The Smart, the Intelligent and the Wise: Roles and Values of Interactive Technologies

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ABSTRACT

Since the early days of computer-based interactive technologies it has been a challenge to make them work or behave according to their user's needs, capabilities and expectations. As an interdisciplinary challenge, researchers from computer science, psychology, engineering, work sciences, human factors, design, and architecture discussed and implemented ideas and theories over many years for interactive systems and media that do somehow what they shall do from their user's point of view. Some of these interactive technologies have been called "smart" or "intelligent". Systems collecting and providing information from social groups have even been attributed as reflecting a kind of "wisdom". Are we able to define and systematically implement interactive technologies as being smart, intelligent and even wise opposed to systems being plain, dull or ignorant? If so, what are the proper domains and system paradigms to apply these technologies? How can their users be enabled to understand, apply and master these technologies by fostering the development of appropriate mental models and skills? How shall the interaction methods been designed to let the users work with these systems in a effective, efficient, engaging and satisfying way. This paper will discuss these questions using examples of interactive systems designed for work, education, entertainment and daily life.

Categories and Subject Descriptors

H.5.2 [**User Interfaces**]: Theory and Methods for User Interface Design and Interaction Styles. Smart Systems. Intelligent Systems. Wisdom of Crowds.

General Terms

Design, Economics, Human Factors.

Keywords

Smart systems, smart media, intelligent systems, intelligent media, wisdom of crowds, interaction paradigms, knowledge representation, mental models, DWIM.

1. INTRODUCTION

The future of human-machine technologies has often been characterized by systems and environments being smart or intelligent. Since the early days of artificial intelligence (AI), especially in the 1970s, there have been visions, concepts and implementations of computer systems that have been denoted as being intelligent [7] [35] [48]. Over two or three decades these approaches have mainly been influenced by cognitive science, or, as a kind of backlash, even defining the field itself. Technologies like knowledge representation languages, knowledge engineering environments, and inference engines made so-called knowledge-based systems and expert systems become available. After a while, the notion of intelligent systems or artificial intelligence has been more or less replaced by terms like smart systems and smart environments without much of a definition or clarification what was meant, what was different to intelligent systems, and how smart systems shall be developed and used. After the general availability of highly connected human intelligence through the internet and its information and communication services, like e-mail, the World Wide Web, search engines and social platforms, notions like Web 2.0 [30] and the "wisdom of crowds" [40] emerged. What can be observed is a frequent up- and down-swing of critical voices and interpretations of machine intelligence related or compared to human intelligence [10] [27] [38] [43]. Today we can study several generations of theories and system concepts that are converging into different human-machine system paradigms that can be defined, distinguished and perhaps even classified according to certain goals, requirements, features and behaviors. These paradigms have to be discussed in respect to mental models, expectations and skills of their human users.

2. SYSTEM PARADIGMS

In this chapter different system paradigms will be discussed independently of their chronological historical emergence. These paradigms can be analyzed from a user's phenomenological as well as from an engineer's technological perspective.

2.1 Smart Systems and Environments

The usage of the term "smart" in the context of future human-machine systems and technologies in general is often accompanied by wishful thinking: technology might do for us just what we expect it to do. A refrigerator shall order the food we like and keep it available, a car shall be able to drive alone or help us to get out of a critical traffic situation, an e-learning platform shall present only what we need to learn [15], and a business application shall decide successfully according to our intentions. This seems to be about the wish that a system should be able to perform like needed as well as it shall be able to know what we intended. *DWIM – "Do what I mean"* – has been an early characterization [42] of systems that are smart. The extended version reads *"Do what I mean, not what I say"* pointing out, that we don't like to cope with complex interaction syntax, but like to express some intension like we do in human communication. Close to this is the "Principle of Least Astonishment" [16]: *"… the program should always respond to the user in the way that astonishes him least."* A similar rule has been called the *"Rule of Least Surprise"* [31] [34]. Smart systems shall obviously be somehow conforming user's expectations however this might be possible and done by technology. Actually we will tend to use the predicate "smart" when a system is able to perform somehow unexpectedly what we actually expect from a "well-behaving" or "ideal" system. Being unexpectedly conforming to expectations may sound weird, but can be easily explained by the frequent disillusions during the use modern technology. Users believe that most of their sound and valid expectations will actually not be met by technology and so they tend to experience a system especially as being smart when it performs unexpectedly as wanted.

In many publications and scenarios the notion "smart" has been used for future systems that will meet our expectations hopefully someday [11]. Smart cars and highways [46], smart cities, buildings and homes [13] [14], smart offices, smart meeting rooms and smart phones are projections of today's expectations into tomorrow's technologies, which may have already been prototyped or even available to some extent. Smart systems and smart environments shall be just doing what we like them to do, and sometimes even a bit more than that. They shall embed human beings into a well performing, comfortable, pleasing and safe environment, or as Mark Weiser put it while discussing ubiquitous computing [45]: *"Most important, ubiquitous computers will help overcome the problem of information overload. There is more information available at our fingertips during a walk in the woods than in any computer system, yet people find a walk among trees relaxing and computers frustrating. Machines that fit the human environment, instead of forcing humans to enter theirs, will make using a computer as refreshing as taking a walk in the woods."*

2.2 Intelligent Systems and Environments

Other than "smart" the notion "intelligent" has been used since the early 1970s in the field of artificial intelligence (AI) to denote computer systems that use well defined knowledge representation and inference methods to act or draw conclusions. These methods have mainly been based on different forms of formal logic and probability theory. Using formal calculus to derive solutions from data can easily run into efficiency problems or may even be undecidable and run forever (halting problem). As it was believed that human beings are able in even difficult domains to come up with an acceptable solution, this led to the insight, that we need weak general methods to control strong problem-specific algorithms to prevent from running into expensive solutions paths or even dead ends.

