



## On Reputation Evaluation in 2.0 Communities

*“How reputation evaluation can help WEB2.0, Enterprise2.0 and other Digital Communities to improve User Generated Contents quality and foster participation and community growth, by a reputation evaluation framework that allows business models that consider reputation as a digital currency”*

**Cristian Brotto**

cristian.brotto@gmail.com

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*Department of Computer Science*  
*Università degli Studi dell'Insubria - Varese, ITALY*

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*Supervisor: Prof. Gaetano A. Lanzarone*

*Internal Advisor: Prof. Elena Ferrari*

*External Advisors:*

**Dr. Rosario Sica**, OpenKnowledge s.r.l.

**Ing. Antonio Tomarchio**, Dada s.p.a. - RCS Group

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## **DEDICATION**

*To my future wife Ksenija*

*for her warmth and support, although we were thousands of miles apart*

*and*

*to my Family*

*for instilling in me courage of convictions*



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## **ABSTRACT**

Current technology has disappointed many members of WEB2.0 communities by its slow and tough adaptability to specific users' skills and competences. Most of the largest WEB2.0 communities rely on the work of their members to create the resources they are built on, a business model known under the acronym UGC (User Generated Contents), which is today very popular yet still very simple and immature. Presently the vast majority of the communities that relay on UGCs lack an accurate ranking system for their most proficient members and almost none of them provide an effective rewarding mechanism. Sometimes they do provide means to cooperatively evaluate and classify the available resources, but very few of these mechanisms take in account the competence of the voters.

Although rough, the current technology seems sufficient to confer to some cooperative web communities a discrete success, which for the most part is due to their core-members passion and commitment. Unfortunately deficiencies like the ones described can involve that, over time, only a small amount of the members keep committed and willing to produce resources of a certain quality. This tendency leads to the situation in which, although the community grows in terms of numbers, in proportion its value decreases.

Considering the fast diffusion of web2.0 communities and the new emerging Enterprise2.0 communities phenomena, this problem needs no longer to be underestimated. 2.0 communities should start thinking about new means to raise their quality standards in order to stay effective and successful over time.

Providing communities with concrete rewarding systems like remunerative ones could fix the problem, nevertheless this approach rarely and loosely has been implemented so far. The reason is that the task involves several and not trivial side problems, such as the necessity of an advanced ranking mechanisms to evaluate the members.

This method should be able to consider complex factors like competence and commitment, but at the same time it should be easily understandable and shared by the members of the community. In order to make sure that the members share and agree with the rating system it must involve their collaboration, which is a non trivial problem, especially in Enterprise2.0 communities.

For the aforementioned reasons I propose as a means to overcome the problem a method based on reputation rather than competence and commitment, which is named Reputation Community Evaluation (RCE). This new approach is not based solely on quantitative measurements but relies on an algorithm which exploits the community member reputations to evaluate the resources and the members themselves. In this method the reputation of the single member grows or decreases according to its activity in the community and the evaluations received from the other members over a certain period of time. All members opinions/votes are themselves weighted accordingly to the single member reputation. This approach makes possible to put in place new kinds of business models, which aim to use users reputations as a digital currency inside Web 2.0 or Enterprise 2.0 communities.

## THESIS ROADMAP

This work is logically divided in two main blocks. Chapters 1, 2 and 3 summarize the basic knowledge needed to understand the background on which RCE rely on. The subsequent chapters focus on current Reputation Systems analysis, RCE description, implementation and comparison over the existing technology.

In particular, chapter 4 aims to define what reputation is about and how it translates in an online environment, laying out the problems in reputation theory and discussing the lessons we can learn from existing models.

The chapter is itself logically divided in four parts.

Part one is about Reputation, Reputation System and the reasons why Reputation Systems are today more than ever before important and why online reputation is not by any means a less effective kind of reputation.

Part two is dedicated to a functional classification of current online reputation systems considering some concrete examples in the main application fields and their technical aspects.

Part three is dedicated to the costs of reputation. Reputation entails costs: if you make it hard to provide reputation information people will not bother, whereas if you reward them in some way they will give more information.

Reputation systems also motivate people in ways similar to monetary economies. Reputation can be earned, spent and traded; that is why in economics they talk of "economy of reputation".

On these bases it will be demonstrated that since reputation is worth money. Any online system that is equipped with reputation systems can benefit from a raise in its value.

Part four generalizes some of the issues and presents some of the solutions (even if partial) in current reputation systems, concluding that any robust online reputation system should take into account:

1. The type of feedback information that is collected in order to evaluate reputation (i.e. consider the right type of reputation system according to the problem to solve).
2. The form in which information feedbacks are distributed and represented (e.g. aggregated, complete history, time-windowed, etc.);
3. the interaction between pseudonymity and the economics of reputation (e.g. the relationship between reputation costs and reputation rewards).
4. The role of the reputation system in providing incentives for the provision of honest and accurate feedback information (e.g. introducing payment schemes);
5. And finally what algorithms can (or better theoretically could) guarantee the robustness of such a system (i.e. eliciting the right amount of feedback at the right

time, eliciting truthful feedback and preventing strategic manipulation by participants).

Chapter 4 ends concluding that despite the many theoretical and practical problems with current online reputation systems it is possible to try to improve the situation by exploiting the latest findings in research and the experience gained from a variety of real systems, like eBay or Amazon.

**In particular we can conclude that social and economical incentives influence reputation systems design criteria in ways that a purely technological discussion do not consider**, and that in a future in which reputation systems will play a more important role in any online identity management solution (2, Resnick et Al., 2000), this aspect will become crucial.

In Chapter 5 the focus is on **Reputation Community Evaluation (RCE)**, a new type of **reputation metric** or **reputation evaluation model** tailored for the needs of digital communities which rely on User Generated Contents (UGC).

Since, at the present, the vast majority of digital communities are WEB-based, the chapter opens classifying them according to three main factors: the presence of **User Generated Contents**, the existence of a **Rating System** for evaluating the UGCs and the use of an explicit **Reputation System** for ranking UGCs' producers. According to this classification the RCE meta-model will be derived and explained detailing differences, possible scenarios of application and benefits over the existing solutions.

The chapter closes with examples on how an RCE approach can concretely exploit the "economy of reputation" using reputation as a social currency in order to improve digital communities standards of quality and remain successful over time.

Any good methodology needs to be proven applicable, therefore Chapter 6 describes how exploiting the RCE meta-model has been developed on a concrete case-study RCE system: **weBBrainys.com**.

The first part of the sixth chapter is about weBBrainys design choices and the way they were crafted around the RCE principles described in chapter 5. The second part describes system features, technological aspects and development methodologies.

Chapter 7 summarizes results achieved so far and includes further implications of research.



## 1.1. Introduction

Web 2.0 is how the experts nowadays call the World Wide Web. Although the term is becoming more and more commonly used just a few people understand what actually the 2.0 stands for.

Chapter one has two major aims. Firstly, to make the point of the current situation clarifying the main differences between Web and its 2.0 version, and secondly to take a peek to the future of Web: the so called Web 3.0 also known as the Semantic Web.

In order to better understand Web2.0 concepts such as **Collective Intelligence**, **User generated Content** and **Collaborative Filtering** will be explained. Knowledge of these terms is needed in order to fully understand the way **Reputation Community Evaluation**, that is the central topic of this thesis, exploits the Web 2.0 main 'features' and why it marks one step forward to the next iteration of the Web.

## 1.2. WEB2.0: The Official Definition

The term "Web 2.0" first became notable after the O'Reilly Media Web 2.0 conference in 2004.<sup>[1]</sup> It describes the changing trends in the use of World Wide Web technology and web design that aim to enhance creativity, communications, secure information sharing, collaboration and functionality of the web.

Although the term suggests a new version of the World Wide Web, it does not refer to an update to any technical specifications, but rather to changes in the ways software developers and end-users utilize the Web, which led to the birth of social-networking sites, video sharing sites, wikis, blogs, folksonomies, etc...

According to Tim O'Reilly <sup>[1]</sup> WEB2.0 is:

***“Web 2.0 is the business revolution in the computer industry caused by the move to the Internet as a platform, and an attempt to understand the rules for success on that new platform ”*** <sup>[1]</sup>

--Tim O'Reilly

Although the O'Reilly definition is the official one it is not enough to completely describe what the Web2.0 is. It does not make explicit several aspects of this complex phenomenon which are worth to be mentioned. In this attempt, in the next chapter, there will be compared the most relevant aspects of "Web1.0" against the "Web2.0" counterparts.

## 1.3. Web1.0 v.s Web2.0

Are we sure about what Web1.0 means? We have been using the web for several years now, and the answer should hence be obvious. The very short answer is: “Web 1.0 refers to the state of the **World Wide Web**, before the 'bursting of the dot-com bubble' in 2001 <sup>[VI]</sup>”. This definition is true and compact but not completely satisfactory. It is indeed not banal to tell what Web1.0 is. It is easier to formulate a description of the term when it is used in relation to the term Web 2.0, comparing the two with examples of each.

Professor Terry Flew, <sup>[V]</sup> in his 3rd Edition of *New Media* <sup>[VI]</sup> described what he believed to characterize the differences between **Web 1.0** and **Web 2.0** like such:

**"Move from personal websites to blogs and blog site aggregation, from publishing to participation, from web content as the outcome of large up-front investment to an ongoing and interactive process, and from content management systems to links based on tagging (folksonomy)"**

*--Terry Flew*

Flew describes the shift from Web 1.0 to Web 2.0 as a direct result of the change in the behavior of those who use the World Wide Web.

Web 1.0 trends included worries over privacy concerns resulting in a one-way flow of information, through websites which contained 'read-only' material.

**On the contrary in Web 2.0 days, the use of the Web can be characterized as the decentralization of website content, which is now generated from the 'bottom-up', with many users being contributors and producers of information.**

Technological refinements also helped the shift from Web1.0 to Web2.0. These days dynamically generated blogs and social networking profiles, such as Myspace<sup>[VII]</sup> and Facebook<sup>[VIII]</sup>, are more popular, allowing for readers to comment on posts in a way that was not available during Web 1.0 . Technological refinements also involved the Internet infrastructure.

At the Technet Summit in November 2006, Reed Hastings <sup>[IX]</sup>, founder and CEO of Netflix <sup>[X]</sup>, stated a simple formula for defining the phases of the Web:

**“ Web 1.0 was dial-up, 50K average bandwidth, Web 2.0 is an average 1 megabit of bandwidth and Web 3.0 will be 10 megabits of bandwidth all the time, which will be the full video Web, and that will feel like Web 3.0. ”**

*--Reed Hastings*

Design criteria were revisited as well. Some typical design elements of a Web1.0 site include:

1. Static pages instead of dynamic user-generated content.
2. The use of framesets.
3. Proprietary HTML extensions such as the **<blink>** and **<marquee>** tags introduced during the “first browser war”. [XI]
4. Online guestbooks.
5. GIF buttons, promoting web browsers and other products.[XII]
6. HTML forms sent via email. A user would fill in a form, and upon clicking submit their email client would attempt to send an email containing the form's details.[XIII]

According to Andrew McAfee<sup>[XIV]</sup> who coined the acronym “**S.L.A.T.E.S**”, Web 2.0 websites typically include some of the following features:

**Search:** the ease of finding information through keyword search which makes the platform valuable.

**Links (Dynamic Links):** links are guides to important pieces of information. The best pages are the ones most frequently linked to. Google's search paradigm exploits correctly this assertion to index informations ‘scattered’ around the web. A links structure that changes over the time reflects the opinions of many people. In Web 1.0 sites links are prevalently made by web developers, in Web 2.0 links can be edited by users dynamically.

**Authoring:** the ability to create constantly updating content over a platform that is shifted from being the creation of a few to being a constantly updated interlinked work. In wikis, the content is iterative in the sense that the people undo and redo each other's work. In blogs, content is cumulative in that posts and comments of individuals are accumulated over time.

**Tags:** categorization of content by creating tags that are simple, one-word descriptions to facilitate searching and avoid rigid, pre-made categories.

**Extensions:** automation of some of the work and pattern matching by using algorithms e.g. amazon.com recommendations.



**Signals:** the use of RSS (Really Simple Syndication) technology to notify users with any changes of the content by sending e-mails to them.” [XV]

As a rule of thumb we can assert that Web 2.0 sites allow users to do more than just retrieve information. They can provide "Network as platform" computing [see chapter 1.4], allowing users to run software-applications entirely through a browser. They feature a rich, and user friendly interface which can be based on technologies such as: Ajax [XVI], Flex [XVII] or similarly rich media.

## 1.4. Why WEB2.0 is not a New Technology?

The Web2.0 as introduced in the last part of the previous chapter may sound like a complex and continually evolving technology, which includes server-software, content-syndication, messaging-protocols, etc...

**However it is a matter of fact that Web2.0 sites have capabilities that go beyond what are in Web1.0 ones and it is logical for people to think about Web2.0 as new technology but, Tim Berners-Lee<sup>[XVIII]</sup>, the inventor of the World Wide Web does not agree with this definition.**

Berners-Lee has questioned whether one can use the term Web 2.0 in any meaningful way<sup>[XIX]</sup>. The reason is that **many of the technological components of Web2.0 have actually existed since the early days of the Web.**

Barners-Lee is not wrong, the shift from Web 1.0 to Web 2.0 can be seen just as a result of technological improvements on different levels: "broadband connections, improved browsers, Ajax, Flash application platforms, etc..."

On the other hand Web2.0 sites have an "Architecture of Participation"<sup>[see next chapter]</sup> that encourages users to add value to the application as they use it. This stands in contrast to very old traditional websites, which limit visitors to viewing content that only the owner could modify.

**We can state, then, that Web2.0 is best defined as a change in the ways users utilize the Web, rather than a new technology.**

Nevertheless we must recognize that this change has been possible thanks to technological improvements which have, in time, enhanced confidence and awareness of the World Wide Web capabilities in its users.

**In the end we can say that the concept behind the Web2.0 can be summarized as "The Web as participation platform" <sup>[see next chapter]</sup> , opposed to the Web1.0, "The Web as information source" .**

## 1.5. Web2.0: The Web as Participation Platform

Andrew McAfee's<sup>[XIV]</sup> definition of Web2.0 websites characteristics (S.L.A.T.E.S)<sup>[Chapter 1.2]</sup> appears now to be lacking. We can complete them with the definition of David Best. According to Best's paper<sup>[XX]</sup>, the essential attributes of Web2.0 are:

1. **Rich User Experience:** through technologies such as AJAX, Flex etc... Web 2.0 applications can achieve some of the characteristics of desktop applications.
2. **User Participation,** the platform is used by the users not only as an information source, but they have an active role in the applications, as they do forums, comments, wiki etc...
3. **Dynamic Generated Content:** the structure of the application encourages users to add contents as they use it.
4. **Metadata**<sup>[XXI]</sup>,
5. **Web Standards and Scalability**<sup>[XXII]</sup>,
6. **Openness and Freedom**<sup>[XXIV]</sup>.

And also in many cases **Collective intelligence**<sup>[Chapter 1.4.1]</sup> by way of user participation (e.g. **Users Generated Content**<sup>[Chapter 1.4.2]</sup>) can be seen as an essential attribute of Web2.0 platforms.

## 1.5.1. Collective Intelligence

“**Collective intelligence** is a shared or group intelligence that emerges from the collaboration and competition of many individuals.”

The above definition has emerged from the writings of Peter Russell (1983), Tom Atlee (1993), Pierre Lévy (1994), Howard Bloom (1995), Francis Heylighen (1995), Douglas Engelbart, Cliff Joslyn, Ron Dembo, Gottfried Mayer-Kress (2003) and other theorists.

Collective intelligence appears in a wide variety of forms, like in bacteria, animals, humans, and can also be defined as a form of networking enabled by the rise of communications technology and the Internet.

According to Don Tapscott and Anthony D. Williams<sup>[XXI]</sup>, authors of the book ‘wikinomics’, collective intelligence can be seen as a form of mass collaboration, which can happen in presence of specific factors like: **openness, peering** and **sharing**.

### Openness

During the early ages of communication technology people and companies were reluctant to share ideas and intellectual property, but rather encourage self-motivation. The reason for this is that these resources provide the edge over competitors. Now people and companies tend to loosen hold over these resources because they reap more benefits in doing so, like gaining significant improvement and scrutiny through collaboration.

### Peering

This is a form of horizontal organization. One example is the Linux OS program where users are free to modify and develop it provided that they made it available for others. Participants in this form of collective intelligence have different motivations for contributing, but the results achieved are for the improvement of a product or service.

### Sharing

Is a fact that Web 2.0 has enabled, or at least greatly improved, interactivity. As a consequence web users are able to generate and share their own content to enhance the pool of existing knowledge on the internet (see **user generated contents**<sup>[Chapter 1.4.2]</sup>).

Considering openness, peering and sharing, we can say that collective intelligence in communications technology, and particularly in the web, is certainly a **human enterprise in which, a willingness to share, and an openness for the common good are paramount**. Therefore it is obviously **not a mere quantitative contribution of information from all ‘actors’, it is also a qualitative process**. As a matter of fact individuals who respect collective intelligence are confident of their own abilities but recognize that the whole is greater than the sum of individual parts.

Unfortunately not everything is perfect and there are some criticisms, especially about the reliability of user generated contents.

### 1.5.2. User Generated Contents (UGC)

The new media are often associated with the promotion and enhancement of collective intelligence, allowing the storage and retrieval of information without difficulty. This happens predominantly through databases and the Internet which promotes online interaction and distribution of knowledge between users and sources, resulting in a form of collective intelligence.

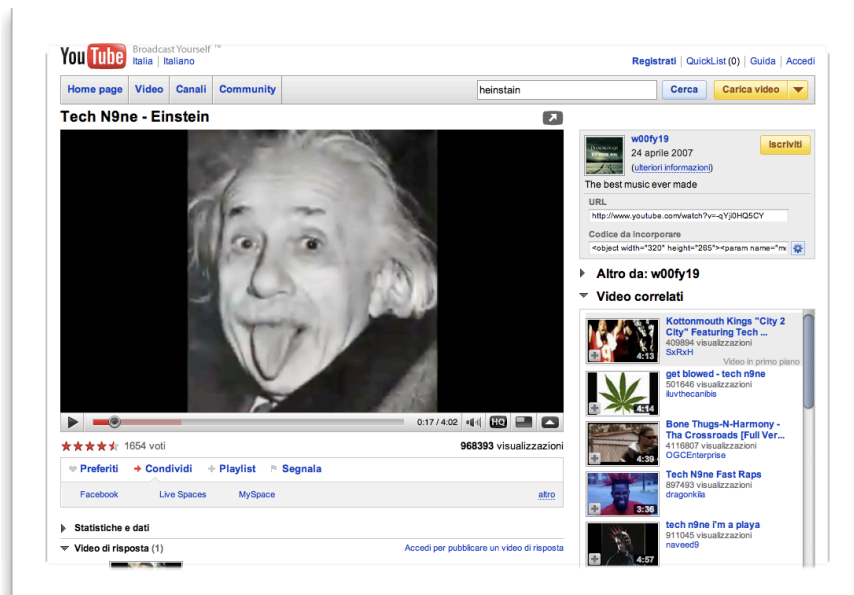
**Web collective intelligence is often confused with shared knowledge. The former is knowledge that is generally available to all members of a community, whilst the latter is information known by all members of a community. For this reason Web Collective intelligence has less user engagement than Collaborative Intelligence, which involves shared knowledge.**

As an example, the most spread mechanism in the Web to evaluate **user generated contents are 'plain' voting methods**. There are various examples of this mechanism on the internet, a very popular one is the web-tv YouTube.com.

In web sites equipped with a 'plain' voting system users simply express their preferences giving a numerical vote to the resources according to their will. The sum of the votes is then averaged in a final score, giving thus the value of that resource.

Although the method clearly has the potential to converge many unique perspectives in a common opinion, there are no means to evaluate the users competence or influence, hence this uninformed voting is to some degree random and thus leaves only a residue of informed consensus.

Critics point out that often bad ideas, misunderstandings, and misconceptions are widely held, and that the structuring of the decision process must favor experts who are presumably less prone to random or misinformed voting in a given context.



*Fig. 1.1 - YouTube.com : an example of collective intelligence exploited in order to evaluate user generated contents.*

One major complaint is about the general quality of user generated contents (UGC). For instance, about web news and blogging, there are those who fear that they are not up to par with the quality produced by formally trained writers and hence UGCs are contributing to the decline of standards in publishing. Such complaints show a misunderstanding of the nature of UGC creations. There is undeniably a long tail of user-generated content that ranges from low to high, however, grammatically correct and compellingly written work is not necessarily substantive, honest or true and vice-versa.

Major questions these days are: What and who can then be considered reliable in the internet environment? Are there any means to certify, in a shared way the reputations of contributors and quality of resources?

This does not seem to be an easy task. Lately, the research community is lately trying to better understand the problem and finding means to solve it. The major aims of **Reputation Community Evaluation (RCE)** is right to move a step in this direction.

Before closing chapter 1 **Collaborative Filtering** is worth a mention too.

### 1.5.3. (Active) Collaborative Filtering (CF)

Collaborative Filtering (CF) is a technique not specifically aimed to evaluate contents quality or users reputation but still is worth the mention because some of the problems in this field are similar to the ones in Reputation Community Evaluation. We can therefore use some of the results achieved in Collaborative Filtering to derive sensible informations.

CF is also worth the mention to better understand the differences in between Collaborative Filtering and Reputation Community Evaluation, which may be confused.

**Collaborative filtering (CF)** is the process of filtering for information or patterns using techniques involving collaboration among multiple agents, viewpoints, data sources, users etc.

Often in the web this method is applied in making automatic predictions (filtering) about the interests of a user by collecting taste information from many other users (collaborating).

Applications of collaborative filtering typically involve very large data sets which are used to perform the following two steps:

1. Look for users who share the same rating patterns with the active user (the user whom the prediction is for).
2. Use the ratings from those like-minded users found in step 1 to calculate a prediction for the active user.

For example, a collaborative filtering or recommendation system for music tastes could make predictions about which music a user should like given a partial list of that user's tastes (likes or dislikes). **Note that these predictions are specific to the user, but use information gathered from many users. This differs from the simpler approach of giving an average (non-specific) score for each item of interest, for example based on its number of votes.**

Alternatively, item-based collaborative filtering popularized by Amazon.com (users who bought x also bought y) , proceeds in an item-centric manner:

1. Build an item-item matrix determining relationships between pairs of items
2. Use the matrix, and the data on the current user to infer his taste.

Another form of collaborative filtering can be based on implicit observations of normal user behavior. In these systems you observe what a user has done together with what all users have done (what music they have listened to, what items they have bought) and use that data to predict the user's behavior in the future or to predict how a user might like to behave if only they were given a chance.

On the net there is a certain amount of sites that implement collaborative filtering systems. Among the most notable are:

**Amazon.com** - web store

**Digg.com** - social bookmarking

**eBay.com** - products

**iTunes** - music

**Last.fm** - music

**Netflix.com** - movies

**StumbleUpon** - websites

There are, though, some disadvantages in using collaborative filtering. The most relevant one is that if you want to rely on users' opinions you have to accept the fact that they may be biased. This happens for instance using ratings methods, which directly exploit the votes in order to generate the recommendations. In this case the problem is usually mitigated using a lot of votes, which statistically lower the risk.

This solution is not always possible. Some items may have just few ratings, especially if an item is new in the system (The Cold Start Problem), and in this case there is no concrete solution yet. Nevertheless, in the next chapters we will see that **Reputation Community Evaluation**, in certain circumstances, can provide means to address this type of problem.

These types of problems are typical of the Web 2.0, finding new solutions means moving toward the next step in this technology: the Web 3.0.

## 1.6. What the future looks like? - Introducing WEB3.0

**“Web2.0 is Just a Piece of Jargon!”** -- This was the “creative” but not completely wrong definition of the Web 2.0. of **Tim Berners-Lee** <sup>[XVIII]</sup>, in an interview for the magazine ZdNet.com.

### **A passage from the famous interview:**

*ZdNet Interviewer: “You know, with Web 2.0, a common explanation out there is Web 1.0 was about connecting computers and making information available; and Web 2.0 is about connecting people and facilitating new kinds of collaboration. Is that how you see Web 2.0?”*

*BERNERS-LEE: “Totally not. Web 1.0 was all about connecting people. It was an interactive space, and I think Web 2.0 is of course a piece of jargon, nobody even knows what it means. If Web 2.0 for you is blogs and wikis, then that is people to people. But that was what the Web was supposed to be all along.”*

The question now is if Web 3.0 is doomed to be a piece of Jargon too.

Previously in this chapter we reported what Reed Hastings <sup>[IX]</sup> in 2006 had to say about:

**“ Web 1.0 was dial-up, 50K average bandwidth, Web 2.0 is an average 1 megabit of bandwidth and Web 3.0 will be 10 megabits of bandwidth all the time, which will be the full video Web, and that will feel like Web 3.0. ”**

*--Reed Hastings*

This definition sounds realistic but at the same time reduces the Web 3.0 to a mere technical improvement once again. Therefore for the final users Web 3.0 may actually sound like ‘just a piece of Jargon 3.0’.

Before, in May 2006, **Tim Berners-Lee** <sup>[XVIII]</sup> was saying about Web 3.0:

**« People keep asking what Web 3.0 is. I think maybe when you have got an overlay of Scalable Vector Graphics on Web 2.0 - today everything rippling and folding and looking misty - and access to a semantic Web integrated across a huge space of data, you will have access to an unbelievable data resource »**

*--Tim Berners-Lee*

Berners-Lee not only proposes the Web 3.0 as a more beautiful and brutally powerful web, but also as **“The intelligent Web”**, a semantic web, capable of natural language search, using data mining , machine learning, and artificial intelligence technologies.

This latter definition emphasizes machine-facilitated understanding of information in order to provide a more productive and intuitive user experience and describes a Web 3.0 which is much more than a mere “piece of Jargon 3.0”.

Skeptics point out that ‘The Intelligent Web’ has yet to come and it may be a longer than expected way to go.

As a matter of fact it seems more likely that the next ‘iteration’ of the web will be a mix of machine-facilitated services through intelligent systems in the sense that they will be capable to better the web but still via the web users intelligence. For instance finding more effective mechanisms to improve quality of user generated contents, accuracy in collaborative filtering etc...

**Reputation Community Evaluation** approach moves right toward this latter direction.



## 2. WEB 2.0 Communities are Social Networks



*Fig.2.0 - A **social network** is a way to classify people according to social bonds of different nature (familiar, working, etc...)*

## 2.1. Introduction

Social Network Services (SNS) are an emerging phenomenon of the Web 2.0 which is changing the way Web users interact with each other and access the net itself.

The amount of Social Network Services spreading the Web is by now very relevant and variegated, it is therefore very complicated to define an exact taxonomy. This chapter proposes a classification which considers social network services according to three main aspects: **accessibility, type of service, and business model**. Such classification will be very useful in following chapters in which will be proposed new kinds of business models that **Reputation Community Evaluation** approach, making applicable to certain types of SNS.

## 2.2. Social Networks as Web Services

A **social network** is simply any group of people which are connected by social bonds of a different nature such as familiar, business, friendship etc...

The study of social networks is often used as a support for intercultural researches as in sociology and anthropology, and more recently it is expanding in internet and intranet contexts in the form of Social Network Analysis,<sup>[See Chapter3]</sup> thanks to the advent of the Web 2.0 and Enterprise 2.0 especially <sup>[See Chapter 3]</sup>.

The Web 2.0 idea of social network was first born in the U.S.A. to spread the whole world whole and become one of the most evolved forms of communication.

The typical **internet social network** is intended as a service, so we can talk rather than internet social network of **social network services**. These services focus on building online communities of people who share interests and/or activities, or who are interested in exploring the interests and activities of others.

Early social networking websites started in the form of generalized online communities such as The WELL <sup>[XXII]</sup> (1985), Theglobe.com <sup>[XXIII]</sup> (1994) and Tripod.com <sup>[XXIV]</sup> (1995).

These early communities focused on bringing people together to interact with each other through chat rooms or simply having people linked to each other via email addresses, and share personal information and ideas around any topics via personal homepage publishing tools which was a precursor to the blogging platforms.

Between 2002 and 2004, three major social networking services emerged as the most popular in the world, causing such sites to become part of mainstream users globally.

First there was Friendster <sup>[XXV]</sup>, then, MySpace <sup>[VI]</sup>, and finally, 2004 saw the emergence of Facebook <sup>[VIII]</sup>, a competitor, also rapidly growing in size but limited at first to the US college environment. In 2006, Facebook opened up to the non US college community spreading all over the world and showing, clearly, that social networking was about to become one of the major components of business internet strategy. Today social networking websites are being used regularly by millions of people.

## 2.3. The way Social Networking Services Work

Typically social networking services require users to create a profile for themselves, providing information such as an email address, a profile picture, some details about personal interests, life, working experiences, skills, etc.



Fig.2.1 - An example of **user's personal profile** taken from **linkedin.com**  
[XXVI]

Social Networks users can often be "friends" with other users too. This feature relies on the convention that both users must confirm that they are friends before they are linked. For example, if user A lists user B as a friend, then user B would have to approve user A's friend request before they are listed as friends.

Social networks usually have some sort of privacy controls that allows for instance the user to choose who can view their profile or contact them, etc... .

Some social networks have additional features, such as the ability to create groups that share common interests or affiliations, upload photo albums, upload or stream live videos, and hold discussions in forums.

## 2.4. Social Networking Services Categories

### 2.4.1. Internal and External Social Networking Services

Social Networking Services can be divided into two big categories: internal social networking (**ISN**) and external social networking (**ESN**).

An **ISN** is a closed/private community that usually consists of a group of people within a company, association, society, education provider and organization or even an "invite only" group.

**ESN's** can be specialized communities (i.e. Linked, business oriented ESN) or they can be generic social networking sites such as MySpace, Facebook, Twitter <sup>[XXVII]</sup> which are open/public and available to all web users.

However, whether **ISN** or **ESN**, whether specialized or generic there is a commonality across the general approach of social networking sites.

Social Networking Services have been developed especially in two main areas: Friendship/Communication (i.e. MySpace, Facebook, Twitter etc..) and lately Business, in which ISN and ESN are the new hot topic.

### 2.4.2. Business and B2B ESN

One popular example of ESN being used for business purposes is LinkedIn.com which simply aims to interconnect professionals on an online network.

LinkedIn is free to join and within a few years has become the most successful business ESN on the internet with over 43 million users in over 200 countries.

When the users join, they can create a profile that summarizes his/her professional expertise and accomplishments. The user can then form enduring connections by inviting trusted contacts to join LinkedIn and connect to you. Your network consists of your connections, your connections' connections, and the people they know, linking you to a vast number of professionals and experts.

Through your LinkedIn network you can:

1. Manage the information that is publicly available about you as professional
2. Find and be introduced to potential clients, service providers, and subject experts who come recommended
3. Create and collaborate on projects, gather data, share files and solve problems
4. Be found for business opportunities and find potential partners
5. Gain new insights from discussions with like-minded professionals in private group settings

6. Discover inside connections that can help you land jobs and close deals
7. Post and distribute job listings to find the best talent for your company

Business Social networks like LinkedIn connect people at a very low cost, and can be very valuable not only to single users but also for entrepreneurs and companies looking to expand their contact base.

