

Crafting Infrastructures. Requirements, scenarios and evaluation in the SPICE project

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Abstract—The evaluation of infrastructures in large and collaborative R&D projects pose novel challenges to UCD methods. The lower level of these technologies if compared with applications meant for direct user interaction brings a level of indirectness to the activities. This paper examines some previous research on the subject and then reports about the ways in which the SPICE project faced this challenge, with special regard to the scenario and requirements design process and how focus groups-based evaluation had an impact on it. Concluding remarks on the experienced collaborative dynamics discusses the possible role of craft-inspired styles of working.

Index Terms: User centered design, Research and development management, Scenarios, Requirements, Focus groups

I. INTRODUCTION

APPLYING UCD-User Centered Design methods usually requires more than a disciplinary grounded, cultural and ethical commitment to user centricity. In fact, every design effort is specifically situated in a certain setting, which calls for interpretation and adaptation from the professionals involved. Design at the R&D stage is even more challenging, given the future orientation, risk-bounded, exploratory nature of the work. Doing R&D in multiple organizations, international, collaborative initiatives – as typically are European IST projects [1] – brings yet another wave of complexity. Finally, scope and nature of what has to be researched and designed are obviously of outmost importance: one thing is to specify and evaluate an application aimed at a well defined task, a very different one is dealing with technology infrastructures not meant for end-users’ direct manipulation and interaction.

The latter is the case of SPICE [2], which is the reference case of this paper. The project aims at building a platform that will enable and ease service creation and execution, integrating advanced features based on complex roaming, discovery, awareness, matching and delivery mechanism. Methods and techniques such as requirements analysis and definition, or scenario building and evaluation, had to be

applied taking into account these specificities. The issue as such is not relevant only for SPICE, since several R&D projects share the same characteristics. This paper will briefly review some of these previous experiences and then will illustrate how SPICE researchers dealt with the issue outlined above; the ensuing discussion will reflect on some possible broader aspects concerning UCD and design methodology in general.

II. PREVIOUS RESEARCH

As anticipated, SPICE tackles with user-centricity in a quite complex setting. Two major aspects are relevant here: first and foremost, the fact that the researched and developed technology is at the infrastructure level; second, the distinctive attributes of large and collaborative projects. Both of them pose important challenges to traditional UCD process and methods [3][4], that are often used and has proved to be fruitful in well defined domains, with a single organization targeting specific users for a set of tasks and activities (the occurrence of two-tier organizational structures, including design consultants and their customer, does not appear overtly different).

A. UCD “extra-large”

Generalising from the MobiLife project experience on the adaptation of UCD in the context of large and distributed projects, [5] proposes an “extra-large” specific UCD style to cope with the critical mass, abstraction and compartmentalization of these collaborative efforts; special attention to the difficulties of researching technology social acceptance is also given. A number of practical recommendations have been formulated there: they include the opportunity to conduct early test of the functional parts of what it is still under development (“Break out of the big loop”); concretization of abstract ideas (even though this is “not always feasible with enabling technologies”, as discussed below); maintenance of an empiric orientation (scenarios are useful for developers but might be unrealistic for people out there); prioritization; frequent interaction among developers and user researchers, making user research a collaborative activity and UCD an “integrating perspective” located at an

higher level or external point of view, somewhat independent of specific technology agendas.

Besides these managerial and organizational issues, there are other critical aspects more related to the research subject, especially with regard to enabling technologies. In fact, [5] highlights as well some inherent difficulties of bringing software components or “enablers” to the field for direct experimentation with end-users.

B. UCD challenges in evaluating infrastructures

As noted by [6], the issue of evaluating lower level components or technology enablers is an important and still not really explored terrain. In general, little research is available on the evaluation of software infrastructure according to user-centred methodologies: once applications with some clear intended scope and user access are not at the centre stage, criteria for designing and evaluating the features of the infrastructure itself are less certain. User-visible applications have long traditions of user-centred design and evaluation, if compared with infrastructures. In the latter case, issues regarding the development of fully working prototypes with acceptable usability or small scale prototypes are to be considered carefully, because they could not generate expected results. The same goes for the usage of fake features or simulations for components that will have some interaction in the future with the infrastructure, but are not strictly related to that. Developing applications with the desirable quality level might be not possible at all or only at the risk of big delays and wasted resources. By going through the evaluation of several applications enabled by an underlying infrastructure, and reflecting on some major pitfalls, [6] comes to the point of consolidating several “lessons learned”. Interestingly, some of them are pretty much in line with those put forward by [5].

