ENGINEERING COLLABORATION 2.0: REQUIREMENTS AND EXPECTATIONS

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SUMMARY: Despite the fact that it has taken a long time for construction industry to enter the information era, information technologies significantly changed and still changes the way professionals in building and construction (BC) industry work. Consequently, construction industry is in relatively early phase of adopting web-based technology, even though the web has already moved deep into its second phase. The Internet today is not only the source of information, but also the way people do business. During the recent years, a phenomenon of Web 2.0 attracted a lot of attention not only in the Internet, but also in business community. It is considered as a next step and a major evolution of the traditional web from both technological and social perspective. This paper presents the concepts, trends and technologies which can affect the way how construction industry currently works and the key reasons why the AEC community should seriously consider the shift towards the next generation of the web. User scenario of the future is presented, most promising technologies are outlined and key predictions for the future are presented.

1. INTRODUCTION

Communication intensity of construction industry has been known for a long time and is (with the advances in the information and communication technologies) becoming even larger. With the adoption of latest findings in ICT and modernization of business concepts, the way the design and construction of the built environment is being done have dramatically changed (and is still changing).

One of the key challenges of AEC is to provide the efficient, effective and flexible access to information and to provide all possible channels of communication. The world today is becoming increasingly mobile and users often do their work with the help of several different devices during their day. That is why the unified access to applications and data is needed. In order to achieve that applications and data cannot reside on local devices anymore, they should rather live in the cloud and be accessible via Web services to a vast spectrum of devices from different locations. The problem of synchronization across devices can finally be solved.

Construction industry is in relatively early phase of adopting web-based technology, even though the web itself has already moved deep into its second phase. During the recent years, a phenomenon of Web 2.0 attracted a lot of attention not only in the Internet, but also in business community. It is considered as a next step and a major evolution of the traditional web from both technological and social perspective. New on-line applications not only make traditional tasks easier, but they also have the capability of upgrading the experience by using the vast amount of information from the Internet, previous sessions and so called collective intelligence of its users. Some of the industries such as marketing, real estate, medicine, newspaper have already discovered benefits of the technologies introduced.

In the following years construction industry will have to deal with the changes that such IT Ecosystems are bringing and to cope with the shift from self-integrating the technology and software investments based on ownership to those based on subscription (that is assembled, managed and maintained by the outside provider). The shift is also closely related to the links with the (outsourced) IT partners and the security that will eventually have to be replaced by trust.

This paper will present and interpret the main requirements for successful collaboration through the use of new technologies that emerged just recently. In addition, most promising technologies and applications will be outlined and key predictions for the future will be presented.

2. BACKGROUND

The web (or the Internet) today is not only the source of information, but also the way people do business. World Wide Web has revolutionized the economy and had impact on the majority of the world's population within the last decade or two. In the meantime, the use of the Internet evolved from static web pages to interactive, user-driven Web experiences (Kabir 2006).

Since the end of the nineties the problem of engineering communication, collaboration and collaborative working environments was addressed by a number of projects, such as ToCEE, ISTforCE, InteliGrid, Laboranova, CoSpaces, ECOSPACE and CovES to mention just few of them. Due to the number of projects dealing with the topic it must be emphasized that most of the conclusions in this paper are derived from the work done within the projects ToCEE, ISTforCE and InteliGrid.

According to Amor et al. (1997) the main goal of the project ToCEE was to develop conceptual framework and a prototype environment for the support of concurrent engineering in the AEC domain. Similarly, the main objective of the project ISTforCE was to establish an open concurrent engineering platform with access to intelligent services and tools that would support individual and multi-project work of the engineers (Turk et al. 2002), while the goal of the InteliGrid was to provide grid-based collaboration infrastructure (Dolenc et al. 2007).

All the above mentioned projects have some common denominators with the vision of developing the infrastructure that would change the way professionals work being the most obvious one. The other similarity includes predefined key user roles relevant to the developed platform and the proposed high-level architecture with the layered bottom-up approach (see Figure 1).

The problem with these approaches is that in this case every aspect of the enterprise is locked in the technology it uses, even though the employees today are technology aware and no longer satisfied with the predefined set of rules

