

2LIPGarden: 3D Hypermedia for Everyone

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ABSTRACT

The early Web was hailed for being easy to use, and what is more important, giving people a chance to participate in its growth. The Web3D was believed to have potential to be the next step in the Web's evolution, since it could benefit from graphics hardware and provide users with new and exciting experiences. Nevertheless, Virtual Reality Markup Language (VRML), the first Web3D standard, and its successor X3D, did not generate commercial success. These languages were excessively complex for average Internet users.

In this paper, we propose 2LIPGarden, a 3D Hypermedia publishing framework that lets individuals who only know basic HTML – those same enthusiasts who could write pages for the early Web – create simple, easy to use yet interactive 3D web pages. Our framework builds upon 2-Layer Interface Paradigm (2LIP), an attempt to marry advantages of 3D experience with the advantages of narrative structure of hypertext. We introduce c-link to HTML, a new type of hyperlink, which connects text with its 3D visualization.

Categories and Subject Descriptors

H.5.4 [Information Interfaces and Presentation]: Hypertext and Hypermedia. I.7.2 [Document and Text Processing]: Document Preparation – *Hypertext/Hypermedia*. H.5.2 [Information Interfaces and Presentation (HCI)]: User Interfaces – *graphical user interfaces (GUI), interaction styles*. I.3.7 [Computer Graphics] Three-Dimensional Graphics and Realism.

General Terms

Design, Human Factors.

Keywords

3D Hypermedia, Publish, 2LIP, Hyper-Storytelling, Copernicus

1. INTRODUCTION

Not so long ago, it was easy for enthusiastic but relatively unskilled individuals to make a mark on the Web by copying other web pages and inserting their own data. These small-time developers were crucial contributors to the early growth of the Web. In contrast, today's hopeful beginners must pick up a whole set of web technologies and tools before they can begin. The evolution of complex web sites has dramatically raised people's expectations of what web sites ought to offer.

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When it comes to the three-dimensional Web (Web3D) and online virtual realities, they can provide us with an opportunity to have experiences that would otherwise be impossible. We can interact and learn in three-dimensional environments that represent present or past cultural heritage monuments and museums along with its exhibits, or other interesting places that would be inaccessible or even not possible to visit for an average Internet user. Pushed by the fast increase in the performance of affordable graphics hardware, 3D computer games, especially Massively Multiplayer Online Role Playing Games (e.g., World of Warcraft) are popular as never before – computer-generated virtual worlds compete with real life and real people. Part of the information society starves for more entertainment on the Web [4].

Virtual Reality Markup Language (VRML), the first Web3D standard, and its successor X3D, allow users to create 3D web sites. At least in theory, because creating attractive 3D web applications is not simple and for average Internet users is usually unfeasible. It requires, among others, 3D modeling skills, understanding of trigonometry, and programming experience. These attributes are not as common as knowledge about HTML, CSS, JavaScript, PHP, or Flash.

1.1 Our Approach

In this article we describe 2LIPGarden, a 3D Hypermedia publishing framework designed to significantly lower the barrier for authoring 3D websites. It lowers the barrier by duplicating the key features that enabled the growth of the early Web:

- A “simple as possible” user interface. 3D navigation techniques, even simple ones, can be very difficult to understand in the context of the Internet hypertext environment. We have worked out a new way for designing interactive 3D web applications – 2-Layer Interface Paradigm (2LIP) [8], an attempt to marry advantages of 3D experience with the advantages of narrative structure of hypertext.
- No installation, configuration, or maintenance. Anyone could “join the Web” simply by putting an HTML file on a web server. Similarly with 2LIPGarden, people only need to put an HTML file on a standard web server and their audience immediately experiences that data through a rich browsing UI.

We direct our research at finding and evaluating new ways of incorporating 3D into the Web. The aim of this article is to briefly report our previous work and propose 2LIPGarden as a model for an easy to use 3D Hypermedia publishing framework.

2. OUR PREVIOUS WORK

In 1992, during the Conference on Hypertext and Hypermedia, Jay D. Bolter gave a keynote speech on Virtual Reality and the Future of Hypertext [2], where he described how the two can be combined into “a *hypertextualized virtual space*”. 2LIP is an attempt to create such space – the new generation of text.

2.1 2LIP

2-Layer Interface Paradigm [8] assumes that building graphical user interfaces involves the integration of two layers: (1) the background layer is a 3D scene; (2) the foreground layer, above the 3D view is the HTML content. Actions on the latter layer, e.g., pressing a hyperlink, or scrolling, can affect the 3D scene.



Figure 1. Two-layer architecture of a 2LIP page.

