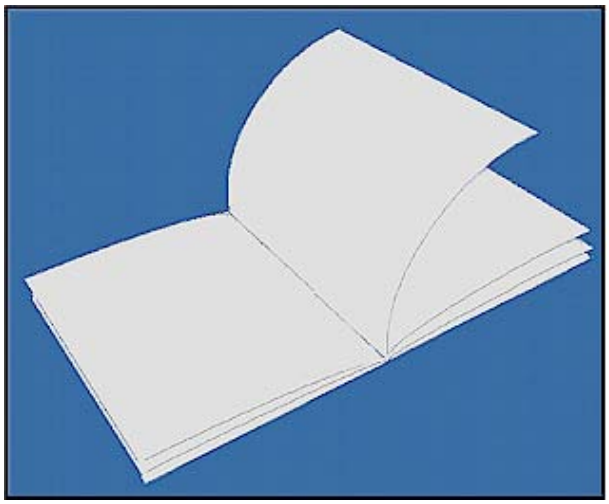
The 3D Publication Model



A Presentation of Methods, Algorithms, Research Models and Publishing Technologies Developed by The Virtual Publishing Company

January 2013

Contents

1. The 3D Graphical Publication Interface Metaphor 3
2. The 3D Publication-Engine Research Project 4
3. 3D Publications in Use 5
4. The 3D Page-Turn Algorithm 6
5. Sharp Text in a 3D Publication 9
6. The 3D Page Turn Geometry Research Model 10
7. The 3D Font Rendering Typesetter Research Model 11
8. The 3D Publication Research Model 12
9. Existing 2D Publication Technologies 13
10. About The Inventor 14

Intellectual Property Notes

The 3D page-turn algorithm described in part of this document has a US patent granted on January 1, 2008 – '3D Publication with Page-Turn'. Details are here:

http://www.google.com/patents/US7315312

The 3D typesetter font rendering engine described in this document has a US patent pending filed July 27, 2005 – '3D Font Engine' Details are here:

http://www.google.com/patents/US20060071948

Written by

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1. The 3D Graphical Publication Interface Metaphor

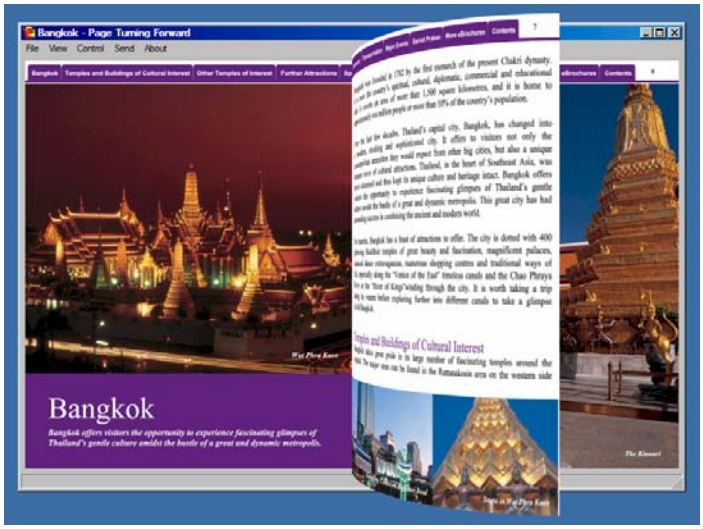
Imagine taking any printed publication like a book, magazine or newspaper and exactly duplicating it in 3D space, correct down to every detail with rich graphics, fluid turning pages, full scalability, clear page layout, and sharp readable text. A 3 dimensional graphical publication would be the ultimate step in the evolution from print to screen.

Publishers would customize 3D publications as hard cover books, paperbacks, glossy magazines, newspapers or directories, and make selections on paper textures, covers, bindings and dimensions. Their goal will be to perfectly reproduce their print titles in 3D and offer them as an alternative to their subscribers. Print publishers will love 3D publishing because it preserves the integrity of their medium, not just for them but for their readers and advertisers too.

The Virtual Publishing Company has a vision to create a practical publishing interface in 3D and has been researching the concept for several years. Research has focused on building fast and efficient algorithms to process turning pages and sharp, readable text in a continuously moving environment.

The 3D graphical publication interface described in this document is a 'work in progress' research project and descriptions of the advanced 3D page turn and font engine algorithms are below together with downloadable demonstration research models.

The Virtual Publishing Company has existing 2D turning-page publication technologies in the market and the editing tools to create them. These have the most advanced page-turn animations in use as well as internal scalable sharp text typesetting and rich text formatting capabilities. They are capable of duplicating any print publication. Already thousands of magazines, brochures and directories have been created and published in this format.



The Virtual Publishing Company is at the forefront of 3D Graphical Publishing Interface Metaphor research. The concepts, methods, algorithms and progress are summarized here.

