Towards a "non-disposable" software infrastructure for participation.

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Abstract. For many years now our research team has been involved in an effort (both theoretical and technological) that can be labeled as an attempt to investigate the notion of cooperation from the 'participation' or 'contribution' perspective. From our perspective, it encompasses a set of situations in which different actors identified or unidentified, ratified or not, distributed in space and time, contribute to a sometimes ill-defined collective goal, using most of the time low-overhead web-based technologies. Doing so, people participate to a collective design that aims at generating a bunch of perpetually moving collective knowledge and decisions submitted to discussion, negotiation and sometimes dismissal. To avoid the design of services as a repeated "one-shot" process we have gradually built a transverse software infrastructure that can be used in various projects aiming to design participatory services using complex knowledge and cooperations. Thanks to this "non-disposable" infrastructure, the participatory services designed take profit from the scientific outcomes of each previous project.

Keywords: Social Semantic Web, Software Infrastructure, CSCW, Participation

1 Introduction

In software engineering, it is not uncommon to describe products, processes and even jobs using metaphors from civil engineering and architecture. For example, the internal complexity is partially hidden by a *facade*, incompatible parts are related by a *gateway*, the result has to be *built*, *layers* upon *layers* upon a *framework*... Software engineers even imported the notion of "pattern" from an architecture book [21, p. 2]. Both domains are indeed at the crossroad of formal and human sciences: the structure must be resilient enough and the resulting areas flexible enough so that users can 'live' safely and freely. For decades, the chief software engineer was then the *architect*, considered as an all seeing and almighty demigod, as in *Matrix*. Interestingly enough, the attention was finally drawn from *architecture* to *urbanization* and *infrastructure*. In other words, the metaphor was extended to embrace longer terms issues, to deal with the heterogeneity of architects and architectures from both the past and the future.

When software is dedicated to participatory and epistemic work, its architecture (data models [31], authorization models [30], distribution models [26], etc.) should be tied to the singularity and dynamics of the community members and the knowledge being constructed. While participatory design explored the way of involving the community in building *ad-hoc* architectures *from scratch*[1], we explored the way of offering the community an infrastructure on which its members could create and modify their *self-built* architecture. A reusable Infrastructure seems us a key condition of socially successful participatory architectures.

This paper will also contribute to the reflection about participatory architectures, as a two-fold concept : on one hand, classically, participatory architectures refer to a context of participatory design limited to the involvement of the actors ("users") in the design process at design time; on the other hand, participation refers to complex socio-technical systems where actors, as "inhabitants" of immaterial participation architectures, (sometimes) get more affordances to permanently co-design their activity (especially for knowledge workers). For example, the W2.0 and the ever growing connectivity enabled by different types of networks can be seen as way for facilitating citizens participation in policy making processes [29] even though introducing collaborative technology allowing contributions from the citizens and different stakeholders may raise new issues regarding legislation and trust between actors [6]. In the cases of social semantic web architectures that we shall illustrate - in the context of more agile design methods for content and software engineering - the two folds are not contradictory and can be boosted, as we shall see in the discussion, by a long term effort associating theoretical research, practice and infrastructure.

The first part of the paper will be dedicated to a rapid state of the art of academic projects aiming at creating reusable software for participation, contrasted with commercial attempts to provide highly reusable software services but which are too "low-level" to be adapted by stakeholders themselves. Then, a second part will give an overview of our sustainable infrastructure, as well as the theoretical background which has been our guideline for the last 15 years. But, following a guideline and an aim does not mean that our theoretical framework and the resulting software infrastructure have not been dramatically updated throughout our experiments. This diachronic aspect of our work will be drawn in the third part.

Last but not least, in a reflexive attempt, we shall explain in a fourth part the lessons learnt and the benefits of such an effort on software in an interdisciplinary research setting.

2 Existing Works

One one hand, when reviewing reusable frameworks and infrastructures presently used in the IT field for building information architectures such as Content Management Systems, Management Information Systems, Semantic Web applications, etc., they do not include a strong theoretical framework guiding the

[1] Which leads to "disposable software" as every new case study brings its new software.

design of participatory applications. They are not oriented towards supporting various participatory applications where activity, roles and knowledge are not congealed and stereotyped.

In the other hand, many innovative software tools and applications can be reviewed (we take some examples in the following) that implement participatory architectures with both organisational and epistemic design issues, but generally they are built for given purposes or communities and do not include multi-purposes and completely reusable theoretical framework, meta-models, protocols and components. Compared to the amount of studies describing empirical analysis of participative practices in real-world settings, documenting participatory processes in the context of design projects, or specifying participatory services for a wide span of human activities, works devoted to the construction of infrastructure and platform for participation in epistemic fields are comparatively more unusual.