and tools that have to be obeyed and used. This is especially true for the dynamic and mobile environments such as AEC industry, where time constraints often play important role and present the difference between success and failure. Employees today are used to live the life of "always on-line", "present 24/7", "access anywhere", social networking, collaboration and feel more comfortable using tools that they are using in their personal life. Some research results have shown that 80% of the workers born after 1980 (also called Gen Xers, born after 1980) are using social networking, collaboration and web tools daily (Perez 2008). The result is that the technology is also brought into workplaces and the use of traditional, conventional and awkward productivity tools are stepping aside in favour of text and instant messaging, mobile devices, web based emails, wikis, on-line document sharing etc. This new trend, emerged in last few years, is called technology populism.
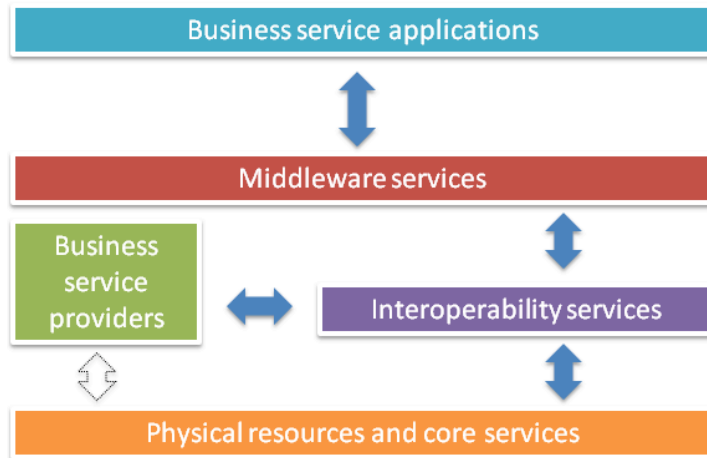

FIG. 1: Typical high-level architecture of services for engineers

2.1 Technology populism

According to Brown et al. (2008), Technology Populism is defined as "an adoption trend led by a technology-native workforce that self provisions collaborative tools, information sources, and human networks — requiring minimal or no ongoing support from a central IT organization" (Perez 2008).

Common practice in the AEC industry is that the IT department generally provides a new user all the equipment (laptop computer and/or stationary workstation, mobile phone device) needed when the user joins the company. What is more, all the necessary tools and software programs are also provided, including office program suites, email, access to email, secure access to internal network of some sort, anti-virus and anti-spyware tools etc. All the above mentioned equipment is usually maintained by the IT department with the security as a core requirement in mind.

The problem with this is that with the technological advances and affordable prices of consumer electronics, accessibility of broadband internet connections, web hype and new generation of applications based on network interactions people are not willing to devote their time learning traditional enterprise applications. What is more, they feel like they are "forced" to use slow and cumbersome applications with poor usability and strange behaviour. On the other hand, the main driver of the "redeveloped" web is simplicity. When using traditional enterprise software it is most often necessary to study literature, attend time consuming seminars, learn where to find help and last but not least, learn how to use it in the way developers predicted.

In contrast to the approach described, workers in their personal life are used to the tools that are freely available and that provide the desired functionality through the intuitive, self descriptive, user oriented interfaces and that "that just work". Forrester surveys show that approximately 45% of employees are using instant messaging, app. 16% blogs

and RSS, 14% wikis and 13% social networking for business purposes regardless of the effort of their employers to bring those technologies to the workplace (Young 2007). Some projections show that by 2010, end-user preferences will decide as much as half of all software, hardware and services acquisitions made by IT departments (Gartner 2008).

Gartner (2008) predicts that by 2012 as much as half of travelling workers will leave their notebooks at home in favour of other (smaller) devices. In spite of the fact that portable computers are constantly becoming smaller and more powerful, the trend is moving towards smaller pocket devices combined with server and web based applications that can be accessed from anywhere.

There are also some concerns regarding the newly emerging web technologies in work place. One of major issues is centralization of the service and is closely related to the nature of web applications. The question is what happens when the server (or servers) goes down or when the Internet connection fails. Another concern is the disperse location of the information and documents, which can cause many practical issues (like searching for the information on different locations, security questions, etc.). Some of them can be solved by using vertical search engines and search engine APIs, while others remain unsolved for the time being. Last but not least, there is also an issue of IT departments which cannot master and support each and every Web 2.0 Ajax application that emerges.

Nevertheless, it is safe to say that most of the technical issues can be solved or at least controlled, but the resistance to IT change which is so common in AEC industry is completely different story.

2.2   Web 2.0

During the recent years, the phenomenon of Web 2.0 attracted a lot of attention not only on the Internet, but also in the business community. New on-line applications not only make tasks such as individual and group on-line learning, communication, collaboration and creation easier, but they also have the capability of upgrading the experience by using the vast amount of information from the Internet, previous sessions and the so called collective intelligence of its users. It is considered as a next step and a major evolution of the traditional web from both technological and social perspective.

Although it has been the most frequently used buzzword in the Internet community in the past several years, there is still no official definition of what Web 2.0 actually is. The term has numerous definitions and more or less all of the authors agree that it is a trend, a perception of the direction the Web is heading, and not an object that can be created (Jewell 2007). It is an attitude towards radically open communities and communication (Nivi 2005).