2. The 3D Publication-Engine Research Project

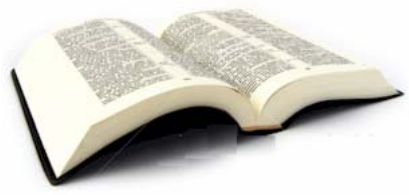
The research goal of the Virtual Publishing Company is to build a fast processing, high quality, fully functional and customizable 3 dimensional publication-engine.

In a 3 dimensional publication, visual quality must be perfect, text must be sharp and continuous animation must be fluid. This puts a lot of work on the device processor to calculate and output a single frame in a fraction of a second, dozens of times in the span of a second and double that in stereoscopic 3D.

Attempting to write a 3D Publication-engine in a high-level programming language would result in wasting a lot of the processors time on unnecessary translation tasks. This processor time could be used instead to improve quality and speed by building the engine in the processor's native assembly language and machine code. This approach exploits the full power of the device processor by using pure optimized assembly instructions to squeeze out the best possible display quality very fast.

```
fld     cos_alpha   ; cos(alpha)
fld r1Y
fmul                ; Y*cos(alpha)
fld     sin_alpha   ; sin(alpha),    Y*cos(alpha)
fld r1X
fmul                ; X*sin(alpha),  Y*cos(alpha)
fadd                ; X*sin(alpha) + Y*cos(alpha)
fstp    TY          ;
fld r1Z ; Z
fmul    cos_beta    ; Z*cos(beta)
fld     sin_beta    ; sin(beta),     Z*cos(beta)
fmul    TX          ; TX*sin(beta),  Z*cos(beta)
fadd                ; TX*sin(beta) + Z*cos(beta)
fst     TZ          ;
fmul    sin_gamma   ; TZ*sin(gamma)
fld     TY          ; TY,            TZ*sin(gamma)
fmul    cos_gamma   ; TY*cos(gamma), TZ*sin(gamma)
fsubr
fild Y              ; TY*cos(gamma) - TZ*sin(gamma)
fadd
fistp ptEdge2.pt3D.y        ; Update
```

The most important elements that need fast processing in a 3D publication-engine are a 3D graphical page turn and a 3D font typesetter/text formatter. Both of these functions are processor intensive but are ideal for optimizing into processor machine code. Both page turn and fonts are driven by plotting and mixing pixels with efficient mathematical equations perfect for writing in assembly language to get super fast calculations.



The Virtual Publishing Company has developed a number of research models to show these critical functions of the 3D Publication. These are detailed later in this document together with links to download them for demonstrations.

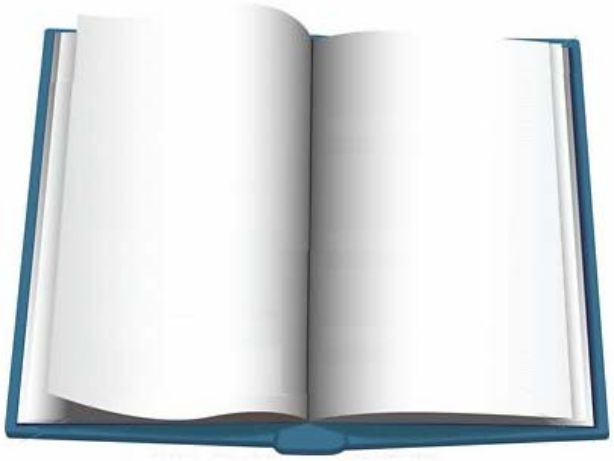
All the tools for working with 3D publications can be built in high-level programming languages; it is only the engine itself which requires hard wiring to the device processor.

The Virtual Publishing Company has made enormous progress in the 3D Publication Engine Research Project. The page turn and 3D typesetting program design and main algorithms have been fully worked out and tested in models. The aim now is to perfect the technologies and bind them together into an all purpose 3D publication engine that could be adapted for different devices and operating systems.

We are at the dawn of the 3D display age with virtual reality, 3D TV and 3D movies. This project anticipates 3D displays on phones, tablets and PCs being commonplace.

3. 3D Publications in Use

The digital age comes full circle with 3D publishing and rediscovers a craft perfected over more than 500 years of publishing as a business. A profession with many professional disciplines; layout, editing, journalism, design, copywriting, photography to name a few. What print publishers want is a digital solution that preserves their medium and professional skills, and creates the potential to grow again in a falling print sales market. The answer is for digital technology is to imitate print products down to the smallest detail in 3D and build in the potential for ever improving quality.



The Publication, Paper and the Page Turn

The publication behavior will become more and more sophisticated and closer and closer to the perfect imitation of paper. Pages will bend in more complex ways, the publication and pages will respond to gravity, text will become sharper, and advanced hand gesture controls will allow flipping through pages like a real page-turner.