In the CSCW research field, Fisher and Herrmann [20] propose a “meta-design” theoretical and practical framework for designing participatory socio-technical systems, with a lot of applications. But this perspective ,as well as other ones presently in CSCW, focus mainly the “social structure” issue of the socio-technical systems (models of roles and activity, cooperation models...). However, in many cases such as Wikipedia or other Web 2.0 applications, the epistemic/semantical issue is a part of the social issue: “socio-technical systems” are also “socio-semantical-technical systems”. “Actor’s Viewpoints” are emblematic of this imbrication (as we will see it more in detail, when presenting our theoretical framework in §3.1).

That’s for, in the process of reviewing relevant literature for the preparation of this article,we looked for re-usable frameworks considering both interlaced social structure and knowledge structure. As far as we know, existing software used for social-semantical experiments in CSCW research is almost partitioned, with disposable developments for each project, and a weak level of capitalization from project to project. We find very few examples of software platforms exhibiting a multi-viewpoints knowledge model and at the same time addressing a large range of cooperative applications.For example the ISICIL platform [10], includes a semantic Wiki, a folksonomy editing tool and semantic social network analysis facilities, that to some extend allow for generalizations in forthcoming projects. But at the moment it is principally used for knowledge management experiments in organizations.

Zhu's Mikiwi system [34] is more oriented towards creative participatory design. Mikiwi is based on the Hive-Mind Space (HMS) model proposed to support distributed collaboration between multidisciplinary design teams and to tackle the issue of co-evolution of systems and users. The always evolving design problems that cannot be predicted require systems that have enough flexibility and tailorability to cope with emergent unexpected requirements.

IMTM Lab in the German University of Bochum [23] has used MikiWiki for metadesign and has developed during the 15 last years an important amount of multi-purposes toolboxes, such as SeeMe or Kolombus (respectively for sociotechnical systems modeling, e-learning...) but without capitalizing strongly on a common platform.

The same remark applies to a set of software tools (Compendium, Cohere, Claimaker... respectively designed for design rationale, cooperative design, argument representation, narrative hypermedia, e-learning and other social software) made successively on a long period by the KMi lab at the Open University. But in a recent project [9], people at KMi insist ambitiously on the point that platforms have to be opened up, envisioning a socio-technical infrastructure “capable of engaging a wide constituency of actors”.

Beside the research area, at the industrial and operational level, it must be noticed that very useful basic web services are nowadays broadly available on the Cloud, for example: Amazon S3 (Simple Storage Service) for document sharing or Amazon IAM (Identity and Access management) for group forming. These PaaS ("Platform as a Service") services offer very simple conceptual models, favoring scalability and distributed services. But they require complex stand-alone developments in order to address social-semantic usages.

Moreover, the idea according to which the adoption of a specified underlying computing paradigm focused on collaboration and participation should lead to the implementation and use of a dedicated infrastructure is barely found [25]. Still, some teams in CSCW and interaction design communities have adopted this kind of agenda (see for example the GIRI initiative [1] and the ITSME project [19]).

3 A long-term, sustainable proposal for participation

3.1 Theoretical background

The proposed software infrastructure is a tangible outcome of different studies conducted from the years 2000 in the domain of collaborative knowledge engineering that gave birth to the notion of "Social Semantic Web" [18][3]. Contrary to the Semantic Web, the "Social Semantic Web" is not interested in formal semantics but in semantics dependent on the human subject and on the semiotic substrate. The main idea is to provide a digital medium for knowledge workers, where knowledge models are created and updated through cooperation and debate. While the (formal) Semantic Web stands that people have to share common-ground concepts in order to work coherently on different items, the Social Semantic Web considers that knowledge workers build different "viewpoints" on shared items. The Sociosemantic Web can borrow concepts and technologies from both the Social Web and the Semantic Web, but combining them in a new way. Moreover, it aims at fostering people participation in knowledge work, such as Web 2.0 does for entertainment. In this trend, software design relies on three human and social phenomena:

- documents, because they are proofs of something else, not in the manner of a mathematical proof but more in line of evidence that is kept and that can be mobilized;
- interpretation, because the meaning of a document depends on its authors and readers;
- intersubjectivity, because the confrontation between conflicting interpretations allows to overcome subjectivity

