DESIGN FOR INNOVATION IN ATM

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Abstract

This paper presents the work carried out in the framework of a study performed under the CARE Innovative Action initiative of Eurocontrol [1]. In particular it accounts for the outcomes of the CREA! project (Creative Research Environment for ATM) [2] both in terms of innovative concepts for Air Traffic Management (ATM) and in relation to design approach developed during the project.

Innovation is a topic of great interest in complex safety critical systems like ATM, nevertheless classical design approaches concentrate on problem definition and analysis, articulating solution within the identified problem space. The approach that will be discussed in this paper focuses on problem setting rather then looking for solutions with respect to actual or potential breakdowns.

Introduction

The CREA! Approach [3] is based on the idea that original and innovative outcomes are not accidental but can be generated as the product of a collaborative social process of co-construction of knowledge and meaning negotiation within multidisciplinary teams. The case study in which the approach was applied to Air Traffic Management showed that an innovative design can be produced and discussed with domain experts and lead to satisfactory results in a relatively short time.

The most popular methodologies for creative design in complex system are based on problem solving. Most of the effort is devoted to the problem definition; then a set of techniques is proposed to solve the problem within the boundaries defined by the initial analysis. These methods put emphasis on analysis and problem solving rather than on design. The development of innovative outcomes is regarded as an activity of searching for alternative solutions within the constraints of the problem analysis. For a thorough analysis of the different approaches to creativity see [6].

The design of innovative concepts in complex systems is a challenging area of research. Standards, regulations and the difficulties of envisioning truly futuristic scenarios often constraint creativity and process, and orient towards conservative solutions. Indeed a creative process should not be intended as the simple addition of new information onto the pre-existing information, most of the times based on a redefinition of the reasoning premises themselves [7].

Intersection between art, design and technology was used in the CREA! project to enlarge the conceptual space of the problem and to negotiate the construction of a shared meaning within a multidisciplinary team. The result of such negotiation process is the envisioning of innovative concepts.

In the followings we will go through the main phases of the CREA! project to illustrate the design approach and the outcomes of the process.

The CREA! project was initiated with the creation of a collaborative environment where artists, designers and technologists could work as equal partners in the exploration and development of innovative concepts and media for Air Traffic Management (ATM). We set up a group of artists and designers representative of a range of visual and multi-media arts with a focus upon the following disciplines: music, architecture, visual design and interaction design. Human factors and domain experts completed the range of competences of the project. Each participant brought to the group his/her own expertise both in terms of ideas and theoretical background. The first issue of the project concerned the definition of a design vision. We pointed out three hypotheses of transition from the current ATM scenario to more visionary and futuristic scenarios:

- the *control scenario*: the current situation where air traffic controllers act mainly as air traffic managers.

- the *advisory scenario*: an envisaged future free flight situation where the responsibility of traffic management is mainly moved to the pilot on board and the controllers play an advisory and support role to the pilots.
- the *service scenario*: a completely futuristic scenario where the traffic management is decentralized and totally moved on board. In this scenario the controllers play the role of connecting air services to ground services becoming "service and information brokers".

As integral part of our vision, we decided that our solutions should address the following objectives:

- to support personalization and individual styles of work.
- to guarantee a certain level of transparency of the processes and on the related activities.
- to facilitate the adaptation of the environment to different situations.
- to use multiple channels and reduce the information overload on the visual interfaces.

Our goal was to take into account a wide unit of analysis and offer sustainable solutions for improving the quality of life in the work context through an alternative use of the physical space, the distribution of media in the context of work, the exploitation of sensorial paradigms for interacting with technologies, the definition of media for sharing memories and support the life of the community.

The CREA! project adopted the co-evolutionary process of the CREA!© approach, now copyrighted, where concept design, technology design and activity design were carried out in parallel so that each strand of the process could inform the others. The process was articulated in the two phases of divergence and convergence.

Divergence included inspiration to get insights from the application domain (user and domain understanding); and elaboration to develop concepts from the perspective of single disciplines (music, architecture, interaction design, visual design, human factors). Convergence included a phase of sharing to present and confront concepts elaborated separately (concept testing); and production to evolve single concepts in integrated "concept scenarios" (scenario testing and briefing).

