WEB TECHNOLOGIES ON THE MOVE
Enhanced dynamicity for web applications

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ABSTRACT
Business, commerce, marketing, education, research, science, any form of divulgation of information and communication...the way forward in today's world is only across the World Wide Web. It has taken the world by storm and revolutionised the way people access information as well as the way society interacts, communicates and functions. In this respect, web developers are continuously looking at ways of optimising individual users' experience emphasising on efficiency, effectiveness and performance of the applications and services being made use of; hence the emergence of new technologies such as AJAX.
Dynamicity, interactivity, fluidity and flexibility are among the key words featuring in this paper which will explore some of the benefits as well as limitations of using this emerging technology for a number of applications running over the web. It will also discuss the possible application of AJAX for educational services to higher education students in the area of plagiarism prevention by enhancing the application's usability and interactivity over the web.

GENERAL TERMS
Performance, Design, Human Factors

KEY WORDS
World Wide Web Technology, Interactivity, Dynamicity, Flexibility, Plagiarism Prevention

1. INTRODUCTION
There seems to be an ever increasing need across a number of Universities worldwide, for plagiarism to be not only identified and detected but also to be prevented. Various universities are making use of plagiarism detection software to detect plagiarism in students work. Many of these universities are also taking a stand in trying to prevent the plagiarism of academic work amongst students. This is being done through a series of educational programmes such as dissemination of information, specialised courses and even online resources. The use of a number of easily accessible online resources to students can aid the further education and the ensuing prevention of plagiarism. At this point in time only a limited number of departments are actually taking an active stand in the prevention of plagiarism and most frequently there is a lack of consistency in the approach which students are advised to take. Making use of a technology which offers more flexibility, more interactivity and more dynamicity to the students will not only ensure that all students across University will have access to plagiarism prevention tools but it will also ensure more consistency in the use of these tools.
Moreover, such an application will introduce more flexibility to the students' needs and requirements by offering and ensuring faster and easier access to educational sites and information related to plagiarism prevention.
This paper will discuss a definition of plagiarism and what various educational institutions are doing in terms of educating for plagiarism and ways of disseminating information for its prevention using the Web as a resource. It will moreover discuss how a new technology for the Web is evolving, developed in view of the need for enhanced user interactivity. This technology which has been termed AJAX, will be reviewed and explored in terms of the way it works, its benefits and limitations. This paper will also discuss the ways in which plagiarism prevention through dissemination of information and the AJAX web technology can be merged in order to come up with an innovative enriched application which will not only act as a means of presenting static information but as a means of offering the users a quality experience through enhanced interaction.

2. HOW IS PLAGIARISM DEFINED?
According to the London Southbank University Library Services [21], plagiarism is defined as the "passing of an individual's work as one's own". This also includes exploiting ideas and/or thoughts without having obtained permission from the original author or originator of ideas or without having referenced the source accordingly. However plagiarism is given many definitions and the extent of plagiarism may indeed appear fuzzy and subject to many interpretations.
What all academics agree with however, is that the solution to plagiarism lies in the use of correct referencing or citing. It is true that the reasons why one chooses to plagiarise may be different and varied, as is also true that students do not often choose to plagiarise consciously. Most often plagiarism occurs due to insufficient knowledge and information about how one should reference, how to present findings, how to paraphrase and what's acceptable and unacceptable within the parameters of research ethics. Many universities have decided to tackle this problem directly from its roots and make such information publicly available through the Internet and the World Wide Web.

2.1 What online access is there to plagiarism prevention resources?

One can find a number of online tools and applications dedicated solely towards disseminating information regarding plagiarism; how to avoid it and how to best present one's findings within the dimensions of academic research. Such resources include online writing labs, as well as a variety of papers and guidelines helping students document their work in the correct manner. Making all of these tools readily and easily accessible for students at the University of Malta is giving them the right not to plagiarise. Offering the students the opportunity to handle this information interactively and dynamically in context, will enhance their educational experience as World Wide Web Users. Examples of online resources include PLATO which is a Plagiarism Teaching Online Resource[1], Glatt Plagiarism Screening Program[2], as well as online resource sites such as Leeds University[3], Association of College and Research Libraries[4], Northwestern University[5], Joint Advisory Systems Committee[6], the London SouthBank University[7] as well as University of Cambridge[8] amongst many others.