These networks often act as a customer relationship management tool for companies selling products and services. For instance, companies have found that social networking sites, such as Facebook and Twitter, are great ways to build their brand image.

Since some companies operate globally, they can also use social networks to make it easier to keep in touch with contacts around the world.

One more popular use for this new technology is social networking between businesses.

We can conclude that there are at least six major uses for businesses and social media:

1. To create Brand Awareness
2. Can be used as an online reputation management tool
3. For Recruiting
4. Can be used to learn more about new technologies and competitors
5. Can be used as a tool to intercept potential prospects
6. B2B relationships management

It is then clear that the use of social network services, in an enterprise context, presents the potential of having a major impact on the world of business and work. This new trend is pushing companies not only to invest money and effort in ESN but also to invest in their own ISN, completely dedicated to the benefit of the company itself, like, to better production processes and to foster communication among employees. This new trend has recently emerged with the name of Enterprise 2.0 [See Chapter 3].

### 2.4.3. ESN and ISN Side Application Domains

#### Science IES and ESN

One other use of Social Networks is in the Science communities.

Social networking allow scientific groups of any kind to expand their knowledge base and share ideas in faster and more flexible ways, avoiding the risk that some sensible resources might become isolated and hence irrelevant.

As an example, biotechnology firms are starting to use social networking sites to share scientific knowledge, in order to increase their flexibility in ways that would not be possible within a self-contained hierarchical organization [XXVIII].

### **Educational IES and ESN**

The National School Boards Association<sup>[XXIX]</sup> reports that almost 60 percent of students who use social networking talk about education topics online and, surprisingly, more than 50 percent talk specifically about schoolwork.

Social networks focused on supporting relationships between teachers and between teachers and their students are now used for learning, educator professional development, and content sharing.

Learncentral.org is an example of this trend of ESN sites built to foster relationships that include educational blogs, formal and ad hoc communities, chats, discussion threads, and synchronous forums. In some cases these sites also have content sharing and simple rating features for the shared contents.

### **Governance ESN**

Social networking is more recently being used by various government agencies. Social networking tools serve as a quick and easy way for the government to get the opinion of the public and to keep the public updated on their activity. As an example NASA has taken advantage of a few social networking tools, including Twitter and Flickr [XXX]. They are using these tools to aid the Review of U.S. Human Space Flight Plans Committee, whose goal it is to *ensure that the nation is* on a vigorous and sustainable path to achieving its boldest aspirations in space.

### **Medical ESN**

Social networks are beginning to be adopted by healthcare professionals as a means to manage institutional knowledge, disseminate peer to peer knowledge and to highlight individual physicians and institutions.

A new trend is emerging with social networks created to help its members with various physical and mental ailments.

For people suffering from life altering diseases, PatientsLikeMe<sup>[XXXI]</sup> offers its members the chance to connect with others dealing with similar issues and research patient data related to their condition.

For alcoholics and addicts, SoberCircle.com gives people in recovery the ability to communicate with one another and strengthen their recovery through the encouragement of others who can relate to their situation.

SparkPeople<sup>[XXXII]</sup> offers community and social networking tools for peer support during weight loss.

## Dating ESN

Online dating ESN are social networks in the sense that users create profiles to meet and communicate with others, but their activities on such sites are for the sole purpose of finding a person of interest to date. An important difference between social networks and dating services is the fact that online dating sites usually require a fee, where social networks are free. This difference made this kind of ESN very profitable. Presently the online dating industry is seeing a massive decrease in revenue. As a matter of fact many use friendship oriented social networking services for similar purposes, without paying any fees.

Very popular online dating services are Match.com, Yahoo Personals, and eHarmony.com.

## 2.5. Social Networks Services Business Models

Dating social Networks usually apply a business model that is fee based, but currently just few social networks charge money for membership. In part, this may be because social networking is a relatively new service, and the value of using them has not been firmly established in customers' minds.

Companies such as MySpace and Facebook have online advertising on their site, so they are seeking large memberships, and charging for membership would be counterproductive.

Social networks operate under a business model in which a social network's members serve dual roles as both the suppliers and the consumers of content. This is in contrast to a traditional business model, where the suppliers and consumers are distinct agents. Revenue is typically gained via advertisements, but subscription-based revenue is possible when membership and content levels are sufficiently high.

As an example LinkedIn.com is free to join but they also offer premium accounts that give you more tools for finding and reaching the right people, whether or not they are in your network.

Several social networks in Asian markets such as India, China, Japan and Korea have reached not only a high usage but also a high level of profitability. Services such as QQ.com (China), Mixi.jp (Japan), Cyworld.com (Korea) or the mobile-focused service Mobile Game Town by the company DeNA.jp in Japan (which has over 10 million users) are all profitable, setting them apart from their western counterparts.

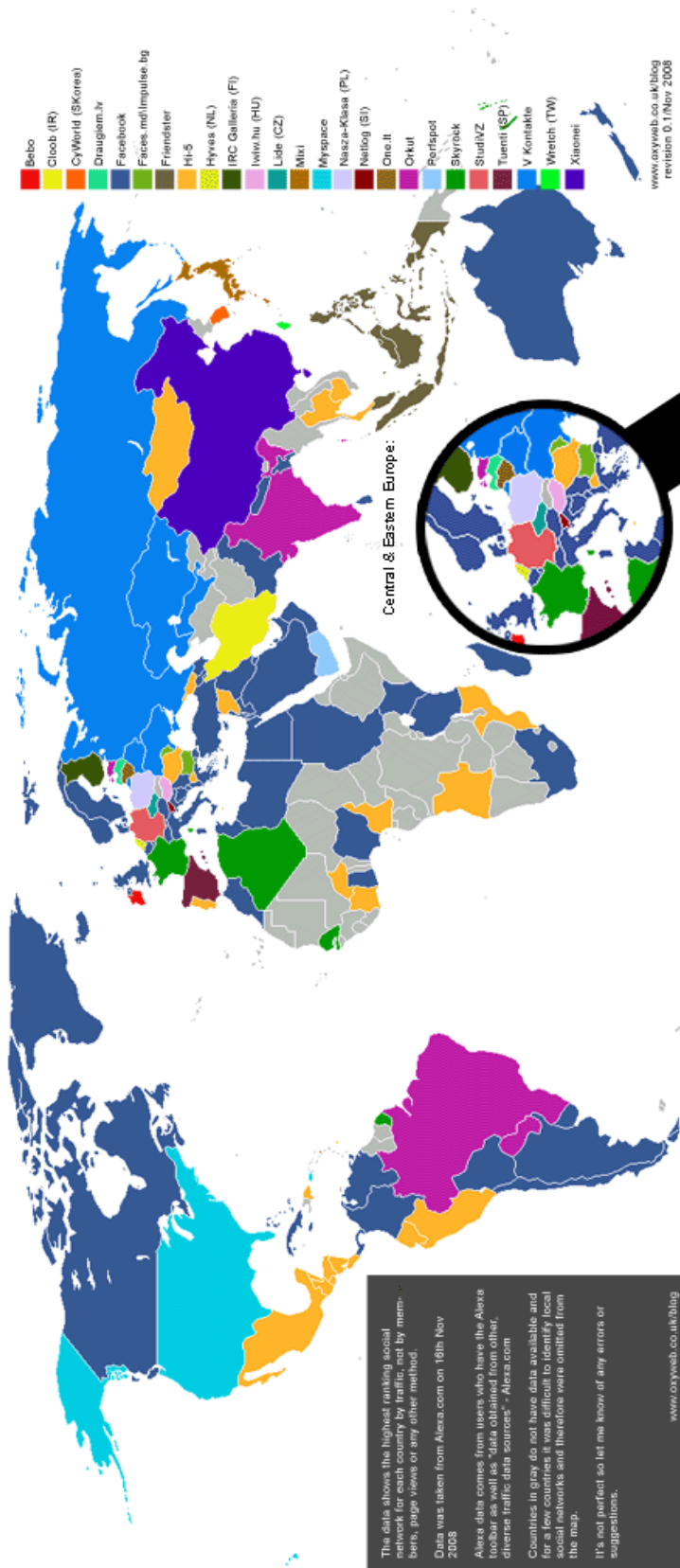
Another business model is the 'Prize Based Rewarding System', which applies usually on social networks relying on some form of users generated contents, such as blogging platforms. In this business model revenue comes from the advertising inside the site, and most active users are rewarded with prizes according to their performances which are evaluated on some quantitative criteria, such as number of posts a month, number of comments etc.

The latest evolution in the social networks business model is to give for free the membership to the service but having inside the website ads plus some sort of marketplace where to buy, usually, digital contents like music or movies. This last business model applies to social networks like lastfm.com or musicoverly.com, which gather together people who like to share their passion for music with others.



## 2.6. World Map of popularity of social networks around the world

[Fig.2.2, XXXIII]



## 2.7. S2W: The Evolution of Social Networking Services

Social networking services are not only rapidly evolving in the way they are doing business but also in their technological aspects.

The most relevant emerging phenomenon related to Social Networking Services is about the so called **socio-semantic web** (S2W). S2W aims to complement the formal Semantic Web vision by adding a pragmatic approach relying on description languages for semantic browsing using heuristic classification and semiotic ontologies.

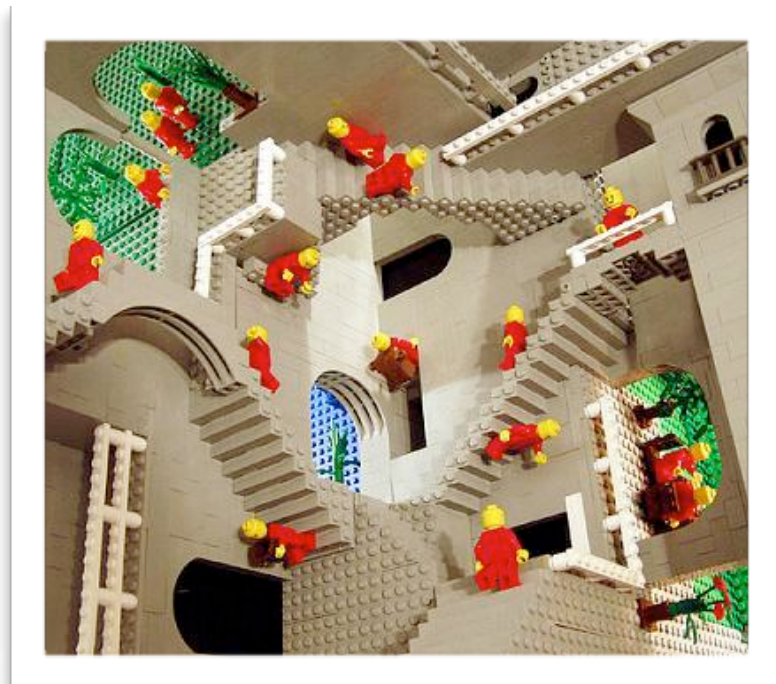
The socio-semantic web opens up for a more social interface in which humans are collaboratively building semantics aided by socio-semantic information systems.

An early example of this new approach is the Semantic Social Network like the famous StumbleUpon. These services represent a hybrid in between a web social network and a resource aggregator via collaborative filtering <sup>[See Chapter 1]</sup>.

StumbleUpon allows its users to discover and rate Web pages, photos, and videos, through a personalized recommendation engine that works via a special rating badge that people can embed in their web pages, the official website (stumbleupon.com) or preferably via a specific web browsers plugin. The user clicks the "Stumble!" button on the browser's toolbar and StumbleUpon chooses which Web page to display based on the user's ratings of previous pages, ratings by his/her friends, and by the ratings of users with similar interests.

Social Networking Services latest tendency is to spread from the web into Enterprises, in order to enhance the way they are doing business. It is the Enterprise 2.0 phenomenon to which next chapter is dedicated.

### 3. Enterprise 2.0: Web 2.0 Goes Business?



*Fig.3.0* - Social Networking is not only changing the way companies deal with partners and customers but also the way they organize themselves.

## 3.1. Introduction

Internet Social Network Services are powerful tools for quickly reaching and connecting the masses. As a result, Social Networks are becoming more and more important for organizations to intercept their target markets.

In the future, while we might see some B2B organizations create their own online communities, social networking will become not an option but a necessity to understand the needs and wants of their prospects and clients.

Social Networking is not only changing the way companies deal with partners and customers but also the way they organize themselves, including social and networking modifications to corporate intranets and other classic software platforms. This new trend in Enterprise Software is known as **Enterprise Social Software**, which is a major component of the so called **Enterprise 2.0**.

Chapter 3 aims to describe the characteristics and the state of Enterprise 2.0, which is undoubtedly connected with Web2.0 but, at the same time, has distinctive features that add technological and infrastructural approaches to the original Web 2.0 concept. Among the latest and most relevant there is Enterprise Social Network Analysis (SNA), a tool for investigating Enterprise2.0 communities.

The knowledge of the basics about **Enterprise 2.0** and **SNA** is necessary to fully understand in following chapters the way **Reputation Community Evaluation (RCE)** could be used in Enterprise 2.0 System to improve their efficacy through innovative approaches to accomplish Enterprise Social Network Analysis.

## 3.2. About Enterprise 2.0: History and Definitions

**Enterprise 2.0** was named after Web 2.0 and has lately become a catchier term used to describe social and networking changes to enterprises, which often includes social software too.

Enterprise 2.0 was defined in many ways; a very compact definition comes from a report written for the **Association for Information and Image Management (AIIM)** [XXXIV]:

*"Enterprise 2.0 is a system of web-based technologies that provide rapid and agile collaboration, information sharing, emergence and integration capabilities in the extended enterprise" [XXXV]*

**A much more elaborated and complete definition of Enterprise 2.0 comes from Andrew McAfee** [XIV], professor of Harvard Business School, which first defined it in the

paper “Enterprise 2.0: The Dawn of Emergent Collaboration”, published by MIT Sloan Management Review. [XV]

After the paper publication McAfee was not completely satisfied with his first definition and through his blog proposed a refined one [XXV]:

*“ I am not satisfied with my earlier definition of Enterprise 2.0, so let’s propose a refinement (I’m sorry if this feels a bit pedantic, but clear constructs are important to academics):*

**Enterprise 2.0** is the use of **emergent** social software platforms within companies, or between companies and their partners or customers.

*Social software enables people to rendezvous, connect or collaborate through computer-mediated communication and to form online communities.*

*Platforms are digital environments in which contributions and interactions are globally visible and persistent over time.*

*Emergent means that the software is **freeform**, and that it contains mechanisms to let the patterns and structure inherent in people’s interactions become visible over time.*

**Freeform** means that the software is most or all of the following:

1. *Optional*
2. *Free of up-front workflow*
3. *Egalitarian, or indifferent to formal organizational identities*
4. *Accepting of many types of data ”*

Recently another very interesting definition came from the Enterprise 2.0 Observatory of School of Management of Politecnico di Milano [XXVII], which defines the Enterprise 2.0 as a dramatic change in the assets of companies , and summarizes its three major elements:

1. Usage Web 2.0 collaborative tools,
2. Presence of adaptive architecture (SOA & BPM) [see chapter 3.3],
3. Usage of technology as a platform to realize the so called “Virtual Workspace” [XXVIII].

What is very interesting to observe in this latest definition is that Web 2.0 collaborative tools are just one part of the Enterprise 2.0. It is then straightforward to observe that Enterprise 2.0, although inspired by Web 2.0 principles, is lately taking on its very own identity.

### 3.3. Enterprise 2.0: Why Not Just Web 2.0 behind firewalls?

From the technological point of view, according to the official definitions, Enterprise 2.0 applies tools directly inspired by the Web 2.0, such as:

1. **Search Tools,**
2. **Wiki,**
3. **Weblog,**
4. **Social bookmarking for tagging**
5. **Feed RSS,**
6. **Social Networking Tools,**
7. Etc...

But, according to studies like the ones carried out by The Enterprise 2.0 Observatory previously mentioned, Enterprise 2.0 is taking its own path, adding new technological and infrastructural approaches such as:

8. **Collaborative planning software** for peer-based project planning and management.
9. **Prediction markets** for forecasting and identifying risks.
10. **Service-oriented architecture (SOA).** In a business domain, SOA defines a set of principles that allows different applications to exchange data with one another.
11. **Business Process Management (BPM).** A management approach that promotes business effectiveness and efficiency while striving for innovation, flexibility, and integration with technology.

Enterprise 2.0 is a phenomenon still in evolution and only future years will clearly define its characteristics. Meanwhile, researchers are trying to identify the minimum set of functionalities that a social software for an enterprise must have to work well. Among them, Andrew McAfee, in 2006, was proposing as the minimum set the followings <sup>[XVI]</sup>:

1. **Search:** allowing users to search for other users or content.
2. **Links:** grouping similar users or content together.
3. **Authoring:** including blogs and wikis.
4. **Tags:** allowing users to tag content.

5. **Extensions:** recommendations of users; or content based on profile.
6. **Signals:** allowing people to subscribe to users or content with RSS feeds.

In 2007 Dion Hinchcliffe<sup>[XXXIX]</sup> expanded the list by adding the following four functions<sup>[XL]</sup>:

1. **Freeform function:** no barriers to authorship (meaning free from a learning curve or from restrictions).
2. **Network-oriented function:** requiring web-addressable content in all cases.
3. **Social function:** stressing transparency (to access), diversity (in content and community members) and openness (to structure).
4. **Emergence function:** requiring the provision of approaches that detect and leverage the collective wisdom of the community.

For the near future, considering the increasing interest and the consequent fast development of Enterprise 2.0, it is very likely that this list will expand.

### 3.4. Why Enterprise 2.0 has become an appealing reality?

Blogs, wikis, and RSS feeds have been around since the 1990s, and technologies such as the popular AJAX<sup>[XVI]</sup> since the early years of this decade, why then has Enterprise 2.0 become an appealing reality just now?

It is not because of any recent technology breakthrough. Technology is certainly one of the reasons, but focusing just on this component is misleading. We can find an answer in what McAfee defines as the three basic trends that converging have changed the relationship between those who offer technologies and those who use them.

According to McAfee, the trends<sup>[XXXVI]</sup> are :

#### 1) **Simple, Free Platforms for Self-Expression**

For about a decade companies have been providing users around the world with free Web-based communication channels like email and instant messaging, but the information exchanged via these channels is not persistently visible, so it is not consultable.

The birth of free blogs was a big change. With five minutes of effort anyone can build themselves a worldwide platform for self-expression using text, audio, photos or videos.

## 2) Emergent Structures, Rather than Imposed Ones.

As an example McAfee cites Yahoo!. In the early years of its existence Yahoo attempted to organize the Web's content hierarchically, placing individual sites into pre-defined categories like Health, Arts, and Computers, and into sub-categories within them.

The company employed taxonomists to create and update this structure. Taxonomy is the science of classifying things, usually hierarchically. Taxonomies are developed by experts, and then rolled out to users to help them make sense of the world and relate things to each other.

At a certain point the Web was becoming too big and growing too fast for the taxonomists to keep up with and it became more productive to enter free text into Google than to navigate through Yahoo's hierarchy.

Web categorization schemes were out of date for several years, until the advent of services like del.icio.us<sup>[XLI]</sup>, which is based not on an up-front taxonomy developed by experts, but instead on a 'folksonomy' <sup>[XLII][XLIII]</sup>, a categorization system developed over time by folk.

## 3) Order from Chaos.

If everyone were starting blogging, making edits at Wikipedia, and uploading photos to Flickr, isn't chaos the inevitable result?

Amazingly the answer is NO. This is because in addition to building platforms for self-expression and overcoming their previous tendencies to impose structure there have been tools developed that help us filter, sort, prioritize, and generally stay on top of the flood of new online content.

These tools include powerful search, tags (the basis for the folksonomies), and automatic RSS signals whenever new content appears.

In its last analysis, Enterprise 2.0 has become an appealing reality just recently because of new ways of interacting between the existing technology and the end users. An evolution that clearly has a lot in common with the passage from 'Web1.0' to Web2.0.

There are nonetheless things that completely set Enterprise 2.0 apart from Web 2.0. Some of these, as we have seen, are structural. The others are new trends and technical improvements. Among the latter, an emerging phenomenon is certainly the Enterprise Social Network Analysis (SNA).

Enterprise SNA, which will be defined in the next chapter, is lately becoming more and more important as an Enterprise 2.0 tool. It is especially worthy of mention because, as it will be explained in chapter 7, **Reputation Community Evaluation** Systems, if used in conjunction with SNA, could lead to a new methodology to accomplish Enterprise Social Network Analysis.



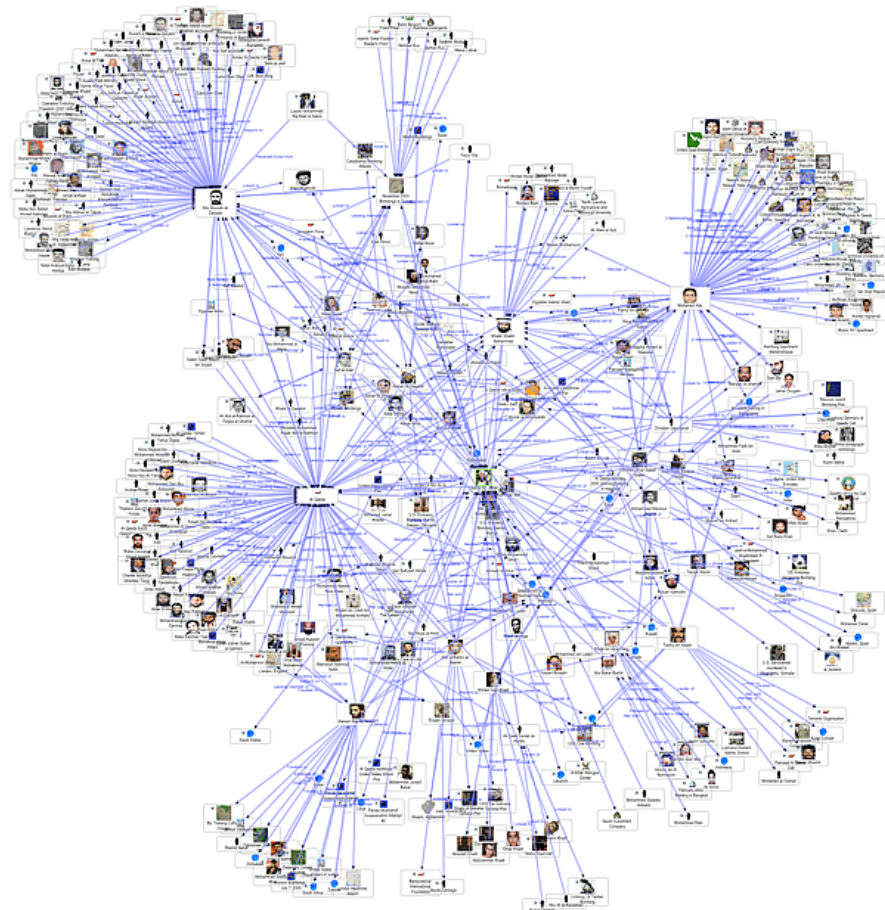
## 3.5. Social Network Analysis: Investigating Enterprise 2.0 Communities

Social Network Analysis (SNA) exploits a mathematical formalism that involves the use of the theory of graphs in order to represent and then analyze a social networks structure.

This technique consists of various means of mapping and then measuring the network in order to infer sensible information from it.

In Social Network Analysis a social structure is represented with nodes (which are generally individuals or organizations) that are tied by one or more specific types of interdependency, such as values, visions, ideas, financial exchange, friendship, sexual relationships, kinship, dislike, conflict or trade.

In the image below (Fig 3.1) an example of social network represented by a graph structure.



*Fig.3.1 - An example of social network represented by a graph structure (Copyright © FMS Inc.).*

Analyzing fig. 3.1, from a visual standpoint, some clusters are certainly visible, but the density of information makes it difficult to see all the centrality aspects.

Using Social Network Analysis, you can get answers to questions like:

1. How highly connected is an entity within a network?
2. What is an entity's overall importance in a network?
3. How central is an entity within a network?
4. How does information flow within a network?

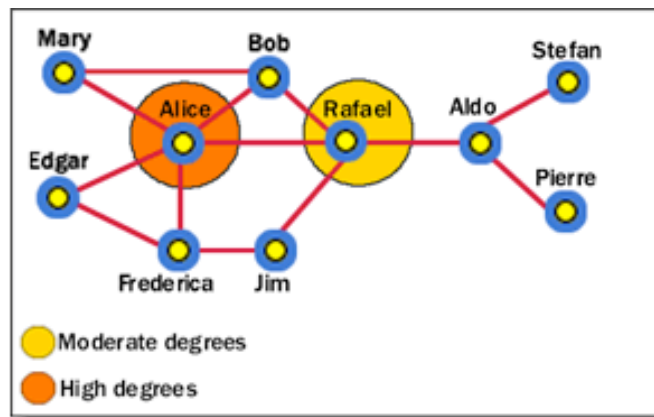
In this respect SNA provides a set of methodologies and formulas for calculating a variety of criteria that map and measure the links between things. Some of them will be discussed with concrete examples in the next chapter taken from real world tools examples. Following some example that has been taken from the specifications of a tool called Sentinel Visualizer (Copyright © FMS Inc.) .

## 3.6. SNA Metrics and Examples

### 3.6.1. Degree Centrality

Degree centrality is simply the number of direct relationships that an entity has. An entity with high degree centrality:

1. Is generally an active player in the network.
2. Is often a connector or hub in the network.
3. Is not necessarily the most connected entity in the network (an entity may have a large number of relationships, the majority of which point to low-level entities).
4. May be in an advantaged position in the network.
5. May have alternative avenues to satisfy organizational needs, and consequently may be less dependent on other individuals.
6. Can often be identified as third parties or deal makers.



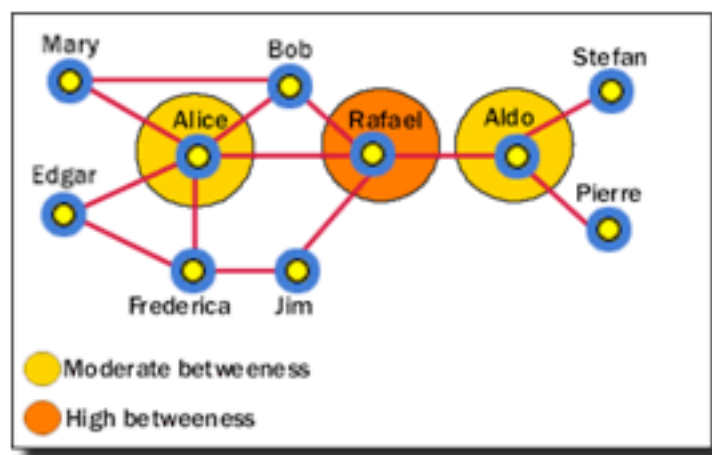
*Fig.3.2 - Degree Centrality Example.*  
(Copyright © FMS Inc.)

In the example-image above (Fig 3.2) Alice has the highest degree centrality (number of arches, representing direct relationships), which means that she is quite active in the network. However, she is not necessarily the most powerful person because she is only directly connected within one degree to people in her clique and she has to go through Rafael to get to other cliques.

### 3.6.2. Betweenness Centrality

Betweenness centrality identifies an entity's position within a network in terms of its ability to make connections to other pairs or groups in a network. An entity with a high betweenness centrality generally:

1. Holds a favored or powerful position in the network.
2. Represents a single point of failure. Take the single betweenness spanner out of a network and you sever ties between cliques.
3. Has a greater amount of influence over what happens in a network



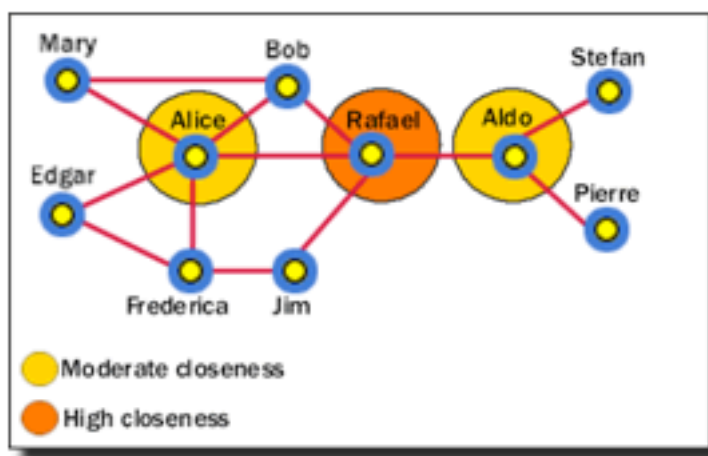
*Fig.3.3 - Betweenness Centrality Example.*  
(Copyright © FMS Inc.)

In the example above (Fig.3.3), Rafael has the highest betweenness because he is between Alice and Aldo, who are between other entities. Alice and Aldo have a slightly lower betweenness because they are essentially only between their own cliques. Therefore, although Alice has a higher degree centrality, Rafael has more importance in the network in certain respects.

### 3.6.3. Closeness

Closeness centrality measures how quickly an entity can access more entities in a network. An entity with a high closeness centrality generally:

1. Has quick access to other entities in a network.
2. Has a short path to other entities.
3. Is close to other entities.
4. Has high visibility as to what is happening in the network.



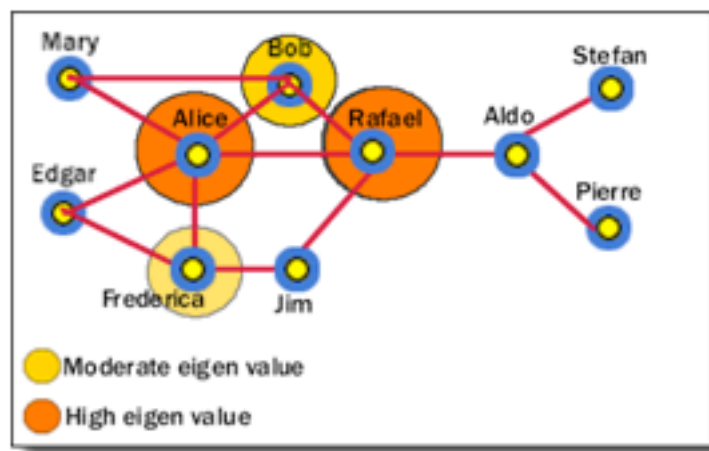
*Fig.3.4 - Closeness Example.*  
(Copyright © FMS Inc.)

As with the betweenness example, Rafael has the highest closeness centrality because he can reach more entities through shorter paths. As such, Rafael's placement allows him to connect to entities in his own clique, and to entities that span cliques.

### 3.6.4. Eigenvalue

Eigenvalue measures how close an entity is to other highly close entities within a network. In other words, Eigenvalue identifies the most central entities in terms of the global or overall makeup of the network. A high Eigenvalue generally:

1. Indicates an actor that is more central to the main pattern of distances among all entities.
2. Is a reasonable measure of one aspect of centrality in terms of positional advantage.