Our long-term practice of the social semantic approach has enabled us to progressively build a reflective approach inspired by the Humanities and the Human and Social Sciences (Semiotics, Philosophy...) [27][28]. This multidisciplinary attempt leads us to tackle some critical theroretical issues (intersubjectivity, collaborative construction of meaning, trust between actors) and, in the same time, strongly guides the software engineering strategy related to the development of the platform. The analysis of results drawn from the multiple experiments we have performed provides us arguments and explanation on the practical and theoretical viability of the socio-semantic concepts, and give us new ideas to complete the existing model . It give also insights for building new tools for the next versions of the platform. This point is especially important, because we do not consider ourselves as “pure computer science people” waiting for requirements and theoretical foundations from HSS researchers. On the contrary, putting to work an experimental practice (see §4.2) we build our own HSS social semantic theory iteratively. This posture may lead occasionally to the emergence of passionate debates (Fig. 5.7) and multi-disciplinary discussions with various human and social sciences colleagues.

Since 2003, Social-semantic Web resumes our perspective of a Web which is both semantic and ‘Social’. Collective intelligence can arise from a shared place where contradictory viewpoints can be expressed. In Web 2.0, this can be achieved by allowing people evaluate a resource or a person, comment a blog post, edit a wiki discussion page, or tag a resource with a free keyword. These are situations where trust is needed, and can be socially constructed little by little. Web 2.0 tools usually try to aggregate the viewpoints into an average of marks, a ‘cloud’ of tags, or in a consensual wiki page. Because we are more interested in smaller communities, we focus on visualizations which preserve each actors’ viewpoint [32]

3.2 The Hypertopic infrastructure

For almost 15 years now, to experiment and complete our research towards a social semantic Web, we have developed, enhanced, and modified a software infrastructure named “Hypertopic” dedicated to the collaborative representation and participative manipulation of data, contents and knowledge (http://hypertopic.org/) are mainly driven by an empirical and theoretical effort we just exposed in §3.1, drawing inspiration from human and social sciences, and not by technological trends.

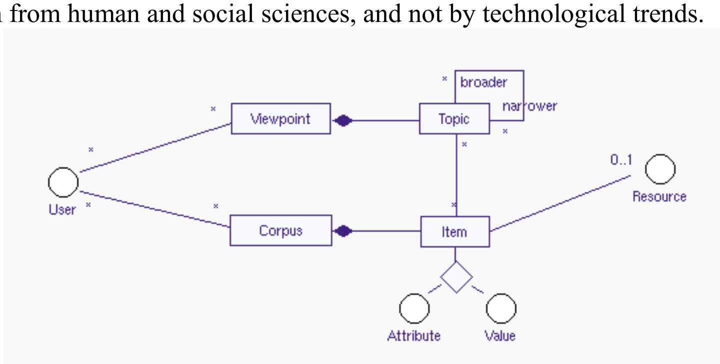

Fig. 1. The Hypertopic model (2003), basis of the Hypertopic protocol (2006) [31]

This multi-viewpoint model (see Fig. 1) called "Hypertopic" has been progressively implemented by a coherent reusable set of software components (see Fig. 2). It includes a core service (Argos), manipulated by users through cataloguing (with Agorae), document annotation (with LaSuli), and multi-dimensional browsing (with Porphyry). To add ease-of-use or automation facilities to the management of specific items types, additional services were developed for texts analysis (Cassandre), pictures classification (Steatite), scientific bibliographies management (Tiré-à-part) and design forums (Argile). The glue ensuring a strong coherence between the component is since 2006 the Hypertopic protocol, defining precisely how the low-level social semantic operations have to be realized (for example, all components of the software suite need to create new viewpoints, move a topic in a given viewpoint, associate an existing topic or a new one to an item, etc). Technically speaking, this standardization of the protocol allows to use it with various lower level IT standards. For example, between 2010 and 2012 , we migrated all components from traditional relational database and client-server environment to a resource oriented architecture (REST), allowing to distribute easily viewpoints and items on several servers, reinforcing the potential use of the infrastructure in bigger communities.