The hypertext information, together with graphics and interaction interface, is presented semi-transparently on the foreground layer. The background layer introduces the entertainment aspect to the information presented in the foreground. A user cannot directly interact with the 3D scene presented in this layer. However, it is possible to “browse” the scene following predefined paths (camera moves) invoked from the interaction interface on the foreground layer.

2LIP builds upon several well established techniques:

- Constraint 3D Navigation – it limits users’ freedom while travelling through a virtual world [5]. It constrains the audience’s movement to interesting and compelling places, and thus avoids the classic problem of users getting ‘lost-in-cyberspace’.
- Transparency – like Harrison and colleagues [7], we found that it can improve workspace visibility without harming interaction performance.
- The *Focus + Context* (F+C) information visualization technique [3] – 2LIP links textual information presented on the foreground with visual context displayed in the background of the interface.
- Animation - like Bederson et al. [1], we found that animation improves users’ ability to reconstruct the information space, with no penalty on task performance time.

The evaluation has shown that 2LIP is simple yet interactive 3D web interface that better supports human attention, has a positive effect on visual memory, improves spatial cognition of presented information, and increases overall user’s satisfaction [8].

2.2 Copernicus – 2LIP in Practice

In order to illustrate and evaluate the 2LIP model we have implemented the prototype system called Copernicus ([8] or see <http://copernicus.deri.ie>). It was designed to resemble Wikipedia. We decided to bring this most popular online encyclopedia into the third dimension – in addition to a classic wiki page, the background in our system is a three dimensional visualization of the place/object described in the article (see Figure 1).

As Wikipedia became successful because it was written collaboratively, we are also going to give potential users an

opportunity for collaboration. We work on a content editor (see Figure 4), conceptually similar to the one from MediaWiki. The process of creating new Copernicus page consist of (a) writing an article using a wiki markup language, (b) composing a 3D scene from objects used on other scenes (option for *wikimaniacs*) or uploading a 3D models or scenes (option for *3D geeks*), and (c) interesting places in the 3D scene may be selected and connected to the links in the text.

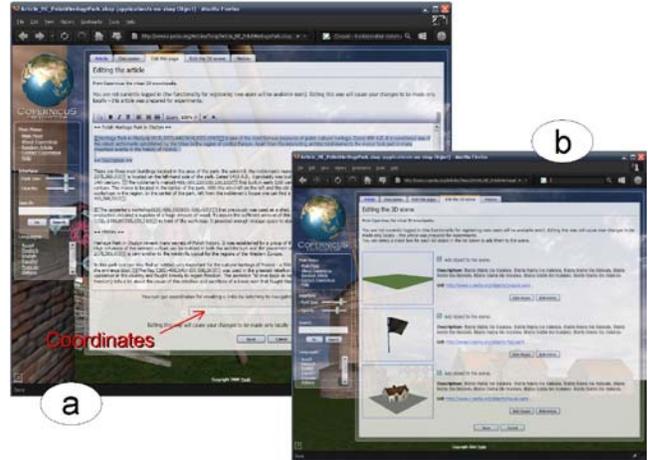


Figure 2. Authoring interfaces: (a) the text, (b) the 3D edit tab.

At the moment it is impossible to say whether Copernicus is going to draw some attention and bring together enough enthusiasts to create a new 3D online encyclopedia. However, if it is any successful, our database will store some scenes, which can be used in different applications on the Web. We came up with 2LIPGarden, an idea of how we can let individuals who know only basic HTML use our 3D content to create interactive 3D Hypermedia for the Web.

3. 2LIPGARDEN

The Web3D Consortium was formed to provide a forum for the creation of open standards for Web3D specifications, and to accelerate the worldwide demand for products based on these standards [10]. The consortium offers a great source of information and resources for researchers and professionals interested in developing three-dimensional web applications. However, it fails in attracting attention of average Internet users. Their flagship standard, X3D, is just too complex, comparing to HTML, CSS or PHP.

2LIPGarden (see <http://2LIPGarden.deri.ie>) is a 3D Hypermedia publishing framework designed to significantly lower the barrier for authoring three-dimensional websites. We envision people using predefined 3D backgrounds (e.g., from Copernicus). Instead of writing the line:

```
<body background="/images/image_name.jpg">
```

they would be able to simply choose 3D scene from the list (e.g., an idyllic view on nature) and add it to their web pages as a second layer.

3.1 Interface Design

As 2LIPGarden is a publishing framework, it has two interfaces: one facing every user of the published information and one facing the author. A web page that implements 2LIP will be referred to as a *2lip* in lowercase hereafter.

