Towards AI Usability: Problems, Strategies and Practicals

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Abstract
We report part of the design experience gained in X-Media, a system for knowledge management and sharing. Consolidated techniques in interaction design (scenario-based design) were revisited to capture the richness and complexity of intelligent interactive systems. We show their design requires methodologies (faceted scenarios) that support the investigation of intelligent features and usability factors simultaneously.

Keywords
Intelligent Interfaces, HCI methodologies, Interface design, User Centered Design, Low Fidelity Prototyping

ACM Classification Keywords
H.5.2 User Interfaces-Graphical user interfaces (GUI), Prototyping, User-centered design; I.3.6 Methodology and Techniques; General Terms: Design

Background and Main Questions
Recommender technology is a successful fusion of AI and HCI. The reason for Amazon's success, for e.g., is that it is both useful and usable: users clearly find a benefit in using it (usefulness), and Amazon has experimented with interface designs over the years to improve its usability. However, which design process should be followed to achieve such success is not clear:

Timeline	Narration	Rationale	Technology	Questions	Interface
	A new gas turbine has recently entered into service. During a shop visit, an issue was identified. Following that a standard **Issue Resolution** procedure is issued, an **Issue Owner** is nominated.			**Automatic evidence collection after samples are input?**	Fig.1 (Issue resolution case set-up)
Month 0 Set up Teams	An **Issue Investigation Team** is set up to investigate the issue and its potential impact; setup temporary solutions; identify the root cause; propose the (potential) solution and how to validate it. 15 members of this team are recruited; members are included on the bases of their expertise and availability and the group is distributed. One member of this group has also the responsibility to record the progress into the (official) reporting system. The investigation team collaborate/ interact with other teams to different degrees and at different times.	**The investigation team will do the search, the analysis and the synthesis Produces documents for PT/CIT Teams look at each other to understand the problems others are facing and learn from their experience. X-Media should support knowledge sharing across groups.**	Members of the investigation team will be kept informed progress r semantic Everyone receive a email dep their role status of t resolution	**Need for process support? e.g., the investigation team**	

Figure 1. The initial passage of a faceted-scenario. Please note that selected regions (in this and subsequent figures) have been edited for content.

is a user-centred process enough or should new practice be developed to address the specificity of systems able to take autonomous decisions? In the context of X-Media[1], a large multi-site EU project aiming at studying technology for knowledge management, sharing and reuse, we started by applying user-centred design but discovered standard practice needed to be modified to support effective communication between users and AI experts.

Users and Developers Focus-Group Failure

The goal of X-Media is to study, design, implement and evaluate technology for sharing and reuse of knowledge from disparate sources: text (technical reports), images (pictures from workshops), and sensor data (monitoring of phenomena). The context is manufacturing: mechanical (FIAT S.p.A., the Italian car company) and aerospace engineering (Rolls-Royce plc. global provider of power systems and services).

Based on use cases selected by the users' representatives in X-Media, workshops were set up in FIAT and R-R to promote mutual understanding between the many different types of expertise of the 16 X-Media partners. We collected users' requirements with the help of the final users and jointly defined which features the system should provide. We quickly realised that having AI specialists and engineers in the same room does not guarantee communication and mutual understanding. AI experts in knowledge extraction and representation were not able to see how their technology could help users with their problem-solving tasks; users were unable to envisage an intelligent system that extracts knowledge from different sources, integrates this and proposes solutions. The positions of the two groups were too far apart to be easily reconciled.

A mediator was needed, a designer of interactive intelligent systems (IISD) able to envisage how and where intelligent technology could improve users' jobs and present this in simple enough terms for the users to understand. Simultaneously, the creativity of AI technologists had to be stimulated and channelled toward useful applications. It is essential that intelligent techniques provide a true advantage to the user to be perceived as worth having [3]. It is the role of the IISD to combine traditional and intelligent features to support the user's tasks with whichever interaction is most appropriate in the perspective of a usable system.

Usability for AI Technology

To assure control and transparency [2]: i) the user should be able to check and correct mistakes the system may have made (*control*), and ii) the system should show its internal mechanisms to the degree needed to understand its behaviour (*transparency*). X-Media then cannot be a closed system that presents the user with already packaged knowledge, but should:

1. visualise in an easy-to-understand way why one assertion is considered more valid than another;
2. allow the user to track provenance of a piece of evidence (i.e. link to all source documents);
3. allow the user to override the system's decisions;
4. allow the user to contribute their knowledge.