The process allowed sub-processes (user understanding, briefing, concept testing…) to evolve in parallel and to converge by sharing, refining and developing integrated concept scenarios. In the project we implemented such a process through a series of four workshops, organized as a collaborative environment where artists, designers and domain experts worked as equal partners in brainstorming sessions.

The results we obtained adopting this process model were encouraging both in terms of the envisaged solutions that were generally appreciated by air traffic controllers and in terms of the amount and quality of the material we produced in a quite limited amount of time and resources. The solutions are scalable, which allows a future exploitation in different scenarios; and an open and flexible to support further elaboration in different directions. In the following, concept scenarios are described in detail.

The CREA! Tools

The project has developed five main concepts/tools [3, 8], which eventually converged in a set of integrated elements that maintain all features and functionalities of the previous tools but in a more integrated way:

- The Trittico, a multifaceted radar display, to provide both controllers or external observers (e.g. the supervisor) with a view of the process (what is going on in the airspace managed by the control centre - ACC), which represents the main interface for the operational work with a strong emphasis on the radar control activity
- The HardBook is a personal tool that permits both to focus on specific processes, to share information and activities with others and to interact with the Trittico and to manage communication flows.
- A further element, the Cameo, as an extension of the HardBook, creates a digital bridge between the tools permitting the personalization of the system according to the individual preferences and supporting the integration of the system features.
- The Environment, constituted by a number of ambient qualities, includes:
- the Osmosis Skin, defined by spatial, ambient and sensorial qualities of reactive physical spaces as interface to the everyday life working practices and rituals
- an Advanced Audio Environment
- the Flag/lamps, personal/public displays that can be used to extend the action/communication area of the single user and support awareness by visualizing the processes.

Details about the tools can be found in [3].

Thanks to an extensive data collection, the analysis of air traffic control activity lead to the modeling of ATCO's work in three main phases:

- acquisition, the phase in which the controller accesses preliminary information about the traffic in the area of competence (sector-s),
- management, the phase in which the controller manages traffic in a specific area of competence (sector-s),
- debriefing, the phase in which the controller elaborates information related to the previous activity, shares this information with other controllers, uses recording of activities for training purposes.

As mentioned in [3] today design solutions and technological tools exclusively support the management phase, mostly ignoring the other two phases of information acquisition and debriefing. The CREA! system on the other hand were designed to horizontally support the activity intended as a whole.

Figure 1 indicates how the CREA! tools were mapped on identified phases to assess their level of support. Each tool was meant to have a specific focus in supporting these phases, as it will be explained in detail in the followings

- the Cameo creates a continuous horizontal bridge between the different phases
- the HardBook is used in all three phases in stand alone mode (acquisition and debriefing) and in relation with the Trittico (management)
- the Trittico supports principally the air traffic management phase but can be used also indirectly in the acquisition phase and in the debriefing phase in relation to the HardBook
- the Environment support awareness and communication along the three phases.