3. WHAT IS THE NEW WEB TECHNOLOGY PROPOSED?

New web technologies are being designed to provide the users with rich Internet applications which emulate the same environment as having desktop-running applications. Garrett (2005) [9] rightly admits that

> "Desktop applications have a richness and responsiveness that has seemed out of reach on the Web. The same simplicity that enabled the Web's rapid proliferation also creates a gap between the experiences we [web interaction designers] can provide and the experiences users can get from a desktop application"

Such a gap, as the same article suggests is being narrowed down and nowadays the user is being offered more interactivity and dynamicity when it comes to Web applications. One such application which makes use of a number of technologies designed with the sole aim of enhancing the user experience is AJAX. AJAX which stands for Asynchronous Javascript And XML is defined [25] as a "web development technique for creating interactive web applications".

Kiely [13], in his white paper for Telerik, 'Enabling AJAX in ASP.NET with No Code' describes Ajax as providing:

> "a design pattern for elements in a Web page to communicate with a Web server without requiring that the entire page be rebuilt from scratch if only a small part of the page has to change in response to user action".

The implication of this is based simply on the technology's ability to act and interact with the web server asynchronously. This means that the page encompassing all the objects, does not need to be refreshed every instance the user makes a request.

3.1 HOW DOES THIS NEW WEB TECHNOLOGY WORK?

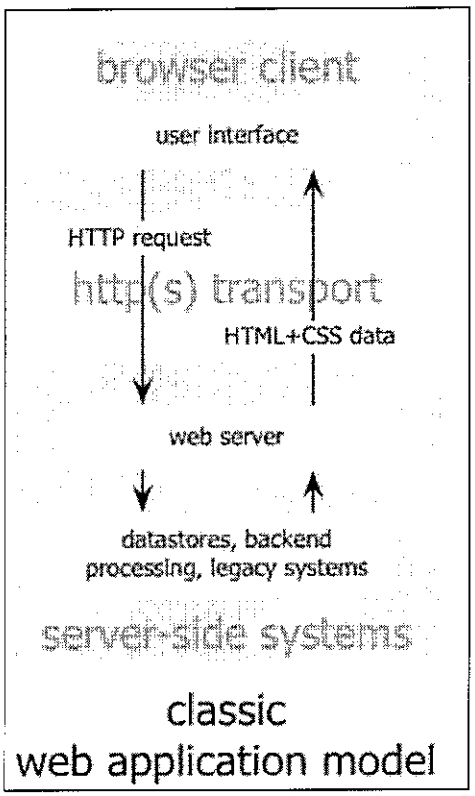

Figure 1 A classic web interaction model; adapted from Garrett (2005) [9]

In the normal web application model, the user makes an HTTP request through the interface of his/her browser client which is received by the web server and processed. Once the data request has been processed the response is sent once again to the Web browser client through the web server. This will infer that there will be a wait time during which the page is reloaded and the newly processed request is displayed.

The second model below shows the way AJAX works and how asynchronicity is achieved through its model architecture.

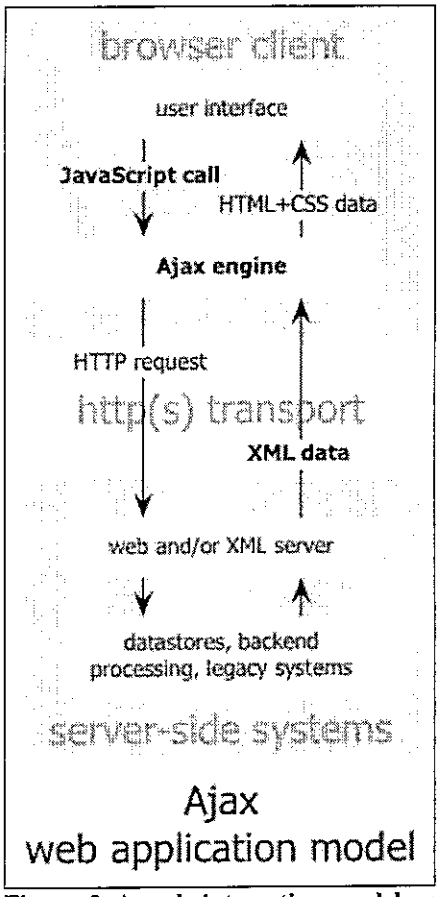

Figure 2 A web interaction model using the AJAX engine; adapted from Garrett (2005) [9]

The web interaction model shown above displays the browser client interface which will place a JavaScript call to the Ajax engine. This then makes the HTTP request on behalf of the client to the web server. Therefore while the user is viewing the HTML page sent by the AJAX engine, the engine itself is working 'behind the scenes' in order to request data and information from the server continuously. What happens is that when the client requests specific information or places a query to the server, AJAX is able to carry out that request on the fly.

