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The three ‘W’ of the World Wide Web call for the three ‘M’ of a Massively Multidisciplinary Methodology

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Abstract. This position paper defends the idea that the development of the Web to its full potential requires addressing the challenge of massive multidisciplinary.

Keywords: web, multidisciplinary

1 Introduction: social, political and economic implications of the Web.

This position paper was triggered by the topic of a joint panel at the conferences CLOSER and WEBIST 2014. The topic of the panel was: “social, political and economic implications of the cloud and the Web”. I focused on the Web and the position that I defended during the panel, and that I report here, is that, while implications of the Web can be identified in social, political and economic domains, the global challenge raised by the Web is the need for massive multidisciplinary to lead it to its full potential [1] that goes beyond any individual prediction. This article starts with three sections respectively confirming the social, political and economic impacts of the Web. The fourth section shows that in fact many other domains are impacted and the fifth section proposes that this spreading is in fact due to several existential characteristics of the Web. The sixth section concludes insisting on the importance of preserving this open nature of the Web, of assisting it and of addressing the challenge of a massive multidisciplinary approach for developing the Web.

2 On social implications of the Web.

The Web was initially conceived as a read-write space [2,3]. But it took the advent of wikis in 1994, with WikiWikiWeb by Ward Cunningham, to really have a read-write Web. With wikis we moved away from a rather static document-oriented Web where a page was essentially published by one user and read by several others. This change suddenly also supported social interactions on the Web by allowing several users and even lay persons in terms of Web technologies, to contribute and interact through shared Web resources leading toward what is now sometimes referred to as a global conversation.

Almost ten years before the term “Web 2.0” was coined, Wikis were adopted and then followed by blogs, forums, social networks and a wealth of social Web applications providing new means of social interaction (e.g. object-centered sociality as in Flickr with photos, YouTube with videos, etc.) and social relations (e.g. followers, groups, circles). These agile ways of supporting social linking foster self (re)organization, collaboration, and transfers between social structures.

Therefore social constructs are impacted by Web applications. In particular, the Web can make boundaries between social groups more porous (cultures, languages, institutions, etc.). It can also bridge scales, for instance bringing local initiatives to the global scene and more generally fostering “glocal” connections [4].

Social Web networks support strong ties but also foster weak ties. For some users they increase socialization time, leading even sometime to over-socialization. Companies also started to hire “community managers” and other job titles dedicated to manage their presence and image on the Web. New practices of users creating and maintaining several online identities question the very notion of identity.

The resulting interconnectivity impacts not only online activities but propagates to offline activities. Massive socialization is spreading to many objects and activities of our lives for instance:

- cars (blablacar, zilokaoto, voiturelib)
- sailing (vogavecmoi.com, co-navigation.fr, equipier.fr)
- taxi (provoiturage.fr)
- package delivery (expediezentrevous.com)
- parking, car park (monsieurparking.com)
- housing, accommodation (AirBnB, Couchsurfing)
- storage (costockage.fr)
- funding (kisskissbankbank, kickstarter)
- offices (coworking)
- food (colunching.com, cookening.com)
- sport (Unlish.com, Cleec.com, kikourou.net)
- washing machines (lamachineduvoisin.fr)
- clothes (pretachanger.fr, vestiairecollective.com)
- etc.

The Web is not only increasing the amount of social activity, it actually creates new socialization objects. So called « social » bookmarks are an example of a personal object- the bookmark - that was massively published, shared and linked by social Web applications like delicious.com.

As soon as the Web was reopened to write access, the log files of the social applications showed how powerful the Web could be in tracing and capturing very large social activities. But an important property of the Web is that it is supporting active social media *i.e.* media that not only communicate but store, process, reuse, enrich, route, manage the information far beyond plain passive communication. This active nature is both an opportunity of enrichment and a concern. For instance the implications of over-customization and its impact in terms of socialization and knowledge

diffusion are raised by the filter bubble phenomenon [5] making it harder and harder for us to find different or alternative points of view.

The Web never sleeps and these evolutions are getting faster and faster, each evolution building on the network effect of the previous one. It took 89 years for the telephone to reach 150 million users, 38 years for television to reach the same number, 14 years for the cell-phones, 8 years for the internet, 5 years for Facebook and 3 years for Instagram.