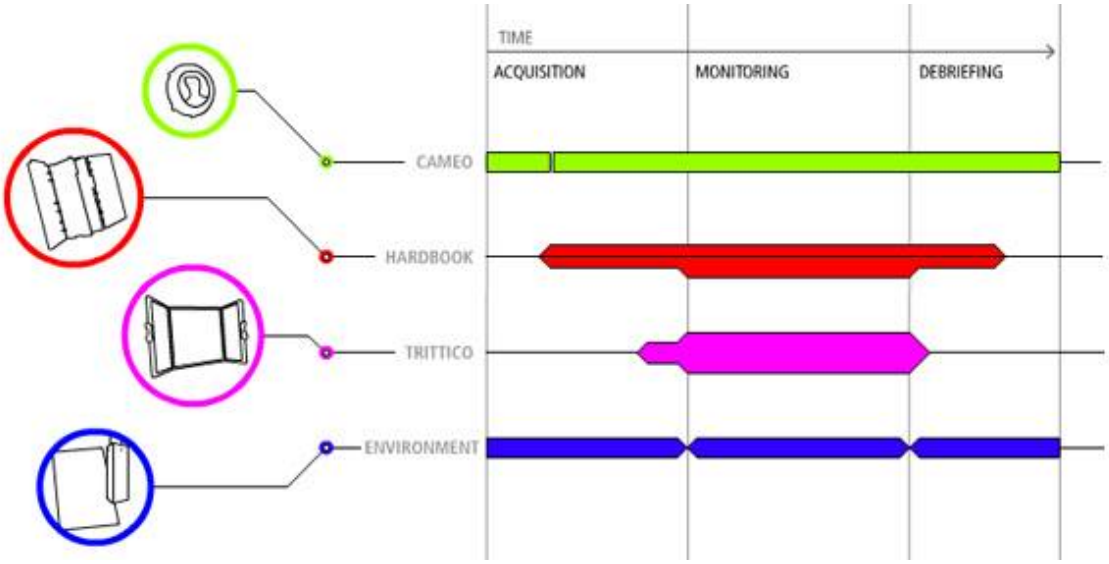

Figure 1 . The CREA! tools mapped on ATC activity

In compliance with the project vision and with the outcomes of the activity modeling phase, the following requirements were identified as key drivers for the development of the interaction functionalities of the system:

Continuity and consistency: To support both working and not working activities creating a tool that can be used for both purposes and that guarantees a continuity and consistency in the typology of the software applications (i.e. agenda, file storage, etc.), as well as in the interaction mechanisms.

Transition and adaptation: To support the transition between different phases of the activity from pre-operational phase of information acquisition, to management, to post-operational phase of debriefing. Features of the tools change according to activity.

Personalization: To guarantee the possibility to assign to the system (and to retrieve) personal setting permitting to update/change the settings during the working activity.

Roles and activity: To highlight the relation between the features provided and supported by the tools and the roles of the different actors defining the level of accessibility to the different procedures and features.

Turn shift and switch of responsibility: To provide mechanisms for ensuring an appropriate switch of responsibility during a turn shift and to avoid tools misuse.

Information display: To organize the visualization of both information and commands of the different interfaces according to clear and simple rules based on a hierarchical structure (view with context); to reduce the visual overload on the radar screen.

Audio/voice control: To integrate the visual interfaces with audio/voice control features; to permit to easily access and organize information related to voice communication by using voice to text feature and by adding vocal annotations on visual representations.

Resource access: To facilitate the access to work-related resources providing an automatic download of the updated information via the HardBook according to the context of use; to permit to access to the resources also in contexts not directly related to the air traffic management, like information acquisition before getting in turn and training post-processing.

Sharing data: To permit to share data in the operational mode by providing different level of accessibility to the same situations (i.e. visibility, active control); to permit the exchange of data in the pre and post-operational modes.

The Value of CREA! Tools

The solutions we elaborated represent innovative concepts that are not strictly related to solve problems but more in general to envision livable, workable, attractive environments and tools that people can easily use to perform their activities. We elaborated visions on future ATM systems adopting a holistic view of the activity without focusing on single tools apart from their context of use. The proposed solutions are oriented to exploit real and perceived affordances of the work environment, to provide visual continuity and realism in information representation, to support the use of different sensorial modality, nowadays largely neglected.

The scenarios we developed depict the experience of the user interacting with tools within a defined space. This experience is not limited to the cognitive aspects of interaction but includes aesthetic, intimate, social and emotional terms as well. This is the reason why the proposed solutions are not strictly "functional" but include aspects of the "quality" of work taking into account beauty, satisfaction, comfort and engagement.

The added value of our solutions is specifically defined around key features of the scenarios:

Openness: In the project, we decided to focus on solutions that can be appropriate in the short and medium term but in principle they could be elaborated also to support more visionary and futurist situations like the "service scenario", where the traffic management would be moved on board and the air traffic controllers would become "service and information brokers".

Transition: The scenarios were inspired by the idea of supporting "transitions". During the three workshops performed in the project, we elaborated solutions to support different kinds of transitions:

- transition among "control", "advisory" and "service" scenarios
- transition between resting and working situations
- transition between macroscopic views of the activity (support to the supervisor) and microscopic dimension (individual and personal settings of the working position)

Mise en scène – Theatre setting: The physical space has been used as a representational space for the activity. Flags reproduce choreography of the ongoing activity and the awareness of the situation.