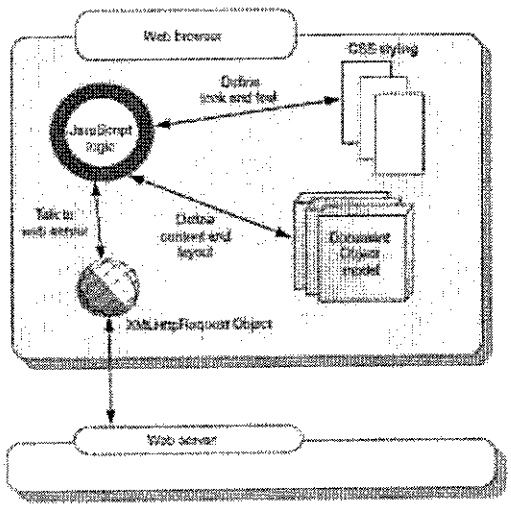

Figure 3 How Ajax works [8]

Figure 3 shows how the AJAX engine acts as an intermediary between the web browser and the web server. Forestier (2006) shows how it makes use of a number of key elements [8] which define the fluidity of the concept behind AJAX. These elements include:

- CSS which defines the style of the page displayed by the web browser,
- Document Object Model which defines content and layout thus allowing the application to model the user interface in real time
- XMLHTTPRequest Object, which allows for background data retrieval from the web server in an asynchronous manner

Garrett (2005) [8] also incorporates XML and XSLT, as languages capable of manipulating data in a format which dissects the information content from the layout so that objects are described in real world terms (Kay, 2005) [12].
Therefore all the three elements mentioned above will interact directly with the JavaScript logic which is the main scripting language used for AJAX. All the elements will converge to make way for a design setting where behaviour becomes detached from the content. This is achieved by having the content strictly adhering to mark-up languages and extensible language transformations, while the behaviour becomes a direct derivative from JavaScript. The flexibility of AJAX comes in when designing object behaviour. The ability of specifying elements or classes as JavaScript triggering factors, means that the mark-up applied will transform the web application into a package with a more meaningful and semantic nature.
The document object model will then re-integrate the content with the behaviour in a manner which is fluid and which provides for a rich user interface within the application itself.

3.2 What are the limitations of AJAX?

AJAX is still in its infancy stage. As a result of this, there are a number of issues which do create some limitations when using the application.
Kiely (n.d.) [13] lists a number of these limitations:

- AJAX may require the use of advanced JavaScript coding in order to customise the functions for increased interactivity. The complicated client side code may contribute towards lack of maintenance on the same code.
- The fact that AJAX will only refresh certain parts of a page may cause a complication in the page lifecycle leading to a break up in the application.
- Another break up in the application may occur due to the fact that not all form data is sent as part of the request to the server, making it unable to process the whole packet of data which may sometimes result in an incomplete or wrong response.
- ASP.NET pages with AJAX may give a "corrupted view state" due to the fact that it is not automatically transmitted through AJAX.
- AJAX needs an amount of development in JavaScript, XMLHTTPRequest, DML and the DOM. Therefore developers wishing to implement this technology would need to be conversant with these languages.

There are also other factors which have to be considered when using AJAX for rich Internet applications. Maurer (2006) [17] discusses how the quality of the richness in Internet applications may pose a challenge to designers. Richness according to Maurer should only be added where usability is improved. The fact that users identify the controls and the interactive page elements, she argues, is an important factor to consider. One cannot be caught up in too much enthusiasm and add too much richness and interactivity where users still have to get

accustomed to using such an application. AJAX will not only affect how the application is viewed. It will also affect the application's usability in such a way that transparency and guidance in navigation become imperative.
As Garrett (2005) [9] rightly concludes in his article, one of the biggest challenges in AJAX can hardly be called of a technical nature since most of the technologies used are already quite stable and have been used over and over again in various applications. The biggest challenge lies mostly in adapting what is already known to suit the users' needs and enhance their experience when navigating the web.