It is not possible to define classic and next generation web by describing the technology. Instead, the focus has to be on the changes in human behaviour that the technology enables, and those changes are hard to describe or to define (Nivi 2005). Therefore it is not surprising that it is difficult to define Web 2.0 since there is no good definition of Web 1.0 either. Both principles are more are less always presented as a comparison between them.

Tim O'Reilly (2005) stated that the concept of "Web 2.0" began with a conference brainstorming session between O'Reilly and MediaLive International. O'Reilly stated that Web 2.0 does not have a hard boundary, but a gravitational core and later enumerated the characteristics of successful Web 2.0 companies:

1. The Web is used as a platform.
2. Harnessing collective intelligence.
3. Data is the next Intel Inside.
4. End of software release cycle.
5. Lightweight programming models.
6. Software above the level of a single device.
7. Rich user experiences.

Almost a year later O'Reilly formed a Web 2.0 compact definition as follows: "Web 2.0 is the business revolution in the computer industry caused by the move to the internet as platform, and an attempt to understand the rules for success on that new platform. Chief among those rules is this: Build applications that harness network effects to get better the more people use them." (O'Reilly 2006)

One of the key challenges of AEC is to provide the efficient, effective and flexible access to information and to provide all possible channels of communication. Web 2.0 may have some solutions to such problems, since the collaboration over the internet has never been easier. Working with a group of people on the same spreadsheet, sharing calendars, reading emails with attachments on mobile phones, publishing video tutorials on internal or external company pages, sending pictures from far distant construction site locations directly to co-workers concerned using only mobile phone and web based services, etc. - all those tasks became more or less trivial with the expansion of modern web services.

2.3 Semantic web

Despite the common misunderstanding the semantic web is not a separate web, but "... an extension of the current one, in which information is given well-defined meaning, better enabling computers and people to work in cooperation" (Berners-Lee et al. 2001). It is not different from the World Wide Web (WWW), nevertheless has an enhancements that makes the Web even more useful (Feigenbaum et al. 2007).

The vision of the Semantic Web is to extend principles of the Web from documents to data, which would reveal more of the Web's potential. It allows data to be surfaced in the form of real data (so that a program does not have to strip the formatting, pictures and ads off a web page and guess the location of the data on this web page) and allows people to write (or generate) files which explain the relationship between different sets of data to a machine (W3C 2008).

Semantic Web technologies can be used in a variety of application areas such as data integration (integrating data in various locations and various formats in one, seamless application), resource discovery and classification (in order to provide better, domain specific search engine capabilities), cataloguing (for describing the content and content relationships available at a particular Web site, page, or digital library), by intelligent software agents to facilitate knowledge sharing and exchange, in content rating, intellectual property rights of Web pages etc. (W3C 2008).

Alex Iskold (2007a, 2007b) noted that the original vision of the semantic web as a layer on top of the current web, annotated in a way that computers can "understand", has been a kind of academic exercise rather than a practical technology for at least a decade. The main problem Iskold has found is the bottom-up nature of the classic semantic web approach (each web site needs to annotate information in RDF, OWL, etc. in order for computers to be able to "understand" it), and therefore he proposed the top-down approach, which is focused on leveraging information in existing web pages, as-is, to derive meaning automatically (Iskold 2008).

Semantic Web is sometimes mentioned together with another buzzword Web 3.0, the term used to describe the future of the WWW, although the views on the next stage of the WWW's evolution vary greatly. Some authors believe that the semantic web will transform the way the Web is being used; other visionaries on the opposite side suggest that increases in Internet connection speeds, modular web applications, or advances in computer graphics will play the key role in the evolution of the World Wide Web.

2.4 Enterprise 2.0

With the popularity rise of digital platforms for generating, sharing and refining information on the Internet, McAfee (2006c) used the term Enterprise 2.0 to focus on Web 2.0 technologies and platforms that can be used (or sometimes even bought) in order to make practices and outputs of knowledge workers visible. McAfee identified six most important components of Enterprise 2.0 technologies:

- Search. It is important that users can find what they are looking for.

- Links. Many technologies work best if there is a structure of links that reflect the opinion of majority of people.

- Authoring. In order to obtain valuable income from the users, there has to be a simple way for publishing.

- Tags. Users prefer to tag instead of gather into predefined categories.

- Extensions. Smart add-ons are automating some of the work and creating added value.

- Signals. With all the tools and the simplicity of them there is too much content created every day. That is why signals in the form of email alerts, pings, trackbacks and also RSS feeds are almost mandatory.

McAfee (2006a) described Enterprise 2.0 as "the use of freeform social software within companies", where freeform software is optional and free of up-front workflow, indifferent to formal organizational identities and is accepting many types of data. McAfee (2006b) later changed the definition since the first one was not clear enough: "Enterprise 2.0 is the use of emergent social software platforms within companies, or between companies and their partners or customers."