Meanwhile, with recent economic events, many people realized that in flash trading some algorithms were already taking decisions at a speed of more than 500 000 times per seconds. Hybrid communities on the Web are not only bridging different scales in terms of spaces or communities, they are also bridging different time scales. The human heart beats roughly once per second. A double click on the mouse is roughly two clicks in one second. The images of a movie are typically 24 per seconds and they are already below our ability to perceive them individually. An algorithm taking 500 000 decisions per second is far beyond our direct control for any of the individual decision it takes. When such an algorithm is acting not in the stock market but in a social network with more than a billion users, if things go wrong they can go wrong very far and very fast.

Taking a step back, the Web is raising the question of the limits and rules we should master before coupling automation and human on large scales and at high speeds as we are doing right now in social media for instance. This automation and acceleration might be alienating us [6] or hurting us.

The Web both traces and changes the social activity and therefore has become the subject of sociological studies (e.g. sociology of the internet) and at the same time a sociological probe to get social data and run social studies. For any domain, the Web now provides observatories [7] (data on users, practices, products) and active interaction media (communication, collaboration, online services). Social machines associating people and software online [8] are being created on the Web for a huge variety of topics of interests and reasons. This trend of designing and growing hybrid Web communities is requiring massive interaction design and new social theories to allow all the participants to interact with all the actors around them.

Finally, at the time of writing the Web has nearly 3 billion direct users and we could think it impacts everyone indirectly. But is that really true? More precisely is this impact as democratic and fair as it should be? It appears the answer is no, as soon as we consider the price or even the availability of an internet connection. The open fracture of the digital divide means that 60% of the world population does not have access to the Web, its resources, its services, its wealth. And because the Web impacts many domains and activities when it does not actively contribute to reduce the divide, it ends up making it worse. In particular a digital divide on the Web will propagate in all the domains we will mention in this article. This is one of the reasons why the Web must always tend toward the largest accessibility.

3 On political implications of the Web.

The Web and its social applications are now heavily used to run political campaigns, encourage donations, perform recruiting, etc. Web-based political campaigns are now spreading in all democratic systems.



Fig. 1. Web platform of the Obama campaign in 2008.

Among the many social interactions the Web is supporting, the e-government applications are changing the relations between a government and the citizens, the businesses and the other governments it interacts with, at all the scales of government (citizen, city, region, state, province and nation). Obama's campaigns (Fig. 1) made extensive use of data analysis and his administration is responsible for the initiative DATA.GOV pushing the publication of governmental data to allow new applications (e.g. comparators), new analysis (e.g. data journalism) and more generally to improve the access the public has to this data, including his campaign team.

Web-based government services do not only provide new democratic means, they also raise new challenges for instance to manage this enlarged democratic bandwidth between all the actors and instances of a government in general and between the citizens and their representatives in particular. For instance the social networks and on-line forums have opened a new way for citizen to voice their opinions and concerns and the political system is often not ready to receive and process that massive feedback.

The effects of Web applications and the weight of Web actors have political impacts in particular because Web communities can grow to sizes comparable to largest nations. At the time of writing, Facebook for instance announces more than 1 billion active users. If Facebook was a country it would be the third largest country in the world and it is currently the dominant social network in many real countries (Fig. 2). When Facebook started to adapt the content of time lines by filtering what it displays

based on the profiles they learned from users and their friends, this had an impact in terms of the propagation of political views [5].



Fig. 2. World map of social networks, December 2013 by Vincenzo Cosenza and Alexa. Facebook is the dominant social network in 127 out of 137 countries analyzed and has 1,189 billion monthly active users.

Not only could the governmental processes be impacted: the political norms and rules that govern their functions could also be influenced by and modified on the Web. For instance ConstituteProject.org provides a repository to read, search, and compare constitutions from around the world in particular to assist the creation of new constitutions. And outside the political systems themselves, Web activism now refers to the use of Web technologies to campaign and bring about political changes [9]. Designing efficient and trusted Web-based ways to manage our political systems remains an open question.

The Web does not only impact our political activities and structures, it also calls itself for new political practices and institutions to maintain and organize this new space. In particular, a very important question today is the defense of the Web in general and of neutrality, free speech, and privacy on the Web in particular. As in any country this is a never ending fight and it will require us to always stay vigilant [10]. Again the Web can be its own support and for instance TheWebIndex.org (Fig. 3) monitors the state of the Web providing country-level data on Web usage, readiness, and human impact.