3.3 So what benefits are there in using AJAX?

The technologies behind AJAX make it such that flexibility in web design is improved while concurrently dynamicity from the user's perspective is richly enhanced. This is the argument which McLellan (2005) [18] presents in his article 'Very Dynamic Web Interfaces'. In his example, a user tries to input a serial number into a web application. This would need to be submitted to the server for validation, and every time there is a failure in the input, thus resulting in a failure to validate, the whole page would have to be reloaded. AJAX provides the user with the advantage of having fast interface reactions especially when the business logic belongs mostly at the backend of the server.
The benefits of AJAX can in fact be summarised in two points [2]:

- Interactivity; AJAX can be used to perform a number of activities which the user is accustomed to handling from desktop applications. Schiefelbein [23] in a review of the BackBase AJAX framework[9], mentions a variety of rich Internet applications ranging from web page controls and information handling and presenting as well as data manipulation and user interactions.
- Bandwidth Utilisation; AJAX will only download the data which has been requested rather than the full page objects and elements such as tables. This means that pages appear to load much more quickly using AJAX and the user won't have to wait until the page refreshes every time he/she requests data. This will reduce server traffic and decrease the bandwidth usage...hence churning out a seamless, fluid web page display.

Education and training also play an important role within business and industry. White [26] argues that although business and industry will indeed exploit the potential benefits of such a technology in order to cut down significantly on costs, a number of these benefits are hard to quantify. Benefits like,

- improved user responsiveness,
- a significant reduction in the number of steps to complete a task and
- a familiar user interface with the same interactivity levels as that of a desktop application, are not easily measurable.

Yet these come in as very important goals which are not to be underestimated when it comes to handling web applications as part of the users' daily experiences. Having users handling online training material and resources as well as other applications needed in their everyday jobs with a degree of ease does play a major role in the profit making ability of any company.
An additional benefit suggested by Wayner (2005) [25] in his article, 'AJAX breathes new Life into Web Apps', is the software distribution itself. AJAX, unlike many other applications, loads directly into the clients' browser without needing additional installation of other applications. This in itself may contribute to having such a technology being welcomed and accepted effortlessly by the users. Describing another benefit of this technology Wayner (2005) [25] supports Garrett when describing the server traffic reduction referring to:

> "Well-designed code that is truly asynchronous also gives the server more time to respond to queries, reducing this load even further by spreading out peak demands. It even increases security by encrypting data on the client side, before it travels across the network"

An article on E-week Microsoft Watch (2005) [6] explores the virtues of smart clients versus the more favourable AJAX. AJAX is described as being platform independent and will co-exist with 'Macromedia Flash[10]', in addition to which it will also exhibit the 'smart' features relevant to the user.
Garrett (2005) [10] comments that:

> "The rise of Ajax represents the new and widening recognition that the days of "Yes, if..." are numbered. It's analogous to the realization we had a couple of years ago, when it became apparent that maturing browser support for CSS and XHTML would finally allow designers the flexibility and ease of maintenance the Web had always promised but never quite delivered. In both cases, the technologies aren't new; what's new is our ability to make the most of them on the broadest possible scale".

Applications widely known to make use of AJAX include Google Maps[11], Google Suggest[12], Google GMail[13], Google Spreadsheets[14], Amazon A9[15] and Writely[16].

4. MERGING EDUCATION WITH A NEW WEB TECHNOLOGY

So the question is: *how to go about merging the educational factor inter-meshed within the dissemination of information as illustrated in the plagiarism prevention model with an innovative Web Technology?*
In addition to that one might also ask whether such a technology is truly needed within the 'educational context'.
The new web technology AJAX proposes a richness in the application which leads to enhanced interactivity. Interactivity does not make sense as a word on its own and without a broader purpose. Were it just for the simple dissemination of information where static pages don't make a real difference to the user the classic web interface model would come in quite handy. However one of the main scopes of plagiarism prevention is to educate. Computer assisted learning, virtual or online learning as well as e-learning though varying on some grounds, do share one common perspective; the student needs to be involved in his/her own learning process which is only achieved through the increased activity and interactivity with the application, program or machine. As Papert (n.d.) [20] describes, reproducing a traditional classroom environment virtually is at times not enough. Students of all ages, need to be involved actively in a dynamically enhanced environment. When discussing online learning environments one cannot help but discuss the nature of the Internet. As Downes (2005) [5] states in his article 'E-Learning 2.0' the nature of the Internet is changing and so is the nature of the "Internet users". In his own terms:

> "They [Internet users] absorb information quickly, in images and video as well as text, from multiple sources simultaneously. They operate at "twitch speed," expecting instant responses and feedback."