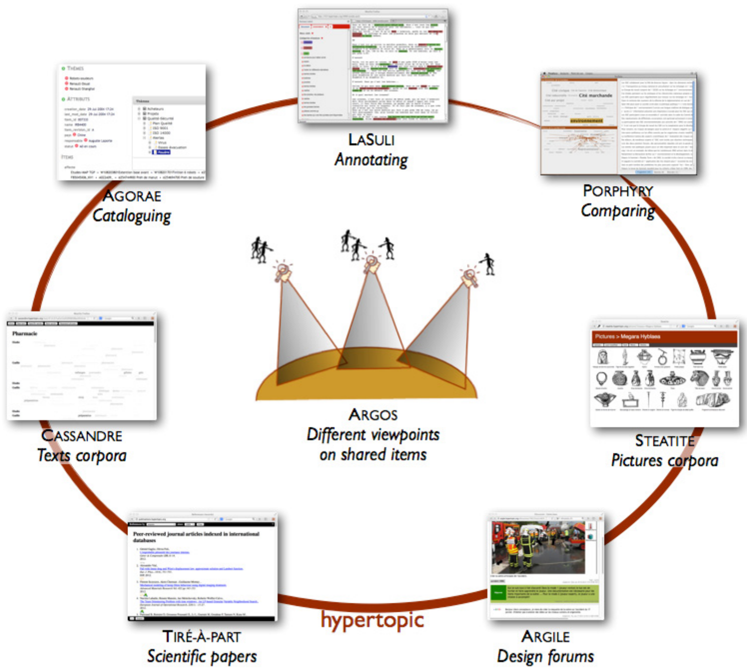

Fig. 2. The Hypertopic infrastructure (2013) integrated through the Hypertopic protocol: a coherent set of software for generic interpretive actions and different items types

4 A diachronic overview

4.1 Diachronic view of the software

Since the software is not a research product by itself but a mean to carry on experiments, few resources can be assigned to its development and there is an obvious interest in mutualizing and capitalizing prototype software developments between experiments. However the software should be mature enough to be used by different people at the same time and on the long run. Moreover, its features should be continuously updated in order to be able to publish the related experiments. Last but not least, PhD students and postdocs should be able to contribute to the software without having to embrace the subtleties of the whole platform.

In these settings, we had to avoid an uncontrolled growth of the platform that otherwise may become more complex, and hence more difficult to fix and enhance. Years after years, we strived to improve the platform while constraining drastically the volume of lines of code (see Fig. 3). “Doing more with less” was made possible by refactoring: the process of continuously changing the structure of the code to improve inner reusability and code abstraction. Refactoring has been fostered by the early adoption of specialized programming environments for parts of the platform, and the resulting separation into loosely coupled components.

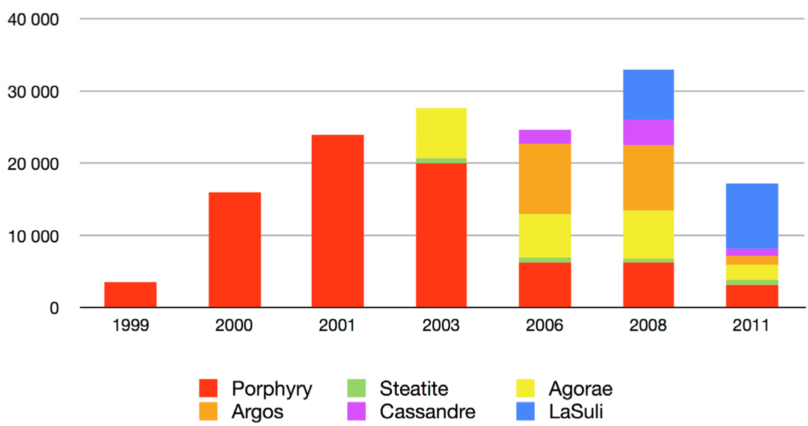

Fig. 3. Lines of code by component and major versions (Hypertopic Suite)

For example (see Fig. 4), everything in 2000 was done by a single piece of software. The first major refactoring consisted in creating a specialized component for contents storage (Steatite). However, in 2003, two different sets of software were available (Porphyry and Agorae). While one was a digital library system and the other a cataloguing system, their main features were similar enough to carry on a refactoring (from 2004 to 2006) so that they can use a common storage infrastructure (called Argos) for viewpoints, highlights, and attributes management. The definition of an abstract protocol for this storage led to different implementations for specialized features (like Cassandre for text corpus processing). In 2011, the drastic drop in the number of lines of code was the result of the definition of a new protocol (a REST protocol taking into account the MapReduce design pattern), corresponding exactly to what could be done with a given “postrelational” (aka “NoSQL”) datastore (CouchDB).