Since then, many authors used the term for the technologies and business practices that make the workforce free from the constraints of traditional communication and productivity tools. Enterprise 2.0 provides business managers with access to the right information at the right time (through a web of inter-connected applications, services and devices) a huge competitive advantage over competition, stuck in Enterprise 1.0 in the form of increased innovation, productivity and agility.

However, there are also people who think that vision like that cannot be achieved through new technology alone and that the absence of participative technologies in the past was not the only reason that organizations and expertise are hierarchical. Davenport (2007) believes that organizational hierarchy and politics will not go away on account of Enterprise 2.0 software and the Internet because the barriers that prevent knowledge from flowing freely in organizations cannot be addressed or substantially changed by technology alone, although this can change when generation changes.

3. TOWARDS ENGINEERING COLLABORATION 2.0

The most important component of every project remains the collaboration and sharing of the information amongst different parties. As engineering is always dealing with the unique products and processes, the communication is proved to be the most vital component of a successful AEC project.

Due to the fact that AEC is very information intensive business, the phenomena and the benefits of the ICT were noticed rather soon. Unfortunately, the most used technologies are still the ones from the 1.0 list (see Table 1).

3.1 From communication 1.0 to 2.0

With the introduction of the Internet special kinds of useful communication principles appeared. The majority of them simply assimilated classic communication channels to the new communication media and took advantage of the benefits it offered.

E-mail has probably been the most used Internet communication channel. It inherits all the characteristics of regular mail and adds the value of speed and (almost) no cost. In the AEC industry it is the main channel of communication (and also collaboration). Unfortunately, its main advantages are also its main disadvantages – because it is so easy to send an email, it is quick and costs nothing, everyone is sending emails, even though it is sometimes not necessary. It is considered to be "push service" – recipients are forced to receive emails even though they do not want them, and emails can be received from anyone, even complete strangers. On the other hand, all **social network services** offer

so called personal messages to people you know. The main benefit of those messages is that they are filtered and you can only receive messages from people you want to have contacts with.

TABLE 1: Evolution of web based communication technologies (AIIM 2008)

1.0 Technologies	1.5 Technologies	2.0 Technologies
Static Web pages	Web services	Blogs
Chat rooms	Collaborative filtering	Wikis
E-mail	Agents	Really Simple Syndication (RSS)
Bulletin boards	Portals/Intranets	Social voting/ranking
Discussion forums	Social networking	Social bookmarking
Instant messaging	Social network analysis	Podcasting
Web/tele/videoconferencing	Dynamic Web	Mashups

News system was an evolution of the e-mailing system. The news system was (at the time) the global conferencing medium. The principle is the same as for e-mails, except that the common e-mail is a one-to-many service while news system is many-to-many service. The next variety of the news system was the so called **discussion boards**. They can still be found as an add-on to different web sites and portals, designed for the AEC related users, on which the moderated discussions are taking place, but are slowly being replaced by Web 2.0 approaches such as **blogs** or **wikis**. While blogs are more one-to-many service with a moderated discussion among participating commentators, wiki is a strong many-to-many type of dynamic website that allows the visitors to add, remove, and sometimes edit the available content.

Chat is the oldest and the most common representative of the synchronous communication. It was first introduced as an Internet Relay Chat (IRC), accessed with special clients, which is also its main disadvantage. IRC channels offer users the ability to chat in real time in different chat rooms, in which chatters with similar interests can be found. Next evolution of synchronous communication and a logical successor of chat is **instant messaging (IM)**, which can include advanced options such as video conferencing etc.

While chat in its original form is a many-to-many service, IM is more personal, one-to-many service, in which people in the participating group have to be approved in order to be able to communicate. One of the reasons for popularity growth of IM is that the clients for that kind of services are lightweight, easy to use, free and easily accessible; they don't use too many resources, can run in background and always show availability status of an individual. In the latest evolution clients are even not needed since services can be used directly through a web browser.

More sophisticated way of communicating is **audio-video** communication over the internet, which gain popularity with a wide spread of broadband internet connections. It is the technology which is as close as it can be to the "original" face-to-face conversation (although still not the same). If those conferences are extended with the **application sharing** capability, they are highly recommended for the use in the AEC sector.

Among the first internet services for engineers were **virtual libraries**. They did not contain any information, only references and links to the relevant sources and were one of the first AEC related forms of (one-way) communication for engineers. New types of virtual libraries also contain metadata by which the records are referenced and indexed.

The majority of software for the AEC in the past was developed amongst researchers around the world. For the same reason as the research literature they were revealed and promoted through highly popular **software libraries**. That is how those programs became available to the AEC workers and made their work easier. Today, software development is moving towards open source communities, building software solution a true Web 2.0 collaborative fashion. If the software is published under one of the "open licenses" (such as open source or similar or under appropriate creative commons license), it can be modified in any way. That openness usually results in added value of the participating interested users with the final result being better software.