The Publication-Engine and File Formats

By its very nature of being built in processor instructions, the publication engine will be small in file size and perfect for ongoing App updating to any device. The engines themselves need hard-coding for each device standard but the 3D publication file formats will be common to all devices and operating systems.

Customization

Publishers like to choose paper quality and texture, binding, covers, fonts, finish, dimensions, pages and so on. This is an ideal area for tools development and outside designers to create skins for duplicating countless different types of print publications and their formats in 3D Space.

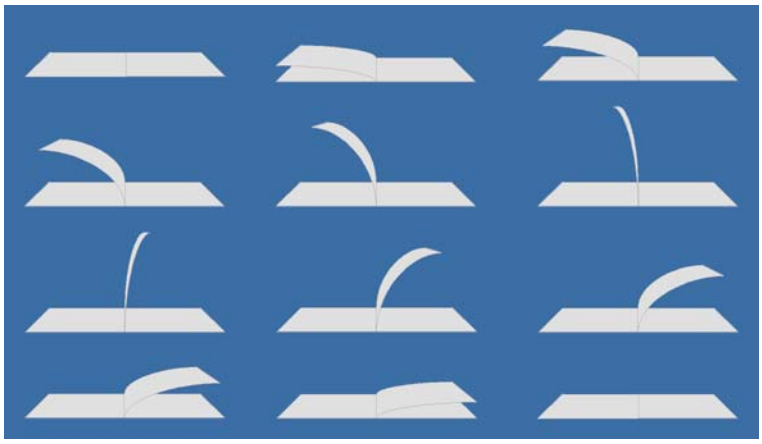
3D Publication File Converters

File converters can be built that instantly generate a 3D publication from Word documents, PDFs or InDesign project files for streaming directly to the device. Publishers will automatically create a 3D version of every new title they publish and offer it as an alternative to paper to their readers and subscribers.

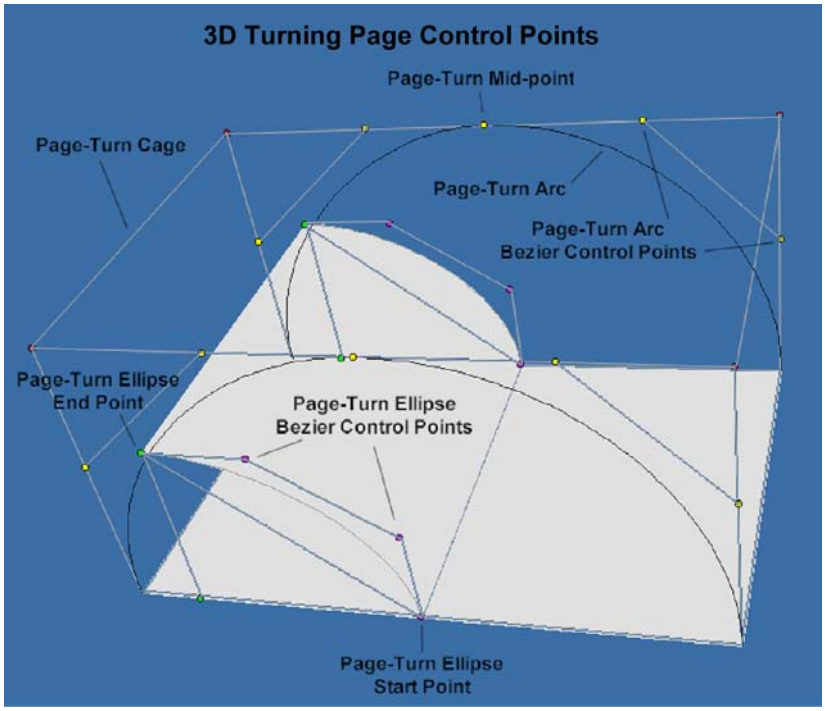
4. The 3D Page-Turn Algorithm

At the core of a 3D publication is a graphical page turn that must be sharp, fluid, responsive and realistic -- a page that flows like paper when it turns. Several years' research into page turn algorithms showed that an ideal geometric curve to describe the top and bottom edges of a page as it is turning is a one-quarter ellipse arc.

This illustration shows a selected sequence of frames of a complete page-turn animation sequence from beginning to end. After initiating the page-turn, the reader will see a fluid turn, either forwards or backwards, to the next or previous page. Using the arc of an ellipse to bend the page gives the turning page a natural flow that mimics paper and looks totally realistic.