Multi-sensorial interaction: The proposed tools support a multi-sensorial manipulation: the Trittico can be physically manipulated to personalize the information presentation, sound effects can be used to identify flights on the Trittico; the HardBook allows to physically pass information to colleagues or to other tools (e.g. a procedure of the day like the definition of a prohibited area in a sector, can be integrated with the current traffic situation); the body is an extension of the working position: the Cameo is a personal wearable tool to manipulate information.

Community: Air traffic controllers perform a delicate work. They are responsible for the life of thousand of travelers every day. They need to share solutions and concerns and help each other. In the current operational scenarios, air traffic controllers are considered individuals rather than a community. Currently there are no tools or spaces designed to support the sense of community. The Cameo, the resting space, the flags representing the others' current status of work are an attempt to make visible and support the sense of community of air traffic controllers.

The impact that the CREA! system could have on the Institution that will adopt it was presented to the project stakeholders through a real time demo, mapping Trittico and HardBook functionalities on current air traffic control activities (from acquisition to debriefing) showing how activities would chance because of the new tools.

The setting consisted of a working position composed by three screens simulating the TRITTICO and a graphic WACOM tablet simulating the HARDBOOK. The cardboard mock-up of the Hardbook was also present.

Figure 2. The CREA! demo setting, including both Trittico and HardBook prototypes

The demo prototypes, for what concerns the **Management phase**, supported the following functionality:

Dynamic information update, as in the case of a military unit informing that activities have terminated and a dangerous area is available to civilian traffic. In such a case the system updates the information on radar screen as soon as the ATCO acknowledges the supervisor's message informing that the area is open .

Bookmaking functionality: the CREA! systems allows enhanced personal and shared note taking, to support both user's personal and shared memory. Every object, and/or selection can be stored in a personal bookmark area in order to be retrieved in any moment. Bookmark can be used in the different modes for triggering related information (resources, messages etc.) both on the Trittico and the Hardbook. ***Flag Bookmarks***, for instance are notes that stick to aircraft and follow them (from sector to sector and from shift to shift) until a the responsible controllers deletes them. ***Reminder Bookmarks*** on the other hand are designed to enable the setting of an alarm to remind pending activities.

Figure 3. An ATCO adding a Flag Bookmark to an aircraft to remind her colleague what were his intentions while giving it a heading instructions

Messaging: thanks to the voice to text functionality, ATCOs can easily drag bits of air-ground communication to compose a digital message like a diversion message to be sent the supervisor.

Recording: controllers can in any moment record a sequence of their activity for subsequent post-analysis, debriefing and reporting In case of dangerous situations thanks to the already existing STCA (Short Term Conflict Alert) the ***recording tool*** starts automatically recording the whole event. All the recorded information is stored in the personal HardBook so that it can also be transferred to another Trittico.

During the **Acquisition phase**, the CREA! systems, .and the HardBook in particular, support the incoming controller in giving his colleague relief. The supported functionalities are:

Overview of traffic workload to support the identification of the most suitable moment to give a colleague relief.

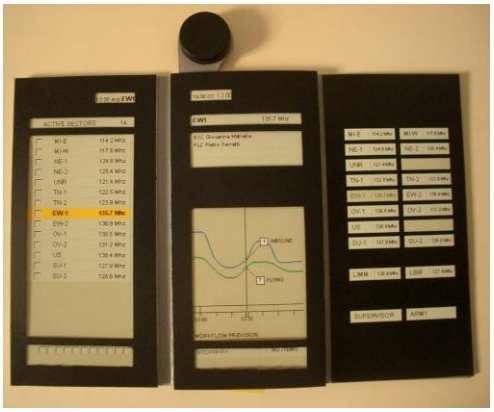

Figure 4. The expected workload in sector EW1 for the next 60 minutes

Download of updated information as new release of LoA , notam, IPI and so on, to receive a detailed brief before getting in turn.

At the moment of ***Turn shift*** CREA! supports the actual duty shift since all relevant information is distributed on the system (shared bookmarks, updated notam, letters of agreement and instructions, active danger areas etc).