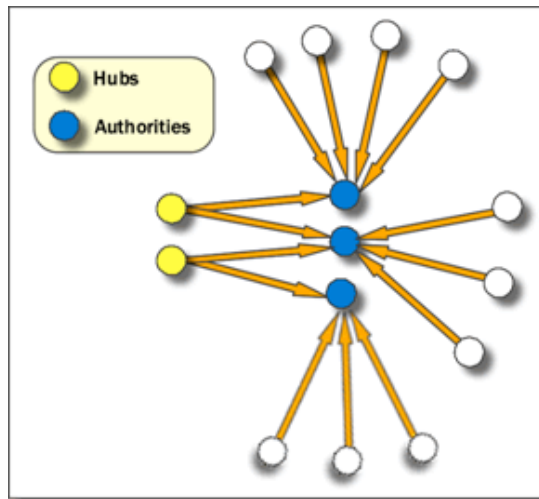
*Fig.3.5 - Eigenvalue Example.*  
(Copyright © FMS Inc.)

In this example, we can see that Alice and Rafael are closer to other highly close entities in the network. Bob and Frederica are also highly close, but to a lesser value.

### 3.6.5. Hub and Authority

If an entity has a high number of relationships pointing to it, it has a high authority value, and generally:

1. Is a knowledge or organizational authority within a domain.
2. Acts as definitive source of information.



*Fig.3.6 - Hub and Authority Example.*  
(Copyright © FMS Inc.)

Hubs are entities that point to a relatively large number of authorities. They are essentially the mutually reinforcing analogues to authorities. Authorities point to high hubs. Hubs point to high authorities. You cannot have one without the other.

## 3.7. SNA: Conclusions

There are some other possible measurements beyond the few ones proposed in chapter 3.6. Recent studies involve finding new ones and the most meaningful way to interpret them. Besides all of these different approaches we can classify them into two major groups: Direct/Subjective and Indirect/Objective.

Direct/Subjective are the ones in which the Social Network Model is built upon using data collected directly with surveys. This represents the most straightforward way, but has a big drawback: it can be biased by personal opinions or insincere answers.

The second type is the Indirect/Objective method, which thanks to the advent of Enterprise 2.0 and Social Networking Tools is becoming more and more popular.

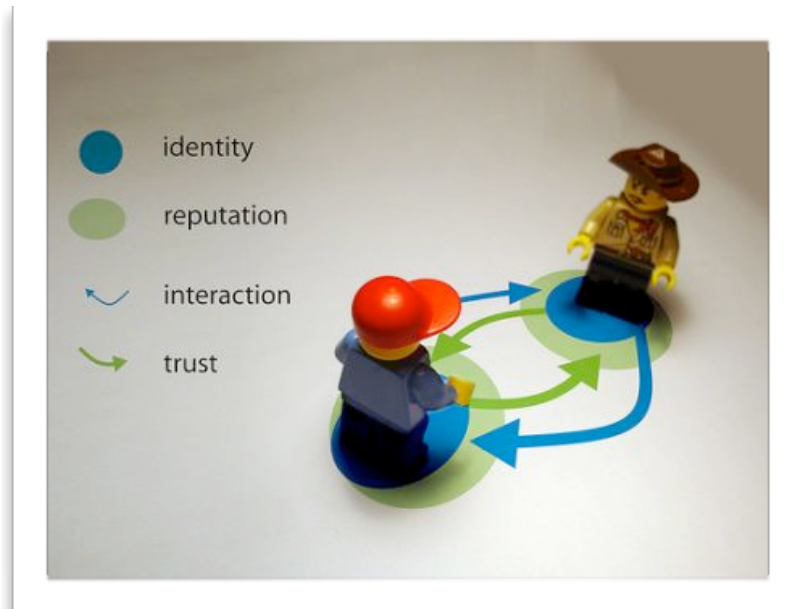
With the Indirect/Objective method the Social Network Model is built by collecting data observing the intranet network and the behavior of its members, like: who they email more often, which parts of the network they access, which parts they do not access, etc...

The method is obviously not biased by personal opinions or insincere answers but can be less effective than the former. Personal opinions, according to the type of investigation we are accomplishing, may matter.

In certain cases it would be nice to have a method able to collect indirectly personal opinions and balancing them with the community knowledge, avoiding thus the problem of biased or insincere answers. As it will be explained in chapter 7 **Reputation Community Evaluation (RCE)**, in conjunction with SNA, may be used in this way.



## 4. About Reputation and Online Reputation Based Systems



*Fig.4.0* - Reputation Based Systems are used to establish trust among members of on-line communities where parties with no prior knowledge of each other use the feedback from their peers to assess the trust worthiness of the peers in the community.

## 4.1. Introduction

Reputation is about what you do, what you say, and above all what other people say about you. This latter aspect implies reputation to be partially biased by peoples' specific points of view. Reputation evaluation is therefore, by the very nature of reputation itself, a very complicated task.

Reputation Based Systems try to accomplish this task to the best that current technology can, in the effort of automating traditional word-of-mouth reputation and to the aim of complementing the new opportunities provided by electronics markets such as **eBay** and **Amazon**. Nevertheless, just trying to mime in an online context the same situations we are all familiar with reputation in the physical world would introduce some pitfalls.

The internet provides us with a great amount of data about preferences, behavior patterns, and other details all theoretically very useful to build a good reputation system but, to make them concretely exploitable we need to find ways to use these data without naively believing in their quality.

Unfortunately, the field of reputation research is still young, and there are no clear technological solutions (*1, Dingleline et al., 2003*), now or on the horizon.

Chapter 4 aims is to explain how reputation translates in an online environment, laying out the problems in reputation theory and discussing the lessons we can learn from existing models.

This chapter is logically divided in four parts. Part one defines the concept of Reputation and Reputation System, exploring also the reasons why reputation Systems are today more than ever before important and why online reputation is not a less effective kind of reputation and, on the contrary, if well managed it has the potential to be even more effective.

Part two classifies online reputation systems according to functional and technical features considering 'real life' examples.

Part three is dedicated to the costs of reputation. Reputation entails costs, therefore if it is hard to provide reputation information people won't bother, whereas if you reward them in some way they will give more information.

Reputation systems also motivate people in ways similar to monetary economies. Reputation can be earned, spent, and traded; that's why in economics they talk of "economy of reputation". On these bases it will be demonstrated that since reputation is worth money any online system that is equipped with reputation systems can benefit of a raise in its value.

Part four generalizes some of the issues and presents some of the current solutions (even if partial) in current reputation systems, concluding that any robust online reputation system should take in account:

1. The type of feedback information that is collected in order to evaluate reputation (i.e. consider the right type of reputation system according to the problem to solve).
2. The form in which information feedbacks are distributed and represented (e.g. aggregated, complete history, time-windowed, etc...).
3. the interaction between pseudonymity and the economics of reputation (e.g. the relationship between reputation costs and reputation rewards).
4. The role of the reputation system in providing incentives for the provision of honest and accurate feedback information (e.g. introducing payment schemes).
5. And finally what algorithms can (or better theoretically could) guarantee the robustness of such a system (i.e. eliciting the right amount of feedback at the right time, eliciting truthful feedback and preventing strategic manipulation by participants).

Chapter 4 conclusions are that despite the many theoretical and practical problems with current online reputation systems it is possible to try to improve the situation by exploiting the latest findings in research (even though they are based on simplified models) and the experience gained from a variety of real systems, like eBay or Amazon. In particular, in a future in which reputation systems will play a more important role in any online identity management solution (2, Resnick et Al., 2000), **social and economical incentives will influence reputation systems design criteria in ways that contemporary approaches don't consider**.

## 4.2. About Reputation and Reputation Systems

The first aspect to be considered about reputation is that although by personal experience we all have an idea of what reputation means, this idea is often partial and doesn't cover all the complexity that reputation involves.

*A 'pocket' definition comes from Wikipedia:*

*"Reputation is the opinion (more technically, a social evaluation) of the public toward a person, a group of people, or an organization. its influence ranges from competitive settings, like markets, to cooperative ones, like firms, organizations, institutions and communities. It is an important factor in many fields, such as business, online communities etc..."*

In particular, when we talk of reputation in online communities we are talking of Reputation Systems, which are systems that attempt to attach reputation to an identity, in order to

make an ongoing assessment of that reputation by automating word-of-mouth reputation <sup>(2,</sup>  
*Resnick et Al., 2000)*.

At the base of any Reputation System there is linkability, that is the ability of linking actions to an identity, and then to make predictions about the identity's future actions <sup>(1, Dingleline et al., 2003)</sup>.

Reputation and linkability are fundamental in environments in which there is asymmetric information. Newspapers are a good example. A reader must pay for the good before evaluating the good, and the seller and publisher likely have better information about the quality of the product.

Without the ability to brand a product like newspapers, that is the ability to link the product to a reputation, the newspaper market would likely end up with quality products unable to differentiate themselves from low quality products and only low quality products surviving in the long-term <sup>(3, Akerlof, 1970)</sup>.

### 4.2.1. The Reasons Why Reputation Systems are so Important

What is so important about reputation is that whether it is online or offline it is always a big part of individuals identity. Reputation systems are therefore relevant because by exploiting reputation they attempt to better define the identity of the peers. It is clear then that every system that makes a point of safety in peers' identity should consider implementing some sort of reputation system.

A fundamental reading about the topic is "**A Crowd of One: The Future of Individual Identity**" (2007), by John H. Clippinger, Co-Director of The Law Lab at Harvard University. Following are some excerpt from his book where he writes about reputation systems:

"Reputation systems are an especially important aspect of social cooperation because they are attached to an individual and form the basis for whether they can be trusted and accepted. **A reputation is really the collection of tags that are assigned to an individual or entity to reflect assessments of their competence or status within a specific social network. ...**

In **eBay**, for example, a seller acquires a reputation score given to them by their buyers. Different reputation score levels not only make it more likely that others will do business with them, but it confers a certain status among other members of the eBay community. **To encourage participation, many online games depend upon accumulated scores, levels, roles and ratings of players.** So do many peer production undertakings such as **Wikipedia, Slashdot** and open source software development. ...

It is not difficult to see how important reputation tags are in small traditional societies where once a reputation is acquired, it may be very difficult to change. Honor-based

societies depend upon reputation tags as the principal governance mechanism for defining and enforcing a social order. "Honor killings" of a daughter or sister in order to preserve a familiar reputation suggest the power of reputation in Human Nature. Even in online communities, reputation tags are the motivator and governor of behaviors. **People take seriously the reputation scores of an eBay seller/buyer, the accumulated scores of a player of online games, or the number of friends and ratings one has in the online social networks of LinkedIn, Friendster, Facebook, or My Space.**

Identity is not something that can be self-defined. It is granted and modulated by one's roles, relationships, and reputations in a variety of social networks. **One's identity (whether it be an individual person, group or organization) is closely tied to reputation tags and roles in social networks. How you see yourself depends upon how other see and rate you.**

**Reputation tags affect an individual or group's ability to participate within and across different networks, thereby becoming the basis for granting/revoking certain privilege and decision rights."**

About online reputation systems there are also experiments that confirm their undeniable value. As an example Bolton, Katok, and Ockenfels in **"How Effective Are Electronic Reputation Mechanisms?"** (2003) utilized a two-stage game where in a simulated eMarketplace buyers decide whether to send money, and sellers then decide whether to ship the item. The conclusions are that in the reputation condition where subjects were informed of each other's past play, trust and trustworthiness increased as compared to a no reputation condition.

Assumed that Reputation Systems have an effective influence even in online context, yet another relevant aspect to be evaluated is if online reputation systems could be inherently useless simply because online reputation is a less effective kind of reputation.

#### **4.2.2. Is Online Reputation a Less Effective Kind of Reputation?**

Online reputations are built in ways in which parties with no prior knowledge of each other use the feedback from their peers to assess the trust they have in the other peers. The lack of personal knowledge and sometimes of community ties, clearly can affect the effectiveness of some Online Reputation Systems, involving some reliability issues. This could lead to question whether or not online reputation is something obsolete and should be substituted with different solutions. In the recent work, **"Is reputation obsolete?"** <sup>(5)</sup> , Judith Donath answers a clear no to the topic.

Following are some excerpts of the most significant parts of her paper.

"... Through discussion about others' actions, people establish and learn about the community's standards. Reputation is the core of rewards and sanctioning – **it amplifies the benefits of behaving well and the costs of misbehavior**. If I work with someone who turns out to be lazy and dishonest, by telling my friends about it, they are spared from a similar bad experience. Having access to reputation information is a big benefit of community membership: insiders know who to trust and how to act toward each other, while strangers do not get the benefit of other's past experiences... In light of this, it would seem that the answer to the question "Is reputation obsolete?" is "No"....

Reputation information exchanged within close-knit communities is more reliable, and members learn when assessments are biased. A colleague recently mentioned that she would never trust another recommendation letter from Professor X again – she'd seen too many in which he claimed that different students were "the top scholar I've known". In overzealously promoting the careers of his students, Professor X acquired a poor reputation for inflated praising. Most letter writers temper the desire to over-enthusiastically praise in order to remain credible in the eyes of their peers, realizing that this close-knit community assesses the assessors. **Without community ties, reputation is generally less useful...**

So, is reputation obsolete in an increasingly archival world? The answer, it appears, is "sometimes". When the immediate facts are primary, we should make use of the vast amount of archived material available. But when situations are ambiguous, when there are conflicting versions of events or codes of behavior, and when developing a shared culture is important (Merry 1997), reputation and the communicative, community-building process of creating it is far from obsolete...

**Your reputation is information about you, but it is not by you.** If you own your own words, then your reputation is owned not by you, but by the people who talk about you. Furthermore, it is a subjective judgment made in a specific context that may not translate well into another. **History is portable in ways that reputation is not...**

**In technologically mediated societies, evaluating the relative merits of history and reputation is especially important, for the habits of such communities are shaped by deliberate design."**

It is a fact that Internet is 'boosting' the field of Reputation Evaluation and Reputation Systems are changing the way reputation is managed and formed, it is also undeniable that Online Reputation Systems have sometimes disadvantages. For example on public rating sites such as eBay, where no community binds the rater and the reader of ratings, there is no check on reliability and the ratings function primarily as a social exchange between the rater and subject (6, David & Pinch, 2006). As a matter of fact as Donath states "**without community ties, reputation is generally less useful**", nevertheless since she states also "**reputation amplifies the benefits of behaving well and the costs of misbehavior**", reputation should play a fundamental role even in online environments, even more, **there are undeniable online-only advantages.**

In this respect, Lucio Picci, senior scientist for the European Commission and Associate Professor Department of Economics of University of Bologna, whose field of research consist in Reputation-based Governance, states that Internet innovates reputation systems in three major ways, in a summary of his research works for the Journal First Monday (7, Lucio Picci, 2007) :

*“**Firstly**, it allows to spread voice-of-mouth to an unprecedented level. This, in turn, permits the existence of reputation-based interactions — be them of the market type, or other — at a global level and among persons many degrees of separation apart.*

***Secondly**, the presence of a digital information infrastructure allows for a careful engineering of many details that contribute to the overall outcome of the system, such as: The condition under which the assessments are made, the metric according to which they aggregate to form a reputation index, the rules for participating and the possibility of changing one’s identity, etc.*

***Thirdly**, the Internet democratizes reputation systems, because it allows for their design so that all relevant parties may play the game under similar conditions. In conventional contexts information on reputation mostly spreads informally and via social networks: people who are better placed within them are at an advantage because they obtain better information. This, in turn, creates an incentive to spend time and resources to place oneself within such advantaged networks, a socially wasteful activity that economists would define as “rent seeking”*

In conclusion, online reputation is not by any means inferior to conventional reputation. On the contrary, it has the potential to be more effective and with a larger social impact. The obvious precondition is that the reputation systems chosen for the task are up to it. It is then necessary to investigate what current technology can offer us in terms of reputation systems and reputation metrics.

## 4.3. Online Reputation Systems and Reputation

### Metrics

As discussed in the previous chapter the process of filtering information to distill a smaller yet more refined set of usable, verified, trustworthy judgments is not easy, but is both more feasible and more necessary now than ever before, due to pressing socio-economic problems, technological advances and information proliferation, especially online.

According to **TrustLet** ([www.trustlet.org](http://www.trustlet.org)), a collaborative project for the scientific research of trust metrics on social networks, classifies the current major trust metrics in:

1. Local or Global.
2. Content Driven or Ratings Driven.

Which are currently applied in five major fields:

1. Peer to Peer File Exchange.
2. Internet Pages Ranking.
3. E-Commerce
4. Recommender Systems
5. Wiki edits, Spam Filtering of email, etc...

Current researches explore the possibility of applying trust and trust metrics in new fields of application. In this respect, web-based social networks look promising. Among the latest works "**Computing and applying trust in Web-based social networks**" (11, Golbeck, J. A., 2005) and "**Inferring binary trust relationships in Web-based social networks**" (12, Golbeck, J. A. and Hendler, J. 2006) there are present solutions to determine how much one person in a Web-based network should trust other people to whom he is not directly connected.

### 4.3.1. Local vs. Global Trust Metrics: What is Trust and what is Reputation?

A local trust metric predicts trust scores that are personalized from the point of view of every single user. For example a local trust metric might predict "Alice should trust Carol as 0.9" and "Bob should trust Carol as 0.1", or more formally  $\text{trust}(A,C)=0.9$  and  $\text{trust}(B,C)=0.1$

Local trust metrics start from the assumption that every single trust statement is an equally worthy subjective opinion and that there are no wrong opinions and that there are no global reputation values on which all the users must agree.

On the other hand, a global trust metric computes a single global trust value for every single user.

There are obviously reasons of using a local trust metric rather than a global one and vice versa.

Local trust metrics are particularly useful in order to avoid that the opinion of the majority exclusively drive the community (tyranny of the majority), however they might suffer from the risk that the user can lose the point of view of the community at large and relying just



on the opinions of few trusted users, which may invalidate the relevance of being part of a community itself.

Usually the choice between local or global trust metrics is a choice between computing reputation or trust. The concept of reputation is certainly closely linked to that of trustworthiness, and their differences have been extensively studied <sup>(8, Jøsang et Al., 2007)</sup>, nevertheless the fundamental difference for the purposes of this thesis is that reputation is a quantity derived from the underlying social network which is globally visible to all members of the network. Trust usually involves private knowledge about the trustee, e.g. through direct experience or a relationship. Often these factors are more important of any reputation that a person might have. So a person could trust you because of your good reputation or trust you despite your bad reputation <sup>(8)</sup>.

In the absence of personal experience, like in online environments, trust often has to be based on referrals from others or can be derived from a combination of received referrals and personal experience.

Reputation is also addressed as Objective Trust. In reality trust cannot be defined objectively, simply because every person is free to express a different level of trust in the other. For this reason, it is better to use the term "reputation" when referring to an aggregated value computed by a **global trust metric** trying to represent what the community as a whole thinks about a certain person or topic.

Of course different global trust metrics can compute different values of reputation for every individual and so not even the reputation can be called "objective" but simply an aggregation of the subjective trusts computed according to the characteristics of the global trust metric (simple majority vote, average, propagation of trust on the social network, ...).

Jøsang et Al. <sup>(8)</sup> describe the differences between trust and reputation systems as follow:

1. *"Trust systems produce a score that reflects the relying party's subjective view of an entity's trustworthiness, whereas reputation systems produce an entity's (public) reputation score as seen by the whole community."*
2. *"Secondly, transitivity is an explicit component in trust systems, whereas reputation systems usually only take transitivity implicitly into account."*
3. *"Finally, trust systems usually take subjective and general measures of (reliability) trust as input, whereas information or ratings about specific (and objective) events, such as transactions, are used as input in reputation systems."*

There can of course be trust systems that incorporate elements of reputation systems and vice versa. The **EigenTrust** model <sup>(9, Kamvar et Al., 2003)</sup> is an example of hybrid solution. It computes peers reputation scores in P2P networks through repeated and iterative multiplication and aggregation of trust scores. Similarly **PeerTrust** <sup>(13, Xiong et Al., 2004)</sup>, a reputation-based trust supporting framework, includes an adaptive trust model for

quantifying and comparing the trustworthiness of peers based on a transaction-based feedback system.

In final analysis it is not always clear whether a given systems should be classified as trust or reputation based, therefore the descriptions of the various trust and reputation **systems that follow must be considered in light of this consideration.**

### 4.3.2. Content-Driven Reputation Systems

Content Driven reputation is a metric suitable for collaborative web environments, such as wikis. This kind of reputation systems are usually tested (though none of them are implemented) on Wikipedia, to determine the level of trust one can have in its authors (an example: “**A Content-Driven Reputation System for the Wikipedia**” by Thomas Adler and Luca de Alfaro. WWW 2007 ).

This type of reputation metrics generally works as follows. The reputation of the authors is computed according to how long their contributions last in the Wikipedia. Specifically, authors whose contributions are preserved, or built-upon, gain reputation; authors whose contributions are undone lose reputation.

The value of a given person's contributions can then be evaluated as the product of Quantity of contributions (in characters of text and images uploaded) and Length of time the contributions remain posted.

Of course there are some problems with Content-Driven metrics. One major complaint is that if an article is undone it does not necessarily imply a fault of the author, the situation may simply have changed and the article needs therefore a major update.

Yet another example of content driven reputation system is Page Rank used for web searching engines (15, Sergei Brin and Larry Page,1998).

In the 1990's, web searching engines downloaded and catalogued millions of web pages. Engines responded to queries based on simple metrics, such as whether the page included the search phrase, and how many times a page included the search phrase.

Over time, people began "attacking" these search engines to steer visitors to their respective pages. People created pages with many common key words: if a page contained enough attractive words, search engines would be more likely to return it to users searching for that phrase. The attack was improved by creating many copies of a given page, thus increasing the likelihood that it would be returned.

In response to these attacks, and in hopes of developing more accurate search engines, researchers began evaluating alternative trust metrics for search engines. In 1998, Stanford researchers opened a new search engine, called **Google**, that uses reputation technology. Google's fundamental innovation is to determine a page's usefulness or *page rank* based on which pages link to it.

Google's trust algorithm can be visualized as follows: Begin on the front page of a very popular website (e.g., Yahoo, CNN, Slashdot, etc.). Now randomly follow links from the front page for a few minutes. The page you end up on receives a small amount of reputation. Repeat this operation millions of times. Over time, pages which are commonly linked to will emerge as having higher reputation because they are "more connected" in the web. Pages on the borders of the WWW will have lower reputation because few other pages point at them. Sites which are linked from many different reputable websites will be ranked higher, as will sites linked from extremely popular websites (e.g. a direct link from the main Amazon page to an offsite page).

Though complex, Google's reputation-based scheme results in far better results to search queries than other search engines.

### 4.3.3. Ratings-Driven Reputation Systems

What makes the Wikipedia and Page Rank examples content-driven reputation systems is that the reputation is computed automatically via text analysis.

This contrasts with other reputation systems, such as Peer to Peer file exchange where computer based cooperative infrastructures are usually very automated systems but still require a little manual intervention in order to provide trust informations.

Generally the reputation (trust) system in P2P networks follows four steps.

**Step 1:** a requestor  $r$  locates available resources sending a broadcast Query message to ask for the files it needs to download. Other peers will answer with a QueryHit message to the requesting node to notify that they have the requested resource.

**Step 2:** Upon receiving a set of QueryHit messages,  $r$  selects an offerer  $o$  and polls the community for any available reputation information on  $o$  sending a Poll message. As a result of step 2,  $r$  receives a set  $V$  of votes, some of which express a good opinion while others express a bad one.

**step 3:** reevaluates the votes to collapse any set of votes that may belong to a clique and explicitly selects a random set of votes for verifying their trustworthiness.

**step 4:** the set of reputations collected in step 3 is computed into an aggregated community-wide reputation value. Based on this reputation value, the requester  $r$  can take a decision on whether accessing the resource offered by  $o$  or not. After accessing the resource  $r$  can update its local trust depending on  $o$  whether the downloaded resource was satisfactory or not.

Of course there can be some variation over the basic P2P model and research is constantly active in finding alternative solutions <sup>(9, 13)</sup>.

Totally automated systems consider page view count or link count as an implicit trust data; other systems like P2P are just partially automated and require explicit users feedback. Among Systems belonging to the latter category Collaborative Filtering Systems [See chapter 1.5.3] seems to be very similar to P2P and to Rating-Driven Reputation Based systems. As a matter of fact in some ways they are similar, for instance they both collect ratings from members in a community, nevertheless they also have fundamental differences.

The assumptions behind Collaborative Filtering Systems is that different people have different tastes, and therefore rate things differently. If two users rate a set of items similarly, they share similar tastes. This must not be confused with reputation systems which are based on the opposite assumption, namely that all members in a community should judge the performance of a transaction partner or the quality of a product or service consistently.

People will for example judge data files containing film and music differently depending on their taste, but all users will judge files containing viruses to be bad.

Collaborative Filtering systems can be used to select the preferred files in the former case, and reputation systems can be used to avoid the bad files in the latter case.

Another important point is that Collaborative Filtering Systems assume all participants to be trustworthy and sincere, i.e. to their job as best they can and to always report their genuine opinion. Reputation Systems, on the other hand, assume that some participants will try to misrepresent the quality of services in order to make more profit, and to lie or provide misleading ratings in order to achieve some specific goal.

It can be very useful to combine Collaborative Filtering and reputation systems. As an example in 2005 Avesani et Al. <sup>(10)</sup> proposed **Moleskiing**, a trust-enhanced recommender system application. **Amazon.com** also does this to a certain extent letting users rate each item, and using then this information to score the item and to tailor on single customer flavor advice concerning other products they may want to purchase.

E-commerce website usually adopt soft implementations of Rating-Driven Reputation Systems, where users declare a feedback for each transaction and the reputation is then calculated using trust metric algorithm. A similar soft approach is often adopted by website that rely on User Generated Contents (e.g. YouTube, see chapter 1.5.2), where users are encouraged to rate other users' contents.

An example of more 'aggressive' usage of a Rating-Driven Reputation Systems is represented by **eBay**, which uses reputations at the heart of its online auction system for ranking buyer and seller honesty.

Because buyers and sellers on eBay usually have never met each other, they need to decide whether or not to trust each other.

To help them make the decision, eBay collects feedback about each eBay participant in the form of ratings and comments. After a trade, eBay users are encouraged to post

feedback about the trade and rate their trading partner. Good trades, in which the buyer and seller promptly exchange money for item, yield good feedback for both parties. Bad trades, in which one party fails to come through, yield bad feedback which goes into the eBay record. All this feedback can be seen by someone considering a trade.

The idea is that such information will lead to more good trades and fewer bad trades. As we'll see this isn't always the case in practice, but it is often enough to give eBay a reputation of its own as the preeminent web auction site.

## 4.4. Reputation as a Social and a Real Capital

There are many sites with reputation systems of some sort. The eBay system is undoubtedly the biggest and best known, and is also a clear example of the economical implications that a reputation system can have in an online community. Reputation itself is in economy addressed as a social currency, a nice definition of social currency comes from the book '**Identity, Reputation, and Social Currency**', by John H. Clippinger.

*"A social currency is the reputation score an individual or entity acquires in a particular social network that credibly reflects their value in that network. For example, like a monetary currency, the value of a social currency may be set by the demand that an individual in a given social network can command, as in some kind of supply and demand calculation. Yet the calculation may also reflect a more subtle calculation of value based upon peer ratings of performance that cannot be captured in measures of supply and demand.*

*Different social networks have their own social currencies reflecting their reputation and membership rules. Highly proficient members of these networks - those who know how to truck, barter and exchange - can accumulate their own form of social capital - i.e., favors, obligations, goodwill. In many cases, they can convert one social currency into currencies in other social networks. For example, success in sports is often convertible to success in politics, business and entertainment. Likewise, social currencies accumulated in a business network are generally convertible into the currencies of social standing and political credibility. "*

So reputation is considered in the economy as a currency in the sense that it has an **INTANGIBLE VALUE** yet **CONCRETELY SPENDABLE** and therefore can be considered exploitable at the level of every other type of economical capital. Even more, reputation has properties beyond the traditional capitals, it is: **Secure** and **Transitive** (Source: *The Open Privacy Project*).

Secure because reputations cannot be subverted, and the source of reputation assertions can always be traced, especially in online communities. Transitive because, as an

example, if A trusts B as a source of local news, and B trusts C for local news, then it could be determined that A trusts C for local news.

The economical implications of reputation in online systems *have* been in the last few years evaluated by a discrete number of theoretical studies and a fairly large number of empirical studies which for the most part involved the study of the effects of eBay's reputation system on sales (16, 17, 18, 19, 20, 21, 22).

*One of the most complete and recent empirical experiments is “The value of reputation on eBay: A controlled experiment.” (16, Resnick et Al., 2006) .*

In this work the authors prove that eBay sellers with a higher reputation can on average affect buyers' willingness-to-pay more till an 8.1% of the medium selling price of a certain type of good (in this case they were selling collectable postcards). They also consider other 15 similar papers, which in different circumstances and with different type of goods got to similar conclusion.

**The relevance of these studies on eBay reputation systems lies in the fact that they demonstrate that a reputation system is able to affect the perception of the quality of the goods. An item associated with the reputation of a seller is more valuable than the same item not “tagged” with any reputation information. So it is clear that a reputation system increases not only the value of single items but also of the system as a whole. For instance an eBay without any reputation system would be much less valuable than the current eBay, and likely less popular.**

## 4.5. Problems and Solutions in Reputation Systems

From the eBay experiments it is clear that useful reputation mechanisms cannot and should not be designed without regards to the economics aspects that the task involve, but rather through a careful consideration of both the computational and incentive aspects.

According to Roger Dingledine et Al. <sup>(1)</sup> the main design considerations for a reputation system should include:

1. The type of feedback information that is collected in order to evaluate reputation (i.e. consider the right type of reputation system according to the problem to solve);
2. The role of the reputation system in providing incentives for the provision of honest and accurate feedback information (for example via payment schemes);
3. The form of information feedback that is distributed (e.g. aggregated, complete history, time-windowed, etc.);
4. the interaction between pseudonymity and the economics of reputation;
5. The robustness of a system against strategic manipulation by participants.

In the following subchapters tries a classification of main Reputation Systems problems and the solutions currently available, even if sometimes they are only partial.

#### 4.5.1. Problem 1: Reputation Involves Costs and Needs Rewards

We have seen that if buyers are uncertain about seller trustworthiness, they will reward better seller reputations by raising their offers. At the same time we must consider also that it is costly to maintain a reputation for high quality, at least in time and effort, than a good reputation needs to be rewarded by at least the cost of building one. Similarly a bad reputation or a decline in reputation should incur a loss that exceeds the benefit from opportunistic behavior (18, Shapiro, 1983). Thus, in equilibrium, a good reputation must command a price premium. Therefore in eBay, since sellers who get negative feedback can start over relatively easily, buyers (or the system by default) should impose some disadvantage on sellers with no feedback at all (34, Friedman *et Al.*, 2001).

We should also expect that buyers will not provide information to help determine seller reputations, since to do so incurs a cost (effort and/or time). Unfortunately free riding is hard to punish and for instance eBay reputation system doesn't do anything about that, so in practice it doesn't represent the pure rational game-theoretic processes (Resnick and Zeckhauser, 2002).

#### 4.5.2. Problem2: Avoiding Balance of Powers and Transferability of Reputation

In some rating based reputation systems it is to most raters' perceived advantage that everyone agrees with the rater. This is how chain letters, Amway, and Ponzi schemes (24, 25) get their skills: they establish a system in which customers are motivated to recruit other customers.