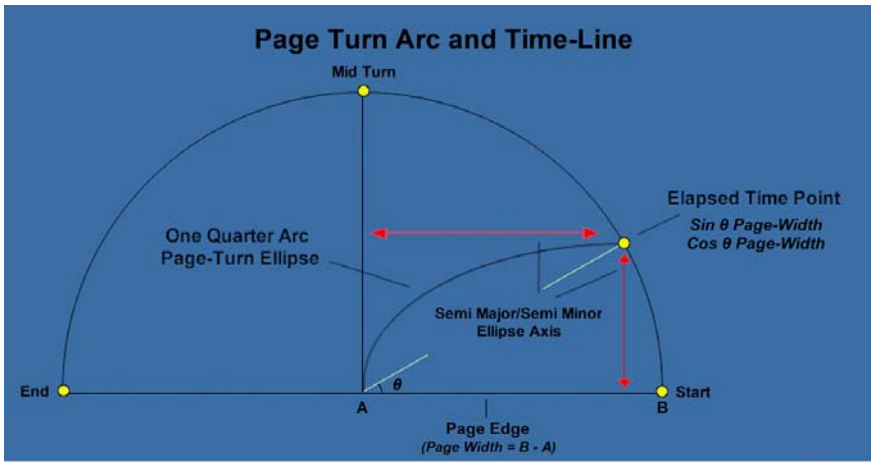


Rather than directly instructing the display to project a frame at a predetermined time (as other graphical page-turns do), a high-resolution timer, which marks the elapsed time from the start of the page-turn sequence, controls the animation. Each time the operating system loop calls for a refresh the algorithm calculates the correct position of the turning page and draws a geometrically accurate frame. This means a fluid page-turn animation can be displayed on any device, whatever the processor speed.



In this page turn algorithm an (imaginary) outer 3D cage is constructed based upon control-points calculated from the dimensions of the page. Within the cage a Page-Turn Arc describes the path of the outer page corner points during the page-turn sequence. The outer arc also represents the proportional time-line for the page-turn and provides a high precision radian value (0 to $\pi/2$) of elapsed time each time the operating system display refresh loop calls for an update.

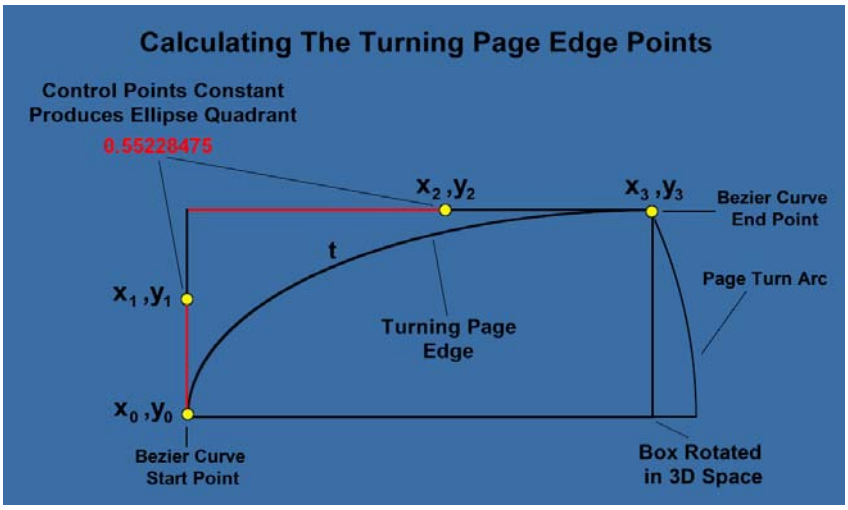
The elapsed-time value provides the critical variable for calculating the whole page-turn page turn sequence and is the key to delivering a fluid, flowing and realistic page-turn animation. It determines the position of the page turn end point, the start point being the spine of the publication. These two points provide the semi-major and semi-minor axis values of an ellipse and from here it is possible to construct a one-quarter-arc ellipse page edge. These control points are manipulated in a cubic Bezier curve equation and rotated in 3D space to the orientation and scale of the publication being viewed.



The outer page turn arc is also the time-line for finding the position of the edge of the page based on the elapsed time since the page turn start. From there geometric points can be determined for the one-quarter-arc ellipses that become the turning page top and bottom edges.