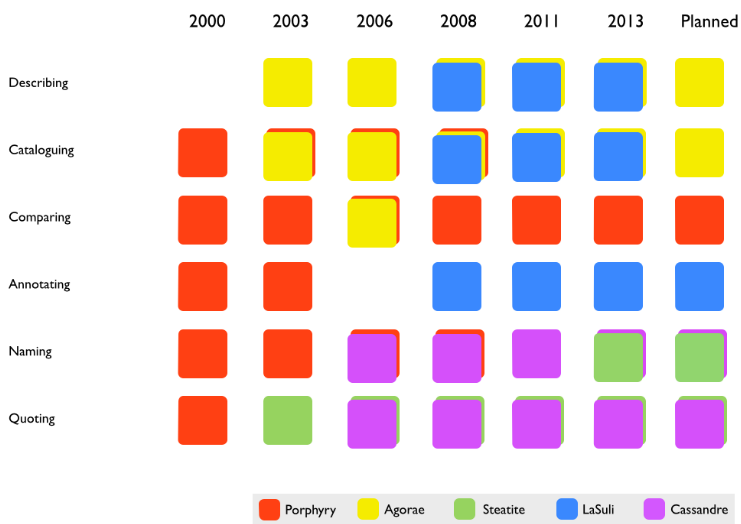

Fig. 4. Features deduplication and specialization by components and major versions

4.2 Diachronic view of experiments and findings

In the whole period, more than 20 experiments were performed with the Hypertopic tools, addressing various problems and fields of interest. At each time, one or several researchers focuses an experiment requiring the creation of a customized "participatory service" on the Web. For a better readability, we present here a selection of 9 examples that illustrate different categories of “participatory services” (see Table 1). All this cases were published in journals or conferences of various IT or HSS communities, that’s for we do not illustrate them by screen shots again. Each new use case is based on one or more Hypertopic tools, and generally the experiment is an opportunity to develop the previous version (or to create a totally new version) of a component of the platform.

These experiments aimed at illustrating facets of the "Social Semantic Web", mixing knowledge problems and cooperation issues. It also aims at experimenting concrete co-construction within communities of new high-level knowledge and artifacts (catalogues, categorizing, "topic maps", game specifications...) with many distant actors with different points of view. But all these experiments do not have the same scientific goals. They are all in the social semantic Web current of thinking, but they do not aim to lead to a single coherent theory. Since these experiments use the same platform and the same model, each researcher has to define in his/her field of interest, for a given activity or a community of interest. Conversely he/she has to define what are the “items”, the “topics”, the actors, the “viewpoints” available in the model and in the software. A researcher can have his/her own conception of the notions of “viewpoint “, “item”, that differs from other researchers’ conceptions. On the long time, the multiplication of these experiments, generates confrontation between users of the platform, who come from different disciplinary fields (sociology, knowledge engineering, document sciences, archeology, etc). This process gave birth to an ever growing “Hypertopic community” whose members share a common conception of the notions of “viewpoint“ and of “item”(this point will be discussed in §5).

Tab. 1. Features developed, reused and extended throughout experiments

	Excavation chronicles	Agora F-T, aeronautics skills, YEPOSS	Vases iconography	Qualitative analysis	i-Semantec	CartoDD	Argile
Describing		XX	X		XX (from a PLM)	XX	XX (from a forum)
Cataloguing	XX	XX	XX		XX	XX	X
Comparing	X		XX	XX	X	X	X
Annotating	X		X	XX			
Naming	X (rich text)		XX (pictures)	X (texts)			X (pictures)
Quoting	X (rich text)		XX (pictures)	XX (texts)			X (pictures)

Excavation chronicles. In 1999, Porphyry was designed to provide “semantic” access to a valuable corpus of about ten thousands of short articles (by the French school of archaeology in Athens) of yearly archeological findings in Greece and Cyprus since 1920. The idea was to combine, in a multidimensional browsing space, the recurring geographical table of contents, the year of finding, and kinds of “emerging thesauri” (esp. for artifacts typology and periods) created by readers according to their conflicting viewpoints. Once a part of the corpus was tested (in 2000), it appeared that this prototype could be considered as a more general “assisted interpretation system” [2].