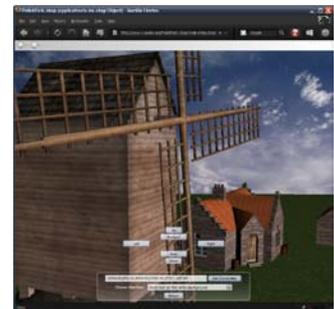
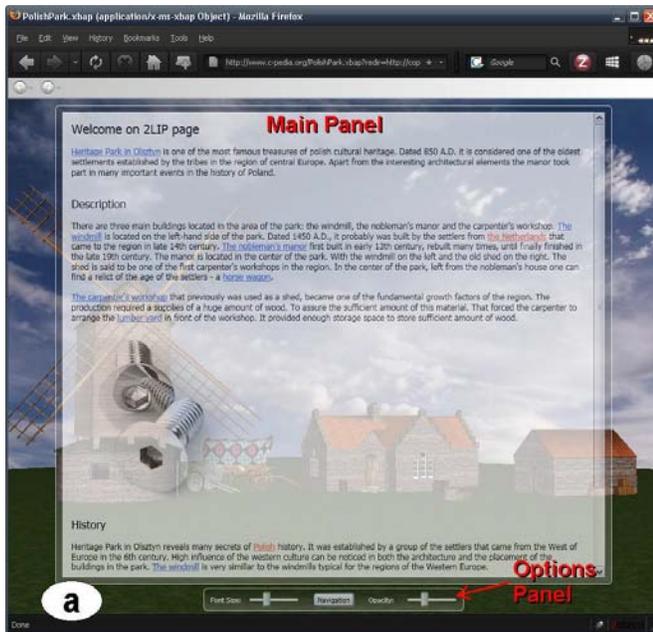


Figure 3. 2lips' examples: (a) Polish Heritage Park – black text on white background, (b) the same 2lip displayed on a computer without .Net Framework 3.0 installed, (c) the same 2lip – the free navigation mode, (d) Mustang Fighter – white text on transparent background, (e) the same 2lip displayed on a computer without .NET 3.0 installed.

3.1.1 User Interface

We have decided to use Windows Presentation Foundation (WPF) to build Copernicus and our new publishing framework (see Section 3.2. Architecture). All applications created in WPF need Microsoft .NET Framework 3.0 (.NET 3.0) or later to work. As this framework is not installed on all computers connected to Internet, we had to create a method that would allow all users to browse web sites developed based on 2LIPGarden.

The method is simple: if a user does not have .NET 3.0, he or she experiences a 2lip just like any other web pages (see Figure 3b and 3e). Otherwise the user is presented with the web page augmented by a 3D background – similarly to the articles stored in Copernicus (see Figure 6 for the architecture overview). Figures 3a and 3d show two 2lips styled slightly differently, but there are several common elements, as described below.

2lip's main user interface consists of two panels: the main panel and the options panel, whose locations on the page are fixed at the moment (in future they will be controlled by the author). The main panel displays HTML content and is positioned above the options panel (see Figure 3a). There is also the free navigation mode available, which is accessible from the options panel (see Figure 3c).

The Main Panel

At the moment, the information presented on the main panel consists of hypertext and images. Like in Copernicus (see section 2.2), while interacting with content on this panel, a user can be presented with details from the 3D scene; clicking on the blue hyperlinks (there are two kinds of links in the articles: the blue links (c-links) to the places on the 3D scene and the red links to the other, external web resources), e.g., related to interesting places triggers a predefined camera movement. For example: a user reading an article about Polish Heritage Park in Olstzyn (see Figure 3a) might be interested in taking a closer look at a flag used during the great rebellion. Clicking the "flag" link triggers

the animation. The camera will smoothly move over the 3D scene following the predefined motion path; it will stop behind the workshop showing the historical artifact.

The Options Panel

In the options panel users can change the font size and the transparency level of the presented text using a set of sliders; they can make their reading experience more convenient by adjusting these parameters. They can also switch to the free navigation mode at any time.

The Free Navigation Mode

Some people (e.g., video game generation) like direct interaction in 3D environments; others can be interested in taking closer look at elements included to the 3D scene that cannot be reached via c-links. The free navigation mode (see Figure 4c) supports 3D interactions such as zoom, rotate, etc. While being in this mode, users can also change the type of rendering of text – the options provided at the moment are: black text on white background (see Figure 3a), white text on black background, and white or black text on transparent background (see Figure 3d).

The reader is encouraged to visit <http://2LIPGarden.deri.ie> to try out several live 2lips. Images and videos that illustrate the research presented in this paper are available there as well.