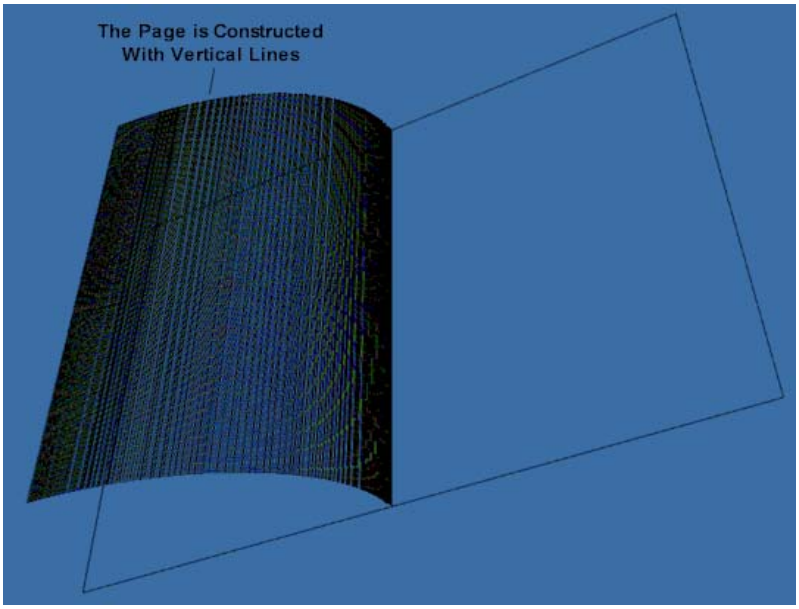
Since the page edge (when it is turning) is one quadrant of an ellipse, it is possible to plot it using a cubic Bezier curve by adding constants. These constants can be varied and changed during the page turn to create more sophisticated and elaborate page bending curves.

A useful property of cubic Bezier curves is that that the four x/y control points can be rotated in 3D space and translated to screen coordinates before calculating the line points. Therefore in calculating the position of the page edge, it is only necessary to calculate the rotated and translated control points and plot the page edge normally.



Using the page turn outer arc to provide a time-line and a geometric curve to bend the page is what makes the page flow naturally as it turns. Using elapsed time to control the page turn means that the number of frames displayed in a page turn sequence depends upon the device but the turning time is constant on all devices.

Once all top and bottom page edge points are known and translated to screen coordinates the turning page itself can be constructed. The page is drawn vertically in lines, which and anti-aliased to 16th of a pixel to produce smooth joining and clean edges. The contents on the pages are mapped to these lines from a laid-out page in memory. This produces a proportional and geometrically accurate transformation of the page contents to the turning page.



The actual drawing and mapping of the page-turn is done when the final display coordinates are known. This illustration shows how a 3D turning page magazine would look face-on in mid-turn. The graphical control points are shown:

5. Sharp Text in a 3D Publication

The single most important element to get right in a 3D graphical publication is sharp and readable small body text. Whereas images and photos can be rotated and transformed to any orientation – small text cannot. If an 'image' of the character is rotated, contour smoothing information is lost in the transformation which results in fuzzy text. This illustration shows what happens when small text is rotated as an 'image'. To ensure sharp and clear text all characters must be individually rendered and smoothed from the font curve points after they have been rotated in 3D, scaled and transformed for the display.

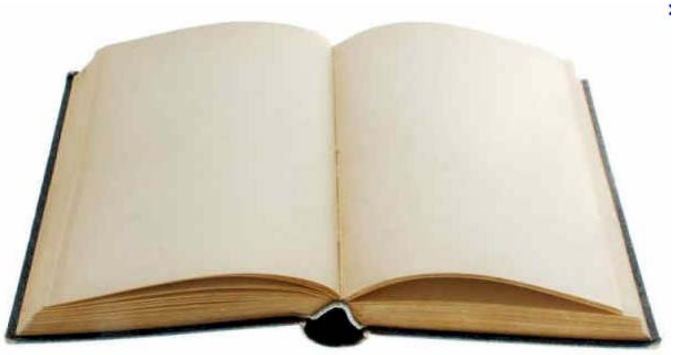
The 3D font-engine typesetter delivers sharp text at any 3D orientation and scale on screen.

It is designed for use in a 3D publication model on either a 2D display screen or in 3D space. In a 3D graphical environment, the font-engine updates the text at every change of orientation. This means is that the text would refocus and sharpen in real-time when the reader changed their viewing position.

This method is the only way to ensure that small body text is always sharp, clear and readable at all times on a 3D page.

In a 3D publication environment, text must be redrawn and character contours re-smoothed at any change of orientation. If the change of orientation is continuous then the font rendering engine needs to be able to output complete pages of refreshed text very fast and in real time. This can be done using assembly language to instruct the processor directly.

A real page in a print publication is rarely perfectly flat. In fact an open book, for example, always has a bend to every page. In this scenario, the 3D typesetter would determine the tangent of the curved page at the point that the character is to be drawn and make the minor adjustments to ensure it appears exactly as it would on a bended printed page, sharp, clear and perfectly positioned.



