);

// Get the widget container for the GenBrush widget
GtkWidget* container = GTK_WIDGET(
  gtk_builder_get_object(
    gtkBuilder,
    "box1"));

// Declare a variable to memorize the size of the GenBrush widget
VecShort2D dim = VecShortCreateStatic2D();
VecSet(&dim, 0, 300);
VecSet(&dim, 1, 200);

// Create the GenBrush widget
app.gbWidget = GBCreateWidget(&dim);

// Get the GTK widget from the GenBrush widget
GtkWidget* widget = GBGetGtkWidget(app.gbWidget);

// Insert the GenBrush widget into its container
gtk_box_pack_start(
  GTK_BOX(container),
  widget,
  TRUE,
  TRUE,
  0);

// Get the UI's button
GtkWidget* btn = GTK_WIDGET(
  gtk_builder_get_object(
    gtkBuilder,
    "button1"));

// Set the callback on the 'clicked' event of the UI's button
g_signal_connect(
  btn,
  "clicked",
  G_CALLBACK(ButtonClicked),
  NULL);

// Get the main window
app.mainWindow = GTK_WIDGET(
  gtk_builder_get_object(
    gtkBuilder,
    "applicationwindow1"));

// Set the callback on the delete-event of the main window
g_signal_connect(
  app.mainWindow,
  "delete-event",
  G_CALLBACK(ApplicationWindowDeleteEvent),
```

```
    NULL);

  // Connect the other signals defined in the UI definition file
  gtk_builder_connect_signals(
    gtkBuilder,
    NULL);

  // Free memory used by the GTK builder
  g_object_unref(G_OBJECT(gtkBuilder));

  // Display the main window and all its components
  gtk_widget_show_all(app.mainWindow);

  // Run the application at the GTK level
  gtk_main();
}

// Callback function for the 'delete-event' event on the GTK application
// window
// 'user_data' is the DemoApp application
gboolean ApplicationWindowDeleteEvent(
  GtkWidget* widget,
  GdkEventConfigure* event,
  gpointer user_data) {

  // Unused arguments
  (void)widget;
  (void)event;
  (void)user_data;

  // Free memory used by the GenBrush instance
  GBFree(&(app.gbWidget));

  // Quit the application at GTK level
  gtk_main_quit();

  // Quit the application at G level
  g_application_quit(app.gApp);

  // Return false to continue the callback chain
  return FALSE;
}

// Callback function for the 'delete-event' event on the GTK application
// window
// 'user_data' is the DemoApp application
gboolean ButtonClicked(
  gpointer user_data) {

  // Unused arguments
  (void)user_data;

  // Paint the GenBrush surface
  PaintSurface(
    app.gbWidget->_surf,
    GBSurfaceDim(app.gbWidget->_surf),
    app.green);

  // Refresh the displayed surface
  GBRender(app.gbWidget);

  // Update the value used to pain the surface
```

```
  app.green += 10;

  // If the value reached its maximum
  if (app.green >= 255) {

    // Stop the GTK window
    gtk_window_close(GTK_WINDOW(app.mainWindow));
  }

  // Return true to stop the callback chain
  return TRUE;
}

// Paint the GenBrush surface
void PaintSurface(
  GBSurface* const surf,
       VecShort2D* dim,
               int green) {

  // Loop on the pixels of the surface
  VecShort2D pos = VecShortCreateStatic2D();
  do {

    // Set the pixel value according to the argument
    GBPixel pixel;
    pixel._rgba[GBPixelAlpha] = 255;
    pixel._rgba[GBPixelRed] = MIN(255, VecGet(&pos, 0));
    pixel._rgba[GBPixelGreen] = MIN(255, green);
    pixel._rgba[GBPixelBlue] = MIN(255, VecGet(&pos, 1));
    GBSurfaceSetFinalPixel(surf, &pos, &pixel);
  } while (VecStep(&pos, dim));
}

// Main function
int main(
     int argc,
  char** argv)
{
  // Initialise the GTK library
  gtk_init(&argc, &argv);

  // Create the application
  app = DemoAppCreate(argc, argv);

  // Run the application
  int status = DemoAppMain(&app, argc, argv);

  // Return the status at the end of the application
  return status;

}
```

7.2.2 Makefile

```
# Build mode
# 0: development (max safety, no optimisation)
# 1: release (min safety, optimisation)
# 2: fast and furious (no safety, optimisation)
BUILD_MODE=1

all: main
```

```
# 0: monolith version, the GBSurface is rendered toward a TGA image
# 1: GTK version, the GBSurface is rendered toward a TGA image or
#    a GtkWidget
BUILDWITHGRAPHICLIB=1

# Makefile definitions
MAKEFILE_INC=../../../PBMake/Makefile.inc
include $(MAKEFILE_INC)

# Dependencies of the executable (*.o)
main_DEP=

# Dependencies of the executable (*.h)
main_INC_H=\
$(ROOT_DIR)/GenBrush/genbrush.h \
$(ROOT_DIR)/PBMath/pbmath.h

# Rules to make the executable
repo=genbrush
main: \
main.o \
$(main_DEP) \
$(genbrush_EXE_DEP)
$(COMPILER) `echo "$(main_DEP) $(genbrush_EXE_DEP) main.o" | tr ' ' '\n' | sort -u` $(LINK_ARG) $(genbrush_LINK_ARG)

main.o: \
main.c \
$(main_INC_H) \
Makefile
$(COMPILER) $(BUILD_ARG) $(genbrush_BUILD_ARG) `echo "$(genbrush_INC_DIR)" | tr ' ' '\n' | sort -u` -c main.c
```

7.2.3 test.glade

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- Generated with glade 3.18.3 -->
<interface>
  <requires lib="gtk+" version="3.12"/>
  <object class="GtkApplicationWindow" id="applicationwindow1">
    <property name="can_focus">False</property>
    <child>
      <object class="GtkBox" id="box1">
        <property name="visible">True</property>
        <property name="can_focus">False</property>
        <property name="orientation">vertical</property>
        <child>
          <object class="GtkButton" id="button1">
            <property name="label" translatable="yes">button</property>
            <property name="visible">True</property>
            <property name="can_focus">True</property>
            <property name="receives_default">True</property>
          </object>
          <packing>
            <property name="expand">False</property>
            <property name="fill">True</property>
            <property name="position">0</property>
          </packing>
        </child>
      </object>
    </child>
```

```
  </object>
</interface>
```