The CREA! systems also supports the ***debriefing*** moment when the TRITTICO configuration can change from the operational context to an off-line (non operational) situation and is used to access saved files (particular traffic situations, case-history etc.), to visualize textual information (regulation, manuals…). In such a modality the Trittico has a function of supporting customized training on the job, including simulation activity.

As the reported highlights suggest the main system features are related to:

- the integration among the different elements, HardBook, TRITTICO and Environment
- the management of the settings related to the profiles of the different users
- the data archiving and backup.

The features managed at system level are activated on the basis of four main parameters:

- the identity and role of user according to the activity
- the type of activity (training, traffic management, control room supervision)
- the context of activity (the working position, the proximity to other tools…)
- operational status of the user according to the activity itself, (I am going to get in turn in half an hour, I am assigned to that sector, I am in the ACC , I am in front of the TRITTICO, I am assigned to…)

The combination of these parameters determines the status of the system and the adaptation of the specific features to its main tools.

Principles Defining the Approach

The CREA! system has been developed thanks to a systematic design approach for envisioning, generating, developing and evaluating innovative concepts for complex interactive systems which integrates best practices, partly documented in literature but mostly coming from the long experience of the authors and the design team that supported the CREA! project; a sound theoretical background including activity theory, distributed cognition and cultural psychology, and well consolidated design approach based on user-centered design and participatory design [9].

First of all, the design process is presented as a co-evolutionary process in which user studies, concept generation and technology development/benchmarking are carried out in parallel (divergence phase) and then integrated (the convergence phase) in form of concept scenarios to feed user-centered and participatory design sessions.

Later the divergence and convergence phases are described in detail together with an indication of a pool of techniques that may be used to implement the approach. The presentation of other key aspects of CREA! like team building, flexibility and scalability of the approach, directorship, complete the overview of the approach.

Co-evolutionary approach

The process that underlies the CREA! integrates well-known design approaches, coming respectively from the industrial design and from the information systems design fields, but it also absorbs the principles of theories including activity theory, distributed cognition and cultural psychology.

The industrial design approach has its specificity in the fact that the design and realization phases are continuously fed by a concept generation activity. In this phase, often defined “simulate to stimulate”, the designers develop and visualize scenarios of use, re-conceive the brief of the project, and specify the qualities and the attributes of the service. The concept generation phase allows a constant flow of innovation into the design process, going beyond the mere interpretation of user needs, to stimulate the demand of new functionalities that will transform the way in which the users see and understand their environment.

The participatory approach to system design has been developed in Scandinavia as a means to achieve a close fitting between user needs and habits and the new system to be developed through the direct participation of the users to the various phases of system development. In the last ten years, participatory design has been enriched both because it has been complemented by ethnographic methods of analysis and because it has been provided with a new technology directly oriented to support the practices of the users rather than to automate parts of their work.

Usually the participatory design approach is weak in the concept generation activity, and the industrial design approach underestimates the social observation phase. To overcome this, we have developed the CREA! approach which intertwines cycles in which the User Driven and the Design

Driven development are parallel, intersecting them frequently to compare the results and re-tune the process. Representative users of the application scenarios are constantly involved in the process even if a pure creative phase of concept generation is carried out independently by the design team and within the design team .

Of necessity, such kind of approach usually generates an extraordinary diversity of 'components', technologies and integrated prototypes. All these activities are performed in strict collaboration with end users including stakeholders at different levels. Towards the end of the development, the parallel processes merge and produce one final result that will take advantage of all contribution and manage both innovation and user adaptation.

A similar design process has been proposed by Agostini, De Michelis, Susani, [10], but in the CREA! the co-evolutionary process has been further elaborated to deeply integrate concept generation and participatory design. In particular CREA! depicts strategies for creative design that are based on the activity of a multidisciplinary team that firstly produces high level concepts from the point of view of a single discipline, and then integrates them in concept scenarios through a collaborative activity of meaning negotiation and sharing of values carried out in brainstorming sessions. Furthermore CREA! elaborates a strategy of participatory design and evaluation that evolves concepts scenarios in form of mock-ups and interactive prototypes to support user evaluation and involvement in re-design. The software development starts only once prototypes have been fully accepted by the users.