Prioritize core infrastructure features is then lesson number one. As before, the aim is to test practically “core design ideas” and build additional features once evaluation results are available. To really achieve this, researchers might have to play with a “minimalist” infrastructure, or, in other words, prototypes with very limited scope but that can effectively convey some of the core ideas. All other work, namely what does not leverage directly on the infrastructure, should be deferred. Have e.g. a prototype that it is robust and secure enough for use in real conditions is often a sensible objective, but since the application layer as such is not the focus, the effort needed to get there might be wasted. Yet test application “must also satisfy the criteria of usability and usefulness”, a criteria that the authors recognize as “difficult to satisfy”, even though the challenge is somewhat lessened by the recommendation that initial proof-of-concept applications should be lightweight.

III. SCENARIOS & REQUIREMENTS

A. Overview of the SPICE project

The SPICE project addresses the problem of designing, developing and putting into operation efficient and innovative mobile service creation and execution platforms for networks beyond 3G [7].

With the growing diversity of services, devices and connectivity means, service platforms such as the SPICE platform intend to provide end-users with communication means and tailored applications anywhere, anytime and on any device. This goal is sought by supplying service providers with service enablers that ease and quicken (context-aware) application development. End-users are not only considered as consumers of those applications, since they can be service creators at the same time. In this view, operators will take the role of service platform provider and, if such it is the case, service provider. The strategic role played by the platform in this vision explains why the project strives to combine a so-called “platform-centric” approach with an end-user orientation [7].

B. Design process

As many other R&D endeavors, SPICE started with a technology vision articulated in a number of specific objectives and embodied by a set of short scenarios, expressed by brief textual narratives. This happened already at the research proposal phase; user-centricity was not greatly emphasized there, but the workplan included explicitly users, i.e. external people not involved with the project, for two iterative evaluation activities, the first at the beginning and the second at the end of the project. Focus groups are mentioned as the method of choice.

The proper design process began with a very detailed requirements specification activity, in partial overlap with the actual scenarios definition and in reciprocal influence with other research activities, namely architecture work, initial analysis of business models and legal issues.

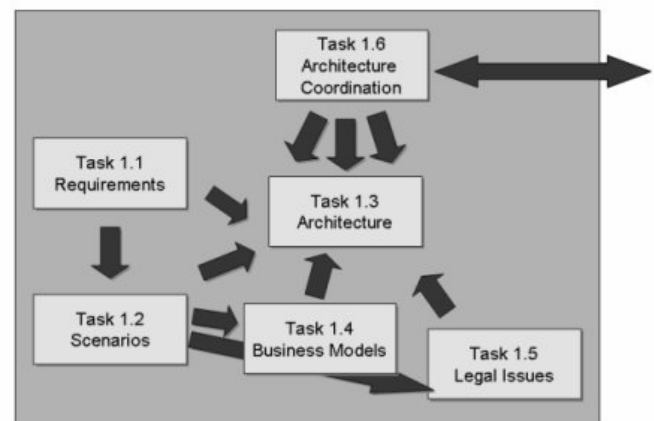


Fig. 1: interactions between requirements, scenarios, architecture, business models and legal issues.

The requirements work produced an output of 48 use cases, considering four types of requirements: user requirements, enterprise requirements, technical requirements and open market requirements.

The ensuing work on scenarios took into account the updated architectural view, the related functions, and once again the parallel work on business and legal aspects to consolidate the first complete version of the project scenarios. These scenarios provided the basis for the first evaluation round with end-users and professional users, conducted through a number of focus groups, reported below.

The user feedback generated in the focus groups, as well as the parallel work in business models and the technical progress of the workpackages, has then been fed into a scenario revision, reported below too with more details.