This issue with reputation systems is known as reputation transferability.

Let's make an example. If a vendor offered to discount past purchases if enough future customers buy the same product, it would be hard to get honest ratings for that vendor. All the buyers, in order to foster new selling and get the discount, would rate the vendor very high.

This example applies to all kinds of investments. Once you own an investment, it is not in your interest to rate it negatively. To mitigate the problem some propose to apply **complete ubiquitous anonymity** to the rating system. This would discourage alleys between buyer and sellers or, unfortunately there are no reputation systems that currently work **completely anonymously** and remain safe (1, Dingleline *et al.*, 2003).

As an example of badly managed balances of powers it can be considered once again eBay. The most striking feature about eBay feedback system is that it is so positive. Sellers receive negative feedbacks only 1% of the time, and buyers 2% (2, Resnick et Al., 2000). Nevertheless we must consider that buyers are in a less powerful position than sellers. This consequently leads to problems with leaving negative feedback, even when deserved, because of fear of an implicit threat of retaliation or the need to have to deal with other party's reaction. The consequence is an artificial low rate of negative feedback and fraud (26, Ben Gross, Alessandro Acquisti, 2003).

In the years some improvements have been proposed to the eBay system in order to mitigate the problem, like:

1. Seller provides the first feedback (26)
2. Blind Reviews (26)
3. Decouple service and feedback trust (27)

None of this solution is definitive but certainly they would improve the eBay system, nonetheless eBay still does not apply any of them. According to Ben Gross and Alessandro Acquisti (26) the reason is that eBay has convenience in appearing to provide a more trustworthy marketplace. The consequences are obvious: many undocumented frauds.

### 4.5.3. Problem 3: Fraud

In this respect it is once again useful and interesting to consider some events that happened and are still happening at eBay.com.

*"In mid-2000, a group of people engaged in eBay auctions and behaved well. As a result, their trust ratings went up. Once their trust ratings were sufficiently high to engage in high-value deals, the group suddenly 'turned evil and cashed out.' That is, they used their reputations to start auctions for high-priced items, received payment for those items, and then disappeared, leaving dozens of eBay users holding the bag."* (28)

This type of attack can be expanded from single entities to entire companies. As an example if a corporation planning a transaction of some millions, would decide to base its decisions on websites that computes and publishes reputations for companies a dishonest vendor might want to forge or use bribes to create good feedback to raise his resulting reputation.

At eBay they tried to mitigate the "cash and run" problem with a tracking mechanism for past transactions that includes transactions details plus a textual description of the outcome of the trade by the buyer (Fig.4.1).



Periodo: <input type="text" value="Tutti"/>		
Feedback / Oggetto	Dall'acquirente / Prezzo	Data/Ora
veloce e preciso ottimo venditore CHIAVETTA WIRELESS WIFI 54Mbps penna USB WI-FI antenna (#380140198292)	ik1hzu ( 175  ) EUR 11,95	29-lug-10 21:35 <a href="#">Vedi l'oggetto</a>
eccellente, come sempre++++ TESTER CAVO CAVI DI RETE RJ45 RJ11 BNC RJ-45 UTP FTP (#120434579239)	virpiricone ( 114  ) EUR 7,49	29-lug-10 21:20 <a href="#">Vedi l'oggetto</a>
eccellente, come sempre++++ PLUG UTP CAT.5E connettori CAVO DI RETE 8P8C RJ45 n.100 (#380182620481)	virpiricone ( 114  ) EUR 7,99	29-lug-10 21:20 <a href="#">Vedi l'oggetto</a>
eccellente, come sempre++++ CAVO PIGTAIL ADATTATORE ANTENNA WIFI WIRELESS Rp-Sma N (#400092896795)	virpiricone ( 114  ) EUR 7,99	29-lug-10 21:20 <a href="#">Vedi l'oggetto</a>
eccellente, come sempre++++ ROUTER WIFI WIRELESS ACCESS POINT TL-WR641G 108Mbps LAN (#180530683040)	virpiricone ( 114  ) EUR 21,99	29-lug-10 21:20 <a href="#">Vedi l'oggetto</a>

Fig.4.1 - eBay tracking mechanism for past transactions

Given the rarity of negative ratings in eBay system (below 1%), they should be much more consequential than positives in affecting a seller's overall reputation and the specifics of negatives should be much more informative (2, Resnick et Al., 2000).

However, eBay offers no search mechanism to find negatives. Therefore the eBay solution is far from perfect, it mitigates the problem of “cash and run” but leaves still the possibility of perpetrate it. Nevertheless, assuming truthful feedbacks, in which buyers provide negative feedback if and only if the actual quality is sufficiently less than the reported quality, Miller demonstrated that binary reputation mechanisms like the eBay ones can be well-functioning and provide incentives for sellers to resist the temptations of "misrepresentation and sloth" (35, Miller et Al., 2002). Even more, Dellarocas (33) has considered the role of the type of information that is disseminated by reputation systems based on feedback information, and demonstrated that it is sufficient to provide eBay-style aggregate information instead of a full feedback history.

The limit of the works of Dellarocas and Miller are the assumptions they are based on, in fact the model they assume imply cooperation by buyers in providing truthful and complete feedback, which in practice excludes most part of the the Games Theory findings (especially doesn't consider the existence of any Nash Equilibrium).

Why then does eBay survive? What happens in practice is that eBay still works decently because a few of vocally unhappy customers mean that a vendor's reputation is completely ruined (2, Resnick et Al., 2000).

#### 4.5.4. Problem 4: Verifying and Validating Assertions

So if just a few unhappy buyers can ruin a seller's reputation it is clear that yet another thing that is affecting the eBay system is that ratings are sometimes biased and not verifiable. eBay customers don't have the clear perception of this because of the unequal Balance of Powers discussed in the previous chapter.

How then to solve the problem of verifying assertions? For instance being able to prove the existence of transactions makes it more difficult to forge a large numbers of entities or transactions. EBay users currently are able to directly "purchase" a high reputation by giving eBay a cut of a dozen false transactions which they claim to have performed with their friends. With transaction verification, they would be required to go through the extra step of actually shipping goods back and forth (2, Resnick et Al., 2000).

Validation means also making sure that the statements about some transactions were actually made by the person to whom it is attributed.

One fundamental limitation of reputation systems in online settings is the difficulty of ensuring that each entity only presents a single identity to the system.

Individuals may expose some pseudonym identifier to the system, to which sets of attributes or credentials are bound. So given a set of statements not linked directly to real people, how can we believe them? Of course, one obvious solution to this problem is the introduction of centralized, trusted authorities to authenticate individuals when they register a pseudonym with the system.

Cryptographic techniques known as *blinding* may be used to prevent the authority from linking entities to pseudonyms while still ensuring that an entity can only present one pseudonym to some system environment at any given time. Unfortunately such security often raises an individual's barrier to entry, therefore in practice in normal online contexts are just used classic authentication techniques that only considers whether a presented identity corresponds to the expected entity, but not whether the authenticated identities are distinct from one another. The consequence is that in a virtual setting it may happen that a single person create and control multiple distinct online identities. Thus a dishonest person may establish multiple, seemingly distinct, pseudonyms that all secretly collaborate with each other to attack the system (see "shilling", next chapter).

One technique in a distributed setting to bound the number of pseudonyms that an adversary controls involves requiring "proofs of work" for participating.

To make reputation attestations, users must perform time-consuming operations (2, Resnick et Al., 2000). For example, reviews at online communities (which go toward the reputation of products or services) generally take the form of written descriptions of users' experiences, as opposed to merely assigning some numeric score.

Making one's reputation should also cost something, at least in time, in order to reduce the willingness of switching pseudonym easily after having dedicated to it lots of effort. An example of this type of mental mechanism comes from computers hackers. Computer hackers must protect their personal identities with pseudonyms. If hackers use the same nicknames repeatedly, this can help the authorities to trace them. Nevertheless, hackers are reluctant to change their pseudonyms regularly because the status associated with a particular nickname would be lost (30, Kollock, 1998).

Other online systems may attempt to establish that users are actually humans rather than automated scripts, such as the graphical "reverse Turing tests" employed by Yahoo Mail,

where the user must read a distorted word from the screen, or describe what word characterizes a given picture (see [www.captcha.net](http://www.captcha.net)).

Usually web portals requires also users to login -- i.e., a centralized storage and authentication facility -- in this contexts posted statements are implicitly valid and bound to pseudonyms. When centralized, trusted storage or aggregation entities are assured, users posting statements under their respective pseudonyms know that their rating will be included in their target's report or aggregated totals. For example, eBay ensures that they expose all the feedback on a given user. Furthermore, they can limit feedback to those identities performing a transaction, i.e., the winner of an auction, to limit shilling attacks.

However, while these approaches may bind the number of pseudonyms or attestations, they certainly cannot ensure the one-to-one correspondence.

Friedman <sup>(34)</sup> considered the social cost of cheap pseudonyms, and noted that participants that can effortlessly adopt a new pseudonym should rationally do so whenever their reputation falls below that of a newcomer to a system. As one solution, Friedman proposes that participants can choose to adopt {once-in-a-lifetime} (1L) pseudonyms for particular arenas, such as product classes on eBay or discussion threads on Slashdot. These 1L pseudonyms allow a participant to commit to maintaining a single identity and can be implemented with a trusted intermediary and the standard encryption technique of blind signatures.

The inability to easily bind pseudonyms to single identities, and therefore being in the situation in which it is easy to forge many pseudo identities leads to severe security problems that in literature are addressed as shilling.

#### 4.5.5. Problem 5: Shilling

Among the simpler attacks that a reputation system can suffer the simplest yet most highly spread and dangerous, is called *shilling*. This term is often used to refer to submitting fake bids in an auction, but it can be considered in a broader context of submitting fake or misleading ratings, often exploiting identity forgery like it has been discussed in the previous chapter.

In particular, a person might submit positive ratings for one of her friends (positive shilling) or negative ratings for her competition (negative shilling).

Either of these ideas introduces more subtle attacks, such as negatively rating a friend or positively rating a competitor to try to trick others into believing that competitors are trying to cheat.

Shilling is a very banal attack, but today many systems still remain vulnerable to it. A very notable example is the AOL Instant Messenger system where one can click to claim that a given user is abusing the system <sup>(2, Resnick et Al., 2000)</sup>. Since there is no support for detecting multiple comments from the same person, a series of repeated negative votes will exceed the threshold required to kick the user off the system for bad behavior, effectively denying

him service. Even in a more sophisticated system that detects multiple comments by the same person, an attacker could mount the same attack by assuming many different identities. So the solutions for shilling attacks are the same that apply to the problem of verifying and validating users assertions (Chapter 4.5.4).

Other typical problem with rating-based reputation systems is that sometimes it is very difficult to collect enough information to provide an associated reputation for every entity. The simplest imaginable reason is a very low volume of transactions or activity by the users.

#### 4.5.6. Problem 6: Bootstrapping the System

Reputation-based trust must have some method to bootstrap the system (2, Resnick et Al., 2000).

After a system starts but before sufficient ratings have been collected, how is it possible to make decisions? Sometimes, like in noncommercial domains, it may be fine to list some entities and declare no knowledge or preference. In others, it may be more reasonable to list only entities for which a sufficiently certain score is known. Initial ratings could be collected by user surveys or polls relating only to known out-of-band information, such as if the entity exists in some alternate real-world domain. As the user continues to participate, the system can collect more feedback based on transactions, interactions, etc... .

The process of building a profile for new users is an ongoing process throughout the entire lifetime of the system.

To efficiently bootstrap a reputation system it is vital to leverage on the reasons that make people willing to use the application in which the reputation system is placed.

A certain amount of studies on the reasons of online participation have been undergone in last few years.

Most online communities grow slowly at first, due in part to the fact that the strength of motivation for contributing is usually proportional to the size of the community. As the size of the potential audience increases, so does the attraction of writing and contributing, creating a virtuous cycle.

Community adoption can be forecast with the **Bass Diffusion Model** ("Diffusion of new products: Empirical generalizations and managerial uses", 1995), originally conceived to describe the process by which new products get adopted as an interaction between early adopters and those who follow them. The key for a successful online community is to motivate participants.

### 4.5.7. Problem 7: The REAL Reasons of Participations (And Not Participation)

Several motivations lead people to contribute to virtual communities and several researchers have investigated the matter.

Peter Kollock <sup>(30)</sup> researched motivations for contributing to online communities in his book “**Communities in Cyberspace**”. In the chapter entitled "The Economies of Online Cooperation: Gifts and Public Goods in Cyberspace" he outlines three motivations that are interesting because do not rely on altruistic behavior of the contributor: ***anticipated reciprocity, increased recognition, and sense of efficacy.***

**Anticipated reciprocity.** Active participants in online communities get more responses faster to questions than unknown participants. A person is motivated to contribute valuable information to the group in the expectation that one will receive useful help and information in return.

**Increased recognition.** Recognition is important to online contributors such that, in general, it is a key ingredient for encouraging community participation and reputation development.

**Sense of efficacy.** Individuals may contribute because the act results in a sense of efficacy, that is, a sense that they have had some positive impact on the group and, sometimes, on their own self-image as an efficacious person. In this respect Wikipedia is a good example since the changes that ones can make on any article are immediate, obvious, and available to the world.

Another motivation, implicit in the above is **Sense of community**. People, in general, are fairly social beings and it is motivating to many people to receive direct responses to whether one's contribution was helpful or not.

In contrast to participants many people who join virtual community spaces remain lurkers and do not post.

**There are several reasons why people choose not to participate online:** having nothing to say/share, getting what they needed without having to participate actively, thinking that they were being helpful by not posting, wanting to learn more about the community before diving in, not being able to use the software because of poor usability and not liking the dynamics that they observed within the group <sup>(30, Kollock, 1998)</sup>.

The work of Kollock, in one sense is very exhaustive and on the other hand has the limitation of being mostly based on peoples' opinions and studies based on surveys. Unfortunately often people don't say all the truth.

A more recent work, among others, which nicely explore the matter from a more practical point of view is “**Six degrees of reputation: The use and abuse of online review and recommendation systems**” by David Shay and Trevor John Pinch, 2006.

In this work Shay and Pinch, use as an example the famous e-marketplace Amazon.com to demonstrate concretely that reasons of online participations are mostly bound to economical factors rather than peoples’ good will. Shay and Pinch choose Amazon since they sell predominantly books that are a particular kind of goods for which reviews are particularly powerful because they help establish the meaning of the artifacts in question. Moreover, at Amazon reviewers are invoked as a legitimate authority even though the only thing required in order to be a reviewer is participation.

Shay and Pinch found out that Amazon reviewer participate:

- A. To share their opinion with the community,
- B. To build an identity as a reviewer,
- C. To get a job as a professional book reviewer,
- D. Empowerment of seeing their name and review on a Web site and take pride in their ability to ‘publish’,
- E. To legitimately (or not) promote a certain item,
- F. Slur the competition attack others via posting negative reviews,
- G. Self Promotion: “Reviews” from friends, paid professionals, author,
- H. Review plagiarism (to promote or support the sales of a specific item, agenda, or opinion.),
- I. To increase credibility and to build their identity,
- J. Socket Puppets: Posting the same review multiple times for the same item, under different reviewer names,
- K. Used simply for free advertisements or spamming,
- L. Promotion of political agendas.

So in many cases people contribute in the perspective of getting a direct or an indirect economical advantage. This does not always turn out to be a security or a resource-reliability problem, but often it does. Similarly famous, is the case of Microsoft found guilty for paying for reviews on wikipedia to promote their products <sup>(31, Richard Chapo, 2007)</sup>.

The conclusion is that economical factors are predominant in reputation based systems, and solving the problem of providing incentives for reputation systems to effectively elicit the right amount of feedback, at the right time and with the right level of detail, can be turned to the problem of leveraging on the “economy of reputation” <sup>(2, Resnick et Al., 2000)</sup>, which also implies leverage on economical factors or constraints to push security and reliability.

#### 4.5.8. Problem 8: Finding Economical Means to Incentive Participation and Leverage on Them to Protect or Improve *Security and Reliability*

We now have all the elements to conclude that the best type of incentives for community participation are the economical ones. The problem of finding nice means for providing such incentives can be reduced to a problem in the standard framework of social-choice theory, that seeks to implement good system-wide outcomes in systems with self-interested participants.

Recent years have seen some interesting theoretical analysis that addresses different methods to tackle each of these challenges, although the analysis is often performed for quite stylized models, e.g. with simplified assumptions, and they are mostly not completely usable in practice, we can still draw some useful conclusions.

As an example in “**Market of Evaluators**” (39, Avery et Al., 1999) they consider the problem of eliciting the right amount of feedback about a product of a fixed quality, such as a new restaurant or a new Broadway show. Noting that the value of information in early feedback is higher than in late feedback because it can improve the decisions of more individuals, payment schemes are proposed to provide incentives for a socially-optimal quantity and sequencing of evaluations. Early evaluators are paid to provide information and later evaluators pay to balance the budget, to mitigate the tendency for an under-provision of evaluations and internalize the system-wide value-of-information provided by early feedback. **But in practice the proposed model is unrealistic because it assumes full and honest evaluations.**

Miller et al. (35) suggests the use of proper scoring rules to elicit honest and truthful feedback from participants in a reputation system. The basic idea is to make payments based on how well feedback predicts the feedback from later participants. Thus, in addition to collecting, aggregating, and distributing information, the reputation system also **provides rewards and imposes penalties based on the feedback provided by participants**. In the setting of an electronic market, feedback information provided about a particular seller by a buyer is used by the intermediary to infer *posterior* distributional information about the future feedback on that seller.

The buyer then receives a payment that is computed, according to a proper scoring rule, so that the expected payment is maximized when the buyer provides truthful feedback and maximizes the predictive accuracy of the posterior distribution and honest reporting is a Nash equilibrium.

**The only problem that remains is that there are many Nash equilibrium of the proposed payment scheme, so the proposed methodology is in practice too risky to be applicable in a real context.**

**Nash Equilibrium** (source: wikipedia)

In game theory **Nash equilibrium** (36, John Nash, 1950) is a solution concept of a game involving two or more players, in which each player is assumed to know the equilibrium strategies of the other players, and no player has anything to gain by changing only his or her own strategy unilaterally. If each player has chosen a strategy and no player can benefit by changing his or her strategy while the other players keep theirs unchanged, then the current set of strategy choices and the corresponding payoffs constitute a Nash equilibrium.

Stated simply, A and B are in Nash equilibrium if A is making the best decision he can, taking into account B's decision, and B is making the best decision he can, taking into account A's decision. Likewise, a group of players is in Nash equilibrium if each one is making the best decision that he or she can, taking into account the decisions of the others. However, Nash equilibrium does not necessarily mean the best cumulative payoff for all the players involved; in many cases all the players might improve their payoffs if they could somehow agree on strategies different from the Nash equilibrium (e.g. competing businesses forming a cartel in order to increase their profits).



## 4.6. Conclusions

Despite the many theoretical and practical problems with online reputation systems it is possible to improve the current situation in many ways, exploiting the latest findings in research (even though they are based on simplified models) and the experience gained from a variety of real systems, like eBay or Amazon.

It's been also demonstrated that since reputation is worth money any online system that is equipped with reputation systems can benefit from a raise of in its value. Nonetheless, currently website like eBay do not push to apply more advanced solutions, due to the fact that they have more convenience in being less safe but appearing to be more trustworthy. At the same time, it must be recognized that a more sophisticated reputation systems could discourage users participation, as a matter of fact maintaining a reputation for high quality costs at least in time and effort. Therefore a good reputation needs to be rewarded by, at least, the cost of building one. How to provide such rewards for keeping the system robust is still a not sufficiently defined task.

**What appears to be clear, instead, is that social and economic incentives influence reputation systems design criteria in ways that a purely technological discussion don't consider**, and while the field of reputation system research is still quite young, it is evident that in a future in which reputation systems will play a more important role in any online identity management solution (2, *Resnick et Al., 2000*), this aspect will be crucial.

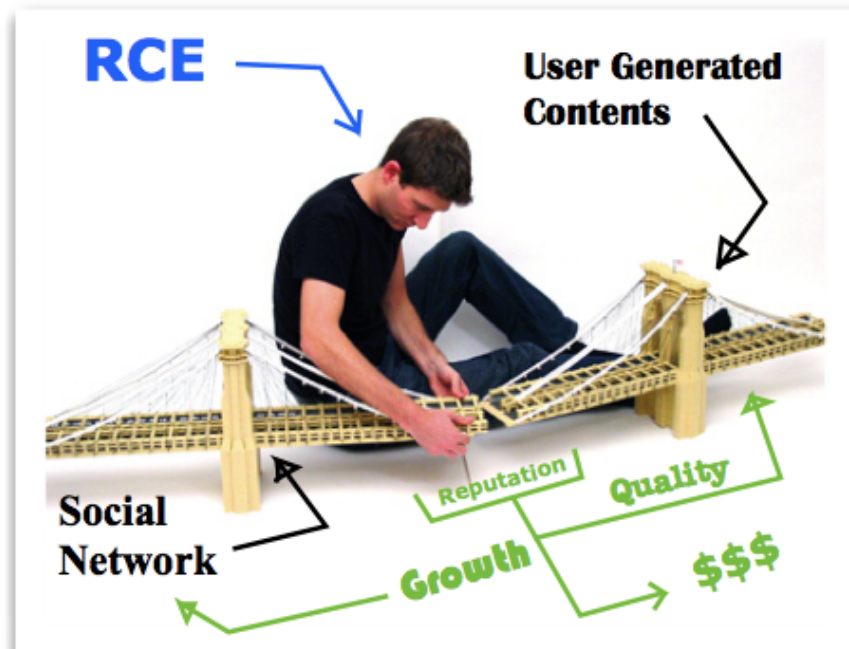
In conclusion, trying to summarize the characteristics of the (so far) state-of-the-art reputation system, it should take in count five aspects:

1. The type of feedback information that is collected in order to evaluate reputation (i.e. consider the right type of reputation system according to the problem to solve);
2. The form in which information feedbacks are distributed and represented (e.g. aggregated, complete history, time-windowed, etc.);
3. The interaction between pseudonymity and the economics of reputation (e.g. the relationship between reputation costs and reputation rewards);
4. The role of the reputation system in providing incentives for the provision of honest and accurate feedback information (e.g. introducing payment schemes);
5. Finally what algorithms can (or better theoretically could) guarantee the robustness of such a system (i.e. eliciting the right amount of feedback at the right time, eliciting truthful feedback and preventing strategic manipulation by participants).

Next chapter is about **Reputation Community Evaluation** (RCE), which is a way of merging together a unique solution with the characteristics of the state-of-the-art reputation system above mentioned, tailoring them for the specific needs of digital communities which

rely on User Generated Contents (e.g. some WEB2.0 and Enterprise2.0 communities) with the purpose of ensuring standards of quality and fostering communities growth.

## 5. Reputation Community Evaluation (RCE)



*Fig.5.0 - RCE = Bridging User Generated Content Evaluation with Community Members Evaluation.*

## 5.1. Introduction

In Chapter 4 the focus was on reputation, reputation systems, online reputation systems issues and solutions. In this chapter the focus is on **Reputation Community Evaluation (RCE)**, a new type of **reputation metric** or **reputation evaluation model** tailored for the needs of digital communities which rely on User Generated Contents (UGC).

Currently the vast majority of digital communities are WEB-based, as the chapter opens with classifying them by three main factors: the presence of **User Generated Contents**, the existence of a **Rating System** for evaluating the UGC and the use of an explicit **Reputation System** for ranking UGCs' producers. According to this classification the RCE meta-model and the associated algorithm will be derived and explained; detailing differences, possible scenarios of application and benefits over the existing solutions.





### 5.1.1. How User Generated Contents, Rating Systems and Reputation Systems blend together into the Web

In chapter 4 it has been determined that picking the right type of reputation system consists in considering factors such as the goal we are pursuing, the type of resources involved and the kind of audience (community) it is aimed to.

Web applications that rely on any kind of reputation model are no exception, therefore we can try a classification considering the three main elements that are influenced by the aforementioned factors:

1. The presence of User Generated Contents;
2. The presence of a Rating System;
3. The presence of a Reputation System.

Following this criterion it is possible to associate to each kind of web application that rely on one or more of the elements listed above, to a reputation model, see table 5.1 (comments after the table).

Application Type	UGC (Users Generated Contents)	Rating System	Reputation System	Reputation Model
amazon (e-shops)	/	★	/	Soft Ratings Driven
ebay (auction based e-shops, P2P)	/	★ <sup>n</sup> → 1 ▲	▲	Ratings Driven
 (wiki, forums)	 or  n	/	▲ 1 ↑	Contents Driven
YouTube Broadcast Yourself™ (UGC-based web apps: youtube, blogs..)	 1 → n	★	/	Soft Ratings Driven

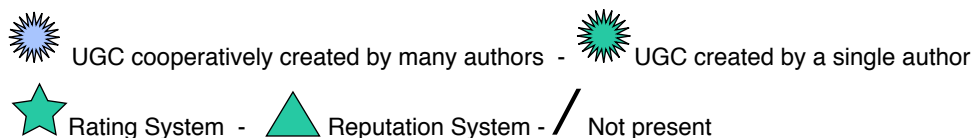


Table 5.1

In table 5.1, the first row, it can be noticed that E-shops applications usually don't rely on UGC. They sometimes have some sort of rating system for the goods they sell, which can be extended with users' comments and reviews. No explicit reputation system is associated to the users (buyers, voters or commenters). This reputation model can be defined as Soft Ratings Driven, in the sense that the reputation affects the objects of the business (goods) but not the subjects (buyers, voters or commenters).

In the second row, Auction-Based e-shops and P2P networks use ratings as a means to derive a reputation for the entity/person that is sharing resources or selling goods. In this case the relationship between the rating system and the reputation system is many-to-one, in the sense that to create a user reputation are required several ratings. The model of the reputation system is therefore ratings driven.

In the third row, wikis, such as wikipedia, rely on the cooperative work of their members to create UGC in the form of articles. Sometimes the reputation of the authors is evaluated according to the type and the amount of their contributions (see wikipedia Barnstar system, chapter 4). The relationship between UGC and the reputation system is many-to-one, many UGCs contribute to create a user reputation. The model is therefore Contents-Driven. There is an extensive usage of this model also in web forums, which usually aggregate user reputations counting the number of posts of a single user. Users reputations are then used

to grant to the most active members moderation privileges. Of course, as explained in chapter 4, the system can suffer security issues.

In the last row of table 5.1 are the remaining web applications that rely on UGCs and have an associated rating system, which is used as a means to rank the contents. There are several examples of this kind: YouTube, some Blogs, etc...

We can classify this Reputation Model as Soft Ratings-Driven because the reputation is derived through an explicit rating system that affects the objects of the business (UGCs) but not, or just indirectly, the subjects (contributors or voters).

There are also variations on this last reputation model. For instance some website generates an explicit reputation for their users aggregating the scores achieved through their contents.

This variation on the Reputations Model is at the present not as common as the previous. It uses reputation mainly to rank user and sometimes to reward them with virtual achievements accordingly. Users can then sport these achievements in their personal profiles. Less frequently users in top-N ranking get also some small prize.

In this type of model users' reputation doesn't have any (or a loose) impact on the rating system. Also, the reputation usually doesn't affect all the users but only the ones that provide contents, excluding thus the raters. This way the mechanism opens the doors to more than one security problem, the most evident is the unbalanced power of peers (Chapter 4).

Because the model is flawed it can't take complete advantage of the potential that reputation has to offer. Nonetheless a model which comprises UGC, a Rating System and a Reputation System, if more robust, could be very valuable. The existence of this model is the assumption on which is based the topic of this thesis: the **Reputation Community Evaluation** model (RCE).

RCE is meant to be a reputation model tailored for the needs of digital communities which rely on User Generated Contents (UGC). The goal of the model is to guarantee UGC standards of quality and a healthy growth of the community.

What follows is how to create such a model. The first step is to define RCE basic building blocks.

## 5.2. Defining RCE Building Blocks

Obviously any RCE model must comprise of UGC, a Rating System and a Reputation System. To visually define the building blocks of an RCE model the same notation of table 5.1 can be used, obtaining table 5.2.





Application Type	UGC	Rating System	Reputation System	Reputation Model
(UGC-based digital communities)				



Table 5.2

The RCE model has similarities with both Content-Driven and Ratings-Driven reputation systems. As a matter of fact it shares some of the functional building blocks with both, but it cannot be defined as either Content-Driven or Ratings-Driven.

The arrows in the model of table 5.2 represent the way the building blocks are connected and interact. In the RCE model users share with the community **UGC**, that are evaluated by community members through a **Global Rating System**, which is used to infer users **Reputations**.

What makes RCE model substantially different with respect to the formers (table 5.1) is the need of an **EXPLICIT Social Network Infrastructure**, capable of “glueing” all the building blocks. For this reason RCE should be defined a **Community Driven** reputation model.

The presence at once of all the building blocks of the previous models (UGC, Rating System and Reputation System) is not per-se a major difference. The real difference is in the way they are connected and interact with one another. In this respect the model of table 5.2 was on purpose left uncompleted, for instance, it still suffers from the unbalanced power of peers problem. In order to prevent this and other hazards we need to improve the model by introducing some refinements.

Following subchapters aim to explain how to merge in a unique solution the characteristics of the state-of-the-art reputation systems discussed in chapter 4, with some innovative approaches to obtain a more robust RCE model, concluding that any RCE model, in order to be considered sufficiently secure, should:

1. **Operate by Approval Votes;**
2. **Operate Accordingly to Voters Reputations and Commitment** (over a fixed time period.);
3. **Use Blind Ratings;**
4. **Grant Voters Anonymity;**
5. **Exhibit a Bidirectional Behavior;**
6. **Consider Action and Resource Weights.**

Following the detailed explanation of the features of above.

### 5.2.1. Approval Votes

One of RCE goals is to guarantee UGC of a certain quality. Being RCE a Community-Based reputation model, this translates in finding a way to remove those UGC that don't meet the community approval.

On the operative standpoint this means that every resource produced by the members of the community (blog articles, pictures, videos, documents, etc...) require it to be approved in order to remain in the system.

Obviously this affects the rating system, which should apply some automatic mechanism in order to approve (or reject) resources. For example we could simply decide that on a scale from 1 to 10 only the resources with an average score higher than 5 are considered approved and can therefore remain in the system.

Once the approval procedure ends resources can't be voted any further and they are either archived with a final score equal to the approval score or, upon rejection, removed from the system.

From the visual standpoint the model changes as follows:

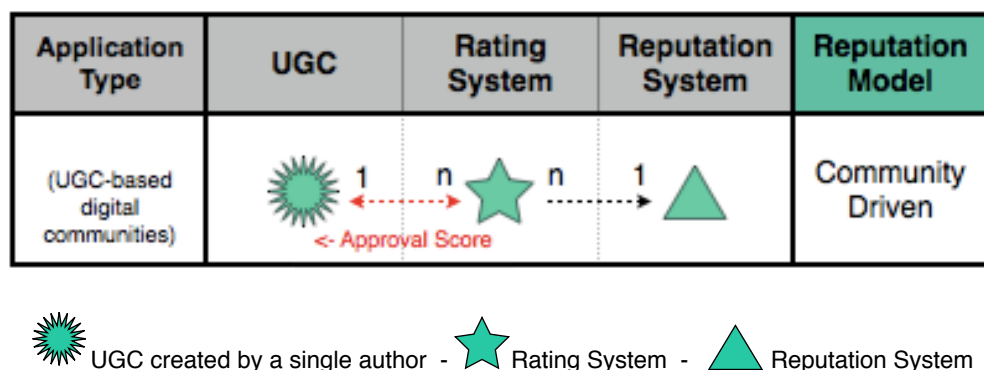


Table 5.3

The relationship between UGCs and reputation system remains many-to-one. As before many UGCs contribute to create a user reputation, nevertheless now the rating system has a retro-effect on the resources. A low score implies the removal of the resource from the system. For this reason the relationship between UGC and rating system is now bidirectional (red arrow).