The idea of integration and collection of all the information relevant to an engineer on one place resulted in the **AEC portals** with connections to other important places on one place. Turk (2001) described them as some kind of "one-stop-shop". Information on portals consisted of AEC literature, tutorials, building codes, software, white and yellow pages of companies etc. They should be replaced with **mashups** and **dynamic websites**, which are built as aggregators of several **RSS** and **Atom** feeds from different sources with enabled comments and **social ranking** as an added value.

3.2   Key requirements

One of the key challenges of AEC is to provide an efficient, effective and flexible access to information and to provide all possible channels of communication. Web 2.0 may have some solutions to such problems, since the collaboration over the internet has never been easier. Working with a group of people on the same spreadsheet, sharing calendars, reading emails with attachments on mobile phones, publishing video tutorials on internal or external company pages, sending pictures from distant construction site locations directly to the concerned co-workers using only mobile phone and web based services, etc. - all those tasks became more or less trivial with the expansion of modern services.

Stewart (2008) just recently stressed that "the continuous process improvement via the strategic implementation of innovative information and communication technologies is essential for the long-term survival of construction firms". Despite that observation, common practice in the AEC industry is still the same as it was in the 1990s - the IT department provides a new user all the equipment (laptop computer and/or stationary workstation, mobile phone device) needed when the user joins the company. In addition, all the necessary tools and software programs are also provided, including office program suites, email, access to email, secure access to internal network of some sort, anti-virus and anti-spyware tools etc. All the above mentioned equipment is usually maintained by the IT department with the security as a core requirement in mind.

The problem with this is that the IT departments in the AEC related companies cannot cope with the pace of the advancements in the technology and software. Nowadays it is relatively hard to even follow the versions and the updates of the core business applications, not to mention keeping up with the security threats when working over the Internet.

Turk et al. (2003) determined the following properties of the successful collaborative environment through the ISTforCE project:

- Independence,
- Individuality,
- Capability,
- Sustainability,
- Leanness.

While those requirements are all from the user's point of view, technical extension came with the project InteliGrid.

Based on previous work, feedback from public demonstrations as well as various formal and informal discussions with different members of engineering community the InteliGrid consortium summarized the top requirements in a "5S" list (Dolenc et al. 2007):

- Security,
- Simplicity,
- Stability & standards,
- Scalable service orientation,
- Semantics.

As it can be seen from the list, industry is eager to move to a secure environment, which would be simple to use, would seamlessly merge with current client applications and operating systems, be stable and built on top of reliable specifications, be scalable and semantically rich.

3.2.1   From security to trust

While it was not easy to keep with all of the requirements in the solutions that have to be built ground-up, 2.0 technologies are offering some great potentials. Web 2.0 services and solutions are known to be easy to use with the rich user experience being a main driver of success. They can usually be seamlessly connected with other related services using widely accepted standard adaptors and APIs with detailed specifications. All services can usually scale rather well and are building added value on semantics gathered from their users.

ClickStream Technologies (2008) report shows that as of November 2008 most widely used productivity application among internet users on home PCs in the USA is still the Microsoft Word, followed by Microsoft Notepad and Microsoft Excel. What is interesting is that 3% of users were using Google Spreadsheets (web based application similar to Microsoft Excel). What is more, Patriquin (2008) states that the combined growth of Google Docs & Spreadsheet was 156% and the trends show it will grow even further. For now, Google's share of 2.4% is not challenging MS Office, but with the following efforts of connecting tools mentioned with other services such as e-mail and web statistic services all this can change relatively soon.

Gartner (2008) predicts that by 2012 around one-third of business application software spending will be as service subscriptions to Software as a Service (SaaS) instead of product license. This is a fundamental shift from the fixed-price license of the traditional on-premises technology. SaaS model of deployment and distribution of software services is endorsed and promoted by all leading business application vendors and many web technology leaders. Another Gartner prediction is that by 2011 early technology adopters will purchase 40% of their infrastructure as a service. With the growing popularity of service oriented architecture (SOA) and the increased high-speed bandwidth cloud computing became convenient solution for economical infrastructure with a single supplier of core business applications.

The crucial problem preventing wide adoption of 2.0 technologies in the engineering is the security. For decades AEC companies have been working hard to keep control over the data and information leaving the organizational boundaries which were considered as a main advantage giving them competitive advantage over the competitors, and they are not willing to give that away.