This new generation of Internet users expects instant feedback, interactivity, dynamicity. These Internet users expect to participate in the build-up of their own knowledge because subconsciously technology is leading them up that route. Such

an attitude can rightly be categorised under the student-centred domain which as Marzano (1992) [16] describes is built around five dimensions of learning, ranging from a "change in the attitudes and perceptions" to the "habits of the mind". O'Neill and McMahon [19] move one step further and describe such student-centred learning as being characterised by a breakdown of the roles between student and teacher in such a way that the teacher becomes someone who offers guidance to students in directing them to achieve their own learning. Taking up on this factor, Downes (2005) [5] has suggested ways in which the Internet can offer such guidance and how the way its users adopt it can be further exploited. He explains that in such a model;

> "Passive has become active. Disinterested has become engaged. The new Internet user may not vote, but that is only because the vote is irrelevant when you govern yourself."

And the way seems to have become paved for the future of the Web and with it, accompanying technologies like AJAX. There are those [11] who say that AJAX is the new Web 2.0, others say that it's all about new Web Services rendered to users. Sir Tim Berners Lee's vision of the Web (Lydon, 2005) [15] is more about attitude rather than just technology, that is the idea of making use of the web to communicate, to collaborate and to share common information and knowledge. This creates not only "communities of practice" but also common platforms where learning is built gradually through content creation. As Downes (2005) [5] points out:

> "The e-learning application, therefore, begins to look very much like a blogging tool. It represents one node in a web of content, connected to other nodes and content creation services used by other students. It becomes, not an institutional or corporate application, but a personal learning center, where content is reused and remixed according to the student's own needs and interests. It becomes, indeed, not a single application, but a collection of interoperating applications—an environment rather than a system."

AJAX has the potential of becoming exactly that and more. It has the ability to offer the dynamicity and the environment which the students can use to construct the content they need for their own learning. Adkins (2003) [1] in his white paper 'Introduction to Workflow Learning' goes to show how assembly of web services is integrated into a workflow in a "contextual collaboration" between the users and the application itself. This workflow ability stems from complex and dynamic integrations which brings about a change in the "learning technology" leading to education. As he describes,

> "The radical change is the inescapable migration away from the emphasis on learning objects that are "taken" or "accessed" to learning services that are experienced as events in the real-time workflow".

4.1 Bringing together AJAX and the Plagiarism Prevention program: a proposal

This paper proposes a concept...an idea which focuses on how to educate students at their tertiary level of education, on how to prevent plagiarism. This concept plans to make use of AJAX as a technology rather than as a tool to enhance learning via the Web by increasing the dynamicity and the interactive stimulation users are demanding from the World Wide Web.

The main focus of the application for which this proposal is intended, is to integrate AJAX into the design part of the Website [14] so that "the user structured information is used to control and structure the content", which content then appears on the Web page displayed.

A form of informal learning is thus being proposed through the utilisation of space on the Web. This space anticipates that the user would be able to actually build his/her own personalised display containing diverse features and sources of information related to plagiarism and its prevention, as well as a number of collaborative tools in an array of "interaction styles" [22]. Moreover these styles can be of various forms such as use of e-mail or that of using the FOAF[17] (Friend Of A Friend) approach in an attempt to access secure and be part of trustworthy social networks [7]. Other interaction styles can indicate the simple access of online documents or other information material as well as Blogs or the sharing of knowledge through collaboration as per the social constructivist theories [3]. Such theories base their arguments on the premise that knowledge is constructed through the learner's social environment and through the interaction with one's own peers. Dalgarno (1996) [4] proposes a model for computer assisted learning (CAL) built around constructivist strategies and techniques. This model distinguishes itself from the traditional behaviourist approach utilised for CAL, supported by a set of programmed tutorials with end-of-section tests generating a result indicating the learner's presumed knowledge acquisition. Dalgarno also mentions three levels of constructivist theories for CAL. The first type is classified as an 'Endogenous' constructivism. This stresses on the importance of learning by discovery. He proposes the use of "hypertext and hypermedia", "simulations and microworlds" as well as "support tools" to attain cognition at this level. 'Exogenous' constructivism makes use of "tutorials with learner control and guided hypermedia", "cognitive tools" and "practice modules". These resources aim to give learners a degree of control over the way they handle their own learning processes. The last type of constructivist technique which Dalgano proposes is the 'Dialectic' approach, built around the perspective that learning most often occurs through social interaction and communication. The strategies he proposes include the use of tools which allow for synchronous and asynchronous communication to take place.