The approval approach is opposite to the cumulative approach in which any given resource, is by default, considered approved and, unless reported inappropriate, remains archived in the system collecting votes cumulatively no matter the quality. In the Web there are various notable example of this kind (e.g. YouTube.com).

Obviously the approval method, differentiates from cumulative ones, and must include ways to decide when a resource is mature to undergo the approval procedure. In this



respect there are many possibilities; for instance we can decide that a resource is ready to be evaluated if has reached a certain amount of votes within a fixed time period. If the time period expires and the resource does not collect enough votes it is automatically discarded by the system. After-all if a resource does not get enough attention by the community it is clearly not valuable enough and therefore can be removed.

We can sophisticate this method by adding more constraints. For instance we can impose the sum of voters' reputations to be above a certain value. This latter constraint can be especially useful in order to guarantee a good ratio between votes' quality and quantity and most importantly to help prevent security hazards like identity forgery [see Chapter 5.2.6].

Deciding the minimum amount of votes, the time limit or the cumulative reputation needed to start the approval process depends on single digital communities specific characteristics.

Factors like community size, user participation and resources life cycle can be very influent. For instance we cannot require too many votes to approve a resource if the community is too small or if its members are not very active. Similarly we can't afford to stretch too much the approval time period if the resources life cycle is very short. The risk is that by the time the resources are approved they are already too old (e.g. blog news).

### **Approval Votes Example**

As an example of the RCE **Approval Votes** principle let's consider a system in which every new resource posted, in order to undergo the approval procedure, needs a minimum amount of 3 votes within a maximum time window of 5 days. Resources that don't match the aforementioned constraints are considered expired and then automatically removed from the system. Also, to be considered approved and therefore to be kept inside the system a resource needs a minimum Final Average Score of 5 out of 10 points. See the pseudo-algorithm and the examples in the gray boxes that follows (Fig. 5.1, 5.2).

```

Class Resource {

minVotes =3; //minimum number of votes for undergo the approval
aT = 5; // 5 days= approval time limit
Votes [3] = nil; //array of votes
TotalVotes=0; // number of votes collected so far

Method Is_Ready_For_Approval?( Resource_Age=this.Age, Total_Votes=TotalVotes)

    if ( ( Resource_Age < aT) && (Total_Votes = minVotes) )
        // Resource ready for the Approval Procedure
        return 'YES';
    elsif (Resource_Age >= aT)
        // Resource expired, automatically deleted from system
        Resource.Delete();
        return 'EXPIRED!';
    end
    return 'NO';
end

Method Approved?
    final score= sum(Votes)/minVotes;
    if (final score) >=5
        return 'APPROVED:' + Final score.to_string ;
    else
        return 'REJECTED:' + Final score.to_string ;
    end
end

Method New_Vote (vote_value)

    Votes [TotalVotes]= vote_value;
    TotalVotes ++;

    if (TotalVotes == minVotes)
        return this.Approved?;
    else
        return "Remaining votes: " + (TotalVotes-MinVotes).to_string ;
    end
end

} // end Resource

```

Fig.5.1 - Approval Votes Example  
(Class Resource pseudocode)

```

// Usage Examples

//Ex 1
Resource.Is_Ready_For_Approval? (1 day, 1 vote)
=>'NO'
// Wait 2 more days or till the resource reach 3 votes

//Ex 2
Resource.Is_Ready_For_Approval?(8 days, 1 vote)
=> 'EXPIRED!'
// Automatically removes the resource from the system

//Ex 3
Resource.Is_Ready_For_Approval? (1 day, 3 votes)
=> 'YES'
// Than trigger the calculation of the Final score

//Cycle that check for expired resources
//For instance we can run this cycle every late night
Not_Approved_Resource[] = Find_All_Resources_Not_Approved();
For (i=0; i= size(Not_Approved_Resource);i++){
    Not_Approved_Resource[i].Is_Ready_For_Approval?;
}
// Automatically removes all the EXPIRED resources

//Ex 4 - our resource gets 3 votes [10,6,8]
Resource.NewVote(10)
=> "Remaining votes: 2"
Resource.NewVote(6)
=> "Remaining votes: 1"
Resource.NewVote(8)
=> 'APPROVED: 8'

//Ex 4 - our resource gets 3 votes [3,3,3]
Resource.NewVote(10)
=> "Remaining votes: 2"
Resource.NewVote(6)
=> "Remaining votes: 1"
Resource.NewVote(8)
=> 'REJECTED: 3'

```

*Fig.5.2* - Approval Votes Example  
(Class Resource pseudocode usage examples)

## 5.2.2. Rating According to Users Reputation and Commitment

Normally in a community, whether digital or real, not all members are equal. There are users with a higher reputation and commitment than others.

Denying this fact means flattering the relevance of the more proficient individual and inevitably leading to balance of power issues [see chapter 4]. To prevent this scenario any RCE model should grant to users with higher reputation a bigger influence than the others. This can be achieved simply by sophisticating the rating system balancing the votes with users' reputation and commitment.

RCE assumes that reputation and commitment are two distinct values. Reputation refers to the average quality of the actions taken by the user (resources produced or votes given), whereas commitment is a quantitative measurement, compound considering only the amount of resources produced and approved.

Table 5.4 represents a quick example. It considers 5 users with different profiles, who have rated the same resource.

Users	User Reputation (goes from 1 to 10)	User Commitment Factor (goes from 1 to 2)	Given Vote (goes from 1 to 10)
USER 1	9	2	<b>10</b>
USER 2	8	2	<b>9</b>
USER 3	6	1,7	<b>9</b>
USER 4	7	1	<b>4</b>
USER 5	9	1	<b>4</b>

Table 5.4

Considering users' reputations and commitment, the final weighted score for the voted resource is:

$$\frac{(9 \cdot 2 \cdot 10) + (8 \cdot 2 \cdot 9) + (6 \cdot 1.7 \cdot 9) + (7 \cdot 1 \cdot 4) + (9 \cdot 1 \cdot 4)}{(2 \cdot 10) + (2 \cdot 9) + (1.7 \cdot 9) + (1 \cdot 4) + (1 \cdot 4)} = 7.82$$

Users 4 and 5, although have high **Reputations** (7 and 9 rep. points) have a low **Commitment Factor**, this makes them less influential than the other voters. As a matter of fact the resource manages to get a positive score (7.82) despite their low marks (4 and 4). This is just a pretend example, a more complete one will be discussed in chapter 6.

Another consideration about reputation and commitment is that, in order to avoid the tyranny of the elders; that is the overpower of users that over time have collected an enormous amount of reputation and commitment points [see chapter 4], reputation and commitment must be evaluated considering a limited time period, in other words, only the actions performed in the recent past (last six months, last year, etc...) would be considered.

This not only removes the tyranny problem, but at the same time forces the elders to keep productive over time in order to preserve their reputations.

Inside a community users' reputation history is very valuable information too. Computing users' reputations only on the basis of the latest actions could lead to completely forgetting past actions, opening thus the doors to attacks similar to the eBay cash and run. As an example, if the system forgets users' past bad actions after a certain period they can afford to put them in practice again.

To prevent this risk any RCE system must compute the reputation over the last N actions but at the same time should provide means for tracking users' reputation history. In this respect, chapter 6 show a concrete example in which the system described provides charts to track and represent users' reputation variation over time. To some extent the method resembles the tracking mechanism of eBay [Chapter 4.5.3], but it is more complete.

Another fundamental precaution is to forbid voting privileges to users with a too low reputation. It is harmful and useless to grant voting rights to users that have proven to be not up to the task. At the same time the system must be tolerant, letting them the right to create new resources which, once approved, will improve their reputations, getting thus back their voting right.

One more precaution is to prevent the system in being too strict with beginners, blocking their right to vote before they have performed a minimum number of actions, which are necessary to create a reliable reputation.

### 5.2.3. Blind Ratings, Voters Anonymity and Bidirectionality

Yet another hazard that could harm the validity of our reputation system is cross ratings, which can be seen as a form of positive shilling [see chapter 4]. Positive shilling is a system of cross favors that works as follow: I give to your resource a good vote and you make the same with mine, so we both increase our reputation.

To discourage this behavior RCE imposes blind ratings, and anonymity of the voters.

Blind ratings means hiding to the voters the partial score of the resources during the approval phase, to reveal it just once the resource is declared approved or rejected.




Blind ratings clearly prevent raters to be influenced by previous votes, but per-se don't prevent cross ratings. To achieve this effect we need to force voters identity to be hidden too.




If voters identities are unknown and ratings are not visible to voters in the approval phase it is more complicated to organize a cross favor mechanism since the parts can't easily control each other. Nonetheless anonymity of the voters could open the doors to yet another hazard. Voters could use the voting mechanism at will to harm producers reputations without incurring in their (cross) revenge [Negative shilling, see chapter 4].

Now someone could think that this latter threat would be easily solved via **ubiquitous anonymity**, that is the anonymity of both parts, voters and producers. Nevertheless **RCE** methodology discourages the application of this solution because of potential security hazards [See chapters 4 and 5.5.1] and also because RCE considers producers identities as an important feature of the resources themselves, and shouldn't therefore be hidden.

RCE solves the problem in a different way, using a **bidirectional voting mechanism**.

By construction any **RCE** model evaluates community members' reputations by exploiting their resources ratings. A bidirectional bond links users' reputations with their resources' ratings, since the latter must be used to evaluate the former and the former are used to weight the latter. In light of this consideration, the RCE model must be updated with a bidirectional arrow connecting the rating system with the reputation system (see table 5.5).

Application Type	UGC	Rating System	Reputation System	Reputation Model
(UGC-based digital communities)				Community Driven

  $\xleftarrow{1}$   $\xrightarrow{n}$    $\xleftarrow{n}$   $\xrightarrow{1}$    
 <- Approval Score      <- Influence

 UGC created by a single author -  Rating System -  Reputation System

Table 5.5

**RCE** 'bidirectionality' is even more sophisticated than what can be appreciated at first glance from the model above. In RCE, a bidirectional rating system implies that a resource approval score impacts not only the reputation of the producer but also the reputations of all voters, too. This is obviously required to avoid balance of powers that privilege voters over resource producers.

Deriving a reputation score for a producer usually consists in calculating an average of all its resource votes. Deriving a reputation score for voters is less obvious, but with RCE we can solve the problem exploiting its specific characteristics.

Since RCE ratings are collected **blindly** to the voters, weighted **according to voters reputation & commitment**, and the resources undergo an **approval procedure**, we can imagine for voters a rating method that works comparing their votes vs. the resource final score.

A possible procedure is the following.

Once a resource has obtained a definitive score we consider, for every voter, the distance between the given vote and the resource final score.

If the distance is within a certain tolerance (excess or defect), the voter is rewarded with a positive vote, if the distance is outside the tolerance the voter gets a negative vote. Both, negative and positive votes must be balanced according to the accuracy shown by the voter (i.e. the closer is the voter's rating to the resource final score the better the voter should be rated).

Choosing the right tolerance value is a design problem which depends on the characteristics of the community and on the nature of the resources evaluated.

Considering this last refinement the final reputation of the user is computed considering not only **the average of the votes obtained posting resources, but also voting someone else's resources**.

The benefit of a bidirectional rating system is obvious; voters behavior is forced to be more responsible and less random.

Bidirectionality though is prone to severe security hazards if not applied in concomitance with blind ratings and voters anonymity. As an example if during the approval phase users could see the partial votes they could adjust their ratings accordingly to maximize their reputation gain, rather than voting faithfully to their knowledge and opinions.

Yet another observation is that the method still favors voters over producers. Voting a resource needs less effort than producing one, users could then start trying to develop their reputations only by voting, causing thus a contraction in the growth of the community in terms of resources produced.

Another complaint is that in the real world not all the resources require the same effort to be created but, since in our model they are all valuable at the same level, it is likely that producers will stick just with the ones less 'expensive' to produce.

For the reasons listed above the system need to be further sophisticated introducing **Action** and **Resource Weights**.

## 5.2.4. Action and Resource Weights

Action Weights consists in weighting the actions of voting and posting differently, that is, in terms of reputation, considering voting less remunerative than posting.

As an example let's imagine an RCE system in which voting a resource has weight 1 and posting has weight 10. In this system a user has posted 2 resources getting respectively a score of 7 and 8. The user also votes someone else's resource, gaining thus a personal score of 10 points.

According to the **Action Weights** rule the user's reputation is:

$$(7p * 10w + 8p * 10w + 10p * 1w) / (10w+10w+1w) = 7.6 \text{ points}$$

Supposing that the resources in the system are not all equal in terms of effort needed to be produced, let's introduce a new variable: **Resource Weights**.

Using the example of above we can now imagine that voting a resource has weight 1 and that a post can assume either weight 3 or 10, according to the type of resource posted. Let's now consider a user which has posted 2 resources, one with final score 7 and weight 10, and the other one with final score 8 and weight 5. The user also votes someone else's resource gaining a personal score of 10 points. User's reputation computed applying **Action and Resource Weights** now becomes:




$$(7p * 10w + 8p * 3w + 10p * 1w) / (10w+3w+1w) = 7.4 \text{ points}$$

**Action** and **Resource Weights** can be further refined, we'll see how in chapter 5.2.6 example.

## 5.2.5. Complete RCE Model

Considering **Resource Weights** and the **Commitment Factor** discussed in chapter 5.2.2 it is understood that in the RCE model users' reputations are directly affected also by the amount of UGC created and their nature/value. So, since **n** UGC contribute to generate **1** user's reputation, to visually complete the RCE model we need to connect UGC with the Reputation System with one way arrow (table 5.6).



Application Type	UGC	Rating System	Reputation System	Reputation Model
(UGC-based digital communities)				Community Driven

 UGC created by a single author -  Rating System -  Reputation System

Table 5.6

### 5.2.6. An Example to Recap

In this chapter we'll use another pretend example in order to better clarify chapters 5.2 main concepts.

Let's imagine a Reputation Community Evaluation system in which a resource, in order to be eligible for approval, requires:

1. A minimum of 10 votes,
2. That must be obtained within a time limit of 1 day,
3. And with a sum of the reputations of all the voters above 50 points.

In our play system, 10 is the maximum positive reputation for a user and -10 is the minimum. All beginner users have a starting reputation of 1 out of 10 (minimum positive reputation) and no commitment points. Users with negative reputation are forbidden to vote.

Now let's assume that an attacker posts a malicious resource inside the system and, in order to make it approved, forges 10 fake identities. These identities, as beginners, will be with a reputation 1 and no commitment points.

Using the forged identities the attacker gives 10 very high marks to the malicious resource he owns. Now the resource has 10 votes and becomes then theoretically eligible for approval. Nevertheless the sum of the voters reputations, considering that they are all beginners, is just 10 (  $1 \cdot 10 = 10$  reputations points), which is inferior to the required 50. The attacker's resource is therefore not suitable to undergo the approval procedure yet. The attacker then decides to forge 20 more identities.

Meanwhile some real users, with good reputations and some commitment points, start rating the malicious resource. **They can't perceive that an attack is ongoing, the**

**approval procedure forces blind and anonymous votes. They aren't influenced by attacker's biased votes, therefore they give very low marks.**

By the time the attacker is ready to submit more votes through other forged identities the resource has collected enough reputation points for the approval procedure thanks to real users votes.

**The approval procedure evaluates the resource weighting the votes according to voters' reputations and commitment points**, as a result the negative votes of the few real users have a higher impact than the many given by the forged ones. The malicious resource gets a low final score and is rejected.

The rating system works **bidirectionally**, so the rejection of the resource impacts on the reputation of the resource owner, which is decreased, and the reputations of the voters as well.

Forged users, which gave high marks, see their reputations decrease from 1 to negative. Honest users sees their reputation increase.

The attacker could now simply try the trick again, posting another malicious resource and reusing the forged identities he/she has previously created to vote it. Unfortunately, seeing that the reputations of the forged identities are very low, the system decides to forbid them to vote, and the attacker has now only two choices:

1. Forge more identities,
2. Try to increase blocked identities reputations posting in their name resources worth the approval.

The second option is more theoretical than practical, since it is obviously not worth the while. Forging new identities appears to be easier but, in concrete not even this option is that convenient, as creating several fake identities requires too much time and effort, especially if we bind them to unique identifiers, such as email accounts (like it usually happens in real web systems). Moreover, it must be mentioned that the problem in some cases doesn't really exists; for instance in Enterprise 2.0 communities accounts creation is exclusive competence of community managers.

There is yet another option for the attacker. He/she could simply use the complicity of other attackers. After-all it is convenient for a bunch of users to make an agreement to increase their reputations cross-rating their resources.

The only risk is once again that some users outside the agreement could vote honestly causing loss of reputation for the attackers.

One easy counterattack to the cross-rating problem can be to increase the number of votes necessary to approve a resource. Unfortunately this solution can't be applied if the size of the community is small.

Yet another counterattack is to make reputation easier to lose than to acquire [See chapter 4]. In this respect **RCE** can operate simply by sophisticating the **Action and Resource Weights** mechanism seen in the previous chapter.

As an example let's assume that in our system voting a resource has weight 1 only if the performance of the voter is judged positively, and weight 3 in case of negative judgment.

Let's imagine now that an attacker makes an agreement with some other people to cross-rate their below-average resources. The attacker starts voting four resources unfairly, and thanks to the complicity of the others gains very good marks anyway: 8, 9, 8, 8.

Now the average reputation of the voter is:

$$(8*1 + 9*1 + 8*1 + 8*1) / (1+1+1+1) = 8.25 \text{ reputation points}$$

The attacker and his friends try to play the trick once more, but their attempt is this time blocked by other users, which were giving fair ratings and caused the attacker to get a negative mark: **-3**.

Now, according to the sophisticated **Actions and Resources Weights** mechanism, the new average reputation of the attacker becomes:














$$(8*1 + 9*1 + 8*1 + 8*1 + \mathbf{-3*3}) / (1+1+1+1+\mathbf{3}) = 3.4 \text{ reputation points}$$





Without any sophistication it would have been:

$$(8*1 + 9*1 + 8*1 + 8*1 + \mathbf{-3*1}) / (1+1+1+1+\mathbf{1}) = 6 \text{ reputation points}$$

In conclusion with just a small tuning of the basic RCE behavior, it is possible to make reputation-loss easier than reputation-gain. Most importantly, the attackers losing reputation lose also influence in the system, making for them more complicated to iterate the cheat.

## 5.2.7. Reputation Models Chart

Web Applications	UGC (Users Generated Contents)	Rating System	Reputation System	Reputation Model
<b>amazon</b> (e-shops, p2p networks)	/ 1 reviews are parts of the rating system		/	Soft Ratings Driven
<b>ebay</b> (auction based e-shops)	/ 1 comments are parts of the rating system			Ratings Driven
 (wiki, forums)	 or 	/	 or 	Contents Driven
<b>YouTube</b> Broadcast Yourself™ (UGC-based web apps: blog, flickr, etc.)			/	Soft Ratings Driven
<b>RCE</b> (UGC-based digital communities)				Community Driven

 UGC cooperatively created by many authors · 
  UGC created by a single author · 
  Rating System · 
  Reputation System

## 5.3. Security in Ratings-Driven Reputation Systems and RCE

Another major aspect of reputation we must consider is that it can be subject to manipulation for various reasons. People use it to influence opinion to advance their own causes, to maliciously harm someone, or to curry favor by providing entertaining or seemingly confidential material. We need to understand what circumstances make reputation reliable.

Two main questions determine the security of a reputation system. First, what's the context for the reputation system? Second, who are the adversaries? (See chapter 4)

The capabilities of potential adversaries and the extent to which they can damage or influence the system dictate how much energy should be spent on security. In this respect we have discussed various examples of fraud like the following one from eBay.com in chapter 4:

*"In mid-2000, a group of people engaged in eBay auctions and behaved well. As a result, their trust ratings went up. Once their trust ratings were sufficiently high to engage in high-value deals, the group suddenly 'turned evil and cashed out.' That is, they used their reputations to start auctions for high-priced items, received payment for those items, and then disappeared, leaving dozens of eBay users holding the bag."* [LVII]

This type of attack can be expanded to entire companies:

From Chapter 4:

*"if a corporation, planning some millions transaction, would decide to base its decisions on websites that computes and publishes reputations for companies a dishonest vendor might want to forge or use bribes to create good feedback to raise his resulting reputation. "*

The eBay example seems to be too different to be compared with any RCE system, where economical transactions are not present. Nonetheless, as will be explained in chapter 5.4.4, RCE systems are encouraged to include rewarding systems based on reputation and therefore they may be affected by the same problem.

Considering RCE systems founding blocks (*Approval Score, Blind Ratings, Voters Anonymity, Bidirectionality, Actions and Resources Weights*) and their community structure, which makes them capable to track users' reputations over time, we have many weapons to contrast the problem.

Even more, we will see that in RCE systems it is easy to put in place a rewarding mechanism that makes more convenient to develop and preserve ones' reputation rather than "cash and run".

eBay tried to mitigate the "cash and run" problem with a soft tracking mechanism for past transactions [Chapter 4.5.3], but this solution is not perfect because it leaves still the possibility of "cash and run" and is very prone to bias. In this respect the RCE approach which relies on *Bidirectionality of votes* appears to be more flexible.

Among the simpler attacks that can be performed against a reputation system we have seen *shilling*. This term is mainly used to refer to submitting fake bids in an auction, but it can be considered in a broader context of submitting fake or misleading ratings, similarly to what it has been discussed in chapter 5.2.6 about identity forgery. In particular we have seen that a person might submit positive ratings for one of her friends (positive shilling) or negative ratings for her competition (negative shilling).

Either of these ideas introduces more subtle attacks, such as negatively rating a friend or positively rating a competitor to try to trick others into believing that competitors are trying to cheat.

Shilling is a very banal attack, but today many systems still remain vulnerable to it. RCE responds to shilling attacks as described in chapter 5.2.6 combining, *Approval Score*, *Users Reputation and Commitment Based Ratings*, *Blind Ratings*, *Voters Anonymity*, *Bidirectionality and Action and Resource Weights*.

Other typical problems with rating-based reputation systems are that sometimes it is very difficult to collect enough information to provide for every entity an associated reputation. The simplest imaginable reason is a very low volume of transactions or activity by the user. In this respect RCE responds simply weighting user ratings not only according to their **Reputations** but also with their **Commitment**, implying thus that users with less activity have less influence than others.

## 5.4. RCE Some More Design Considerations

Yet another big point of reputation is the way it is represented inside the system [Chapter 4] so, to be completely efficient any **RCE system** should be designed to grant reputation to be:

1. **Not Transferable;**
2. **Content-Specific;**
3. **Community Membership Life Cycle Wise;**
4. **Bond to a Rewarding System;**
5. **Translucent to the Users.**

### 5.4.1. About Transferability of Reputation

An important issue with reputation systems is reputation transferability.

In chapter 4.5.2 we made the following example:

*“If a vendor offered to discount past purchases, and if enough future customers buy the same product, it would be hard to get honest ratings for that vendor. All the buyers, in order to foster new selling and get the discount, would rate the vendor very high.”*

To mitigate the problem we could apply **complete ubiquitous anonymity** to the rating system. This would discourage alleys between buyer and sellers or, in the RCE case, between producers and voters. Unfortunately, there are no reputation systems that currently work **completely anonymously** and remain safe <sup>(1, Dingleline et al., 2003)</sup>.

Theoretically it might be possible to develop such a reputation system, but we must consider then ways to address other type of attacks like the ones connected with spoofing or in this case pseudo-spoofing.

Since removing or completely hiding identities in reputation systems is a dangerous move, especially in Community Resources Driven Reputation systems, in tuning any RCE model **complete ubiquitous anonymity** is not an option [See also the blind ratings mechanism in chapter 5.2.3].

### 5.4.2. Reputation is Context-Specific

So far reputation has been treated as a single value attached to a single entity never considering that actually there can be several reputations per entity according to the context we are considering. *Hassan Masum and Yi-Cheng Zhang*, in the article “*Manifesto for the Reputation Society*” [LVIII] explains why reputations need to always be considered a context-specific value. Following an important passage from the article:

*“Reputation is context-specific. A Ph.D. degree, medical license, or award of merit is meant to certify particular abilities. When a credit agency evaluates your financial history and generates a reputation, the context is your ability to repay loans; this ability may be correlated with but is quite distinct from more general character traits. And reputation could refer to any of these more general traits, like one’s sense of humor or ability to work in a team.*

*Since there is no absolute objective reputation quantity stamped on people’s foreheads, measurable proxies are necessary, such as book sales rankings, citations in academic papers, Web site visits, and readership of blogs.*

...

*Emerging information tools are making it possible for people to rate each other on a variety of traits, generating what is really a whole set of reputations for each person. (Information technology is also indirectly increasing the need for such reputations, as we have to sift through more and more possibilities.) You may mentally assign a friend a bad reputation for being on time or returning borrowed items promptly, while still thinking them reliable for helping out in case of real need. No person can be reduced to a single measure of 'quality.'*

***So people will have different reputations for different contexts. But even for the same context, people will often have different reputations as assessed by different judges. None of us is omniscient ..."***

In the last analysis it is clear that representing people's reputations with just a single global value is a mistake. As will be shown with a concrete example in chapter 6, a possible solution consists in using a global reputation value which at will can be broken down according to single areas of activity or competence. Even more, for each area it will be possible to keep track of reputation variation over time.

### 5.4.3. Community Membership Life Cycle and RCE

*"Given that individuals play different roles in social networks - they can serve variously as connectors, gatekeepers, truth-tellers and enforcers - reputations are tied to roles within social networks. "*

(A Crowd of One: The Future of Individual Identity" 2007, by John H. Clippinger)

There are several possible membership life cycles for online communities, **among the most cited in literature is the one proposed by Amy Jo Kim (2000) in her book: 'Community Building on the Web'**.

She states that members of virtual communities begin their life in a community as visitors, or lurkers <sup>[LIX]</sup>. After breaking through a barrier, people become novices and participate in community life. After contributing for a sustained period of time they become regulars. If they break through another barrier they become leaders, and once they have contributed to the community for some time they become elders.

Other authors describe online communities membership life-cycle according to types of participation levels:

1. Peripheral (i.e. Lurker) – An outside, unstructured participation



2. Inbound (i.e. Novice) – Newcomer is invested in the community and heading towards full participation
3. Insider (i.e. Regular) – Full committed community participant
4. Boundary (i.e. Leader) – A leader, sustains membership participation and brokers interactions
5. Outbound (i.e. Elder) – Process of leaving the community due to new relationships, new positions, new outlooks

This five-step life-cycle applies to many virtual communities like blogs, wiki-based communities, and RCE systems as well.

As it is evident membership life cycle is directly connected to users commitment over time, therefore, since in any RCE system commitment is a component of reputation, reputation itself must be structured accordingly. An example of application of this design principle is the way RCE addresses the tyranny of the elders problem, which has been discussed in chapter 5.2.2 .

#### **5.4.4. Social Currencies and Business Models in Online RCE Systems and Enterprise RCE Systems**

Most online communities grow slowly at first, due in part to the lack of motivation for contributing [Chapter 4.5.6]. The key for a successful online community is to motivate participants. In this respect we have concluded that economical factors (implicit or explicit) are predominant in reputation based systems. Solving the problem of providing incentives for reputation systems to effectively elicit the right amount of feedback, at the right time and with the right level of detail, is ultimately a problem of leveraging on the “economy of reputation”. To this aim Social Currencies can play an important role, driving a society from stagnation to innovation (Archelof, ‘markets of lemons’). For this reason any implementation of the RCE model should use reputation as a social currency that is to bond users’ reputations to a rewarding mechanism.

This not only has the potential to propel Web 2.0 RCE communities growth but is basic to make any Enterprises 2.0 community efficient.

Enterprise is about business and business is about money. Enterprise 2.0 collaborative/ cooperative systems are wrongly thought to be, from the business-model point of view, web 2.0 systems and this usually causes problems.

In a working environment having a knowledge that others do not have makes an individual very valuable. Therefore sharing ones’ knowledge can be seen as counterproductive.

Sharing also involves a significant amount of time from contributors, distracting them from regular working duties, usually without any additional monetary gain.

Concretely Enterprise 2.0 systems can comport even losses for its contributors, legitimating thus reluctance for participation. A rewarding mechanism tied to users' reputation is then a fair means to counterbalance their losses.

Counterbalancing loss is not enough. RCE systems can also empower employees by making more visible the ones with an higher reputation. This way the Enterprise 2.0 System turns from an enemy to a valuable alley for effectively promoting oneself.

Also it can represent an invaluable data mining tool for executives in detecting the people with specific skills or with implicit leadership over the others.

Thanks to the RCE design characteristics there are many ways in which a rewarding mechanism can be implemented either in Web 2.0 or Enterprise 2.0 RCE systems. Of course there are differences from the approaches applicable to Web 2.0 RCEs and the ones suitable for Enterprise 2.0 RCEs.

Let's make some examples.

Here are some further examples; In Enterprise 2.0 RCE systems contributors' reward could be measured using a meta-score computed on the basis of users' performances in posting or rating resources. This meta-score should be converted in real money or perks according to a fixed exchange rate.

As an example let's imagine a toy Enterprise 2.0 RCE system in which the weight associated to posting resources is 10, and similarly the weight associated to voting resources is 1.

An imaginary contributor posts in the system 4 resources, two of them are accepted with approval score 8/10 and 7/10, one fails to meet the requirements for entering the approval procedure and is automatically discarded by the system and the last one is rejected with evaluation score for the producer **-3**.

Our imaginary user also votes someone else's resource, obtaining 6/10 as vote for this action [See bidirectionality, chapter 5.3.3].

Table 5.7 summarizes the events and the variables of the problem.

User's Action	Action / Resource Weight	User's Performance (goes from -10 to 10)
Posting Resource 1	10	8
Posting Resource 2	10	7
Posting Resource 3	10	Automatically Rejected
Posting Resource 4	10	<b>-3</b>
Voting Another User's Resource	1	6

Table 5.7

The associated **meta-score**, considering all user's actions (posting and voting) could then be evaluated as the sum of all actions/resources weights balanced by the associated user's performances:

$$(8*10) + (7*10) + (-3*10) + (6*1) = 80 + 70 - 30 + 6 = 126$$

The example's user gets 126 meta-points. Imagine that 1 meta-point is worth 0,20€, and that meta-points can be cashed out at the end of the month by every employee as part of the regular wage. This way the user of our example would earn:

$$126 * 0,2€ = 25,20€$$

It is important to notice that every resource rejection or any action evaluated negatively causes a meta-score loss, which impacts on the users gain, limiting thus spamming problems and fostering quality of the resources.