Agora-FT. In 2002 "Agora-FT" (cataloguing R&D projects and deliverables social, for a telecom operator) was the first application of Hypertopic for social tagging and cataloguing of items by a real organization at a whole scale. The service was created to experiment the Knowledge-Based Marketplace model [11]. At this moment the Hypertopic model was completed (excepted a point of vocabulary: until 2004 we used to speak of "entities" and not of "items"; this generated strong debates in our group in order to know if we could accept documents as "items"). In Agora-FT, there were 7 viewpoints (corresponding to various “languages” used in the organisation (scientifical, technological, marketing, usages...), 2000 topics, and 400 items. A drastic customization of the service was then required. Agora-FT was a “one-shot” standalone application, but after this experiment in 2003 we decided to build a first version of a generic tool (Agorae), implementing the Hypertopic model, useful for other communities having such needs for social tagging with multiple viewpoints.

Aeronautic skills and OSS Yellow-pages. In 2004, a first “Yellow-pages" experiment [12] in partnership with Knowledge engineering searchers of an European aeronautic industrial, was the first application of the generic tools Agorae (V1), to categorize engineers’ skills according to 4 viewpoints and 2500 topics). In this experiment, items were “engineers” (persons), characterized (with attributes and topics) by engineers themselves. In 2006, in the YEPOSS experiment (YEllow Pages for Open Source Software) [13] we used Agorae V2 and Argos to socially construct (in laboratory) a multi-viewpoint Topic Map of Open Source Software items.

Vases iconography. In 2004, a research team in history of fine arts and archaeology started to use Porphyry to carry on a study on the iconography of Dionysos and banquets on vases from the area of Paestum (Italy). To do this, the team gathered more than 600 photographs from museums all over the world. In 2005, three master students analyzed a subset of the vases showing an altar.Unexpectedly, the viewpoints to be compared were on different item levels: each vase was analyzed according to its form and datation, while each scene (usually 2 per vase) was analyzed according to its figurated characters, animals, objects, etc. To cope with item levels, we updated the Hypertopic model, the multidimensional browsing algorithm and the interfaces.

Qualitative analysis. According to our colleague sociologist Christophe Lejeune, “practitioners of qualitative research often suffer from the Cassandra complex, in that they produce interesting, serious and solid results but their colleagues fail to take them seriously” [24]. In 2004, he had an insight of the potential of the Hypertopic infrastructure to enable researchers to show colleagues or clients the categories on which the conclusions are based. Moreover, at that time, while not designed for this purpose, the software seemed more adapted to real “grounded” and “interpretive” analyses than well known CAQDAS (Computer-assisted qualitative data analysis software) in which the analysis framework was a single, top-down-created hierarchy. On top of Argos, LaSuli was created to meet the requirements for both art historians analyzing pictures and sociologists analyzing texts. Since users of CAQDAS software were accustomed to semi-automatic concordances (and basic text mining), Cassandre was developed to add these specific processing features into LaSuli [4].

i-Semantec PLM. In 2008, the i-Semantec project was developed in the context of the issues of knowledge capitalization, management and reuse among large industrial corporations. In these corporations, data and documents related to their products and coming from various actors are already integrated by `Product lifecycle management' (PLM) systems. However, this integration is based on the formalization of the main processes of the corporation. And this is often a detriment to the specificity of the different professions. Hence, those professions have established their own databases and documents beyond the capitalization. Our partners in the i-Semantec project had extracted the data from a major PLM software and convert it to RDF triples, to be queried through a SPARQL service. Then we used Hypertopic (Agorae and Argos tools) to allow users themselves to add emerging data [33]. For this project we developed i) a web service adapter (rdf2hypertopic) and ii) a new version of Agorae (V3), so that it can integrate data coming from different Hypertopic servers. Through this architecture, Agorae can query and display both read-only stabilized data from PLM projects and read-write emerging data stored in Argos, (5000 Items, 70000 relations). i-Semantec Items were technical component of projects and of artifacts.

CartoDD. Between 2007 [14] and 2010 [15], we made another participation experiment, in several stages, in the field of Sustainability, to apply Argos and Agorae (V2 then V3, with a service including dynamic topic cloud and item cloud) to the social cataloguing of Sustainability items. Seventy students at the Troyes University of Technology participated to the field inquiry in order to collect information, to constitute viewpoints (8 viewpoints) and describe 200 items on a social semantic Web approach. Our experimental goals were especially to determine how multi-viewpoints social semantic approaches can improve Information seeking (2007), and what could be the method to realize the social semantic participation (2010): how to effectively bootstrap (at the very beginning) and to articulate the use of the tool with the inquiry activity of the users. In this example "direct" items were emerging from observation, discussion and all forms of oral culture and memory of experienced situations by which the contributor selects points of interest in the situation.