Starting again from this revision, currently yet another iteration is ongoing, aiming at consolidate the different scenarios into a unique and streamlined storyline, as well as a more compact set of requirements, prioritized against the most distinctive objectives and outcomes of the project.

C. Scenarios

The scenario work in SPICE is focused on the development and refinement of a series of demonstration textual and visual narratives that illustrate the main features and the potential impacts of the service platform on European citizens, as well as on service providers and telecommunication operators. Given the necessity to communicate both with end-users and professionals (included semi-professionals and talented amateurs), a wide spectrum of diversified situations is represented in these scenarios, ranging from context-aware personal navigation for tourist groups to natural language, semantically-enabled searches in components repositories accessed by technical developers.

As said above, scenarios have been shaped early in the project lifecycle, and have been initially consolidated in a set of four stories, named respectively I-Portal, e-Tourism, e-Emergency and Service Creation [8]. The first two, I-Portal and e-Tourism depict different groups of end-users, mostly families, in various service settings. The SPICE platform as such does not appear in the foreground; the specific experiences made possible by the platform are described instead, mentioning SPICE as the enabling technology.



Fig. 2: scenes visuals from the I-Portal and e-Tourism scenarios, describing usage of local navigation services and context-aware push mechanisms.

The last scenario, Service Creation, has an explicit orientation to business and technical users: it describes all the service lifecycle from the ideation phase down to each development step (shortly: design, implementation, deployment, management and termination) and makes explicit all the related interactions between various parties (e.g. a sponsoring company, a developer partner, an operator).

The e-Emergency scenario includes both aspects, with some scenes closer to the end-user point of view and other scenes dedicated to the involved organizations and their usage of the technology.

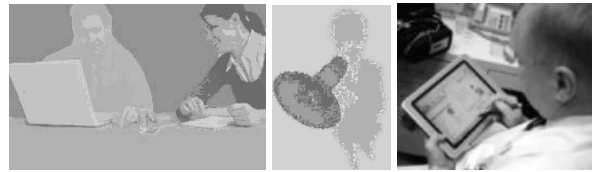


Fig. 3: scenes visuals from the Service Creation and e-Emergency scenarios, describing prototyping processes, service announcement and personalized alerts.

D. The indirectness issue

Despite some differences in the emphasis and point of view, a common aspect across the four scenarios is that many scenes - if not all - are about an infrastructure that is not directly accessible by end-users: in fact, they will use services enabled by this platform. Even the case of professional users, which will have indeed access to the platform functionalities, is not entirely straightforward, as the disciplinary and technical backgrounds of the professionals will likely be varied: business and creative people will have to cooperate with engineers; for them, the processes enabled by the platform will be of outmost importance, more than its direct manipulation.

The platform influence embraces also some key aspects of the terminal capabilities, but also in that case the relevant software layers might lie behind the users' level. Indeed, they enable several application features that are in the users' reach, from the capability to find a service suitable in a given context to the possibility to use it while roaming abroad, but are not directly visible per se. The most notable exception in the project is perhaps the Dynamic Desktop, which provides an interface to let the user interact with the platform, but actually this is part of a broader work about technological issues and features that again are well behind users' visibility [9].

IV. EVALUATION AND REWORK

It is now obvious that the UCD challenge of evaluating technology infrastructures has been met and is being faced in SPICE. Furthermore, SPICE is experiencing the same "extra-large" characteristics described above, similarly to many other cooperative projects.

As anticipated, the project workplan included focus groups

as the evaluation method of choice, especially for the initial project phase. The results of this evaluation and their impact in the design process will be discussed in the following paragraphs.

A. Focus groups

The evaluation has taken place in three countries: Poland, Spain and Italy. It has involved both individuals with an end-user profile (8 focus groups) and professionals (2 mini focus groups). End-user oriented meetings have been mostly dedicated to the discussion of SPICE-enabled services from a consumer / citizen point of view, trying to elicit respondents' opinion about potential benefits and disadvantages of what was shown in the stories. Professionals-oriented meetings were concentrated instead on the process of creating, delivering and managing these services, with special attention to design, development and prototyping issues; potential benefits and disadvantages were examined in this case too.