Presently some online web services which heavily rely on user generated contents, manages to be very successful even without any form of rewarding mechanism. This is mostly due to a very broad audience that makes them de-facto monopolies. An example is [youTube.com](https://www.youtube.com).

Although the web is crowded with youTube clones, none of them manage to be nearly as popular as the original. The problem is that none of the competitors of youTube propose evident improvements over the original business model. The introduction of an innovation like a reputation based rewarding mechanism can represent the keystone to let new competitors to gain a broader market-share.

There are problems though. Collaborative websites, unlike Enterprise 2.0 RCE systems, can not afford to pay their users. The reason is simple, they can not rely on revenue from other activities to cover this cost. Nonetheless, different business models can apply.

In RCE systems the more a user reputation grows the more the user is thought to be reliable and the more it is likely that he/she becomes visible and its profile and resources generate page views. Exploiting this fact makes it possible to imagine an RCE system that gives its members the right to embed in their pages (e.g profile pages, blog pages, etc...) advertising in the form of Web Ads (e.g. Google AdSense <sup>[LXIII]</sup>), granting them a revenue proportional to page views or impressions (ads clicks). Such a system would have a clear edge over non-RCE competitors, in **quality of contents**, thanks to the reputation mechanism and **user commitment** and to the rewarding system.

This advantage can be capitalized by the RCE platforms' owners advertising in common pages (e.g the home page).

Advertises though might be not enough to make the community economically sustainable or profitable. One further step could be to integrate the RCE system with a digital store (digital music, digital books, videogames, movies etc...), in which the users could spend the money gained through the ads in the form of discounts on purchases.

We can imagine a healthy cycle in which people are attracted in the RCE system by the quality of contents, and they remain as producers in the perspective of rewards, granting thus a broad customer base for an associated digital store.

Even more, the RCE platform could be open and flexible, letting single users or groups create and customize their own RCE communities and try to attract audience and contributors. Without any constraint on topics, appearance, etc... similarly to what happens with blogging platforms.

In this case the RCE platform should provide the required social networking technology and a distributed **cross-RCE's** rating and rewarding mechanism, which could benefit the partnership with other external web services and digital/web stores (e.g. Google ads, iTunes, Amazon, etc...).

In conclusion the possibilities in RCE systems' business models appear to be very broad and worth to be further investigated.

### 5.4.5. Social and Reputation Translucence

Social Translucence, definition (from Wikipedia):

“Social translucence is a term that was proposed by Thomas Erickson and Wendy A. Kellogg to refer to ‘design digital systems that support coherent behavior by making participants and their activities visible to one another’.

Social translucence represents a tool for transparency, which function is to

1. Stimulate online participation
2. Facilitate collaboration (via collaborative filtering but also by helping the construction of trust)
3. Facilitate navigation (social navigation)

Social translucence is in particular a core element in Online social networking such as FaceBook or LinkedIn, in which they intervene in the possibility for people to expose their online identity, but also in the creation of awareness of other people activities, that are for instance present in the activity feeds that these systems make available.”

Social translucence mechanisms are part of many web 2.0 systems such as: Online communities, Online social networking, Wikis and of course are parts of any RCE systems too.

Besides **Social Translucence**, RCE systems require something more specific, which could be defined as: **Reputation Translucence**.

**Reputation Translucence** refers to design principles that support comprehension of the way reputation is represented and formed inside RCE systems. It is comprised of three main elements:

1. **Ad-hoc Interfaces** (and/or metaphors).
2. **Transparent Reputation Algorithms**. Any security decision should not be taken on the fact that the reputation evaluation algorithm is unknown to the users. It is a security hazard rather than an efficient solution because once the algorithm is unveiled, the system whole is compromised. On the contrary it should not be too complicated to figure out, letting the users understand the rules of the 'game'. Security should be achieved only using the RCE defining characteristics [Chapter 5.2].
3. **Reputation Development Mechanisms Interactive Learning**. The system should not force the users to learn the way the reputation mechanism works, on the contrary it should be up to the system to drive 'in-process' the user to understand the reputation mechanism behavior.

**Reputation Translucence** is paramount to the success of any RCE system, and must not be underestimated.

In chapter 6 **Reputation Translucence** principles will be further clarified with a concrete implementation of an RCE system.

## 5.5. RCE Meta-Model and Algorithm

This chapter generalizes the RCE Model in a Meta-Model in order to define the RCE Algorithm, which represents the business logic that any RCE system must apply to score UGCs and to derive a reputation score for its users.

Before starting we need some variables to describe the problem:

RCE Meta-Model Variables			
Name	Variable	Range	Description
Action	<b>A</b>	/	In a RCE model users can perform two type of actions: posting UGC or voting UGC.
Action weight	<b>Aw</b>	1 .. infinity	Each action (posting or voting UGC) has a different weight [See chapter 5.2.4].

RCE Meta-Model Variables			
Name	Variable	Range	Description
Reputation Time Spread	<b>rT</b>	1 .. M months	User's reputation must be computed considering just the actions taken within the last M months or days [See chapter 5.2.2].
Approval Time Spread	<b>aT</b>	1 .. D days/hours	Approval procedure must have a time limit expressed in D days or hours. After D days/hours the UGCs that don't receive a minimum amount of <b>minVotes</b> are automatically removed from the system [See chapter 5.2.1].
Minimal Amount of Votes for approval	<b>minVotes</b>	1 .. n n = integer	The approval procedure requires UGCs to collect a minimum amount of n votes within <b>aT</b> in order to be eligible for undergo the approval procedure [See chapters 5.2.1].
UGC Weighted Final Vote	<b>wV</b>	0 .. 10	<b>wV</b> Represents the final vote achieved by a UGC after the approval procedure [See chapter 5.2.1]. This vote is weighted by voters reputations and their commitment [See the definition of <b>Pf</b> below].
UGC Weighted Final Vote	<b>AS</b>	0 .. 10	Represents the minimum score that a UGC need to achieve to remain in the system.
User's Reputation	<b>Rep</b>	-10.. +10	Unlikely <b>wV</b> users reputation varies from -10 to +10.
Total Posts	<b>TotP</b>	1.. infinity	Total number of UGCs published over time <b>rT</b> by a single user.
Proficiency Factor	<b>Pf</b>	domain dependent	Proficiency Factor represents a quantitative value that should indicate user's commitment (e.g. amount of UGC posted and approved). It is used in combination of users reputations to evaluate UGC weighted votes ( <b>wV</b> ).

Table 5.8

We need also a representation of the objects/subjects involved in our system, to this aim we use the following Class Objects representation (Fig.5.3 and tables from 5.10 to 5.13):

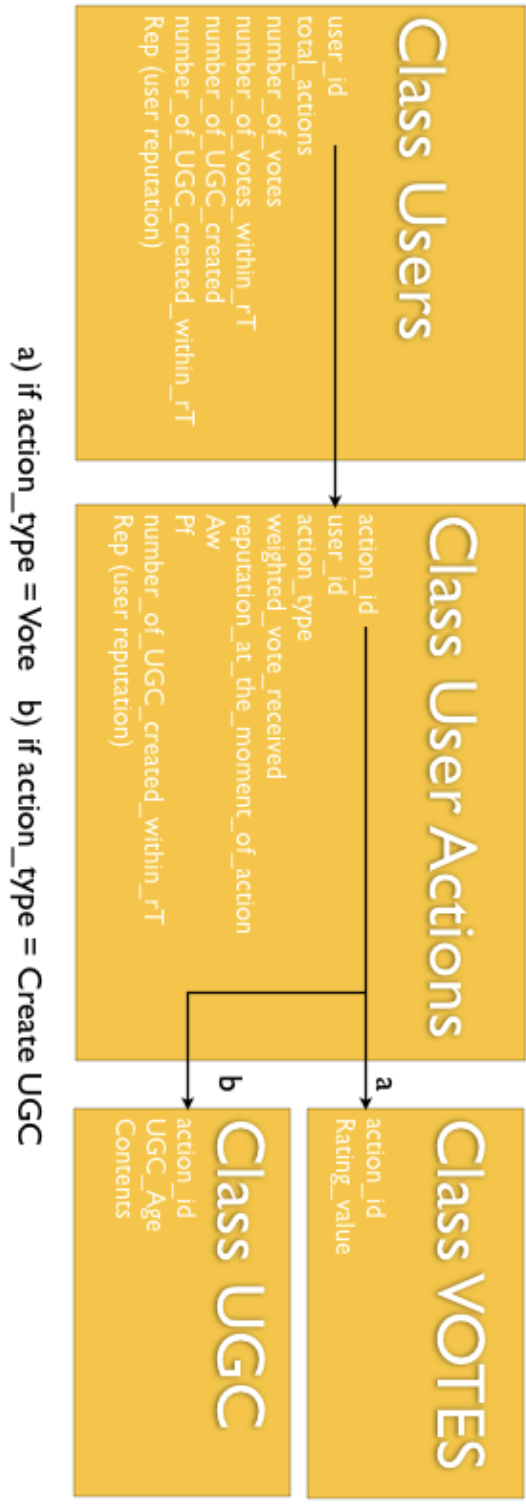


Fig.5.3 - RCE Meta-Model (Class Object representation)

Each class is defined by some variables:

Class USERS	
Column Name	Description
user_id	Unique user identifier
total_actions	Sum of the of the actions taken by a single user (voting or posting UGCs)
number_of_votes	Sum of the voting actions taken by a single user
number_of_votes_within_rT	Sum of the voting actions taken by a single user within the time spread rT
number_of_UGC_created	Sum of the UGCs created by a single user
number_of_UGC_created_within_rT	Sum of the UGCs created by a single user within the time spread rT
Rep	User Reputation

Table 5.10

Class USER_ACTIONS	
Column Name	Description
user_id	Unique user identifier
action_id	Unique action identifier
action_type	Vote or UGC creation
weighted_vote_received	Rating associated to the action of voting a UGC or posting a UGC
reputation_at_the_moment_of_action	User's reputation at the moment the action was taken
Aw	Action weight
Pf	Proficiency factor at the moment of action (only if action = vote)

Table 5.11

Class VOTES	
Column Name	Description
action_id	Unique action identifier
rating_value	User's given vote

Table 5.12



Class UGC	
Column Name	Description
action_id	Unique action identifier
UGC_age	aT
Content	Contents associated with the UGC (text, pictures, videos, etc...)

Table 5.13

Each user that belongs to the RCE system can perform two type of actions, that are either voting or creating UGCs. For each action there is an associated a value ( $A_w$ ), a proficiency factor ( $P_f$ ) and a user's reputation at the moment the action was performed. All of these values are used to evaluate the weighted vote associated with the action, wich is the vote that the action scores at the end of the RCE Algorithm procedure.

The RCE Algorithm is following described according to the definition of the RCE Meta-Model.

### 5.5.1. RCE Algorithm

The RCE Meta-Model describes the way Users and UGCs are defined and correlated inside an RCE system. Relaying on the RCE Meta-Model, it is possible to define the RCE Algorithm, which aims at scoring the UGCs and deriving an associated reputation score for UGCs producers or voters.

The RCE Algorithm behavior can be schematized as follow:

**Input:** a UGC having the characteristics defined by the RCE Meta-Model is produced by a member of the community (UGC Producer).

**RCE Elaboration:** RCE proceed with the elaboration, which is logically divided five major steps.

**Output:** the UGC is scored while UGC's Producer and Voters increase/decrease their reputations.

#### Explanation

The RCE procedure starts when a UGC is produced and proceeds on in five steps that can be summarized as described in table 5.4:

**Step0:** wait till the UGC reach enough votes to undergo the approval procedure.

When the UGC is ready, proceed as follow:

- **Step1:** calculate the final score of the UGC weighting every UGC's vote with the associated voter's reputation and commitment.
- **Step2:** evaluate **UGC's Owner** assigning him some points according to the UGC's final score.
- **Step3:** evaluate each **UGC's Voter** assigning them some points according to the distance from the UGC's final score and the given vote.
- **Step4:** update **Reputation** of **UGC's Owner** and **UGC's Voters** considering the points achieved (or lost) at steps 2 and 3.

Fig.5.4 - RCE Procedure

As a result of the RCE procedure the UGC is scored and UGC's Producer and Voters increase/decrease their reputations accordingly.

To better understand the procedure, following a more detailed description of steps from 0 to 4.

**Step0:** after a UGC has been posted into the system it needs to collect a certain amount of votes to be eligible for the approval procedure. We need of a way to detect when the UGC is either ready for the approval procedure or expired, because too much time has passed.

One possible algorithmic solution is the following (Fig.5.5):

```
Class UGC{
Method Is_Ready_For_Approval?(Total_Votes, UGC_Age)

    if ( ( UGC_Age < aT) && (Total_Votes = minVotes) )
        // UGC ready for the Approval Procedure
        return 'YES';
    elsif (UGC_Age >= aT)
        // UGC expired
        return 'EXPIRED!';
    end
    return 'NO';
end
} // end UGC
```

Fig.5.5 - RCE Procedure pseudocode (STEP0)

The algorithm above is similar to the procedure explained in chapter 5.2.1 . UGCs that reach **minVotes** votes within a time limit **aT** are ready for the approval procedure and can therefore pass to subsequent steps, the others eventually expire.

Assuming that our UGC reaches the necessary amount of votes within aT, the approval procedure can carry on with step1.

**STEP 1:** step1 consists in calculating the final score of the UGC weighting every vote with the associated voter's reputation and commitment.

UGC final weighted score (**wV<sub>i</sub>**) is computed averaging all the votes **V** given by **k** voters (**V<sub>k</sub>**). Each vote **V<sub>k</sub>** is also balanced by the respective voter's reputation (**Rep<sub>k</sub>**) and proficiency factor (**Pf<sub>k</sub>**), as follows:

$$wV_i = \sum_{0..k} [ V_k * ( Rep_k * Pf_k) ] / \sum_{0..k} ( Rep_k * Pf_k)$$

Fig.5.6 - UGC final weighted score calculation.

If **wV<sub>i</sub>** is > **AS** (acceptance score) the UGC is accepted, otherwise it is rejected and removed from the system.

Proficiency factor (**Pf<sub>k</sub>**) is a value introduced as a quantitative measurement of voters commitment [see chapter 5.2.2]. The way to compute Pf is domain dependent, see chapter 6 for a concrete example.

**STEP 2:** now we assign some reputation points to the UGC's Owner (UoP = UGC owner's points) considering the UGC final score (wV<sub>i</sub>). Algorithm shown in the box below (Fig.5.7).

```

if ( wVi <= AS)
    UoP = negative reputation points;
else
    UoP = positive reputation points;
end

```

Fig.5.7 - RCE Procedure pseudocode (STEP2)

If the post final vote  $wV_i$  is  $\leq AS$  the owner receives a negative amount of reputation points, computed according to a domain-dependent strategy. Otherwise the owner receives a positive amount of points.

**STEP 3:** at step3 we assign some reputation points to UG's Voters (UvP = UGC voter's points) according to the distance from the UGC final score ( $wV_i$ ) and single users voting accuracy.

If the distance between  $V$  (given vote) and  $wV_i$  exceeds a certain fixed TOLERANCE voters lose some points (negative reputation points), otherwise they gain some points (positive reputation points). The amount of points gained or lost must be defined by a domain-dependent strategy.

Algorithm in the box below (Fig.5.8).

```
K = number of voters ;  
Vk = vote given by the  $k_{th}$  voter ;  
PvPk = points gained by the  $k_{th}$  voter;  
  
for (k voters){  
  
    if (abs( Vk - wVi ) > Tolerance){  
        // If the distance exceeds the tolerance  
        // give a negative amount of points to the voter  
        return PvPk = negative reputation points  
  
    else  
        // If the distance is inside the tolerance  
        // give to the voter a positive amount of points  
        return PvPk = positive reputation points  
    end  
}
```

Fig.5.8 - RCE Procedure pseudocode (STEP3)

**STEP 4:** the algorithm ends calculating the reputation of UGC's Owner and UGC's Voters considering the points achieved (or lost) at steps 2 and 3. At Step 2 the UGC's Owner gain or lose some points (UoP), the same happens for UGC Voters at step 3 (UvP), now we can call both UoP and UvP just Action Points (AP), and consider them like a certain amount of points gained or lost by the users as effect of posting or voting UGCs.

For UGC Owner : **AP = UoP**

For UGC Voters : **AP = UvP**

Not every action is worth the same. There are different actions associated with different Action Weights (**Aw**). To compute the cumulative reputation a user gains or loses performing the  $n^{th}+1$  action (vote or post) we need to multiply the associated **AP** by the respective **Aw** as follows:

$$\text{Cumulative-Rep}_{n+1} = (\text{AP}_{n+1} * \text{Aw}_{n+1})$$

Similarly to compute the total cumulative reputation for a user we need to consider all the  $n$  actions performed before the action  $n+1$  within the time spread **rT** :

$$\text{Cumulative-Rep} = (\sum_{1..n} (\text{AP}_n * \text{Aw}_n) \text{ in } \text{rT}) + (\text{AP}_{n+1} * \text{Aw}_{n+1})$$

*Fig.5.9 - Coumulative-Rep calculation.*

Once computed the **Cumulative-Rep** (Fig. 5.9) we can calculate the updated users' **Reputation** averaging the **Cumulative-Rep** by the sum of all **Actions Weights** of the actions taken within **rT**:

$$\text{Rep} = \text{Cumulative-Rep} / (\sum_{1..n} (\text{Aw}_n) \text{ in } \text{rT}) + (\text{Aw}_{n+1})$$

*Fig.5.10 - Reputation calculation.*

**Reputation**, differently from **Cumulative-Rep**, is a value that by definition varies between -10 and +10 ; -10 being the minimum possible reputation and +10 the maximum.

**Reputation** can be used in order to rank users and sorting their contents, but also to grant them specific rights. **Cumulative-Rep** is, instead, a progressive value that is meant to be used as a metric in defining a virtual currency to reward users [See chapter 6 for a practical example].

## Complete RCE Meta-Model Algorithm

Now it is possible to define the complete RCE Meta-Model Algorithm in a function as follow:

```
Compute_RCE (UGC Ugc){
    while ( Ugc.Is_Ready_For_Approval?.equals('NO') ){
        //Wait for Approval
    }
    if ( Ugc.Is_Ready_For_Approval?.equals('Expired') ){
        //Discard UGC from the system
        Ugc.remove_from_system!
    }else{
        //UGC is ready for the approval procedure
        //Compute UGC Score (wVUgc)
        K = number of voters of Ugc;
        Vk = vote given by the kth voter of Ugc;
        Repk = reputation of the kth voter of Ugc;
        Pfk = proficiency factor of the kth voter of Ugc;
        wVUgc =  $\sum_{0..k} [ \mathbf{V}_k * ( \mathbf{Rep}_k * \mathbf{Pf}_k ) ] / \sum_{0..k} ( \mathbf{Rep}_k * \mathbf{Pf}_k )$ ;

        //Compute reputation points gained or lost by UGC' Producer
        if ( wVUgc <= AS){
            PoP = negative reputation points assigned to the producer;
        }else{
            PoP = positive reputation points assigned to the producer;
        }
        }

        APn+1 = PoP;
        Cumulative-Rep (Producer) =  $( \sum_{1..n} ( \mathbf{AP}_n * \mathbf{Aw}_n ) \text{ in } \mathbf{rT} ) + ( \mathbf{AP}_{n+1} * \mathbf{Aw}_{n+1} )$ ;
        Rep (Producer) = Cumulative-Rep /  $( \sum_{1..n} ( \mathbf{Aw}_n ) \text{ in } \mathbf{rT} ) + ( \mathbf{Aw}_{n+1} )$ ;

        //Compute reputation points gained or lost by each UGC' voter
        K = number of voters of Ugc;
        Array PvP[k] = points gained by the kth voter;

        for (k voters){

            Vk = vote given by the kth voter to Ugc;

            if (abs( Vk - wVUgc ) > Tolerance){
                // the distance exceeds the tolerance
                PvPk = negative reputation points assigned to the kth voter;
            }
            else{
                // the distance is inside the tolerance
                PvPk = positive reputation points assigned to the kth voter;
            }

            APn+1 = PvP;
            Cumulative-Rep (Voter kth) =  $( \sum_{1..n} ( \mathbf{AP}_n * \mathbf{Aw}_n ) \text{ in } \mathbf{rT} ) + ( \mathbf{AP}_{n+1} * \mathbf{Aw}_{n+1} )$ ;
            Rep (Voter kth) = Cumulative-Rep /  $( \sum_{1..n} ( \mathbf{Aw}_n ) \text{ in } \mathbf{rT} ) + ( \mathbf{Aw}_{n+1} )$ ;
        }
    }
}
```

## 6. *weBBrainys.com: Putting Theory Into Practice*



*Fig.6.0 - weBBrainys.com logo.*

## 6.1. Introduction

Chapter 5 was about the RCE methodology and its collection of guidelines aimed to avoid known issues with current reputation systems, foster community growth and improve user generated contents quality. Any good methodology needs to be proven applicable; for this reason a case-study RCE system named **weBBrainys.com** has been developed; which is the main topic of chapter 6.

The first part of the chapter is about weBBrainys' design choices and the way they were crafted around the RCE principles described in chapter 5. The second part describes system features, technological aspects and development methodologies.

## 6.2. About weBBrainys: A Brief Introduction

WeBBrainys.com is a case-study RCE system which from a technical standpoint is a web application, available free of charge at the address: <http://www.webbrainys.com:3000>.

As any RCE system weBBrainys respects the fundamental building blocks described in chapter 5, which imply the presence of a Community, User Generated Contents and a Rating System. It is composed of a **Social Network Service Infrastructure**, whose members aim to share with the community **User Generated Contents** in the form of blog articles, which are evaluated by community members through a **Global Rating System**, capable to infer community members' reputations through their actions in the community, which consists in posting and voting blog articles.

Functionally it can be considered a crossover between a blogging platform and a social network service, in which participants and resources are evaluated with an RCE reputation mechanism.

The name weBBrainys derives from the voting system, which exploits brain cells as a metaphor to measure users' reputation and commitment. Brain cells also represent the digital currency used for rewarding the most proficient users. The more brain cells users collect the more they are considered successful.

## 6.3. weBBrainys Reputation Algorithm Explained

WeBBrainys represents only one of the many possible ways of realizing a system that respects the RCE founding principles.

This chapter describes in detail the algorithm that weBBrainys uses in order to evaluate users' **Reputations** and assign them **Brain-Cells**, which represents the digital currency bond to the reputation evaluation mechanism.

We need some variables to describe the problem, to this aim the RCE Meta-Model described in chapter 5.5 can be used as a template, making explicit the values that the Meta-Model assumes to be domain dependent, such as: **rT**, **minVotes**, **aT**, etc... . These



variables are highlighted in light blue in the table below (Table 7.1). There is also the need for a new variable to keep count of the brain cells that represents the system's virtual currency: **Brain-Cells**. WeBBrainys' Brain-Cells logically substitute the concept of Cumulative Reputation [Chapter 5.5].

weBBrainys Meta-Model Variables			
Name	Variable	Range	Description
Action	<b>A</b>	/	WeBBrainys users can perform two types of actions: posting articles or voting articles.
Action weight	<b>Aw</b>	1 .. infinity	Each action (posting or voting articles) has a different weight [See chapter 5.2.4].
Reputation Time Spread	<b>rT</b>	1 .. 12 months	WeBBrainys evaluates users' reputation considering just the actions taken within the last 12 months [see chapter 5.2.2].
Approval Time Spread	<b>aT</b>	1 .. 5 days	WeBBrainys approval procedure has a time limit of 5 days. After 5 days posts that don't receive a minimum amount of 3 votes are automatically removed from the system [See chapter 5.2.1].
Minimal Amount of Votes for approval	<b>minVotes</b>	3	WeBBrainys approval procedure requires posts to collect a minimum amount of 3 votes within <b>aT</b> in order to be eligible for undergo the approval procedure [See chapters 5.2.1].
Post Weighted Final Vote	<b>wV</b>	0 .. 10	Represents the final vote achieved by a post after the approval procedure [See chapters 5.2.1]. This vote is weighted by voters reputations and their commitment [See the definition of <b>Pf</b> below].
Post Vote	<b>V</b>	0 .. 10	Represents the single vote given by a voter to a post during the approval procedure.
User's Reputation	<b>Rep</b>	-10.. +10	Unlikely <b>wV</b> users' reputation varies from -10 to +10. Beginner users have a default reputation of +6/10. Users with a reputation lower than 4 have restricted rights (e.g. they are forbidden to vote).
Total Posts	<b>TotP</b>	1.. infinity	Total number of posts published over time <b>rT</b> by a single user.
Proficiency Factor	<b>Pf</b>	1 .. 2	Proficiency Factor represents user's commitment. It is used in combination of users reputations to evaluate posts weighted votes ( <b>wV</b> ).

weBBrainys Meta-Model Variables			
Name	Variable	Range	Description
Brain Cells	<b>Brain-Cells</b>	1 .. infinity	Brains Cells represent the virtual currency of the system. They can be achieved posting or rating articles.

Table 7.1

## Webbrainys' RCE Algorithm

In weBBrainys, users' Reputations and Brain-Cells, are bind to specific users' actions: posting articles and voting articles.

According to the RCE **Approval Votes** principle every new article posted is listed in weBBrainys' home page with status pending, waiting for the necessary number of votes to undergo the approval procedure.

Posts that don't collect at least 3 votes within an approval time (**aT**) of 5 days are considered expired and are automatically removed from the system. See the algorithm (Fig 6.1).

```
Class Post {  
  
  minVotes =3 votes;  
  aT = 5 days;  
  
  Method Is_Ready_For_Approval?(Total_Votes, Post_Age)  
  
    if ( ( Post_Age < aT ) && ( Total_Votes = minVotes ) )  
      // Posts ready for the Approval Procedure  
      return 'YES';  
    elsif ( Post_Age >= aT )  
      // Post expired  
      return 'EXPIRED!';  
    end  
    return 'NO';  
  end  
end  
  
} // end Post  
  
// Usage Examples  
Post.Is_Ready_For_Approval? (3 votes, 1 day)  
=> 'YES'  
  
Post.Is_Ready_For_Approval? (1vote, 1 day)  
=>'NO'  
  
Post.Is_Ready_For_Approval?(1 vote, 8 days)  
=> 'EXPIRED!'
```

Fig.6.1 - weBBrainys Approval Procedure pseudocode.

Posts that reach 3 votes within a time limit of 5 days are ready for the approval procedure.

The approval procedure as described in chapter 5.5 consists of a 4 steps process.

**Step1:** calculate the final score of the post weighting every vote with the associated voter's reputation and commitment.

**Step2:** evaluate **Post Owner** assigning him some points according to the post final score.

**Step3:** evaluate each **Post Voter** assigning them some points according to the distance from the post final score and the given vote.

**Step4:** update **Brain-Cells** and **Reputation** of **Post Owner** and **Post Voters** considering the points achieved (or lost) at steps 2 and 3.

**STEP 1:** calculate the final score of the post weighting every vote with the associated voter's reputation and commitment.

Posts final weighted score ( $wV_i$ ) is computed averaging all the votes  $V$  given by  $k$  voters ( $V_k$ ). Each vote  $V_k$  is also balanced by the respective voter's reputation ( $Rep_k$ ) and proficiency factor ( $Pf_k$ ), like follows:

$$wV_i = \sum_{0..k} [ V_k * ( Rep_k * Pf_k ) ] / \sum_{0..k} ( Rep_k * Pf_k )$$

*Fig.6.2 - Posts final weighted score calculation*

If  $wV_i$  is  $> 4$  the post is accepted, otherwise it is rejected and removed from the system.

Proficiency Factor ( $Pf_k$ ) is a domain dependent value introduced as a measurement of voters commitment [see chapter 5.3.2]. In weBBrainys it is computed as follow (Fig. 6.3):

```

if (TotPk < 50)
    // If the total amount of posts approved within last 12
    // months is inferior of 50
    Pfk = 1 + (TotPk / 50)
else
    Pfk = 2
end

```

Fig.6.3 - weBBrainys Proficiency Factor calculation.

Note that in order to prevent the tyranny of the elders [See chapter 5.2.1], Pf<sub>k</sub> grows at most of 1/50 per posts approved within a time spread of 12 months (definition of TotP in the variables of table 7.1). Moreover Pf<sub>k</sub> can't grow bigger than 2, granting thus to most proficient users at most a voting influence doubled than the others.

Note also that according to the definition of Rep (table7.1) voting rights are reserved only to voters with reputation > +4, this means that although Rep can vary from -10 to +10 , in the post's final score formula it is always a positive value.

**STEP 2:** assign some points to the Post Owner (PoP = post's owner points) considering the post final score (wV<sub>i</sub>). In this respect weBBrainys customizes the algorithm of chapter 5.5 as follow (Fig. 6.4):

```

if ( wVi <= 4 )
    PoP = wVi - 10
else
    PoP = wVi
end

```

Fig.6.4 - weBBrainys Post' Owner points calculation.

If the post final vote wV<sub>i</sub> is <= 4, the owner receives a negative amount of points, computed according to the negative distance from the post final vote (wV<sub>i</sub>) and the maximum score (10). Otherwise the owner receives a positive amount of points equal to the vote of his post (wV<sub>i</sub>) (Fig. 6.5).

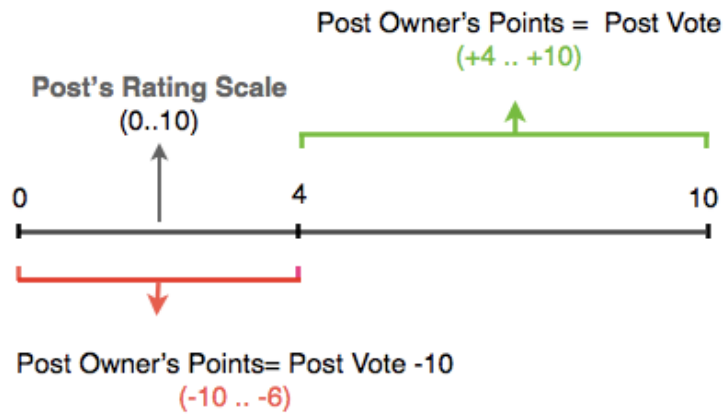


Fig.6.5 - weBBrainys Post' Owner points calculation (visual explanation)

**STEP 3:** assign some points to Post Voters (PvP = post voter's points) according to the distance from the post final score ( $wV_i$ ) and single users voting accuracy. If the distance between  $V$  (given vote) and  $wV_i$  exceeds the fixed tolerance voters lose some points (negative points), otherwise they gain some points (positive points). Once again weBBrainys must adapt the RCE algorithm of chapter 5.5 according to its domain-specific needs. The solution that has been adopted is described by the algorithm that follows (Fig. 6.6 and 6.7).

```

K = number of voters = 3;
Tolerance = 2;
Vk = vote given by the  $k_{th}$  voter ;
PvPk = points gained by the  $k_{th}$  voter;

for (k voters){

  if (abs( Vk - wVi ) > Tolerance){
    // If the distance exceeds the tolerance
    // give a negative amount of points to the voter
    // equal to the distance from Vk to wVi
    PvPk = - abs( Vk - wVi )

  else
    // If the distance is inside the tolerance
    // give to the voter a positive amount of points
    // equal to 3 times the inverse of the
    // distance from Vk to wVi
    PvPk = 10 - (abs( Vk - wVi ) * 3)
  end
}

```

Fig.6.6 - weBBrainys Post' Voter points calculation

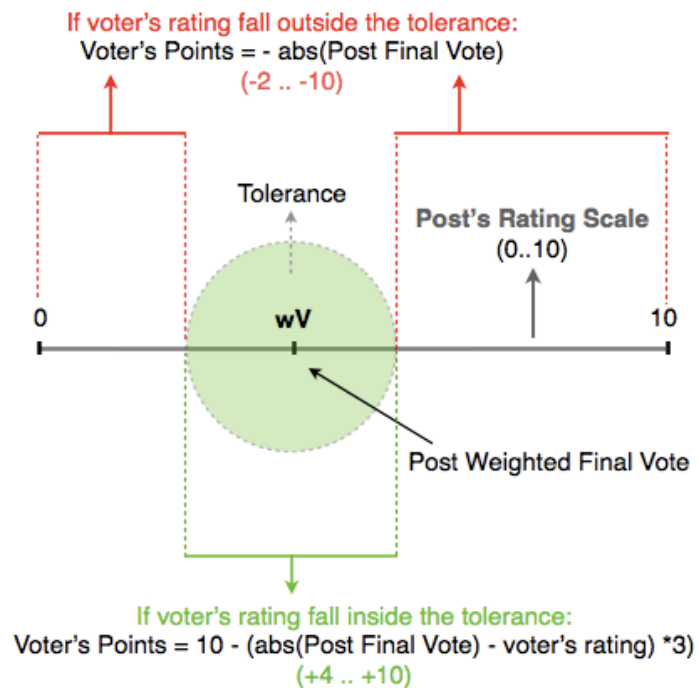


Fig.6.7 - weBBrainys Post' Voter points calculation  
(visual explanation)

**STEP 4:** update Brain-Cells and Reputation of Post Owner and Post Voters considering the points achieved (or lost) on steps 2 and 3.