The problem is with the core nature of the engineering companies which have always been working on the "inside-out" manner, while the world is more and more "outside-in". Today it is impossible to close the knowledge workers inside the boundaries of their intranets and personal computers because the whole world is connected and they want to be a part of it. That is why IT departments have to change the focus and the scope of their work. Usually they are maintaining and establishing infrastructure from the ground up (see Figure 1), taking care of all aspects of the business IT infrastructure. Instead, they will have to become a service taking care of the layer for adaptability of services that originally resides in the computer clouds, established and maintained by others (see FIG. 2).
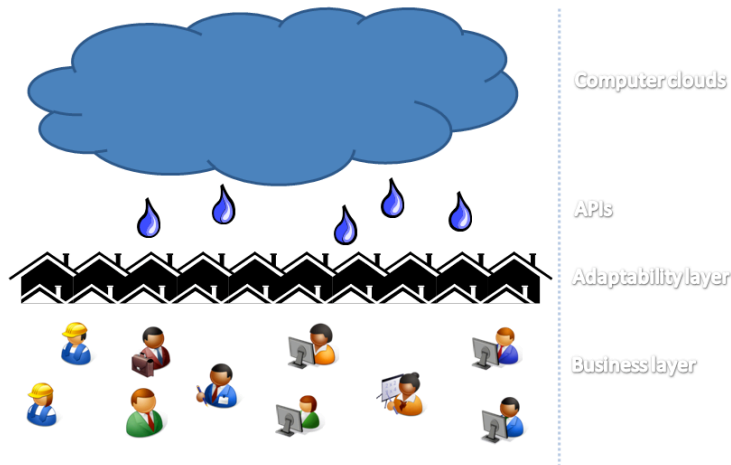
FIG. 2: Four main layers of 2.0 service architecture for engineers

The key shift is that many times there will be no contractual obligations dealing with all aspects of business (responsibility, security …) between a provider and consumer, which is common in current relations among participants dealing with IT infrastructure inside an organization. Instead, the relationship will mostly rely on trust, which will be the main differentiator among the companies offering cloud based business solutions, and whose business concept completely depends on the reputation they have among consumers.

3.3 Strategic points for successful transformation to Enterprise 2.0

According to Collins (2008) there are six key steps on the road to success when implementing Enterprise 2.0 ideas into the organisation:

1. **Enterprise 2.0 is not all about tools.** It is primarily about people and the way they are working and solving real problems. While the whole cultures are changing, people find a way to function on a completely different level. Brian Tracy, business guru, said: "People are not the only thing, people are everything."

2. **Introducing Enterprise 2.0 into an organisation can have a lot of benefits if it is done right.** Successful implementations are followed by dramatic shifts in ability to locate expertise and information, collaborate, innovate and introduce leadership and management change.

3. **Research on the organisation and issues is needed while experimentation is not prohibited.** Sometimes it is enough to give a willing group of participants an option and step aside. Encouraging them to try it with their everyday work instead of pure introduction of the tools is a way to a success. If the tools prove to be useful it is advisable to work from there on.

4. **It is better to fail than to work on mistakes.** When experimenting, there is always some risk present. It is better to stop as soon as it is realized that it is not working.

5. **Do your homework**. When introducing Enterprise 2.0, it is necessary to look at best practices of similar organisations that have solved similar issues and try to learn from their examples.

6. **Focus on success**. If there is no improvement or added value for the company reported, there is no need to evangelize Enterprise 2.0 any further.

For now, AEC industry is still holding on the business models based on acquired and leveraged knowledge within the organisation and on the false sensation of the self-sufficiency. Unfortunately, for the AEC industry most of the new business models are based on mass customization and customer self-service where organizations routinely

outsource activities and collaborate with partners and customers in order to be innovative. In addition, the demographics have changed. Workers (and customers as well) are very comfortable with the technology that is becoming more and more open and collaborative in nature (Oracle 2008). The majority of the AEC related organizations still fit into the description of closed corporation working under the influence of the conventional wisdom.

It is interesting to see that in the Web 2.0 era even the traditional business such as AEC is in the first place becoming a knowledge business and that the source of innovation is moving beyond the company walls (Oracle 2008). Dawson (2009) pointed out that from a corporate perspective Enterprise 2.0 is meaningless unless it results in a competitive advantage, making organizations truly different from their competitors.

The other conclusion that can be derived is that innovation in business models is highly interconnected to demographic changes and the human capital, which is still mainly underestimated. According to Dawson (2009), any Enterprise 2.0 initiatives sit squarely at the intersection of technology and culture. Dawson (2009) also noted that whereas these technologies facilitate interaction and the creation of value through participation, the technologies are only as valuable as people's desire to interact, collaborate, and create something worthwhile together.

3.4   AEC knowledge worker of the future – use case 2.0 scenario

To understand how working in the AEC Enterprise 2.0 will look like, consider the following scenario (based on Chi 2008).