6. The 3D Page Turn Geometry Research Model

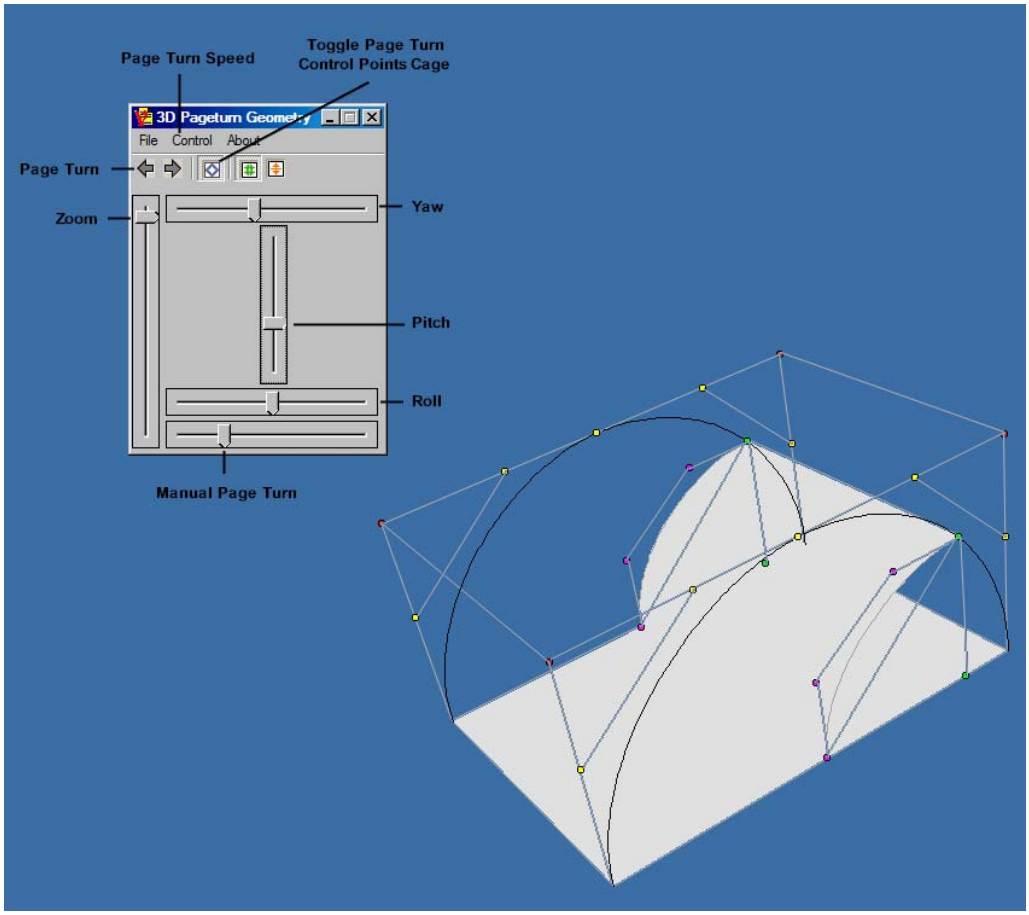
Download and run '3D Pageturn Geometry Model.exe'

http://www.internetpublisher.com/Models/3DPageturnGeometryModel.zip

This model is built in 32 bit assembly language and runs on any Windows PC.

This research model was developed to give a dynamic visual representation of the geometry of a 3D turning page and its control-points as described in the page turn algorithm above.

Use this model to view page turns at any orientation and adjust for roll, pitch and yaw as well as zooming in and out. The control-points cage showing the page turn arc and points can be toggled on and off. See how fluid the page turn is and how completely realistic and flowing it is at any viewing orientation and scale. To see a page turn in slow motion adjust the page turn time in the control menu.



This graphical page-turn sequence is based on the 'elapsed time' method where the operating system display refresh loop initiates the drawing of each page frame in real time based on a 64 bit measurement of elapsed time since the beginning of the page-turn sequence.