The primary aim of the evaluation proposed in CREA! is not only to verify, validate, and test the acceptance of a system, but to determine problems and design opportunities. Frequent, small, informal evaluation activities iteratively improve the design. The approach hinges on iterative cycles of evaluation with end-users, from concept generation to functional specifications, from early mock-ups to the testing of interactive prototypes on the field. Evaluation is continuous and as closely and authentically related to use as possible. In order to guarantee such a close relationship, the design and evaluation process are strongly informed by scenarios of use. An important strategy for this is close interdisciplinary collaboration between different perspectives: use, design, technology and work analysis. Concepts, ideas, scenarios, prototypes and evolving work practices are continuously examined in the light of all the perspectives to ensure their quality and appropriateness.

The proposed approach suggests to adopt cheap, fast and easy to use methods that still achieve the goal of designing effective solutions that affect human activity providing added value. Techniques include brainstorming, focus groups, mock-up development, storyboarding, scenarios, walkthroughs and participatory heuristic evaluation. These techniques allow users to enhance their ability to relate to the design team without being afraid of the innovation process (which is usually associated with a loss of control), and ease the creative process however innovative the concepts are.

Rising above current practices requires a connection to them and the value of mock-ups, prototypes and scenarios stems from this view of epistemology.

Divergence and Convergence

The CREA! design approach is based on a co-evolutionary process where concept design, technology design and activity design are carried out in parallel so that each strand of the process can inform and transform the others without constraining them. The process is articulated in two main phases: divergence and convergence.

Divergence is the phase in which the boundaries of a design situation are extended so as to have a large enough, and fruitful enough, search space in which to seek a solution. Therefore objectives are general and tentative, problem boundaries are instable and undefined, evaluation is deferred and nothing is disregarded as long as it seems to be relevant to the problem, the initial brief is treated as a starting point for investigation and is expected to be revised. In this phase the aim of the designers is to deliberately increase their uncertainty, getting rid of preconceived solutions and being inspired by a mass of information that may be relevant.

The divergent phase far from being merely an activity of inspiration is also a sort of testing for stability or instability in everything connected with the problem. It is an attempt to discover what, in the hierarchy of community values, systems, products and component is susceptible to change and what is to be regarded as fixed points of reference. Stable and unstable points are just very high level collective goals and values. They do not constitute boundaries at this stage for the search for solutions. The aim of the designers is to avoid, as far as they can, imposing a premature pattern upon what they discover. They should defer decisions until next stage, by which time they should know enough about the background of the problem to be able to envisage the probable

consequences of organizing data in any selective way.

Convergence is the stage in which the problem (scenarios) has been defined, variables have been identified and objectives agreed. The designers' aim becomes that of reducing progressively the initial uncertainties until one or a few of many possible alternative designs are left as the final solution to be further elaborated.

The main features of convergence are:

- Application of structured and systematic methodologies for evolving high level concepts into concept scenarios. The main objective is to reduce the uncertainty by defining solutions in more and more details.
- The snag in convergence is that unforeseen sub-problems may prove to be critical. These situations should be anticipated by cycles and iterations on the soundness of concepts should be exploited as much as possible.
- The activity models used to represent the alternative solutions should now be sufficiently detailed to sustain the evaluation with end users.

From convergence to the system development, scenarios are used to guide the next stages of the design process, in particular they support in structuring data gathered through activity analysis, envisioning system role and functionalities, and finally to asses and validate envisioned solutions. The scenarios specify in a narrative form the features of the future system in relation to the user activity, interaction paradigms, information contents, technological solutions. Five categories of scenarios are used in the CREA! approach. In particular Activity Scenarios and Envisioning Scenarios support convergence, whilst Mock-up Scenarios, Prototype Evaluation Scenarios and Scenarios of Integration feed user-centered and participatory design and evaluation sessions. Details about the use of scenarios in CREA! can be found in [11].