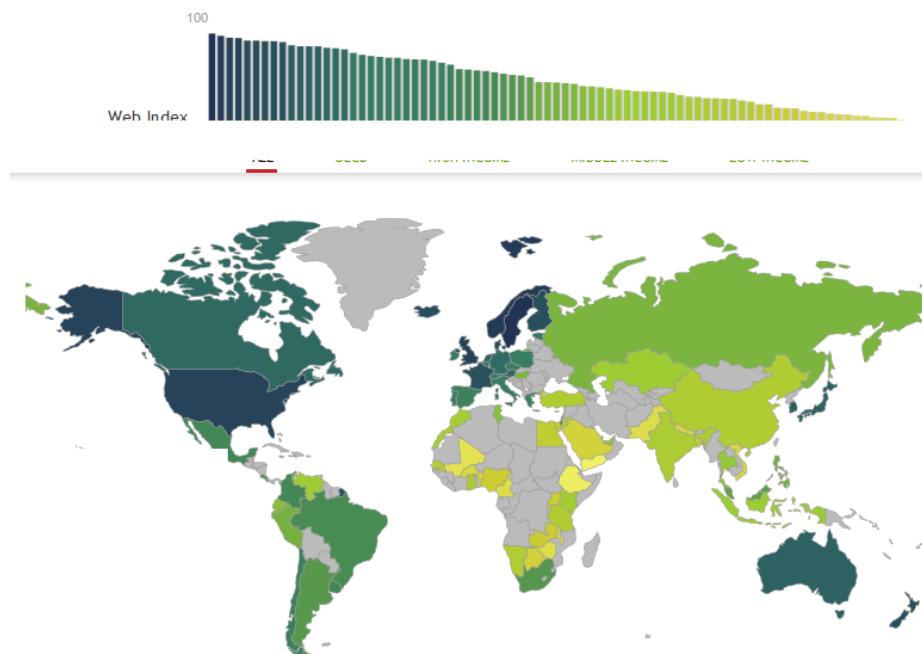


Fig. 3. World map and distribution of the Web index ranking 81 countries with a measure of the Web's contribution to development and human rights. The higher the index is, the better the situation in that country is. Scores are given by the World Wide Web foundation in the areas of: access; freedom and openness; relevant content; and empowerment.

4 On economic implications of the Web.

Because of the ability it provides to gather and share knowledge the Web has a huge impact on knowledge intensive work and in general on any human activity that can benefit from data, information and service sharing. This leads to the emergence of new giants (e.g. Google) providing services on the Web (e.g. search engine).

But new markets also appeared. For instance, initially, the URL of a page wasn't supposed to be used directly by persons surfing on the Web. It was a technical identifier essentially internal to the Web architecture. Now with the advent of the Web, domain names became a market and some domains are worth a fortune. Likewise Google ads are creating a world-wide word market (Fig. 4) and impact our languages [11, 12].

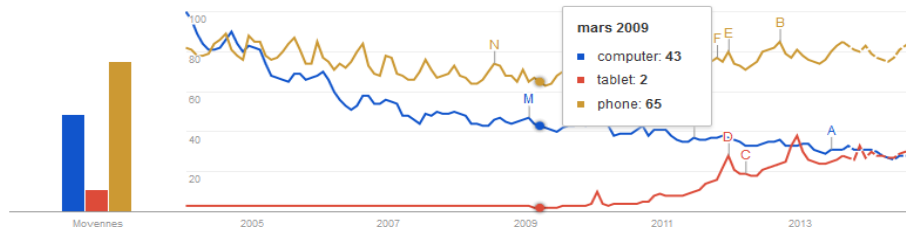


Fig. 4. Evolution of the interest and price of words in Google AdWords.

The Web impacted traditional business at their core, changing the way business is done in many sectors. For instance Amazon started by revolutionizing bookstores business before expanding its activity to many other domains and becoming the most well-known electronic commerce company. And as already mentioned for the social impacts, the Web is creating “glocal links” [4] for instance, in an economic perspective, supporting a global market access even for SMEs.

With more and more content and services available on the Web the attention of the users is becoming a scarce commodity for which a growing number of Web applications compete. The approach of attention economy applies economic theory to manage attention as a resource or a currency. In 2004 the chairman of the first TV channel in France (Patrick Le Lay, TF1) declared his job was to sell “available human brain time”. This could now be extended to a number of Web media competing for brain time. Of course selling a product or a service is the most obvious way of cashing attention - thanks to advertisement for instance. But there are other ways of paying. User profiles, and private data such as tastes, hobbies, whereabouts or address books are valuable information gathered and exploited. Privacy in particular is a new currency and, more generally speaking, data is the new oil, raising concerns even at the international level as to where the data flows.