In Step 2 Post Owner gains (or loses) some points (PoP), the same happens for Post Voters at step 3 (PvP), now we can call both PoP and PvP just Action Points (AP), and consider them like a certain amount of point gained or lost by the users as effect of posting or voting.

For Post Owner : **AP = PoP**

For Post Voters : **AP = PvP**

Not every action is worth the same. Associated with different actions are different Action Weights (Aw). In weBBrainys posting original articles is worth 10 points, instead posting 'excerpted' articles is worth 6 points [See chapter 6.5.4], therefore for the Post Owner the associated Action Weight will be:

**Aw = 10 or 6** (according to the type of post)

Voting articles has also a variable weight, also. Voting an article weights 2 points upon a positive judgment of the voter and 4 points upon negative judgment. Therefore for **Post Voters** the associated action weight will be:

**Aw = 2 or 4** (according to the outcome of STEP 3)

Now, to compute the amount of **Brain-Cells** that a user gains or loses performing the  $n^{th}+1$  action (vote or post) we need to multiply the associated **AP** by the respective **Aw**.

$$\mathbf{Brain-Cells}_{n+1} = (\mathbf{AP}_{n+1} * \mathbf{Aw}_{n+1})$$

Similarly, to compute the total amount of **Brain-Cells** currently owned by a user, we need to consider all the  $n$  actions performed before the action  $n+1$  within the time spread **rT**:

$$\mathbf{Total Brain-Cells} = (\sum_{1..n} (\mathbf{AP}_n * \mathbf{Aw}_n) \text{ in } \mathbf{rT}) + (\mathbf{AP}_{n+1} * \mathbf{Aw}_{n+1})$$

*Fig.6.8 - weBBrainys Total Brain-Cells calculation*

WeBBrainys, in respect of the principle that reputation should be time-sensitive [Chapter 5.5.3], evaluates users' reputation considering just the actions taken within the last 12 months. This way it can happen that the  $n$  actions considered in computing the **Brain-Cells** are inferior of the total amount of actions performed by the users since the subscription.

Once the total amount of **Brain-Cells** is computed we can calculate the updated user's **Reputation** averaging the **Total Brain-Cells** by the sum of all **Actions Weights** of the actions taken within **rT**:

$$\mathbf{Rep} = \mathbf{Total Brain-Cells} / \sum_{1..n} (\mathbf{Aw}_n) + (\mathbf{Aw}_{n+1})$$

*Fig.6.9 - weBBrainys Reputation calculation*

**Reputation** is a value that varies between -10 and +10, -10 being the minimum possible reputation and +10 the maximum.

WeBBrainys uses **Reputation** mainly for ranking users and sorting their contents, but also to grant them rights. In this respect it is a bit strict, in fact, all users with a reputation lower than +4 have restricted voting rights (e.g. they are forbidden voting).



**Brain-Cells**, instead, are meant to be used as virtual currency in order to reward users, even though, as will be explained in the last chapter this part of the system does not implement a monetary reward yet.

Following subchapters will further clarify weBBrainys' domain of application and technological solution, in order to help the reader better understand functionalities and implementation of this first RCE system.

## 6.4. weBBrainys' Development Tools and Methodologies

WeBBrainys was developed under budget and time restrictions (i.e. no budget, and a very short time). The technologies chosen reflect thus the imposed constraints. All the libraries and the development framework are open-source, freeware and easily integrable in an **Agile Software Development** cycle. In any case they represents examples of cutting-edge technologies in their respective fields. WeBBrainys was built on a budget but not at the expense of quality and effectiveness.

As web development framework it has been used **Ruby on Rails**. All Javascripts are handled with three main libraries, **Prototype**, **script.aculo.us** and **Yahoo User Interface**.

Chapter 6.4 aims to give a brief overview about the technologies involved in the development of weBBrainys.com, the most of the informations provided are a brief or are excerpts from producers' websites or wikipedia.org, the free encyclopedia.

### 6.4.1. Ruby On Rails Web Development Framework

**Ruby on Rails** <sup>[LXIV]</sup>, often shortened to **Rails** or **RoR**, is an open source web application framework for the Ruby programming language. It is intended to be used with an Agile development methodology <sup>[see chapter 6.4.4]</sup> which is used by web developers for rapid development.

Ruby on Rails was extracted by David Heinemeier Hansson <sup>[LXV]</sup> from his work on Basecamp <sup>[LXVI]</sup>, a project management tool by 37signals <sup>[LXVII]</sup> (now a web application company).

Like many contemporary web frameworks, Rails uses the Model-View-Controller (MVC) <sup>[LXVIII]</sup> architecture pattern to organize application programming.

Ruby on Rails features several tools intended to make commonplace development tasks easier "out of the box". Rails provides scaffolding which can automatically construct some of the models and views needed for a basic website. A simple ruby web server (WEBrick) <sup>[LXIX]</sup> and Rake <sup>[LXX]</sup> build system are also included. By including these common tools with the Rails framework, a basic development environment is, in effect, provided with all versions of the software.

Rails is also noteworthy for its extensive use of JavaScript libraries Prototype <sup>[chapter 6.4.2]</sup> and Script.aculo.us <sup>[chapter 6.4.2]</sup> for Ajax <sup>[XVI]</sup>.

Ruby on Rails is intended to emphasize *Convention over Configuration* (CoC)<sup>[LXXI]</sup>, and the rapid development principle of *Don't Repeat Yourself* (DRY) <sup>[LXXII]</sup>.

"Convention over Configuration" means that a developer only needs to specify unconventional aspects of the application. For example, if there is a class *Sale* in the model, the corresponding table in the database is called *sales* by default. It is only if one

deviates from this convention, such as calling the table "products sold", that the developer needs to write code regarding these names. Generally, this leads to less code and less repetition.

"Don't repeat yourself" means that information is located in a single, unambiguous place. For example, using the ActiveRecord <sup>[LXXIII]</sup> module of Rails, the developer does not need to specify database column names in class definitions. Instead, Ruby on Rails can retrieve this information from the database based on the class name.

RAILS is a concentrate of innovative software development design principles, and it was fundamental for the successful deliver of weBBrainys. No other frameworks could grant today, the same productive ratio.

## 6.4.2. Prototype JavaScript Framework and script.aculo.us JavaScript Library

The **Prototype JavaScript Framework** <sup>[LXXIV]</sup> is a JavaScript framework which provides an Ajax <sup>[XVI]</sup> framework and other utilities, for developing JavaScript applications. The features range from programming shortcuts to major functions for dealing with XMLHttpRequest <sup>[LXXV]</sup>.

Prototype also provides library functions to support classes and class-based objects, something that the JavaScript language does not have. It is distributed standalone, but also as part of larger projects, such as Ruby on Rails and Script.aculo.us.

**Script.aculo.us** <sup>[LXXVI]</sup> is a JavaScript library built on the Prototype JavaScript Framework, providing dynamic visual effects and user interface elements via the Document Object Model <sup>[LXXVII]</sup>.

It is most notably included with and Ruby on Rails, but also provided separately to work with other web application frameworks and scripting languages.

**Script.aculo.us** was extracted by Thomas Fuchs from his work on fluxiom <sup>[LXXVIII]</sup>, a web based digital asset management tool by the design company wollzelle <sup>[LXXIX]</sup>. It was first released to the public in June 2005.

## 6.4.3. Yahoo User Interface JavaScript Library

The **Yahoo! User Interface Library (YUI)** <sup>[LXXX]</sup> is an open-source JavaScript library for building richly interactive web applications using techniques such as Ajax<sup>[XVI]</sup>, DHTML <sup>[LXXXI]</sup> and DOM <sup>[LXXXII]</sup> scripting. It is available under a BSD License <sup>[LXXXIII]</sup>. Development on YUI began in 2005 and Yahoo! properties such as My Yahoo! and the Yahoo! front page began using YUI in the summer of that year. In February 2006 YUI was released for public use under BSD and it is actively developed by a core team of Yahoo! engineers.

The YUI Library project at Yahoo! was founded by Thomas Sha and sponsored internally by Yahoo! co-founder Jerry Yang. Its principal architects have been Sha, Adam Moore, and Matt Sweeney. The library's developers maintain the YUIBlog where the YUI community discusses the library and implementations in its community forum.

The YUI Library is fully documented on its website <sup>[LXXX]</sup> and detailed API documentation accompanies the library download. It has six types of components: YUI core, utilities, UI controls, CSS components, developer tools, and build tools.

#### 6.4.4. Agile Software Development

**Agile Software Development** refers to a group of software development methodologies based on iterative development, where requirements and solutions evolve through collaboration between self-organizing cross-functional teams. The term was coined in the year 2001 when the Agile Manifesto was formulated.

Agile methods generally promote a disciplined project management process that encourages frequent inspection and adaptation, a leadership philosophy that encourages teamwork, self-organization and accountability, a set of engineering best practices that allow for rapid delivery of high-quality software, and a business approach that aligns development with customer needs and company goals.

In 2001, prominent figures in the field of agile development created the **Agile Manifesto**.

The Agile Manifesto states:

“We are uncovering better ways of developing software by doing it and helping others do it. Through this work we have come to value:

1. **Individuals and interactions** over processes and tools
2. **Working software** over comprehensive documentation
3. **Customer collaboration** over contract negotiation
4. **Responding to change** over following a plan

That is, while there is value in the items on the right, we value the items on the left more.”

Some of the principles behind the Agile Manifesto are:

- A. Customer satisfaction by rapid, continuous delivery of useful software
- B. Working software is delivered frequently (weeks rather than months)
- C. Working software is the principal measure of progress

- D. Even late changes in requirements are welcomed (this does not mean code & run. Instead removing an existing feature or moving a deadline forward to accommodate late/unplanned feature requests)
- E. Close, daily cooperation between business people and developers
- F. Face-to-face conversation is the best form of communication (Co-location)
- G. Projects are built around motivated individuals, who should be trusted
- H. Continuous attention to technical excellence and good design
- I. Simplicity
- J. Self-organizing teams
- K. Regular adaptation to changing circumstances

The manifesto spawned a massive movement in the software industry to the extent that nowadays, Agile Software Development refers not only to a group of software development methodologies, but also to the group of software professionals who foster its adoption.

## 6.5. About weBBrainys: Features and Design Choices

In the chapters that follow, weBBrainys will be broken down in its fundamental parts: the **Home Page**, **Users' Profiles**, **Users' Blog**, and **Users' Statistics**.

### 6.5.1. Home Page and Registration Process

Users can access weBBrainys home page (Fig. 6.10) by browsing <http://www.webbrainys.com:3000>.



Fig.6.10 - weBBrainys.com, Home Page

From a visual standpoint the home page resembles a news website.

In the top part there is a carousel with the most popular blog posts [Bubble 1, fig. 6.10] and in the center part there are briefs of the latest posts [Bubble 2, fig. 6.10], which can be filtered by topics accessing the thematic channels on the right [Bubble 3, fig. 6.10].

On the left the most successful users are listed [Bubble 4, fig. 6.10], which in the slang of the system are addressed as '**Big Brainys**'.

At the top of the page, next to the weBBrainys logo, there is a keyword search system [Bubble 5, fig. 6.10] which allows the user to find weBBrainys articles using specific keywords.

On the top-right corner of the page [Bubble 6, fig. 6.10] there are two main links: 'Brainsys Search' and 'My Brainspace'.

'Brainsys Search' leads to an advanced searching tool used for finding people in the community, while 'My Brainspace' leads to users' personal areas.

Users' personal area access is restricted to registered users.

To be an active member of the community registration is required. Registration is free of charge and comprises access to all website areas (users profiles, users statistics, etc...), posts voting rights and facilities like, a personal profile area, friendship management tool, personal blog, and personal statistics tool.

To register or to log-in click on 'My Brainspace' link or on the Register or Log in link on the right-top corner of the home page and fill-in the requested data [Bubbles 7 & 8, fig. 6.11].

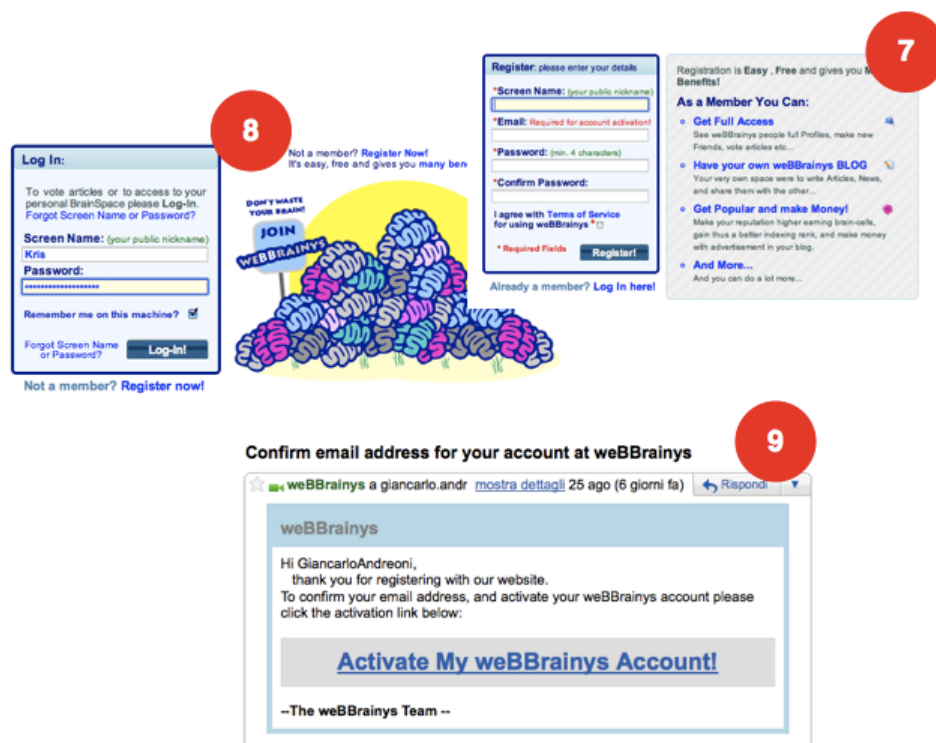


Fig.6.11 - weBBrainys.com, Registration Mechanism

Upon a successful registration an activation email [Bubble 9, fig. 6.11] is sent to new users. Clicking on the activation link inside the email allows users to authenticate their email addresses and activate their accounts.

Activation emails are a necessary precaution in order to discourage security hazards like identity forgery.

## 6.5.2. Personal Profiles and Friendship Management

Once a user is registered and has activated his account he can access his personal area by clicking on the 'My Brainspace' link [Bubble 6, fig. 6.10] in the home page.

Users' personal areas comprise of the user's profile page, a friendship management tool, a personal blog and a statistics tracking tool.

Personal areas can be browsed from the tab menu at the top of personal pages [Bubble 10, fig. 6.12].

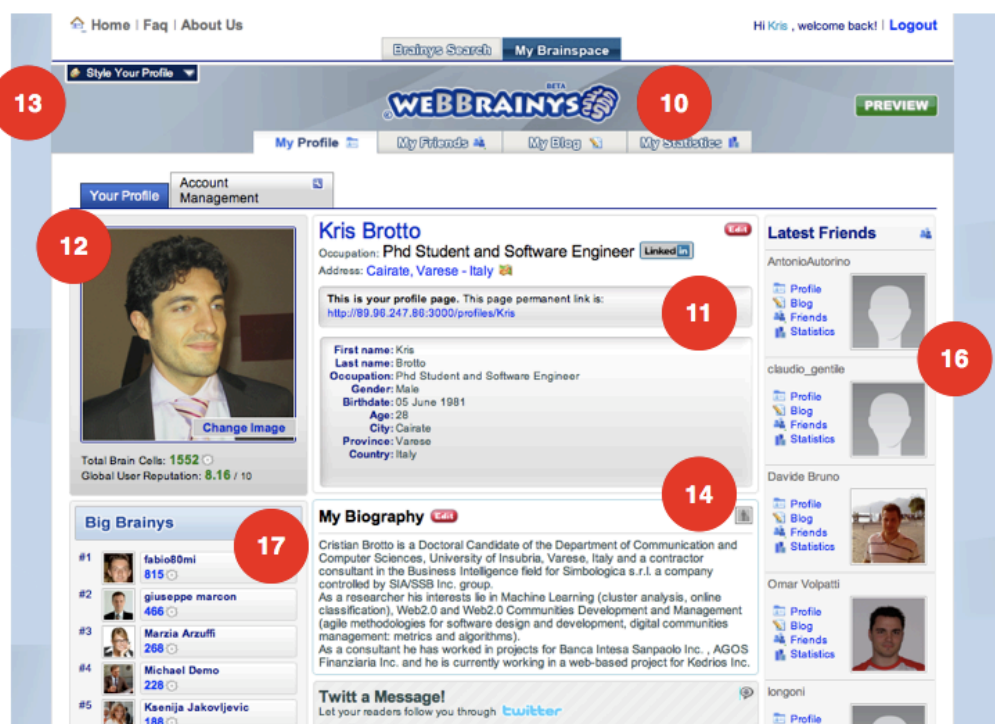


Fig.6.12 - weBBrainys.com, User Profile Example

The first of the personal pages is the user's profile page (Fig. 6.12).

In profile pages users can add basic informations about themselves [Bubble 11, fig. 6.12], and also import some other informations from external web-services that they may be already using, such as: **LinkedIn**, **Twitter** or **GoogleMaps**.

In RCE systems users identity is very valuable information. Therefore weBBrainys encourages its users to arrange their personal profiles through many facilities. Profile images can be managed with an advanced online cropping tool [Bubble 12, fig. 6.12], a custom appearance tool allows user to personalize colors of their pages [Bubble 13, fig. 6.12] and freeform info boxes [Bubble 14, fig. 6.12] can be edited using an advanced editing tool [Bubble 15, fig. 6.13], which allows text, picture, movie and widgets embedding.



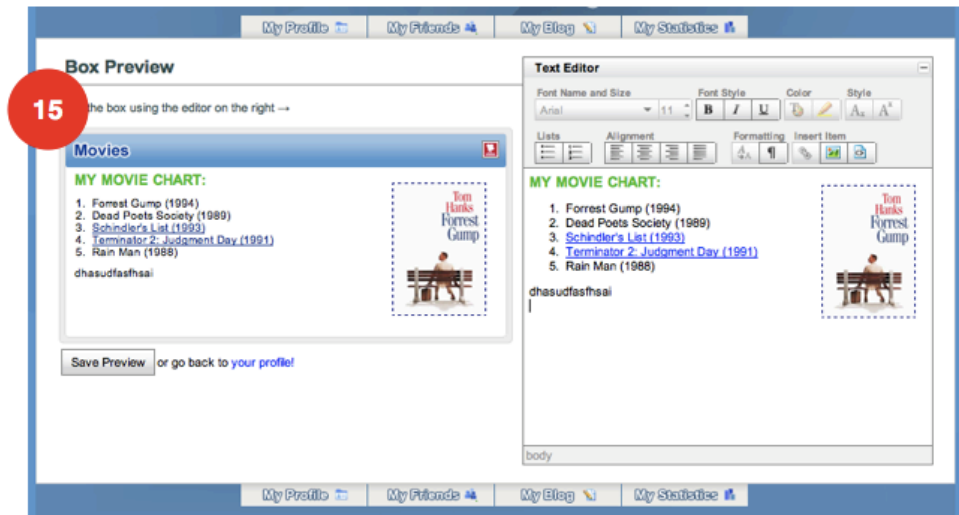


Fig.6.13 - weBBrainys.com, info boxes editor.

To prevent embedding of malicious contents the editor is provided with technologies that allows HTML tags stripping and javascript sanitizing.

WeBBrainys as an RCE system is characterized by a social network infrastructure in which social bonds have a relevant role, for this reason, part of a user's profile is occupied by user's friends data [Bubble 16 & 17, fig. 6.12] .

In order to bind new friendships, registered users can send friendship requests to other registered users through their profile pages.

Friendship requests are notified via email [bubble 18, fig. 6.14]. Receivers can accept or decline the request directly from the links provided inside the email, or by using the friendship management tool [Bubble 19, fig. 6.15], which is available from user's personal area.

### New friend request at weBBrainys.com

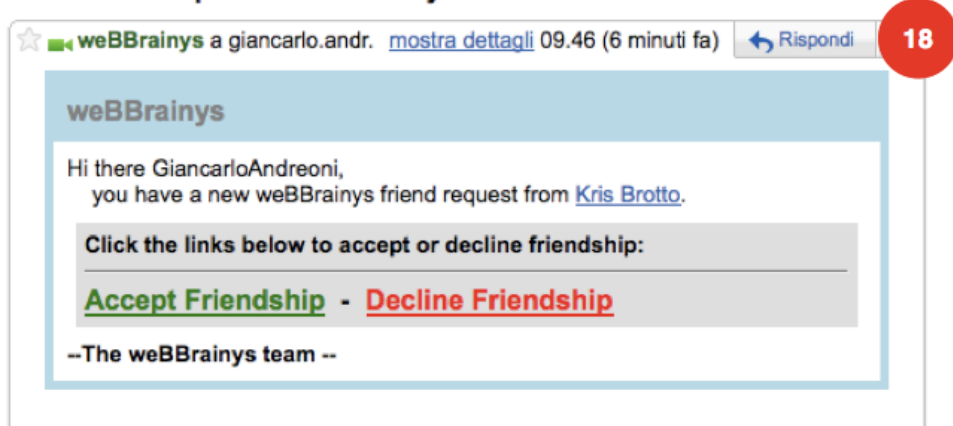


Fig.6.14 - weBBrainys.com, Friend Request Email

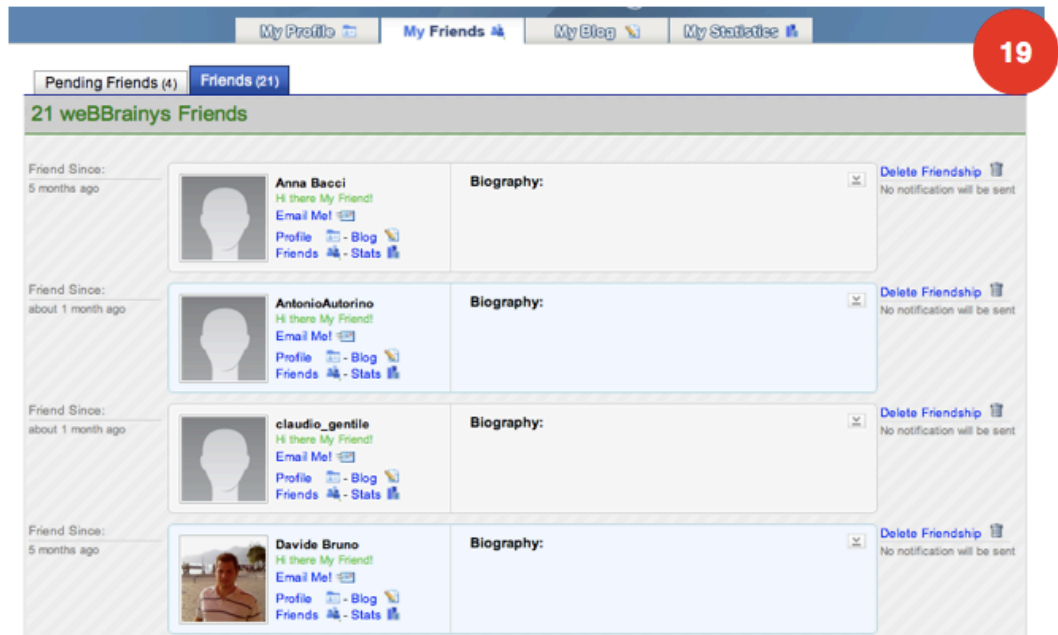


Fig.6.15 - weBBrainys.com, friendship management tool.

### 6.5.3. Users' Blog

WeBBrainys users arrange personal profiles, make new friends and as in any RCE systems, are required to produce for the sake of the community some kind of user generated content. In weBBrainys this goal is achieved via users' blogs.

Personal blogs (Fig. 6.16) are part of users personal pages, and are visible to all users whether they are registered or not.



Fig.6.16 - weBBrainys.com, user's blog.

The blog page contains, in the center, a list of user's most recent posts [Bubble 20, fig. 6.16], which can be sorted according to the thematic channel they belong to [Bubble 21, fig. 6.16] and also according to their status. Like in any RCE system weBBrainys resources needs to be approved in order to remain in the system. Therefore posts can be in different statuses: draft, pending, approved, or rejected [See chapters 6.3.4 and 6.4].

The blog is also provided with an embedded chatting tool [Bubble 22, fig. 6.16]. The tool is meant to connect users with an online assistant who can help users in the procedure of publishing blog articles.

#### 6.5.4. Making ones' Reputation Posting and Voting Blog Articles

Posting an article is an easy and quick procedure.

Clicking the big red button 'Add NewPost' [Bubble 23, fig. 6.16] in the blog page allows the user to be presented with an advanced tool for editing articles [Bubble 24, fig. 6.17], which allows text, picture and movie embedding.

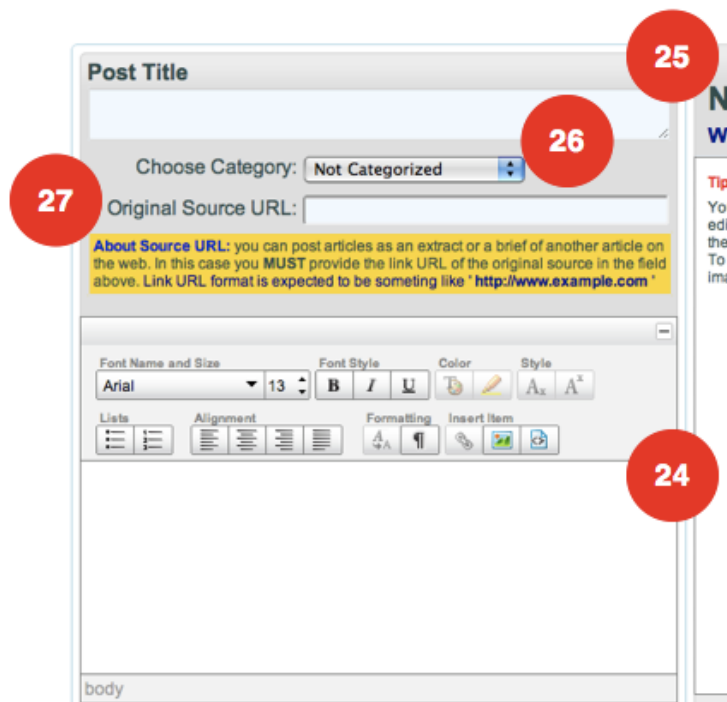


Fig.6.17 - weBBrainys.com, posts editor.

Every post requires a title [Bubble 25, fig. 6.17] and a category [Bubble 26, fig. 6.17], which corresponds to the thematic channel in which the post is meant to be filed. Users can choose among a wide span of categories. In lacking of a suitable area, the article can be categorized as 'Not Categoriz...'.  
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Users can submit posts in the form of original articles or as an excerpt of other web articles. in this case it is compulsory to provide the source [Bubble 27, fig. 6.17].

In respect of the RCE **Resource Weights** principle [Chapter 5.3.4] the reputation algorithm will judge users' reputations considering original articles as more relevant than the excerpted ones.

Once the article is ready it can be saved as a draft, and then published as a pending post [Bubble 28, fig. 6.18] on the home page to undergo the approval procedure.

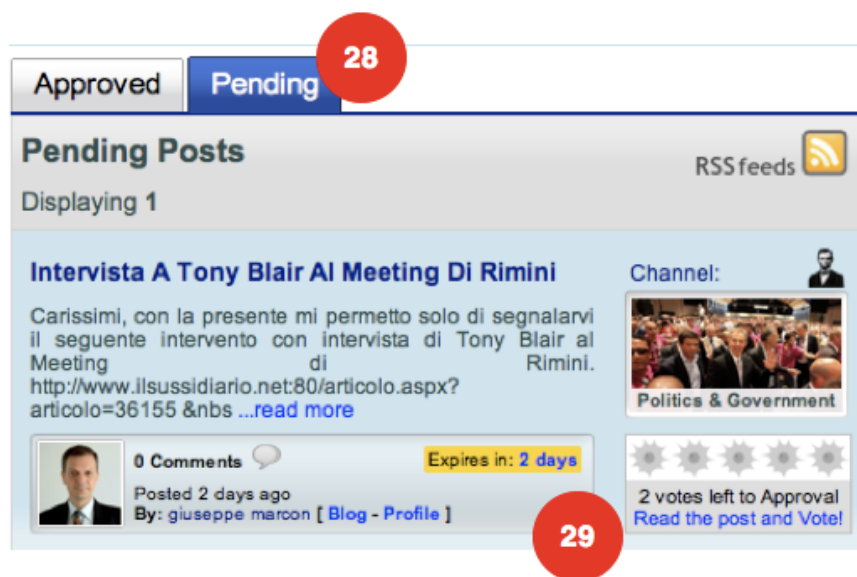


Fig.6.18 - weBBrainys.com, pending post (Home Page).

During the approval procedure in a time period of 5 days the article needs to achieve 3 votes; otherwise it is automatically discarded by the system. In the image above, the article is expiring in two days and requires two more votes to be judged [Bubble 29, fig. 6.18]. Once published the post is also reported to the attention of users' friends via email [Bubble 30, fig. 6.19].