7. The 3D Font Rendering Typesetter Research Model

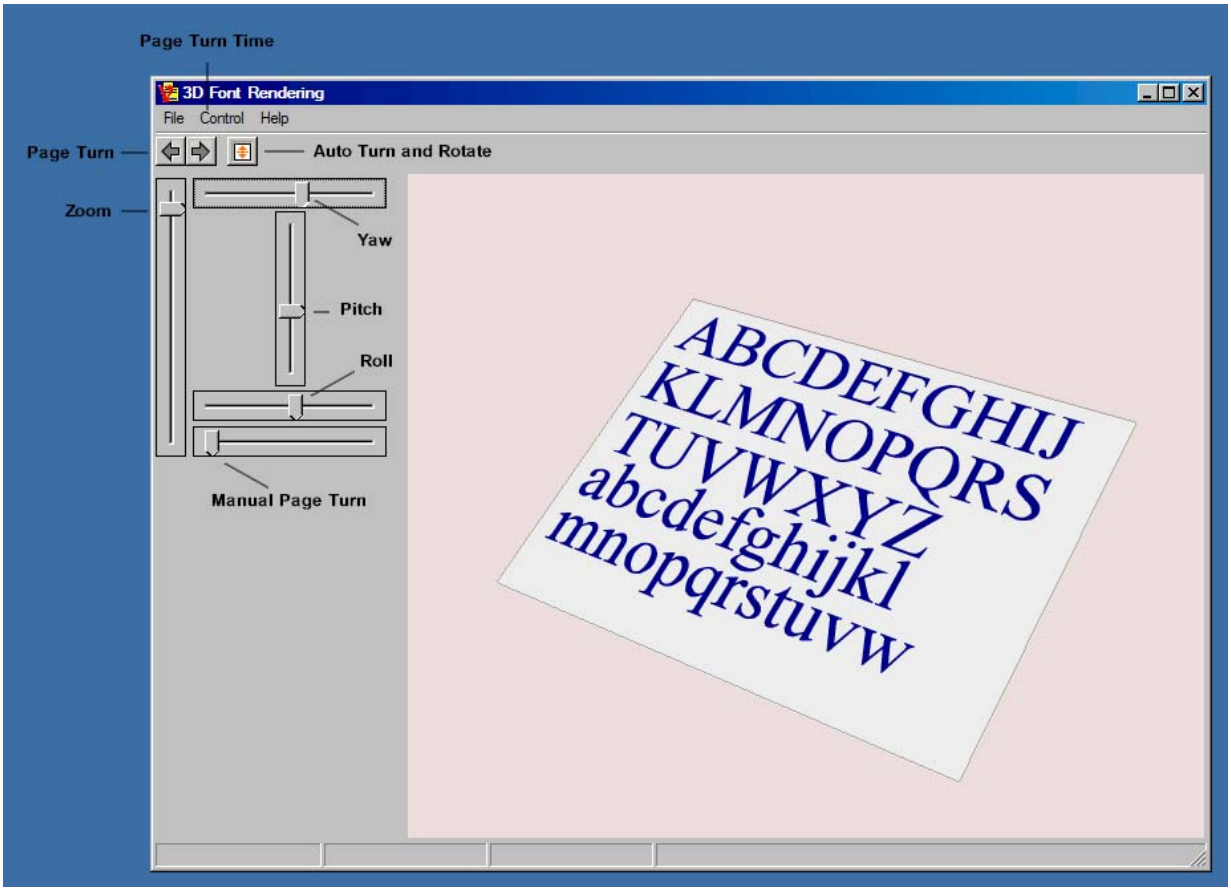
Download and run '3D Font Rendering Model.exe'

http://www.internetpublisher.com/Models/3DFontRenderingModel.zip

This model is built in 32 bit assembly language and runs on any Windows PC.

This research model is a fast processing 3D typesetter that demonstrates a continuous redrawing and smoothing of text in a moving 3D environment.

Any change in orientation causes each character to be redrawn and smoothed in real time. Character heights are scalable to 1/8th pixel and smoothed to a precision of 64 shades.



The typesetter redraws and smoothes the text on a page each time the operating system loop calls for a display refresh. At this point every character is recalculated directly from the font, rotated to the page orientation and rendered individually.

Use the controls to change pitch, roll and yaw or to zoom in and out. Click the 'Auto' button to see how text refreshes in a continuously moving 3D environment. The transparent page turn is for show and can be adjusted for duration.