But, to put it bluntly, to more and more Web actors, available brain time also means available powerful processors. The Web has offered a perfect programming framework for crowdsourcing applications. These applications implement services, gather data and information by soliciting contributions from large groups of Web users. They rely on very different strategies. Some crowdsourcing approaches are explicit such as explicit gamification (FoldIt, GalaxyZoo), crowdfunding (e.g. KissKissBankBank, Kickstarter), surveys or votes, collaborative design or problem solving, etc. Others are implicit in the sense the user is not even aware of being used as a processor such as when the task achieved is side effect of another task (e.g. form validation and Re-Captcha for OCR) or mines the data of another activity (e.g. piggyback analysis of users’ search history to tune AdWords). These approaches can be generalized to the domain of human computing where the machines outsource certain tasks to humans. Human-based computation finds on the Web an ideal platform where to recruit persons through different kinds of incentives: money as with Amazon Mechanical Turk; fun as with gamified tasks like the ESP Game; volunteerism as in Wikipedia; recognition and ego as in many Q&A forums like StackOverflow. For instance, some companies now include their clients in the design of new products either indirectly by min-

ing their feedback or directly and explicitly by turning them into “prosumers” who document, evaluate, suggest and design products on online platforms as Lego does with its Web platform Lego Ideas.

And again we have to be extremely vigilant here to make sure that humans don’t end-up being used as just another resource.

5 On the many implications of the Web.

The three previous sections tried to show that indeed there are important impacts of the Web in social, political and economic domains. The choice of these three domains was imposed by the topic of the joint panel at WebIST/CLOSER 2014. However the implications of the Web can in fact be found in almost all the domains of human activities. To show this, the following list mentions a number of domains of activity and interest impacted by the Web. The list in itself does not seek to be homogeneous or exhaustive. The point we are making here is that the Web has impacted not only the social, political and economic domains but virtually any domain. Consider for instance:

- Psychological implications: Hypertext-based Web surfing have changed our way of reading, working and maybe memorizing and thinking; machine learning and Web mining discover very personal characteristics, profiling our inner self; online image and presence are directly transferred to our everyday lives.
- Philosophical and ethical implications: the Web offers a new space for naming, describing and linking anything and this raises new philosophical questions at the heart of the Web architecture [13,14]; the Web is also a platform to build social machines [8] coupling human and software on large scales thus raising ethical and moral questions; the Web architecture could support all sorts of forums and social medias and there is an important challenge to ensure the Web becomes a public space that effectively allows us to debate and philosophize.
- Educational implications: the Web changed the way we access, diffuse and assess information; pedagogical materials and methodology are adapted to the Web media in learning applications; traditional teaching practices are directly impacted by the availability of the Web, its resources and the interactions it supports; massive online courses also emerged on the Web as a completely different way to teach some topics.
- Scientific implications: peer-to-peer review, conference and journal processes are completely supported by Web applications now and sometime they even experiment with new approaches such as open online reviewing; data from experiences and service composition for analysis are shared and combined on the Web; runnable papers available on the Web propose a new way to support reproducibility of results.
- Medical and healthcare implications: healthcare protocols and drugs are described on the Web; patients and doctors exchange their experiences and expertise in forums; Web mining provides new indicators for epidemics.

- Statistics implications: surveys are democratized by Web applications supporting their full management; logs of Web platforms and Web usage in general provide a huge amount of data to analyze and mine.
- Legal implications: Web applications very easily cross frontiers and jurisdictions raising new problems in terms of legal status of their resources and legal actions that can be taken; terms and conditions of Web applications are not only hard to write they are also hardly read, raising the issue of creating, ensuring and conveying the legal and security context of the users.
- Linguistic implications: linguistic minorities can keep in touch through social media platform and gather linguistic resources; practices like AdWords, suggestion, auto-completion or domain names may influence the salience of words and expressions in our languages; huge corpora are now available for natural language processing leading for instance to new approaches for translation.
- Cultural implications: cultural heritage and its transmission are supported by Web applications; the cohesion of micro-culture can survive geographical and temporal distance; intermingling of communities in social medias foster the cultural exchanges;
- Artistic implications: the Web and its design is the subject of artistic creation; the Web provides new approaches to galleries and expositions; the Web provides new materials and new formats of creation; the Web supports new relations between the creators, the creation and the public.
- Media implications: our relation to classic Medias (TV, radio, newspapers) changed with the Web and the ability to influence, react, participate to the programs; the online archiving of audiovisual resources and the availability on demand of many programs revolutionized our access and use of medias; Web TVs and programs provide alternative channels for independent content creators.
- Design implications: collaboration platforms support the exchange of blue-prints, and also the co-design of products and services; coupled with other technologies like 3D printing the Web provides a social space to exchange, reproduce, adapt and reuse designs.
- Geographic implications: cartography was revolutionized by participatory approaches like OpenStreetMap.org; geolocation and navigation are impacted by Google maps and equivalent services.
- etc.