3.1.2 Author Interface

Making a 2lip involves three tasks: choosing the background from Copernicus, authoring the content and creating the c-links (interesting places in the 3D scene may be selected and connected to the links in the text).

Choosing the Background

The first step is quite easy. Author has to just choose the scene from the list of all 3D scenes developed for Copernicus. The scene will be used as the 3D background for the new 2lip.

```

<html xmlns="http://www.w3.org/1999/xhtml" >
<head>
  <title>Demo of 2LIP</title>
  <script type="text/javascript">
    var BackGround;
    BackGround = "PolishPark";
    if (window.navigator.userAgent.indexOf(
      ".NET CLR 3.0") != -1)
    {
      window.location.replace(
        http://www.c-pedia.org/
        + BackGround + ".xbap?redir=" + window.location);
    }
  </script>
</head>
</body>
</html>

```

Figure 4. Initial HTML code needed to start making a 2lip.

Authoring the Content

The web page itself is just a regular HTML file that can be created locally, iterated locally until satisfactory, and then, if desired, saved on a web server. Figure 4 shows the initial HTML code needed to start making a 2lip. The JavaScript code in grey checks if there is .NET 3.0 installed on the client's machine. If it is, the user is redirected to the new address:

<http://www.c-pedia.org/BackGround.xbap?redir=location>

where: <http://www.c-pedia.org> – the address of Copernicus Encyclopedia, [BackGround.xbap](#) – the background chosen by the author from 2LIPGarden, [location](#) – the original address of the web page.

Authors do not even need to write this initial HTML code from scratch: they can simply copy code from our online tutorial. This is how web pages (and not only web pages) are often made – copying existing code, removing unwanted parts, and

incrementally improving.

The straightforward syntax of HTML and its quick edit/test cycle make HTML authoring easy. We designed 2LIPGarden to afford the same behavior. Figure 5 shows the final HTML code needed to render the 2lip in Figure 3a. The code in green defines Cascading Style Sheets (CSS) and is used to describe the presentation of the web page. Such an approach enables the separation of document content from document presentation.

Creating the C-Links

Once the author has chosen the 3D scene and has created the content for the page, the interesting places/camera positions in the 3D scene may be selected and connected to the links in the text. To create such c-link the author has to switch to the free navigation mode, position the camera, and click the “get coordinates” button. As a result, the coordinates appear in the textbox beside the button (see Figure 3c); the author can use them to create the c-link:

`c-link name`

where: (x1,y1,z1) – the position of the camera, (x2,y2,z2) – the viewpoint, t – time of the camera movement. This notion is very similar to the notion of a standard link in HTML markup; therefore, we hope that creative internet users will have no problem with using our approach. On Figure 5 c-links are marked in blue, while traditional links in red.

This step is not obligatory for creating 2lips. We can imagine people using 2LIPGarden just to have 3D animating backgrounds on their web sites. On the other hand, advanced authors interested in creating new 3D backgrounds will be able to compose 3D scenes in Copernicus, which will be then available in 2LIPGarden.

```

<html xmlns="http://www.w3.org/1999/xhtml" >
<head>
  <title>Demo of 2LIP</title>
  <script type="text/javascript">
    var BackGround;
    BackGround = "PolishPark";
    if (window.navigator.userAgent.indexOf(".NET CLR 3.0") != -1)
      window.location.replace("http://www.c-pedia.org/"+BackGround+
        ".xbap?redir="+window.location);
  </script>
  <style type="text/css">
    a:link { color: #4169e1; }
    a:visited { color: #000000; }
    #Inner { width: 800px; margin: 0px auto; padding-bottom: 10px; }
    p { text-align: justify; font-size: 14px; line-height: 14px; margin: 0px 0px 14px 0px;}
    h1,h2 { margin:3; padding:0; font-weight: normal; font-size: 20px;}
  </style>
</head>
<body>
  <div id="Inner">
    <h1>Welcome on 2LIP page</h1>
    <p><a coordinates="-3615,-3023,440|3614,3023,424|3">Heritage Park in Olsztyn</a> is one of the most famous
    treasures of polish cultural heritage. Dated 850 A.D. it is considered one of the oldest settlements established by
    the tribes in the region of central Europe. Apart from the interesting architectural elements the manor took part in
    many important events in the history of Poland.</p>

    <h2>Description</h2>
    <p>There are three main buildings located in the area of the park: the windmill, the nobleman's manor and the
    carpenter's workshop. <a coordinates="-2358,853,1000|2075,300,0|3">The windmill</a> is located on the left-hand side
    of the park. Dated 1450 A.D., it probably was built by the settlers from <a href="http://en.wikipedia.org/wiki/
    /Netherlands">the Netherlands</a> that came to the region in late 14th century... </p>
    

    <h2>History</h2>
    <p>...</p>
    <h2>External Links:</h2>
    <a href="http://copernicus.deri.ie">Copernicus homepage</a>
  </div>
</body>
</html>

```

Figure 5. The final HTML code needed to render the 2lip in Figure 3a.