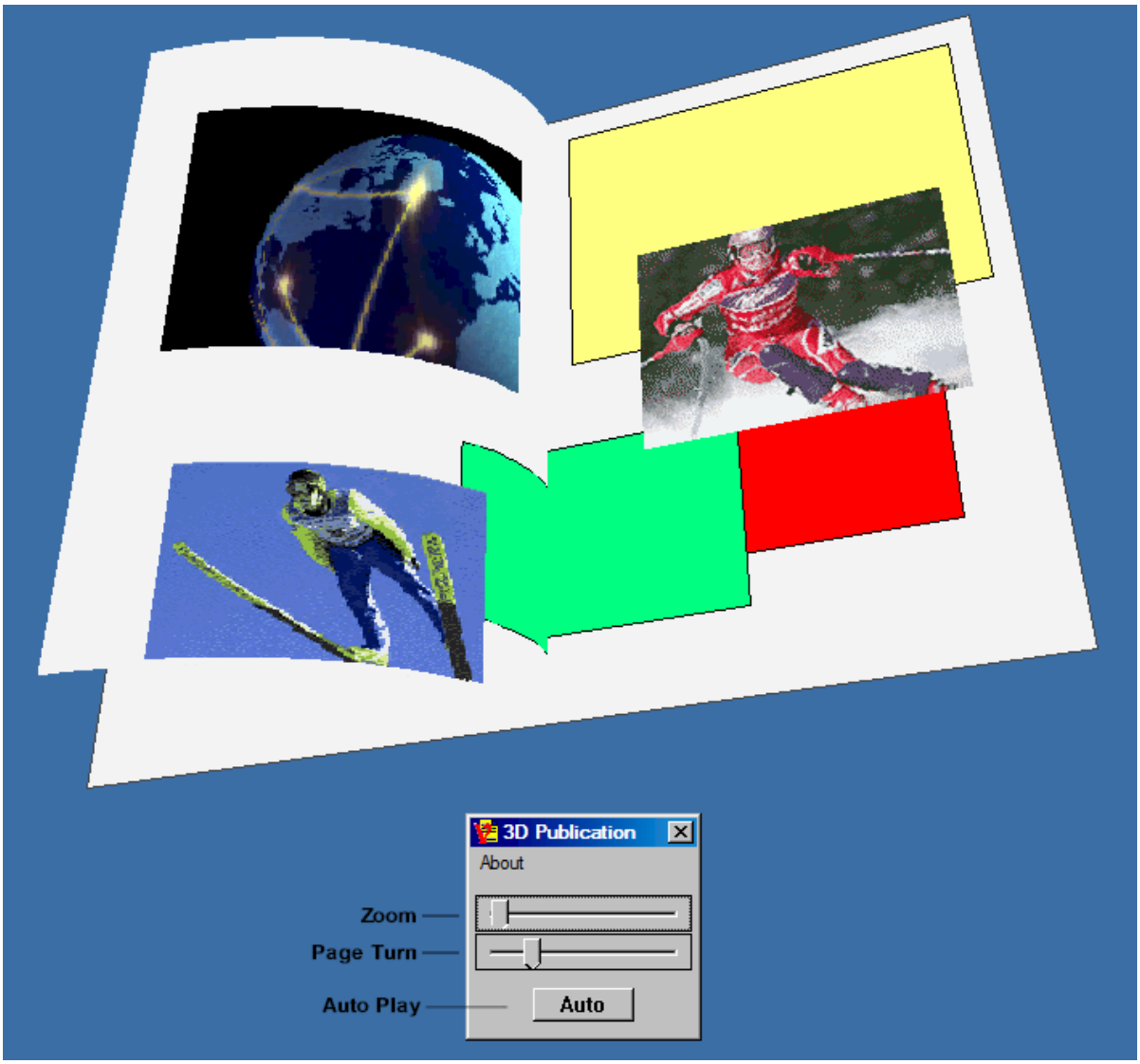
8. The 3D Publication Research Model

Download and run '3D Publication Model.exe'

http://www.internetpublisher.com/Models/3DPublicationModel.zip

This research model is built in 32 bit assembly language and runs on any Windows PC.

This research model demonstrates continuous updating of the display while the orientation and zoom of the page turning publication is changing in real time.



The model automatically changes its orientation and zooms in a continuous flow while the page is turning. The moving video (globe.avi) on the page demonstrates that it is being refreshed and re-laid out each time the operating systems calls for a display update. The animation can be stopped at any time by clicking 'Auto' at which time the page can be turned and the publication zoomed manually.

9. Existing 2D Publication Technologies

Download and run '[Standard Publication Model.exe](http://www.internetpublisher.com/Models/StandardPublicationModel.zip)'

http://www.internetpublisher.com/Models/StandardPublicationModel.zip

This application is built in 32 bit assembly language and runs on any Windows PC.

The Virtual Publishing Company currently has a 2D publication model for Windows in the market and has produced thousands of publications and brochures in this format. This technology already has the most realistic and advanced graphical page turn in use today for presenting publications in 2D on screen. It also has its own internal typesetter for outputting sharp scalable text with a precision 8 times higher than Windows

The 2D publication comes in 3 versions, a stand-alone exe file format, an ActiveX browser viewer and an installable publication reader that opens encrypted publication content files.

- **Scalable to Any Size and Screen Resolution**
- **Realistic, Sharp and Fluid Page Turn**
- **Internal Font Rendering and Smoothing**
- **Rich Text Formatting**
- **12 Foreign Language Character sets**
- **Written in 32 bit Assembly Language**
- **Duplicates Any Print Layout**

The Virtual Publishing Company has developed a number of associated technologies and tools linked to its publication models. These include:

PAGE LAYOUT EDITOR

OTHER TECHNOLOGIES

Page Markup Language and Interpreter

Stand-Alone Publication Compilers for exe and Encrypted Publication files.

Publication Reader for Encrypted Content Files

Online Browser Publication Reader for Internet Explorer

Editing Files Viewer

10. About The Inventor

After a 25 year senior management career in international magazine publishing where he specialized in new launch titles, Chris Hemmings took his programming hobby and spent 7 years researching electronic publishing, mathematics and low-level programming. He is a self-taught programmer and is expert at writing pure assembly language code for graphics as well as being proficient in Visual Basic.

He first started looking at page-turn concepts in the early nineties and has developed the most advanced fast-processing page-turn algorithms in use. He has also developed font rendering engines in assembly language for very fast text layout. All of The Virtual Publishing Company technologies and research were conceptualized, designed and written by him.

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