Arguably, the most important entry in the list above is “etc.” in the sense that this list is by no means exhaustive. On the contrary this heterogeneous accumulation is just to show that we have in fact an open set of domains and activities impacted by the Web. This list could grow not only with additional aspects for each entry but also, and more importantly, with many other domains: mathematics, ecology, history, sexuality, dietetics, transportation, meteorology, food, religions, defense, diplomacy, sport, criminality, agriculture, etc.

Considering all the domains the Web impacts, the multidisciplinary development of the Web is both a characteristic and an issue of the Web.

6 On the evolution of the open Web platform

From an architectural point this tendency of the Web to diffuse itself everywhere and in all our activities is strongly related to the very reasons that made the Web a success from the beginning. The Web became what we know today primarily because its architecture is that of a decentralized, universal, free and open platform. These characteristics are what made the Web so viral.

The Web architecture is inherently open, down to its three basic components, namely:

- open addresses (URL) or identifiers (URIs) to talk about anything on the Web;
- open languages (HTML, RDF, XML) to articulate anything on the Web;
- open protocols (HTTP, SOAP, SPARQL) to interoperate with everything on the Web.

This openness of the Web is a key reason of its adoption by many applications and through them by many domains. It is also a powerful enabler of interoperability and consequently it of cross-pollination.

A second important aspect is the change that happened in the perception of the Web itself: why do we now speak of a Web platform where before we spoke of Web pages and Web sites? We all witnessed Web pages becoming more beautiful, more interactive, more powerful, more ... application-like. Languages like HTML5, CSS3 and JavaScript are now at the heart of the Web platform. With this integration we definitively turned the page of a documentary Web for a Web of interlinked applications. Each page is a potential application or service to a user or another program. The Web still links documents but also, increasingly, data, software and objects.

The Web has become the defacto standard open platform for applications on the Internet. The Web technologies cover all aspects of an application including:

- Access to material resources: geolocation, gyroscopes, cameras, NFC...
- Multimedia interactions: audio and video, graphics, animations, 3D...
- Multimodal interactions and device independence: changes in resolutions, adaptation of virtual keyboards, analysis and synthesis of voice, touch interactions, vibration, mobile Web applications...
- Communications: client-server, real-time, peer to peer, sockets...
- Security: keys, signatures, encryption, authentication...
- Automatic data processing: format interoperability, data integration, semantics of schemas...
- etc.

We went from the idea of "write once, publish everywhere" to the idea of "code once, use everywhere".

Even more important is to realize that in fact the Web never was a hypertext. It was initially perceived as a flexible and clever documentary system but the nature of the Web is now closer to a resource-oriented hyper program (Fig. 5). It is even going beyond the classical view of programming by supporting applications calling on users for some processing.