Forums, chats, news servers and Wikis are all elements which not only can be said to aid this form of constructivist approach but they also form an integral part of the virtual learning environment. Such an environment attempts to construct the 'space' where the students will not only be able to personalise the information displayed but also to contribute, collaborate and communicate their ideas with other users.

The difference between traditional static web pages and the innovative AJAX webpage can be seen at a basic user level (Sherratt, R. & Jeyes, S.) [24]. Whereas in an online mapping example one must click on the direction pointing arrow to have the page refresh painstakingly slowly in order to display the requested area, with AJAX (such as can be seen for Google maps) one drags the cursor field to the requested area and watches while scrolling is done in an efficient and effective manner.

Taking another case example illustrating the added interactivity, in an online forum most often the user places a new thread and waits for the page to refresh once the submit button would have been selected. In addition the user would have to refresh the page every so often, to check for new additions to the thread. AJAX simply does away with the wait time involved. One enters the text in the thread and then waits to be alerted automatically every time a new addition is submitted. This works in a similar manner to GMail.

Google Suggest on the other hand makes use of another useful feature of the AJAX technology by giving the user an enhanced online searching service. Whenever a user starts typing the first

letters in a word, he/she sees the possible matches to that word. In addition, once typing has been completed and the search entered, the user is offered the possibility of viewing the meaning of the word or term definitions.

Various frameworks both at a commercial and an open source level are available for developers with varying degrees of proficiency in programming and developing languages. Amongst these one can find commercial products such as Backbase[18], and R.A.D. AJAX[19] from Telerik.

ASP.NET AJAX[20] from Microsoft, Google Web Toolkit[21], Rico[22] 'Javascript for Rich Internet Applications', SAJAX[23] 'the simple AJAX toolkit' as well as Ruby on Rails[24] are amongst the many examples of open source AJAX frameworks readily available to be used by developers to construct interactive web applications.

Web technology is indeed moving, and it is moving towards the initial vision which Tim Berners Lee (Lydon, 2005) [15] had projected...that of a web whose aim is to act as the *liaison* enabling users to communicate their knowledge and collaborate with other users in an attempt to build a web of information and understanding based on the expertise of humans at the human level. The use of new and continuously improved technologies is yet another attempt to bring humanity together in this intricately woven web. Making use of these technologies to enhance the education of a fragment of humanity means contributing towards adding another weave in the web, another step forward in the way society is evolving across the world.

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Web Links

[1] Innovation for learning - http://www.i4learn.co.uk/edu_HEproducts.html
[2] Glatt Plagiarism Screening Program - http://www.plagiarism.com/
[3] Leeds University - http://www.lts.leeds.ac.uk/plagiarism/
[4] ACRL - http://www.lts.leeds.ac.uk/plagiarism/
[5] Northwestern University - http://www.northwestern.edu/uacc/plagiar.html
[6] JISC Plagiarism Advisory Service http://www.jisc.ac.uk/whatwedo/programmes/programme_cmin frastructure/proj_surpas.aspx
[7] London Southbank University http://www.lisa.lsbu.ac.uk/006_services/help/helpsheet.htm
[8] University of Cambridge http://www.oriental.cam.ac.uk/handbook/plagiarism.html
[9] Backbase http://www.backbase.com/
[10] Macromedia Flash http://www.adobe.com/products/flash/flashpro/
[11] Google Maps http://maps.google.com/
[12] Google Suggest http://www.google.com/webhp?complete=1&hl=en
[13] Google GMail http://mail.google.com/mail/
[14] Google Spreadsheets http://ogb.spreadsheets.google.com
[15] Amazon A9 http://a9.com/
[16] Writely http://www.writely.com
[17] The FOAF (Friend Of A Friend project) http://www.foaf-project.org/
[18] Backbase AJAX Enterprise Framework http://www.backbase.com/#home/home.xml[0]
[19] R.A.D. AJAX Telerik http://www.telerik.com/products/ajax/r.a.d.ajax.aspx
[20] ASP.NET AJAX Microsoft http://ajax.asp.net/Default.aspx
[21] Google Web Toolkit (Beta) http://code.google.com/webtoolkit/
[22] RICO Javascript for Rich Internet Applications http://openrico.org/
[23] SAJAX http://www.modernmethod.com/sajax/
[24] Ruby on Rails http://www.rubyonrails.org/