## New Post Published: 'Intervista a Tony Blair al Meeting di Rimini'

30

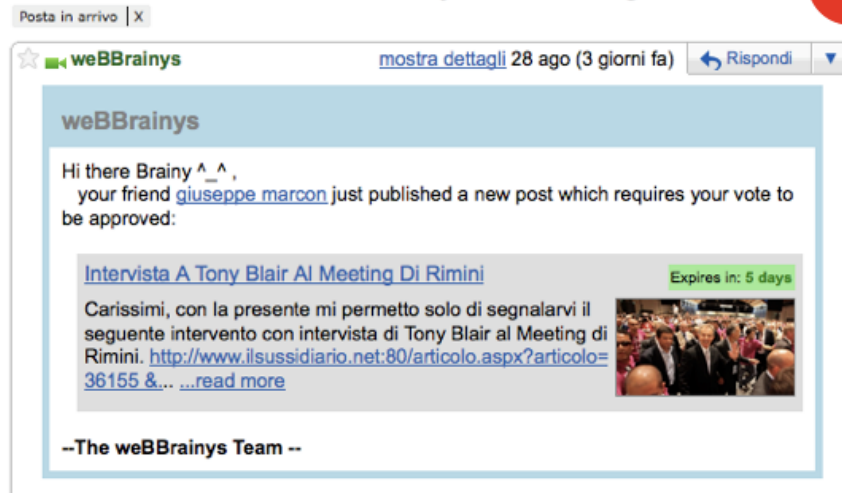


Fig.6.19 - weBBrainys.com, pending post email notification.

Every post (Fig. 6.20) whether approved or pending, is provided with some details about the author [Bubble 31, fig. 6.20] which are positioned in the left-top corner of the page.

Authors identity and their statistics are considered a valuable part of the post.

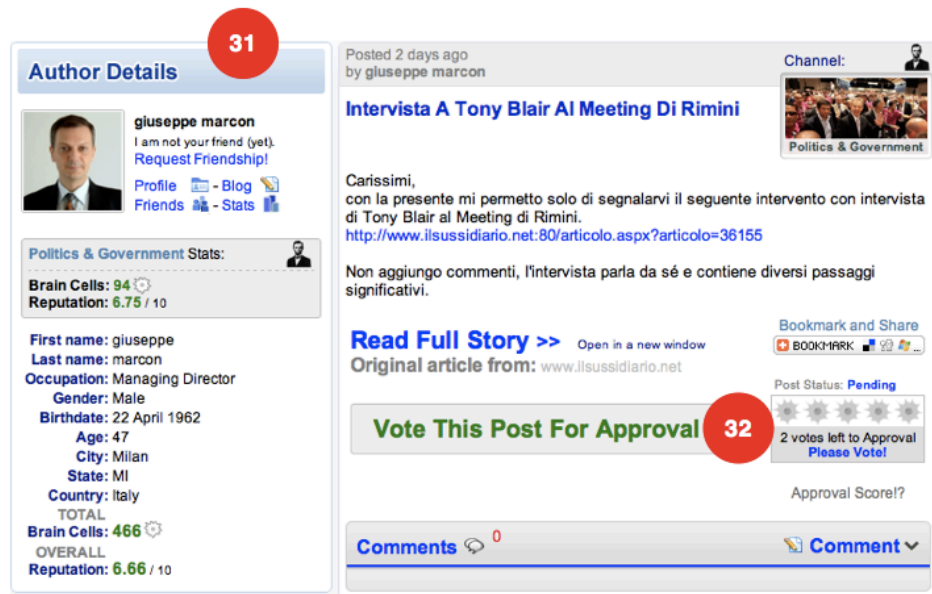


Fig.6.20 - weBBrainys.com, post example.

According to the RCEs' **Blind Ratings** [Chapter 5.3.3] principle voters can't see the partial score of pending posts [Bubble 32, fig. 6.20]; they just see the number of votes remaining to score the article. Moreover the rating panel, unlike the vast majority of rating mechanism available on the internet, does not use the classical star metaphor, but rather relies on brain cells (Fig. 6.21).



Fig.6.21 - weBBrainys.com, on the left a classical star-based rating panel, on the right weBBrainys' braincells rating panel.

The use of a different metaphor meets two design choices. Firstly, since users' **Reputation and Commitment** [Chapter 5.3.2] are evaluated in braincells, it is sensible to use them on the rating panel.

Secondly the braincells rating system is an implementation of the RCE principles, where rating is meant to work **Bidirectionally** [Chapter 5.3.3], therefore the use of a less common metaphor can help users to remind themselves at first glance, that voting is going to influence their reputations.

Braincells rating panel also meets RCEs' **Reputation Translucence** [Chapter 5.7] requirements in the sense that the star's metaphor could be misleading whereas the braincell's metaphor is self-explanatory.

When a post reaches three votes the final score is computed considering voters **Reputation** and a **Proficiency Factor**, which is a value representing voters commitment. In respect to the RCE principles post owner and voters are then evaluated with a reputation score calculated on the basis of the post final score. [See the detailed algorithm at chapter 6.4]

As a reward post owner and voters gain (or lose) some braincells. The amount of braincells gained or lost depends on the quality of the performance . [Chapter 6.4]

If the post has too low of a final score it is rejected and removed from the home page. In case of acceptance it is promoted in the group of approved posts, and its final score, plus some other statistics, becomes visible to everyone [Bubble 33, fig. 6.22].

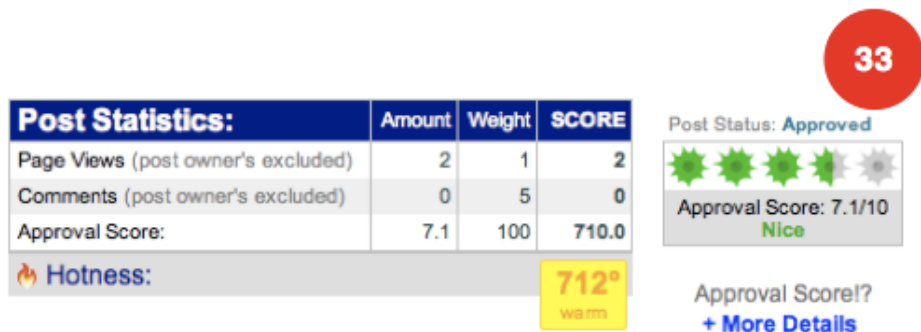


Fig.6.22 - weBBrainys.com, braincells rating panel after approval.

Other precaution that weBBrainys applies in order to improve **Reputation Translucence** are approval email reports. Upon the conclusion of the approval procedure post owner and voters receive in their inboxes, an email explaining to them the way their reputations have changed.

In fig. 6.23 an example of e-mail sent to a post owner [Bubble 34, fig. 6.23].

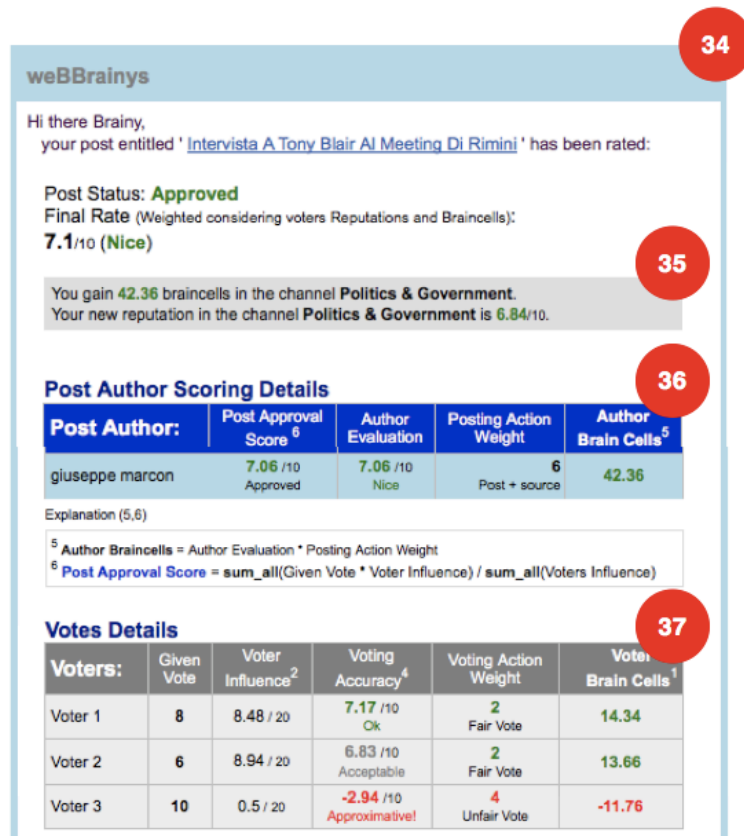


Fig.6.23 - weBBrainys.com, Post owner's approval email report example.

In the example the owner is informed that his post entitled, '*Intervista A Tony Blair Al Meeting Di Rimini*', has been accepted and the final score, weighted according to Voters Reputation and Commitment is 7.1/10. The consequent effect is a gain of 42.36 brancells and a reputation of 6.84/10 in the channel 'Politics and Government', which is the channel in which the post was filed [Bubble 35, fig. 6.23].

The email provides even more information for those that like to know details. In the first table [Bubble 36, fig. 6.23] the authors can check the data used to calculate its reputation and brancells.

In this example, the post has received a final score of 7.06 (which was rounded to 7.1). Therefore he receives, as author, a positive reputation score of +7.06 points, that multiplied by 6, the weight associated to posting an article with source (i.e. extracted from another web article) generates a gain of 42.36 brancells. The table [Bubble 36, fig. 6.23], comes with a legend at the bottom for a better understanding.

The author is also informed about votes details with a table [Bubble 37, fig. 6.23] reporting each given vote, single voters influence (a compound value that considers voters Reputation and Proficiency), their final performance in terms of voting accuracy (computed according to the distance from the given vote and the final score) and their consequent achievement in terms of brancells.

Note that voters identities are hidden, in respect of the RCE **Voters Anonymity** principle. [Chapter 5.3.3]

For a better users' comprehension the table [Bubble 37, fig. 6.23] is provided with a legend (not visible in the image).

At the end of the approval procedure, voters receive an email report similar to the post author one [Bubble 38, fig. 6.24].



**38**

**weBBrainys**

Hi there Brainy,  
the post you have **VOTED**, entitled ' [Intervista A Tony Blair Al Meeting Di Rimini](#) '  
has been rated:

**Post Status: Approved**

**Final Rate** (Weighted considering voters Reputations and Braincells): **7.1/10 (Nice)**

**39**

Your voting accuracy has been judged **-2.94 /10 Approximative!**, you lose **-11.76** braincells in the channel **Politics & Government**.  
Your new reputation in the channel **Politics & Government** is **-0.88/10**.

**Voters Scoring Details**

Voters:	Given Vote	Voter Influence <sup>2</sup>	Voting Accuracy <sup>4</sup>	Voting Action Weight	Voter Brain Cells <sup>1</sup>
Voter 1	8	8.48 / 20	7.17 /10 Ok	2 Fair Vote	14.34
Voter 2	6	8.94 / 20	6.83 /10 Acceptable	2 Fair Vote	13.66
<b>YOU!</b>	<b>10</b>	0.5 / 20	<b>-2.94 /10</b> Approximative!	<b>4</b> Unfair Vote	<b>-11.76</b>

**40**

Explanation (1,2,3,4)

<sup>1</sup> **Voter Braincells** = Voting Accuracy \* Voting Action Weight  
<sup>2</sup> **Voter Influence** = Voter Channel Reputation \* Channel Proficy Factor<sup>3</sup>  
<sup>3</sup> **Proficy Factor** = calculated for every channel considering the number of posts produced by the user in the specific Channel. It can vary from 1 to 2.  
<sup>4</sup> **Voting Accuracy** = calculated considering the difference between the Post Approval Score<sup>6</sup> and the Given Vote by the user. If the difference is > of 2 the vote is considered unfair and you lose Braincells and Reputation. Unfair votes have weight 4, accurate ones 2.

**Post Author Scoring Details**

Post Author:	Post Approval Score <sup>6</sup>	Author Evaluation	Posting Action Weight	Author Brain Cells <sup>5</sup>
giuseppe marcon	7.06 /10 Approved	7.06 /10 Nice	6 Post + source	42.36

**41**

Fig.6.24 - weBBrainys.com, Post voters' approval email report example.

In the image above one of the voters is informed that the post he has voted has reached the final score of 7.1/10, and that his voting accuracy has been judged **Approximative**, causing him the loss of -11.76 braincells and a decrement of reputation in the channel 'Politics and Government'.

To understand why the user has been judged negatively we need to check the table named 'Voters Scoring Details' [Bubble 40, fig. 6.24].

From the table we can see that the voter was giving to the post a score of 10/10 and that his voting influence was very low 0.5, on the contrary voters with a much higher influence were giving lower marks, causing thus the post to achieve a final score of only 7.1/10. Considering now the distance of almost three points from the post final score and the vote given by the user the system has judged his vote approximative.

From the table we can also see that the **Action Weight** associated with voters judged fair is 2 and that, on the contrary, the **Action Weight** associated to voters judged unfair is 4.

This happens in accordance to what was discussed in chapter 5.4.5 about making reputation easier to lose than to acquire. In fact, a voting accuracy of -2.94 points multiplied by an **Action Weight** of 4 causes a loss of -11.75 braincells, rather than only  $-2.94 * 2 = -5.88$  braincells.

### 6.5.5. Keeping Track of Reputations and Braincells

Other basic requirement for any RCE system is the ability to keep track over time of reputation variation (see chapter 5.5.3), and being able to break down users' reputation according to different context (see chapter 5.5.2). In this attempt weBBrainys provides for any registered user a statistical tool, accessible from the users' personal area (Fig. 6.25).



Fig.6.25 - weBBrainys.com, User's statistics management tool.

Any user can browse different statistics [Bubble 43 & 44, fig. 6.26], like: posts approved by channel, votes given by channel, current reputation by channel, current braincells by channel and also reputation and braincells variation over time by different channels.

Users statistics are publicly accessible by every user, and represents a sort of users' Reputation Identity Card [Bubble 44, fig. 6.26].



Fig.6.26 - weBBrainys.com, various users' statistics example.

## **7. Conclusion, Limitations and Further Researches**

## 7.1. Webbrainys Results

If social and human factors are involved they prevail over any algorithm or design pattern, as long as the methodology is good. Obviously the RCE approach, being based on a social networking architecture, is affected too. For this reason it is compulsory to deepen RCE social aspects discussing the results achieved so far, during the first 4 months of weBBrainys experimentation.

WeBBrainys.com is a reality thanks to the courtesy of Simbologica s.r.l, an IT consulting company based in Milan (Italy), which has provided some of the facilities necessary to put in practice the project.

The company was interested in carrying out a little experimentation regarding Web 2.0 social networks and Enterprise 2.0 environments for the purpose of gaining a knowledge about the topic and evaluating a possible internal adoption of Enterprise 2.0 working methodologies.

Webbrainys is currently still in its testing phase. It has around 30 members which are mostly Simbologica s.r.l. employees. These IT professionals are divided into two groups; senior employees and junior employees, generally with little knowledge of Web 2.0 and Enterprise 2.0 social networking paradigms.

The application was created to be used as a general purpose Web-RCE platform and also as an Enterprise-RCE throughout dedicated channels of exclusive usage of Simbologica s.r.l. .

The testing phase was carried out in two steps. In the first step, weBBrainys was released without any reputation mechanism, letting the users post freely, but still forcing every post to be approved through a **non reputation based** rating system.

In this phase, after a positive beginning, some users started being less accurate, posting not so valuable resources and voting without paying the due attention, causing thus a lowering in the general quality of the resources, with a consequent deterioration in the perception of the validity of weBBrainys as tool and a decreasing trend in participation.

In the second phase, the reputation evaluation mechanism was introduced, with two main effects. The trend in active participation didn't change much, but posts started showing a stable medium to high quality. Participants also clearly divided into three groups: the enthusiastic, the lurkers and the afraid. At the moment, interpreting these behaviors, is not banal. The system needs more time to be completely evaluated, after just a few months of testing it is too early to come to definitive conclusions. The amount of participants (30 people) is still too small and at the moment no monetary gain is provided for the users. The only reward is in gaining the pride of collecting braincells and proving to be oneself a capable individual in the community.

Introducing a monetary rewarding is certainly one of the most important goals for the future, even though this may not happen soon mainly due to because lack of founding. Nevertheless, there are some good results that must be mentioned. The RCE methodology, although more complicated than normal rating-based mechanisms, was

surprisingly quite easily comprehended, and the average quality of contents has actually raised and stabilized. Active participants showed a more responsible behavior, with very positive feedback by younger employees.

Fig. 7.1 summarizes weBBrainys testing results.

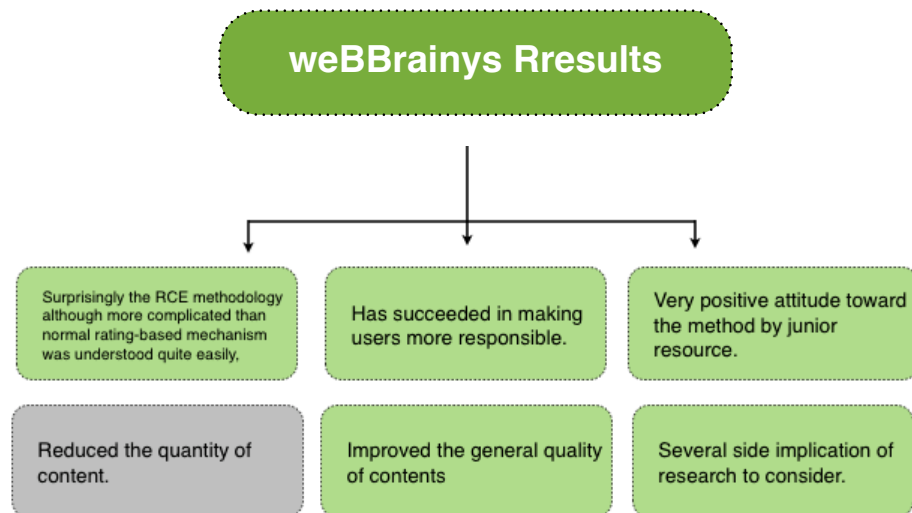


Fig.7.1 - weBBrainys testing results.

## 7.2.RCE Limitations of Applications

The RCE methodology has limitations of applications which are implicit in the RCE definition of chapter 5.

A Community and Resources Driven reputation system, like any RCE system, is built upon a **Social Network Service Infrastructure**. Here members aim to share **User Generated Contents** with the community, in the form of digital resources (blog articles, pictures, videos, documents etc...), which are not collaboratively modifiable (e.g. wikis), but are evaluated by community members through a **Global Rating System**, capable to infer community members reputations exploiting their resources' ratings. Also, in order to be considered sufficiently secure the RCE reputation system must:

1. **Operate by Approval Votes;**
2. **Operate Accordingly to Voters Reputations and Commitment;**
3. **Use Blind Ratings;**
4. **Grant Voters Anonymity;**
5. **Exhibit a Bidirectional Behavior;**
6. **Consider Action and Resource Weights.**

## 7.3. Further Implications of Research

RCE has several implications of research, which can be expanded in six different areas (figure 7.2).

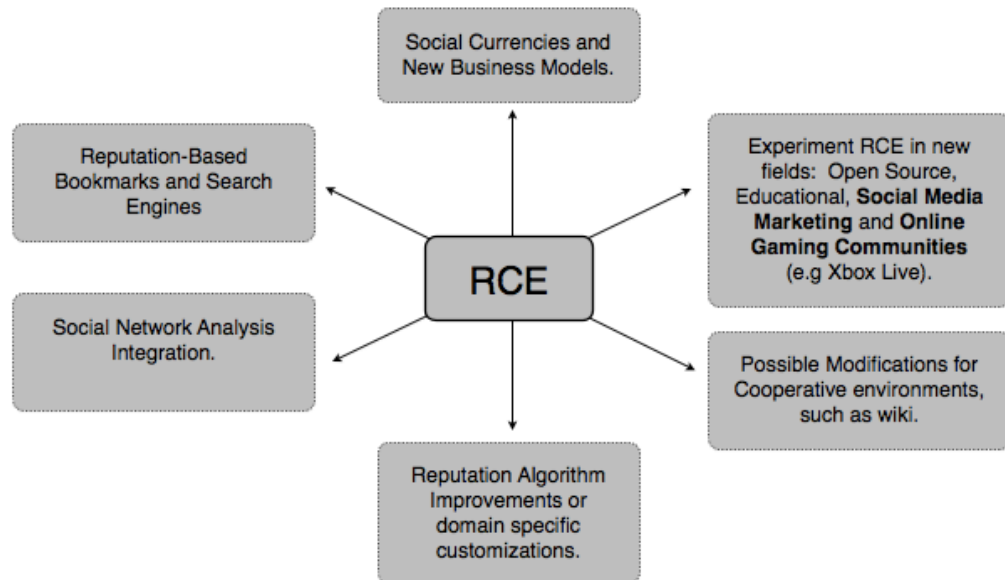


Fig.7.2 - RCE implications of research.

### **Social Currencies and New Business Models**

The first area that should be further expanded is about different ways of implementing reward mechanisms in RCE systems pursuing innovative business models.

### **Apply The RCE Model in New Fields**

New RCE business models could be crafted around new fields of application. Besides the ones cited in this document, which are generic Web 2.0 and Enterprise 2.0 RCE systems, particularly promising fields could be Social Media Marketing, Open Source, Educational and Online Gaming Communities, such as Xbox Live; in order to boost community and platform adoption.

### **Adapt RCE to Cooperative Environment**

One major limitation of the RCE methodology is the non applicability to web cooperative systems such as wikis. This limitation is implicit in the definition of Community and Resources Driven reputation system. Nevertheless it could be interesting to investigate

means to merge the Content-Driven Reputation Mechanism (Chapter 5) with the RCE Community and Resources Driven mechanism.

### **Reputation Algorithm Improvements and/or Customizations**

WeBBrainys has proven that the RCE methodology is applicable in a real world scenario. Nevertheless, its algorithmic adaptation represents just one of the many possible implementations. Since RCE is open to modifications and variations in order to match requirements of systems with different characteristics further researches could involve finding best adaptations to different contexts and/or communities.

### **Social Network Analysis Integration**

Social Network Analysis has been discussed in chapter 3.5 and in chapter 5 we have seen how relevant is in any reputation system to keep track of users reputation variation over time and how RCE approach this task.

Now, merging RCE with techniques and tools belonging to Social Network Analysis (See chapter 3.7) becomes easy to indirectly collect personal opinions, balancing them with the community knowledge and avoiding thus the problem of biased behaviors and providing better means to investigate in Enterprise 2.0 communities' *propagation of reputation through Social Network Analysis. The main goal is to understand the ways in which reputation is created and maintained inside the enterprise community in the attempt of defining its reputation structure, which may collide with the imposed hierarchical one, and in case apply changes in order to make the community more efficient and ultimately more valuable.*

### **Reputation-Based Search Engines and Bookmarks**

The RCE methodology has several side improvements which can lead to new concrete applications such as: "Reputational" Search Engines (RSE) and "Reputational" Social Bookmarking (RSB).

"Reputational" Search Engines (RSE) are inspired by Social Network Search Engines, which are a class of search engines that use social networks to organize, prioritize or filter search results. There are two subclasses of social network search engines: those that use **explicit** social networks and those that use **implicit** social networks.

1. **Explicit** social network search engines allow people to find each other according to explicitly stated social relationships, for example, allowing people to share their relationships on their own sites or pages.
2. **Implicit** social network search engines allow people to filter search results based upon classes of social networks they trust, such as a shared political viewpoint.



The RCE methodology could be the basis for a new **Implicit** Social Network Search Engine called “Reputational” Search Engine (RSE), which indexes users according to their reputation and users’ resources according to the contents and the reputation of the authors, which may very well change over time.

“Reputational” Search Engines (RSE) can also be enhanced with “Reputational” Social Bookmarking (RSB).

The idea behind RSB in a RCE system is that, since it is possible to filter members according to their reputations, it is more convenient to bookmark a trusted author rather than just his resources. This approach will allow the possibility to retrieve trusted and updated resources by a keywords search restricted on the bookmarked authors, throughout the future.

However, this approach contrasts with regular web page bookmarking, which probably would be less effective inside an RCE system.

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## WEB LINKS

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- [II] **Tim O'Reilly**, founder and CEO of O'Reilly Media, Inc.  
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- [III] Tim O'Reilly (2006-12-10). "**Web 2.0 Compact Definition: Trying Again**"  
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- [IV] **Dot-Com Bubble**  
[http://en.wikipedia.org/wiki/Dot-com\\_bubble](http://en.wikipedia.org/wiki/Dot-com_bubble)
- [V] **Terry Flew**: Professor of Media and Communication in the Creative Industries Faculty at the Queensland University of Technology, Brisbane, Australia.  
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- [VI] **Flew, Terry**. (2008). *New Media: An Introduction* (3rd Edition).  
Melbourne: Oxford University Press  
[http://www.oup.com.au/titles/higher\\_ed/media\\_studies/9780195551495](http://www.oup.com.au/titles/higher_ed/media_studies/9780195551495)
- [VII] **MySpace** is a social networking website with an interactive network of friends, personal profiles, blogs, groups, photos, music, and videos for teenagers and adults.  
[www.myspace.com](http://www.myspace.com)  
<http://it.wikipedia.org/wiki/MySpace>
- [VIII] **Facebook** is a free-access social networking website organized by city, workplace, school, and region to connect and interact with other people.  
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- [XIX] Tim Berners-Lee Interview for arstecnica.com  
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 Lecture Web Information Systems. Technische Universiteit Eindhoven.  
<http://66.102.1.104/scholar?hl=en&lr=&safe=active&q=cache:gWl9ub8yE9wJ:page.mi.fu-berlin.de/~best/uni/WIS/Web2.pdf+the+next+big+thing+author:David+author:best>
- [XXI] Don Tapscott and Anthony D. Williams, authors of the book '**wikinomics**'  
<http://en.wikipedia.org/wiki/Wikinomics>
- [XXII] The **Whole Earth 'Lectronic Link**, normally shortened to **The WELL**, is one of the oldest virtual communities in the web.  
<http://www.well.com/>
- [XXIII] **theGlobe.com**, founded in 1994 was one of the earliest social networking services startups.  
<http://www.theglobe.com>
- [XXIV] **Tripod.com** is a web hosting service now owned by Lycos. Originally a company aimed at offering services to college students, it was one of first sites trying to build online communities, exploiting user-generated contents.  
<http://www.tripod.com>
- [XXV] **Friendster** is a internet social networking website. focused on helping people meet new friends, stay in touch with old ones and sharing online content and media.  
 The website is also used for dating and discovering new events, bands, hobbies, and more.  
<http://www.friendster.com>
- [XXVI] **LinkedIn** is a business-oriented social networking site The purpose of the site is to allow registered users to maintain a list of contact details of people they know and trust in business.  
<http://www.linkedin.com>
- [XXVII] **Twitter** is a free social networking and micro-blogging service that enables its users to send and read each others' updates, known as *tweets*.  
<http://www.twitter.com>
- [XXVIII] "**Social Networks Learning and Flexibility: Sourcing Scientific Knowledge in New Biotechnology Firms**" by Julia Porter Liebeskind (University of Southern California), Amalya Lumerman Oliver (Hebrew University in Jerusalem, Israel), Lynne Zucker (University of California) and Marilyn Brewer (Ohio State University)  
<http://www.jstor.org/pss/2635102?cookieSet=1>
- [XXIX] The **National School Boards Association**, or **NSBA**, is a nonprofit organization operating as a federation of state associations of school boards across the United States.  
<http://www.nsba.org>
- [XXX] **Flickr** is an image and video hosting website, web services suite, and online community platform. <http://www.flickr.com>
- [XXXI] **PatientsLikeMe** is a social networking health site that enables its members to share treatment and symptom information in order to track and to learn from real-world outcomes.  
<http://www.patientslikeme.com>
- [XXXII] **SparkPeople** is a social networking site which goal is to show people that they can use health

and fitness to improve other areas of their lives, both personal and professional.  
<http://www.sparkpeople.com>

[XXXIII] **World Map showing the popularity of social networks around the world (year 2009)**  
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<http://www.aiim.org>

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<http://www.aiim.org/What-is-Web-2.0.aspx>

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[http://andrewmcafee.org/2006/05/enterprise\\_20\\_version\\_20/](http://andrewmcafee.org/2006/05/enterprise_20_version_20/)

[XXXVII] **Virtual Workspace**  
<http://www.enterprise20.it/blog>

[XXXVIII] **Enterprise 2.0 Observatory of School of Management of Politecnico di Milano**  
[http://it.wikipedia.org/wiki/Virtual\\_Workspace](http://it.wikipedia.org/wiki/Virtual_Workspace)

[XXXIX] **Dion Hinchcliffe**  
<http://www.oreillynet.com/pub/au/3009>

[XL] **Dion Hinchcliffe's Blog**  
<http://web2.socialcomputingjournal.com>

[XLI] **del.icio.us**  
<http://en.wikipedia.org/wiki/Del.icio.us>

[XLII] **Folksonomy**  
<http://en.wikipedia.org/wiki/Folksonomy>

[XLIII] **Reputation:** from the Wikipedia  
<http://en.wikipedia.org/wiki/Reputation>

[XLIV] **Freeheaven Project**  
<http://freehaven.net/~arma/jean.html>

[XLV] **Open Privacy Project.**  
<http://www.openprivacy.org/opd.shtml>

[XLVI] **John H. Clippinger**  
<http://cyber.law.harvard.edu/people/jclippinger>

[XLVII] **'Identity, Reputation, and Social Currency'**, by John H. Clippinger  
<http://www.commonstdev.us/content.php?id=1065>

[XLVIII] **Judith Donath**  
<http://smg.media.mit.edu/people/judith/>

[XLIX] **"Is reputation obsolete?"**  
Judith Donath, Oct 2008, Harvard Berkman Center Publius Project.

- [L] **Lucio Picci**  
<http://didattica.spbo.unibo.it/picci/>
- [LI] FirstMonday Journal - *Volume 12, Number 9 - 3 September 2007*  
**Reputation-based governance**  
ABSTRACT: <http://firstmonday.org/htbin/cgiwrap/bin/ojs/index.php/fm/article/view/2010>
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[http://www.trustlet.org/wiki/Main\\_Page](http://www.trustlet.org/wiki/Main_Page)
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- [LIV] **Objective and Subjective Trust**  
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- [LV] **Content-Driven and Ratings-Driven Reputation Systems**  
[http://p2pfoundation.net/Content-driven\\_Reputation](http://p2pfoundation.net/Content-driven_Reputation)  
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- [LXII] Bishop, J. (2007), "**Increasing participation in online communities: A framework for human-computer interaction**"  
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- [LXVII] **37signals**  
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- [LXX] **RAKE**  
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- [LXXI] **Conventions over Configuration**  
[http://en.wikipedia.org/wiki/Convention\\_over\\_Configuration](http://en.wikipedia.org/wiki/Convention_over_Configuration)
- [LXXII] **DRY**  
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- [LXXIII] **Active Record**  
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<http://www.prototypejs.org/>
- [LXXV] **XMLHttpRequests**  
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