A typical engineer today is mobile all the time, working in office, from home and also from the road attending a number of meetings from his calendar. He is a member of several project teams, whose members are distributed geographically across several countries, continents and time zones.

For his work, he is using several devices with portable computer as being the main one and the powerful handheld device in a form of sophisticated mobile phone as being the most used one. In addition to using e-mails to deal with specific project and office related matters, he is subscribed to several blogs written by his co-workers using RSS feed. That is how he is constantly aware of the latest company and project news. He is also writing a project blog, which he uses not only to communicate with the rest of the team and his boss, but also to have a written record of the projects' history so that everyone can refer to it in the future as a source of knowledge. While parts of this blog are open to public (with news concerning interested parties), some of them are open to authorized people only.

His tasks and deadlines are managed by specific online cloud based project management software service. He uses web based word processor, spreadsheet, presentation and form application allowing him to create and edit documents online while collaborating in real-time with other team members and customers on specific documents.

He often uses company wiki, accessible and editable by all employees of his company, and also encourages his team members to document their own expertise, experiences and tips. To better understand certain problems, he often reads the contributions of more experienced colleagues. This is of special value when he is preparing for projects with specific constraints and problems he has never worked with before.

To ensure that he always has access to emails, documents, contacts, calendar and bookmarks no matter where he is and that they are always synchronized, he stores, maintains and tags them using dedicated cloud based services which were approved by companies IT department. He often highlights his interests and monitors specific topics that others have bookmarked to discover experts interested in the same topic. While he is exercising and also driving from one meeting to the other, he often listens to audio podcasts of his colleagues which he is subscribed to and that are automatically transferred to his mobile device.

He has a number of profiles across social networking sites, which he uses to keep track on his former co-workers and to advertise new positions on the team and new open projects. He receives several offers per month through business oriented online networking sites where he finds a lot of new contacts and opportunities.

When he works on new public projects and products (such as buildings, bridges etc.), he usually identifies local specialties and expectations of the local population using blogs, discussion boards, forums and maps. He usually promotes his blog URL on the meetings with local residents in order to invite them to participate to the project and to contribute their visions and expectations.

Through his blog, social bookmarking site, intranet tags and wiki entries people from other divisions of his company as well as from the outside of the company constantly contact him. He is asked specific questions based on his past and current work and is seen as an expert, giving him motivation to work even more and to document as much as he can.

4. DISCUSSION AND CONCLUSIONS

Introducing the background, requirements for successful collaboration, key technologies and trends that will play a vital role in the following years it was shown that the world is changing dramatically. That is why it is necessary for enterprises in the AEC industry to closely monitor the advances in the information technology in order to be competitive in a few years time.

The key reasons why AEC industry is not adopting Enterprise 2.0 technologies with a greater pace can be grouped into the following:

- **Cultural barriers.** Successful implementation is closely connected with the human side of the collaborative working. The use of new tools is heavily impacted by organizational culture, confidence and trust – in other words, by people. Up until now most of the enterprise technology has focused on business processes instead of people, even though the way in which people use Web 2.0 (or social) technologies depends mostly on the culture of the organization. The successful implementation of Enterprise 2.0 exists in the intersection of the technology and culture, what makes the task even harder (Dawson 2009). In fact, Nicol (2007) emphasized that until the human side of collaborative working online is considered, Enterprise 2.0 will not get off the ground, let alone make an impact on the way organizations function. Among the largest barriers from this group is the resistance to change (resistance to new tools). Workers are familiar with the current environment and do not want to try anything new if they do not see the immediate benefit. Early adopters are always facing many challenges and they are usually not rewarded.

- **Technological and security barriers.** Concerns regarding privacy, security and protection are always important in any serious business – AEC is not an exception. For that reason, it is not surprising that organizations would like to see that the information that is gathered and shared behind the firewall stays behind the firewall, even when using Web 2.0 and Enterprise 2.0 tools such as blogs, IM, RSS, microblogs etc. All tools need to follow the same rules as traditional business applications when it comes to using and sharing information, even though this may go against core principles of Web 2.0. Not to mention the increased role of IT departments that have to maintain many different products, tools and technologies.

- **Awareness and generational differences.** The lack of awareness of what the tools are or how to use them. Most people know or have at least heard about blogs and social networks (such as LinkedIn and Facebook), but there is a lack of awareness beyond that. If the organization does not have a lot of younger workers, there seems to be no acceptance. What is more, many companies are not concerned

about employing younger generations despite the fact that younger employees generally need no training to use new technologies effectively. Other employees usually need fairly extensive training.

- **There is no one-size-fits-all model.** One of the major barriers of effective utilization of Web 2.0 technologies to the working environment is the recognition that there is no model for the successful implementation that would fit to any organizational structure. In spite of the testimonies from many organizations about what they have done well and what would have to be changed every organization has to find its own path considering its own unique conditions.