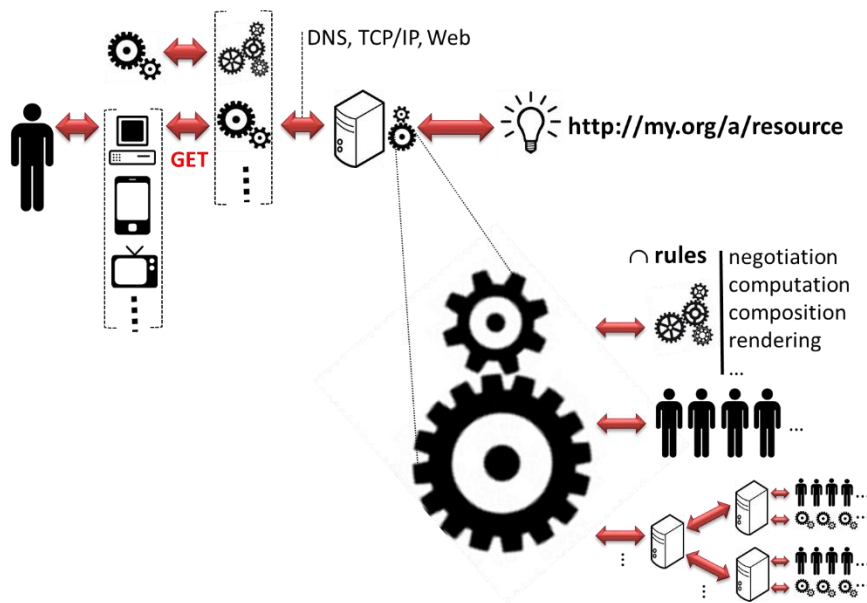


Fig. 5. Behind an HTTP GET call a whole chain reaction can now be triggered calling upon many different resources to provide an answer.

The Web also moved from URLs to identify what “exists on the Web” (Web pages, images, etc.) [15] to URIs to identify on the Web what exists in general (a person, a topic, a place, etc.) [16]. IRIs go a step further allowing these identifiers to be written in any language [17]. This change of paradigm for the Web identifier is a key enabler of the expansion of the Web turning anything we might think of into a potential subject of documents, data and services on the Web.

In parallel, references to the Web became extremely common and not necessarily technologically complex (e.g. QR codes) and the access is no longer limited to browsers on a desktop (e.g. mobile phones, TVs, cars, etc.). So, anything is now potentially subject to representations (pages, images, data, etc.) exchanged on the Web and more and more things are interacting with these representations. These parallel evolutions of the Web combine themselves in making it even more viral.

To summarize, the Web is now an open platform consisting of free technologies that allow everyone to publish and implement a new component of the Web without

having to get or to waive licenses. These non-proprietary and domain-independent technologies allow an open and distributed worldwide innovation in any domain.

But we should not take these important characteristics of the Web for granted [18]. There is always a risk to loose decentralization, universality, freedom or openness with the next evolution or the next major application of the Web.

For instance, if the Web is decentralized in principle, it can be re-centralized in practice by the tools that are deployed. Continued vigilance is needed. The concentration of applications, the ensiling of data and any form of recentralization by an organization must be avoided as much as possible. The interests of an organization is not always the public interest.

Because the Web is of public interest, opening the Web is of public interest. And it is a challenge both for its technical architecture and for its governance. Beyond passive browsing, and even beyond content contribution, we must move towards a more comprehensive stakeholder participation across the Web and beyond, towards a multi-participatory governance.

Open Web is open-mindedness. By establishing a global conversation Web participates significantly to the establishment of freedom of speech. To keep the Web open is also to give a chance to preserve the global conversation it established. The Web has become a very powerful artifact of our situated cognition, our augmented intelligence. This raises the issue of the preservation of the new abilities we attained [18].

To summarize, the open Web platform calls for global developments in all aspects of our societies (economic, legal, political, etc.) and in particular to ensure an equilibrium between the sake of individuals and the sake of collectives.

7 Conclusion: MMM for WWW

If it is true to say that the Web architecture is designed through standards, its participatory nature makes the Web emerge from it as an openly co-constructed global object. This makes it one of the most complex artifacts ever produced by mankind. This complexity explains both its richness and issues. In some ways we do not know the Web, or very little. We design the architecture but the Web object that emerges and constantly evolves, needs to be studied and followed in all its developments.

And the “world-wide way” of deploying the Web everywhere and for everything implies that, as the Web is spreading in the world, the world is spreading in the Web. The resulting world “wild” Web created and evolving every day is contaminated by the complexity of our world.

This complexity and co-evolution of what could have been initially perceived as an engineered technical artefact implies that a huge challenge for the Web development is its need for a massively multidisciplinary cooperation. By its very nature and evolution the Web calls for a multidisciplinary development.

The perception of the Web must once and for all go beyond its initial computational perspective to a truly multidisciplinary Web development. This is the only way for the Web to reach its full potential.

The Web can create problems and at the same sometime providenew solutions.The collaborative landscape the Web can be used to support new co-design and cross-fertilization to help us achieve this Massively Multidisciplinary Making.Hence the title of this position paper: the three ‘W’ of the World Wide Web call for the three ‘M’ of a Massively Multidisciplinary Methodology.

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