Argile Forum. More recently, in 2011, we started a set of experiments to assess the impact of forums in design. More precisely, we intented to explore the social semantic potential of synergies between communities of designers and players, in the co-design of Serious Games, especially when participatively editing items and rules for the “SOS-21” game. In order to do so we built a forum tool for designers, the Argile Forum, based on Hypertopic [16]. For posted message, votes, comments, attributes included in rules, the Argile Forum re-uses the item-based structure of Hypertopic with attributes, topics and viewpoint. The re-use of the existing concepts and software was an important source of savings in this development. In this particular case, the items are the items, actions and rules of the game and the messages and comments posted by designers. The platform makes the management of the images of game items easier (with Steatite) and helps to retrieve these items with with Agorae.

5 Lessons learnt and guidelines

As we saw earlier, research on participation requires experiments on the long term with real communities and contents. Hence a “non-disposable” software infrastructure seems to be needed to reach usable software with minimum cost and time. But the most important benefits are methodological and epistemological. While previous CSCW studies [22] have clearly stated the advantages of the coupling in action research between cooperative services, social usage and continuous theoretical building (see Fig. 5.**4-6**), much has to be said about the adjunct advantages of non-disposable infrastructures.

In the experiments listed in §4.2, we verified that the multi-viewpoints infrastructure we propose, leads effectively to various cooperation architectures and participatory settings accepting very different conceptions of what were “viewpoints”. The infrastructural basic concepts and relations (viewpoint, topic, attribute, item…) reinforced by software, give practical affordances for designers (and users) of the particular Hypertopic-based architectures.

The use of viewpoints in participatory architectures listed in §4.2 was very different whether the context was knowledge management, product lifecycle management, text analysis, or multidisciplinary scientific work... Sometimes the “viewpoints” were viewed (by architects and users using the Hypertopic tools) as opinions, facets, categories of qualitative analysis... But beyond the various cases and methods, we could verify the robustness of the Hypertopic “large concept” of Viewpoint : not only its logical and technical robustness, but also its “social robustness” from a transdisciplinary point of view: Hypertopic viewpoints, in many cases, help successful participation architectures to be designed.

By confronting the same infrastructure with radically different cases and cooperation architectures (Fig. 5.**3**), non-disposable infrastructures allow to address deeper conceptual issues, and to carefully settle the lessons learnt into a coherent conceptual framework (Fig. 5.**8**). As software designers in a interdisciplinary CSCW team, we are also concerned with the borrowings (Fig. 5.**2**) and impacts (Fig. 5.**1**) of our “non-disposable” conceptual framework from and to theories in human and social sciences.

Let’s take another example, concerning another “large concept” of the Hypertopic model: the “item”. In 2004-2005, our Hypertopic community experienced critical philosophical discussions (Fig. 5.**7**) on the ontological status of the notion of “item”. Items were used (in Agora FT) for R&D projects and deliverables, (in Cassandre applications) for sociological analysis themes, (in Paestum application) for vases photos and details, etc. Several members of the Hypertopic community were concerned by the positivistic pitfall of building participation on what was called “an entity” at this time. Instead they wanted interpretations to be built on documents, as stated by philosophical hermeneutics. Others were concerned by the fact that a document approach would specialize the system for scholarly works, leaving the « agora » metaphor behind – a place where any citizen could talk about anything. The controversy was resolved by changing the name and the definition. The new item became similar to Suzanne Briet’s “document” [7][8]: anything that has been selected, given an identifier, described, kept with others, preserved and made accessible so that it can be referenced by secondary documents.

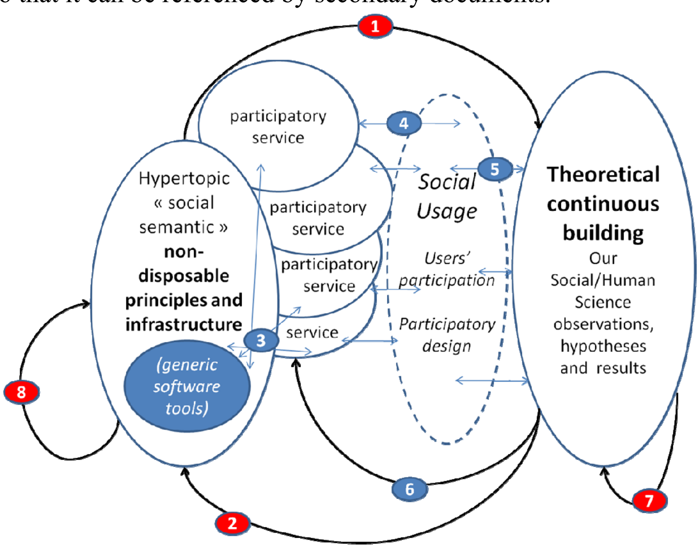

Fig.5. Model of the "long time" loop : social usage, services, infrastructure, and theories.