These guidelines do not impact on the user interface alone. Imposing the traceability of the source of a piece of knowledge requires the knowledge base (KB) to keep

[1] http://www.x-media-project.org

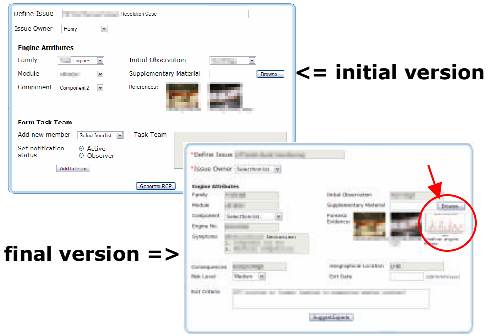
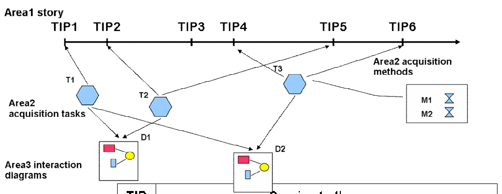


Figure 2: An example of the evolution of one part of the vision demonstrator after the validation of the scenario with users.



TIP	Service to the user
1	**TIP 1: Issue Definition – Team formation/Job organisation** semantic search, semantic e-mail, user profiling
2	**Evidence Collection - Information harvesting** data annotation and classification text mining, semantic and similarity search, pattern detection single-medium IE, knowledge fusion, cross-media KA
3	**Data Analysis/Formulation Of Hypothesis For Root Cause** semantic and similarity search, visualisation, knowledge lenses, categorisation of knowledge, statistical analysis
4	**Hypothesis Verification - Monitoring and expert consulting** data annotation to aid KA, semantic and similarity search X-Media BOX (semantic scratchpad)
5	**Find Root Cause - Data analysis** X-Media BOX, categorisation of knowledge, knowledge lenses, semantic e-mail models for uncertain, dynamic knowledge, setting confidence levels for evidence
6	**Testing Hypotheses** semantic and similarity search, knowledge categorisation

Figure 3. An example of a map of the contribution of intelligent modules (the hexagons) to the overall interaction (top line) and the planned prototypes.

the connection with the original document; the user inspection requires the KB to store data in a human-understandable format. Stating these essential guidelines oriented the design of the system toward a solution that was different from the view, common among AI researchers, that the modelling of the user will build machines cognitively similar to humans [5] with no need to design for usability. Instead in X-Media we focused on the interaction between the human and the system and explicitly designed for usability.

Faceted-Scenarios and Vision Demonstrator

A scenario-based design was adopted. A scenario describes a person with specific characteristics and motivations who performs a specific task by interacting with a specific system [1]. Its narrative is easily understood and it supports discussion within a design team [1]. We revisited this idea to include all the facets of a complex discussion among partners (Fig. 1). The multiple aspects embedded in a *faceted scenario* allow project members to look at the same story from different angles. Users concentrate on the narrative and can check the workflow and tasks are realistic, and contribute their views. IISD instead mainly focus on the rationale to make explicit their design choices. The contribution of AI is discussed and made explicit in the technology column (Fig. 1). The scenario written after a workshop in which RR engineers described their activities reflected the designers' understanding of the users' tasks as contextualised in X-Media.

Low-fidelity prototyping uses paper mock-ups or other forms of simulator that convey the sense of the final interaction [4]. They can be used to illustrate scenarios creating a storyboard. We refined this idea and paired the scenarios with a *vision demonstrator*; an interactive simulator of a working system. It provided a simple but effective tool for communicating the vision of an improved process to end users and the project team. It also supported the validation of the scenario in a participatory design session: IISD met users to discuss features and interaction of X-Media, focusing on cases like that described in the scenario. Discussions of concrete examples (scenarios) generated interaction ideas (compare the two mock-ups in Fig. 2).

The initial layout recorded basic facts for later retrieval. During the meeting we discovered the potential of this straightforward recording for the automatic collection and display of evidence. The new layout (Fig. 2, right) has several new features, including (circled in red) a graph of all the events related to an engine, extracted from the knowledge base and plotted by time. This feature, not foreseen initially, fully conveys the power of an intelligent system able to, on the basis of limited initial data (the number of the engine), retrieve vast amounts of information from heterogeneous sources, and visually summarise it in a graph.