New technologies tend to follow different trajectories of hype, hope, and despair as they are discovered by different groups of people and finally adopted (or ignored) by consumers. In the latest Gartner (Schonfeld 2008) hype cycle for emerging technologies from July 2008 (see FIG. 3) it can be seen that some technologies, such as cloud computing, microblogging and 3-D printing, are still moving towards the "peak of inflated expectations". Public Virtual Worlds, RFID, Web 2.0 and Wikis are troughing, while some of them (Tablet PCs and location-aware applications) are already emerging into the "slope of enlightenment".
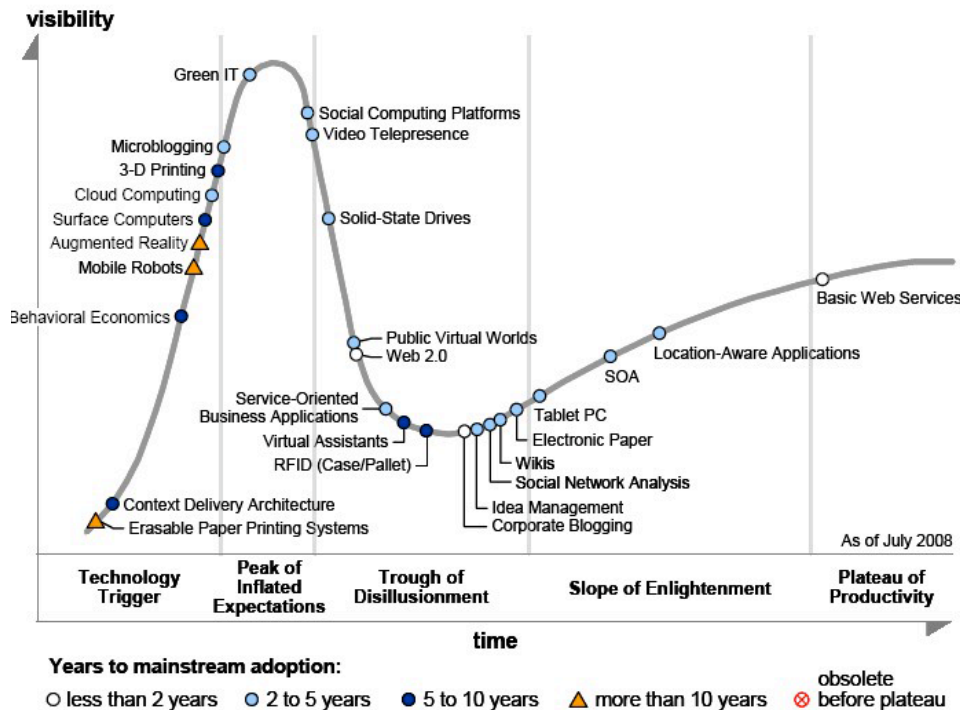

FIG. 3: Hype cycle for emerging technologies (Gartner via Schonfeld 2008)

It has to be noted that some of those technologies will never make through all the phases since some of them will disappear between different releases of the hype cycle. That is why it is very important that all of the technologies described in this paper came through the peak of inflated expectations and can be found on the right side of the figure. In other words, they survived and were finally adopted not only by home users but also by business. All big traditional business companies including IBM, Microsoft, Sun, and SAP to name just few of them adopted them.

The presented newly emerging trends (technologies, services, tools, solutions, etc.) are already changing business processes as we know and even though one might think they will not play an important role in the future all the projections show that a lot can be expected from them in the following years. Regarding AEC, the trend is moving to its favour since smaller devices are very suitable for mobile work force and off-site work places, web based software used as a service can lower licence cost, overcome limitations, improve productivity and help in critical situations. What is more, web based software is usually platform (software and hardware) independent and can be used in

combination with variety of devices (including desktops machines, laptops, phones, smart phones and other hand-held devices).

It took almost 10 years for people to figure out how to use the Web properly and it will probably take another 10 years before decision makers in the traditional industries will realize how to incorporate lessons from Web 2.0 in their core business processes. Although there are still issues that have to be solved, the end result will have a tremendous effect on how business is done.

While predictions about the future (especially for IT based trends) are always a bit untrustworthy, it is probably safe to announce the expansion of the Web 2.0 related business application market in the near future. At the same time the perception of how things are done in the AEC industry will have to be changed. It is important for the industry to become highly collaborative, much more open, decentralized, on demand, ad hoc, capable of quick adoption, lightweight and customer-oriented while staying cost effective and competitive. Organisations will have to listen to initiatives, novelties and innovations coming from the bottom-up since people are the ones creating the added value.

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