Among various preparatory tasks, it is important to remember here that scenarios had to be adapted for the focus group discussion settings. The number of scenes had been reduced, as well as the narrative text, giving more emphasis to the pictures and the SPICE feature main ideas. This way, the translation effort of conveying the SPICE main features through the scenario description has gone one step further as the communication needs for which the scenarios had been conceived moved from the experts to the general public.

Once the focus groups had been held, the analysis of the related reports has gone through the following steps: first, complete country reports have been produced, highlighting the key benefits on one side and major disadvantages and dislikes from the other side, for each scenario; second, common results and variations have been spotted, with special attention to the impact of country perspectives. Finally, a set of actionable recommendations has been elaborated, as a tool for the upcoming scenario revision [10] [11].

Starting with the general results, some clear directions are evident. Regarding the key benefits, across all countries and profiles there was strong appreciation of everything related to "convenience", such as service international roaming, session transfer, possibility to swap devices while using the same service and personalize public devices, personalization in general, access to protected content and content adaptation to various terminals. Professionals appreciated very much the possibility of having a support for faster and more effective prototyping and service creation capabilities (but gave a warning about the organizational challenges of prototyping processes). Proactive context-aware recommendations sparked instead lively discussions, usually prone to stark criticism. Most of the cited disadvantages and dislikes were mentioned in relation to that, especially regarding possible misuse from companies, marketers and public organizations as well. People feared that the tracking and profiles features

that enable these recommendations would trap them into a too powerful system. Moreover, the usefulness of such recommendations was questioned. Still, through the debates, a number of potentially promising usage settings were spotted and anticipated -- some alternative to the ones presented. Notably, people seemed remarkably positive about personal navigation features and the application of SPICE technologies in working environments especially in comparison with leisure traveling and other spare time situations.

Not surprisingly, the indirectness effect discussed above did have an impact on the focus groups' participants understanding of the depicted features. Quite often end-users seemed puzzled by the nature of SPICE itself, given its apparent influence on so many realms (devices, services at home and abroad, general tasks and very special events like an emergency). Professionals too debated a lot about the possible scope of the platform and its applicability to their own environments; those with a non-technical background were ready to pinpoint organizational and cultural challenges related to the presented ideas. Yet such indirectness did not hinder the discussion substance, articulation and richness. As seen, focus groups actually generated much valuable feedback about what was perceived as desirable or less so at the scenario scenes level. Notable distinctions and subtleties emerged as well, mainly dependent on the country and age group of the focus group participants.

As outlined above, the user feedback has then been translated into a set of recommendations for scenario improvement. Some of them were quite high level (such as "the general direction for further scenario development is to build them around an active SPICE user that searches and chooses then receives and accepts"), while most of the others sounded more as practical hints, as the ones below (they are related to different scenarios):

- *Decrease to a few scenes the explicit reference to proactive mechanism altogether*
- *Link clearly the delivery of proactive suggestions to some user action or previous declaration*
- *Explain more about the Semantic Language*
- *Clarify what the emergency service is*
- *[...]*

Taken as a whole, such recommendations have provided a body of suggestions that clearly called for a scenario revision, actually already envisaged in the original workplan.

B. Enhanced scenarios

The user feedback coming from the focus groups was not the only source to be taken into account. Parallel work in business modelling and updated mock-ups features required too some scenario updates. As a consequence, the project had to complete an extremely detailed mapping of old scenes, user feedback, modified requirements and new scenes [12].

First of all, this started by identifying so-called “scene requirements”, i.e. requirements regarding the scenes to be modified according to the mentioned input sources. Second, a controlled three-stage, step-by-step procedure had to be defined:

- 1) Mapping the users’ concerns/comments on each of the scenario slides adapted for the focus group discussions.
- 2) Identifying the correspondence between the focus groups’ scenes and the initial ones in order to put the right “scenes requirements” into the original scenes.
- 3) Taking the original scenarios and applying on them the scenes requirements.

Moreover, special care had to be used in applying such scenes requirements. Given the different sources, the enhancement process has followed a sequential approach, beginning with the users’ enhancement and ending with the business one; each of these steps has included an enhancement and revision iteration.