Team Building

CREA! emphasizes a process of design in which multiple disciplines and seemingly unrelated aspects of design are integrated in a manner that permits synergistic benefits to be realized. The goal is to achieve high performance and multiple benefits at a lower cost than the total for all the components combined. A key of the CREA! approach is the participation of people from different specialties of design: general architecture, music, psychology, graphic design, interaction design, collaborating together to bring multiple points of view into the design process. In CREA! multidisciplinary team building is essential to carry out in particular three activities of the creative design process:

- generation of high level concepts from the perspective of a single discipline,
- concept selection (discussing the rational for reducing the pool of initial concepts) and
- production of envisioning scenarios in which the human activity and the new system are defined.

Flexible Approach

Flexibility is a key characteristic of CREA!. The philosophy of the approach and the associated process model has proven to successfully support the generation of design solutions in different application domains, from complex domains (CREA! project, CARE-Uncertainty project) to everyday life activity and general purpose devices (Master projects in Domus Academy sponsored by Fujitsu, Motorola, Nokia). However, the modalities for implementing the approach can vary according to the characteristics of the domain and the constraints of the project. In what follows we offer a strategy and an overview of techniques to implement the approach adapting to the specificity of the problem domain.

Commonly design methods are reviewed according to three points of view: that of creativity, that of rationality and that of control over the design process [12]. From a creative point of view, the designer is a black box out of which a creative leap comes. From a rational viewpoint, the designer is a glass box inside which a completely understandable rational process can be discerned. From a control view point the designer is a self-organizing system capable of finding short cuts across unknown territory.

The CREA! approach is sensible to all three view points, recognizing at least one component of each in the different phases of the design process. Furthermore, the approach contributes to the definition of a control strategy including both creative ideas and rational decisions.

A significant number of design theorists [13, 14, 15, 16] suggest that the most valuable part of the design process is that which goes on inside the designer's head and partly out of reach of control. In making this point the "creativity" theorists place themselves in opposition to the rationalists of designing. In particular Broadbent [15] identifies "mental rigidity" and desire for certainty as the chief enemy of creative thinking, stating the importance of tolerating ambiguity and conflict for anyone who whishes to produce anything but stereotyped designs.

Even if we find this position reasonable, however, we firmly believe in the importance of sharing and negotiating the creative outcomes within the design team and with the intended users, and the necessity of applying a clear design process which helps to control structure and evolve the creative insights.

Basically the problem of evaluating novel design proposals implies both the search for a suitable design and a control strategy along the design process. If this is achieved, it is possible to replace blind searching of alternatives by an intelligent/opportunistic search that uses both internal criteria (experience, sensibility, individual inspiration) and external criteria (sharing, external representations, negotiation). This process is eased by the adoption of a clear design process model and the means for implementing it.

Conclusions

This paper presents the most important outcomes of CREA! project, i.e. an overview of the system functionality and of the design approach developed to reach the documented results. The CREA! approach integrates best practices, a sound theoretical background including activity theory, distributed cognition and cultural psychology, and a well consolidated design approach based on user-centered design and participatory design. The novelty of the approach relies not simply in the development of new techniques for creative design but in the formulation of a design process that harmonizes creative production with user centered design.

The approach develops a view of design that can be characterized as innovative and stimulating:

Design as a process of devising whole systems including different components (material, cultural, sensorial, organizational, spatial, aesthetical) rather than individual products.

Design as participation, co-construction of knowledge and meaning negotiation. All along the design process ideas are confronted and meanings and values are build, negotiated and shared. Creative activities are social and thinking is not confined to the individual brain/mind, rather the construction of knowledge is embedded in the cultural and historical milieu in which it arises. The approach focuses on the dynamic interdependencies of social and individual processes that leads to co-construction of knowledge, tools and artefacts. Collaborative design partners can build on shared visions, complementarity of knowledge, difference of working habits and motivations. Ideas, tools and processes that emerge from joint activity are appropriated, or internalized, by the individual and become the basis of the individual's subsequent development. Working together productively toward shared goals is a human activity unique and valuable in its contributions to individual and social well-being.

Design as creativity, which is supported by a pool of techniques that can be used during the process.

Design as an educational discipline that unites arts and science and perhaps can go further than either of the two.

Design as value where aesthetics, comfort and well living are never underestimated.

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Keywords

Innovative concepts, ATM, Interaction design, Creative design

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