A consequence was that if two actors handling different viewpoints (even though they share the same situation) do not see the same item, Hypertopic made it possible that they may and can have their own viewpoint, shared for cooperation or controversy. This new item was able to bridge the gap between, on one hand, the activities of designers discussing on a forum the items and rules of a game, and on the other hand, the activities of art historians annotating museum pictures in a qualitative analysis process. We made the demonstration that the same conceptual model and the same software platform can be used. And as a matter of fact, by multiplying experiments we built progressively and pragmatically a "common ground" about the notions of "viewpoint " and "item".

Beside this important dialectical relation between the principles of infrastructure and the theory, it is also to be noticed that reusable infrastructures reinforce the classical ergonomic loop between the design of services and the observations of uses: when a given Hypertopic-based service is used by a community, it allows to study appropriation by users, expression of new needs (Fig. 5.**4**). What are the lessons learned (Fig. 5.**5**) ? For example, is participation improved by the social semantic approach? How to explain this result ? Does another cooperation architecture give better results, by using differently the viewpoints (for example with new roles for semantic regulations)? etc. Experiments generate new hypotheses and ideas (Fig. 5.**6**) for further experiments and participatory services. Generic Hypertopic software tool are customized and used in services used by given communities (Fig. 5.**3**).

Finally, because every computational artifact presents an inherent rigidity and weight, we must take in account structural, logical or performance constraints. Classically, there are continuous bi-directional exchanges (Fig. 5.**3**) between the generic software of the platform and the dedicated applications and services in use. There is always to mention the "computer science" loop (Fig. 5.**8**). As we are experienced in software, we know that we are not completely free to implement all idea. We must continuously take in account logical and technological constraints crossing the social semantic approach, improving software efficiency.

6 Conclusion

The very idea of participation does not date back from the birth of information technology. For example, in a not so ancient past, the idea of participation was at the core of the participatory design approaches that emerged from Scandinavia in the early seventies [5]. The general idea was to promote the direct and active participation of workers in the design process of their workplaces so as to preserve their skills, autonomy and well-being at work.

The motives behind this approach to participation is two-fold and can be crudely summarized as follows: the ideological arguments emphasizes the users' right to influence their own future working conditions; the pragmatic arguments take for granted that, under right conditions, future users can contribute to the design process in a way that sociotechnical systems may be designed that are tailored to user needs. From this point of view, participatory design can be seen as a way to bring more knowledge from different actors and stakeholders into the design process [17].

But in participatory design approaches, the organization of the whole process remains mainly conducted by 'experts', that is people trained to help the workers' participation emerge and inform the design. At the other side of the scope, some tools promote a fully emergentist process and provide facilities to users to build shared contents (data, programs, knowledge). Participation refers here to a set of situations in which different actors identified or unidentified, ratified or not, distributed in space and time, contribute to a sometimes ill-defined collective goal, using most of the time low-overhead web-based technologies. Doing so, people participate in a more or less conscious way to a collective design that aims at generating a bunch of perpetually moving collective knowledge. To some extend, this fits well to the pragmatic and somewhat conjonctural conception of participation we have adopted for years now. But our position here is more moderated: even though we recognize, and in some way revendicate to rely on the participation of the users for developing and extending the Hypertopic infrastructure, we do not take it for granted, and we postulate that the design philosophy underlying the structure of Hypertopic, and the facilities offered to the users should actively support this participation. Providing tools to help users to build knowledge and make decisions submitted to discussion, negotiation and sometimes dismissal is here a key issue.

According to this orientation, cultures of participation depend on the "architectures of participation" supporting them. Such architectures are socio-technical open systems, including rules and software using meta-concepts (viewpoint, actor, item...) appropriable to users. As architects of these systems, we must continuously experiment, in order to understand why architectures are (or not) successful in a given social context. To study the socio-technical architectures and the conditions encouraging cultures of participation, we need long term experiments with real communities. And we must avoid building frontiers between the world of software engineering and the world of HSS. Indeed, the conceptual and technical elements of the infrastructure play a key-role in the emergence of participation. As a consequence, research on architectures of participation need to rearticulate service designers and HSS communities, by promoting long-term experiments consolidation and "non disposable" infrastructures.

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