3.2 Architecture and Implementation

One of the components of .NET 3.0 is the Windows Presentation Foundation (WPF); it uses Extensible Application Markup Language (XAML) as the user interface markup language. XAML allows defining UI elements, 2D and 3D objects, animations, data binding, and events. It is also the one of the first technologies that can take advantage of the Graphical Processing Unit. XAML features allow to easily deliver solutions that can combine 2D and 3D objects; in our case 3D scene and structured text. We have decided to use XAML to prototype Copernicus and 2LIPGarden, our 3D Hypermedia publishing framework.

The only shortcoming of using WPF is that the web pages can only be rendered using Internet Explorer (it needs .NET 3.0) or Firefox (it needs .NET 3.5) on Windows. We hope, however, that either WPF will be adapted by other web browsers, or other similar solutions will be delivered, or both.

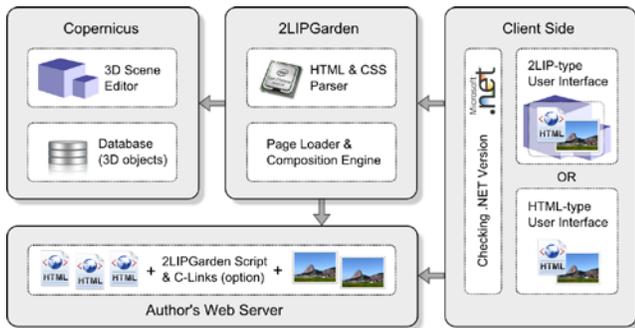


Figure 6. 2LIPGarden software architecture.

This limitation strongly affects 2LIPGarden software architecture, which is presented on Figure 6. Users without proper .NET version are presented with a conventional HTML web page.

3.3 Hyper-Storytelling

While articles in Copernicus should be reliable and specific (like in Wikipedia or any other encyclopedia), their 3D backgrounds can be useful for less serious applications. The one we find very interesting is Hyper-Storytelling (a great survey of the state of the art can be found in [6]). We can imagine for example the Notre Dame de Paris visualization used for telling Hugo's story of a poor Esmeralda and a bell-ringer – Quasimodo, where children can actually learn about French Romanticism and Gothic Architecture at the same time.

4. RELATED WORK

VRML reached the summit of its popularity in 1997, when it was used to build some personal homepages and sites. Nevertheless, this early web standard did not succeed. VRML's potential remained the same while the development of real-time 3D graphics expanded dramatically. The language was excessively complex; the graphics and the interaction model it generated were not attractive for average Internet users.

X3D, developed by the Web3D Consortium, is the successor to VRML. It supports two approaches for interaction with external environments, namely SAI (Scene Authoring Interface) and older, defined by the VRML standard, EAI (External Authoring Interface) [10]. SAI forms a common interface that can be used

for manipulating the scene graph from either an external application or from inside the scene graph. For example, it can be employed to control/manipulate embedded in HTML VRML/X3D scenes via JavaScript.

We want to make using 2LIPGarden simpler. Synchronized Multimedia Integration Language (SMIL) [9] allows an author to define 2D zoom animations just by writing one line of code:

```
<ref src="image.jpg" panZoom="x1,y1,x2,y2" dur="5s" region="l" />
```

The definition of a c-link is a natural extension to the above notation that allows 3D zoom animations.

5. CONCLUSIONS AND FUTURE WORK

The Web as it stands today is an incredible success, which can be attributed to its simple architecture and an easily understandable document format. In this paper, we proposed 2LIPGarden, a 3D Hypermedia publishing framework that lets individuals who know only basic HTML – those same enthusiasts who could write pages for the early Web – create simple, easy to use yet interactive 3D web pages. Our framework builds upon 2LIP, an attempt to marry advantages of 3D experience with the advantages of narrative structure of hypertext.

2LIPGarden is still work in progress: we are currently extending the HTML & CSS parser component, which currently works properly only with simple documents (the work on this parser can be compared to the development of a web browser). Nevertheless, even on this stage, users' opinions on 2LIPGarden are very promising.

6. ACKNOWLEDGMENTS

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