Mediating between User and AI Technologist

New versions of the scenario and vision demonstrator were created, to be discussed with the technical partners, as the new layout could accommodate more intelligent functionalities. The outcome of this step was a number of *Technical Insertion Points* (TIPs) added to the vision demonstrator to provide a deeper description of the technical aspects behind the interface. As signposts, the TIPs highlighted the contribution of intelligent modules to the interaction (Fig. 3).

This final schema was a representation of the user interaction and a plan for technology development. As

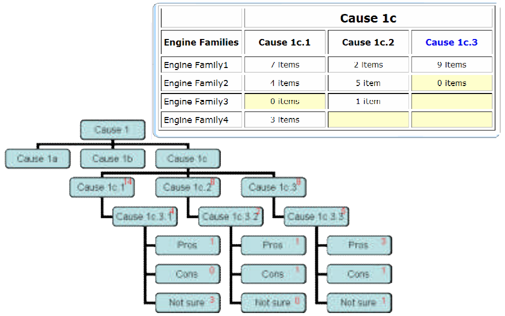


Figure 4: Alternative knowledge views, using (left) a tree, and (top right) a table.

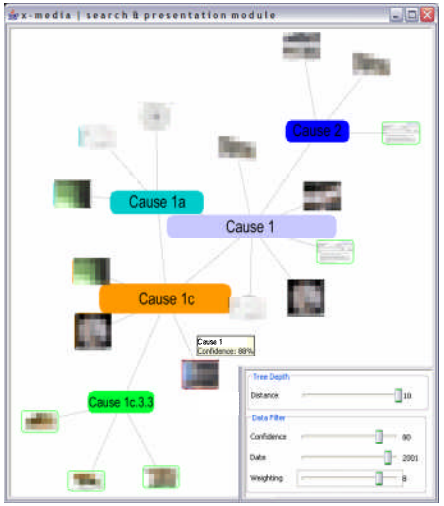


Figure 5. The semantic network shows relationships between assertions in the KB. Node colours map to concepts in the ontology, size maps to the probability the assertion is correct. The graph is built using *prefuse* [http://prefuse.org] and *query sliders* support dynamic searching to focus on sub-sets of data.

such it allowed the different parties to autonomously work on their tasks. The next step for the IISD was to validate the current design with users.

Design Validation

Low-fidelity prototyping allows IISD to explore ideas at low cost. Similarly the vision demonstrator contained alternative views on knowledge presentation; the ones worth pursuing were selected during a collaborative evaluation session with engineers and designers. The complete scenario was also inspected and discussed.

In previous meetings we were shown tables and trees as working tools, we therefore expected them to prefer simpler displays (Fig. 4). Advanced data visualisations were also proposed: a semantic network to explore the relationships between assertions retrieved (Fig. 5); a semantic filter to focus on data sub-sets; and parallel coordinates to provide a temporal or geographical map. To our surprise the more complex visualisations (Fig. 5) were preferred as it was possible to explore and absorb more information at once. Engineers are accustomed to plots and graphs and easily grasped the meaning of the visualisations and the potential manipulation. The semantic network was implemented as it was a close mapping to existing methods for interpreting data relationships. This reinforces the validity of the vision demonstrator as an effective tool for communication.

Design for AI Usability

IISD work to assure the usability of the final system as user interface issues could affect the inner levels. During the system conception they should provide guidelines to assure the foundations for the system usability are in place. In X-Media, to assure control and transparency the architecture was modified to allow inspection of and changes to the KB, and/or to create new knowledge on the basis of spontaneous intuitions.

The main challenge is the need to negotiate between the different positions. Researchers specialised in intelligent algorithms were not accustomed to talking to users and initially failed to see where their technology could be useful. Conversely, users could not always understand and appreciate the advantages of intelligent technology. For a successful communication, IISD acted as mediators between the two opposite positions.

The faceted scenarios and vision demonstrator have been instrumental for effective communication and helped all partners contribute ideas and expertise. This proved how the design of an interactive intelligent system should be a collective learning process where technology is challenged by real world problems and users open their minds to new possibilities.

Acknowledgements

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