Scene	Req. Source	Req. Code	Requirement Description
Scene 1.3: Inferences and service push	users	ReqETS1.3U4a	Mention that this type of services can be switched on/off. Also, as we are talking about a guide service, they can consult the area of leisure to receive this specific type of information
		ReqETS1.3U4b	Depending on users’ reply, additional audio/visual information is provided to get them on the suggested spot
		ReqETS1.3U41f	Elaborate more about the technical concepts in the scenario, still in a way that is easily comprehensible and valuable to end-users

Fig. 4: Excerpt from the mapping work; focus groups users’ inputs are codified into detailed “scenes requirements” that are then mapped to the original scenarios.

The mapping exercise and scenes requirements formulation has resulted in improved narratives, with focused hints and pinpoints at the identified user concerns. To achieve that, some scenes had to be removed altogether, other split in different parts, others just modified.

If we consider e.g. the issue of personal identity and context information matching (a frequent occurrence in the I-Portal and e-Tourism scenarios), explicit reassurances have been added to address the users’ concerns emerged in the focus groups:

...it is impossible that the service makes use of users’ sensitive information in a malicious way since the local SPICE Operator guarantees that user’s personal data (e.g. name, address, mail, telephone...) are never matched with his context information (e.g. position, mood, availability). Before the service can use sensitive information, the user’s consent must always be given.

Push mechanisms raised a lot of discussions in the focus groups (with special regard to the e-Tourism scenario); stronger rationale and clearer behaviours explanation have so

been given:

...The family is notified because they all selected this option in their service preferences. As they do not know much about Valencia, they value any information they can get. Moreover, they trust the SPICE platform because it is internationally well known for using fair recommendations based on users’ preferences and ratings.

With regard to the service provider side, professionals that attended the focus groups made a lot of questions about the prototyping process and capabilities of the SPICE platform. Hence, e.g. the scene depicting what is happening when a developer wish to build a mock-up has been better précised:

...The service description is used as input to a Mock-up builder (Mock-up generator). The Mock-up builder is a graphical tool which enables Paul and his team to put components together by drag and drop. In a couple of hours the mock-up is done. The mock-up is non-functional, but it can be displayed on any standard mobile terminal as well as on PC or TV-based interfaces.

As said above, this set of refined scenarios is currently used as a basis for yet another major iteration aimed at consolidate them into a unique and all encompassing story, in which both the parallel updated needs of the technical developments and the users’ evaluation are combined, providing a global framework for the project final demos and prototypes (to be used again in the concluding evaluation phase).

V. METHODOLOGICAL DISCUSSION

Scenarios, requirements and focus groups are definitively no new tools for the designers, especially for those attentive to user centricity. Yet they are not simple ones; if we consider e.g. scenarios, they have a quite complex and long history, spread among different disciplines and environments, from software engineering to business strategy and futures studies; much attention has been spent already on how to use them in designing forthcoming technologies [13] [14]; the same holds true for requirements and focus groups, with different specificities.

Hence, SPICE could hopefully be useful to reflect on the ways in which these methods or research tools have been used; furthermore, we realized that researchers’ attitudes and group dynamics were not less important than the methods per se – quite understandably, given the situated nature of design processes evocated at the beginning of this paper.

To start with, scenarios usefulness came out reinforced from this experience, despite their limitations (concerning e.g. the fact that they are so often technology biased and prone to generate skepticism). In fact, given the difficulties identified in previous research with regard to the development of applications meant to demonstrate underlying

infrastructure capabilities, scenarios proved to be a flexible and cost-effective way to represent that capabilities; scenario-based evaluations are indeed less substantial than prototype based ones – and for sure they can not just substitute them – but allow at least to get timely feedback from the users and push it back into the project. In order to do that, several iterations might be needed: scenes descriptions and sequences will have to be changed repeatedly, carving texts and visuals until they express a good balance of the various interests and viewpoints. It is much more than polishing: scenarios seem to work better as a dynamic tool, in which rework has to be taken for granted.

A similar approach has to be used to manage a consistent and precise matching of scenarios and requirements; technical and users requirements typically change over time according to the technical progress or evaluations. A successful reciprocal update is not less important than an original complete formulation – which too often risks becoming obsolete.

There are some aspects related to how the activities have been performed, or, in other words, regarding individual and group dynamics. Considering the entire scenario and requirements design and evaluation, it is evident that the process as a whole has been indeed a painstakingly collaborative effort. More than a clearly pre-determined and smooth cycle, the all thing resembled pretty much a craft exercise, as it recalls the slow, cumulative, collective, patient and prone to details work stile of craft. With a reduced interest in focusing on just one or two well-limited application domains, this sort of lower level type of work might actually pay off in shaping the infrastructure features against user inputs.

The metaphor of craft might appear a bit distant, but perhaps less so looking back at the very early stages of user-orientation in design and architecture, way before than by “bringing design to software” [15] UCD started to gain its stance in the IT field. Shaping the designer profile in the face of novel challenges raised by then emerging interaction between humans and machines, complex systems and multidisciplinary, John Chris Jones seminal reflections on methodology called for a partial return of craft skills in contemporary design practice [16] [17]. From a professional and educational standpoint, some of the best qualities of the ancient craft work might turn out to be still valid – above all, a humble and patient attitude to listen people needs and desires, as well the distinctive capability of the craftsman in shaping his own tools.

In this respect, the lesson learned from SPICE is not one of a method, or a set of specific actions, like an immediately actionable answer, but more one of an approach or a way to apply well-known design strategies and methods, forcing their adaptation to the ever more important issue of anticipating the future consequences of pervasive and extended technology infrastructures.

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REFERENCES

- [1] IST program web site: <http://cordis.europa.eu/ist>
- [2] SPICE project web site: <http://www.ist-spice.org>
- [3] D. Norman and S.W. Draper (Eds.), *User Centered System Design. New Perspectives on Human-Computer Interaction*, London, Lawrence Erlbaum Associates, 1986
- [4] J.D. Gould, C. Lewis, *Designing for Usability: Key Principles and What Designers Think*, Communications of the ACM, vol. 28, No 3, 1995
- [5] E. Kurvinen, A. Aftelak, A. Hayrynen, *User-Centered Design in the Context of Large and Distributed Projects*, CHI 2006
- [6] W.K. Edwards, V. Bellotti, A.K. Dey, M.W. Newman, *Stuck in the Middle: the Challenges of User-Centered Design and Evaluation for Infrastructure*, CHI 2003
- [7] C. Cordier, F. Carrez, H. Van Kranenburg, C. Licciardi, J. Van der Meer, J. Zoric, A. Spedalieri and J-P. Le Rouzic, *Advanced Beyond 3G service delivery environment: the SPICE service platform design principles*, WWRF16, 2006
- [8] SPICE project deliverable D1.2 “Scenarios for the representative next generation information and communication services”, edited by V. Boutroux, 2006
- [9] M. Brossard, *SPICE. Best-Configured Communication Environment*, Helsinki WWI Symposium, 2006
- [10] SPICE project deliverable D8.1 “Pioneering SPICE project, a view by focus groups from the fields of I-Portal, e-Tourism and e-Emergency Services”, edited by L. Galli, 2006
- [11] L. Nalaskowski, L. Galli, J. Rovira Simon, *Pioneering SPICE Project. A View by Focus Groups from the Fields of I-Portal and e-Tourism*, WWRF18, 2007
- [12] SPICE project deliverable D8.2 “An in-depth view on SPICE project, using Intelligent Portal, e-Tourism and e-Emergency scenarios”, edited by J. Rovira Simon, 2007
- [13] K. Go, J.M. Carroll, *The Blind Men and the Elephant: Views of Scenario-Based System Design*, Interactions, 2004
- [14] L. Galli, *Scenario methodologies*, MobiLife Oulu Summer School, 2004, available at <http://www.ist-mobilife.org>
- [15] T. Winograd (Ed.), *Bringing design to software*, ACM Press, Ney York, 1996
- [16] J.C. Jones, *Design Methods*, Wiley, London 1970. Third edition: Wiley, 1992.
- [17] J.C. Jones, *Essays in Design*, Chichester, Wiley, 1984.