Herbert Simon coined the term "satisficing" referring to solutions being good enough for a given problem instead of trying to find best solution or an optimum [38]: *"The subject of computational techniques need not be limited to optimization. Traditional engineering design methods make much more use of inequalities – specifications of satisfactory performance – than of maxima and minima."* For hard problems the methods or algorithms shall not run into resource draining states or even into the halting problem. An application system rather shall derive a solution in a timely manner that is just good enough to solve the problem. Such problem solving systems shall be based on formal models controlled by heuristics to search a large solution space [35]. Intelligent systems and environments shall solve problems similar like people do. They shall use rational methods and limited resources to come up with appropriate solutions. Simon [38] and Muth [22] referred to "rational expectations", i.e. model conform expectations of the users within an economic context. So the predictions and the outcomes will fit together appropriately close enough to solve the problem and meet the human expectations.

As a result of formal knowledge representations and inference engines, intelligent systems will be able to explain their solution process and derivation paths [9] [41]. If the calculus or algorithm is close enough to human mental models, the explanation will be semantically rich other than just an algorithmic trace. More than that, the system will be able provide an explanation or even a justification for the results that have been derived, which will be understandable and cause insight for the human user.

2.3 Wise Systems and Environments

Even when AI researchers often used the term "knowledge" for their systems and their representations, only a few dared to use the term "wisdom". Wisdom seemed to be reserved to human beings embedded within some social and cultural context.

The term "wisdom of crowds" has been used by James Surowiecki [40] referring to the usage of information services like the Web 2.0 [30] social platforms. Information constructed by many, i.e. by diverse opinions, independent and distributed members, and proper methods of aggregation, will outperform the information constructed by any of them. Information collected, averaged, prioritized and transformed into an information construct by such a crowd will in the end be more than the sum of its parts. The social collective will derive information and decisions of value and meaning no single human being would be able to come up with. A crowd of people connected by an information platform and supported by some appropriate processing algorithms shall be able to deliver answers to questions no single being can give.

The different forms, how und under which circumstances the wisdom of crowds phenomenon can be achieved by a social platform, have been discussed. The Wikipedia co-constructive approach [21] has been compared with linguistic semantic proximity methods [50]. Different methods will show different performance, but the basic principles seem to hold.

Information transforms into social memories shared and accepted by many people living within a common subculture. The social platform containing raw, preprocessed or constructed information is something like a "collective mind" or "connected intelligence" according to Derrick de Kerckhove [18] and even a source for human wisdom. It is not the system itself that is generally denoted as being intelligent or wise, but the proper processing and linking of information provided by the individuals of a social group as well as the aggregation, transformation, selection and presentation of the information. Thomas S. Elliot [12] expressed the challenge more poetically: *"Where is the wisdom we have lost in knowledge? Where is the knowledge we have lost in information?"* and Derrick de Kerckhove added [17]: *"… where is the information we've lost in data?"*

2.4 Summary about System Paradigms

Smart, intelligent and wise systems and environments seem to be three very basic human-centered paradigms for interactive systems. They have different properties and qualities that make them useful in different applications contexts and for different users as shown in Table 1. Smart systems do what users like them to do. Intelligent systems derive rational solutions based on formal methods and are able to explain their outcomes. Wise systems create reflections on the knowledge of many people and are able to aggregate information to some higher level. All of these systems can be viewed as not being smart, intelligent or wise themselves; they just reflect these properties of their human users.

Table 1. Paradigms for Interactive Systems and Environments

Paradigm	Smart	Intelligent	Wise
Characterizations	behavioral models	semantic models	social and cultural models
	expectation-conform black boxes	logic reasoning	social and linguistic computing
	do what I mean	satisficing heuristics	communication, co-construction and aggregation
	wishful thinking	rational expectations	wisdom of crowds

3. MENTAL MODELS

The effective and efficient usage of interactive application systems and media will always be based on certain mental models and skills, which reflect the application domain as well as the systems and media themselves. In the following discussions a mental model will be defined as a knowledge representation inside a human being [5] [19]. Human skills are abilities that can be applied to specific stimuli in certain contexts to act in a specific way more or less unreflected. The better the mental models and skills fit to the application domain and the application systems or media, the better they might be used to perform tasks or solve problems. How can typical mental models that deal with systems and media based on the three paradigms of smart, intelligent or wise systems be characterized and developed?

3.1 Mental Models for Smart Systems

If a smart system is performing well and close to user's expectations in a given situation, it will be somehow isomorphic to the user's mental model of the application domain as far as the user is knowledgeable about it. The more users know about the inner construction and functionality of an application system, the less they will call it smart. Smartness is an answer to wishful thinking, even unarticulated expectations, especially those, the users wish, but actually do not expect to be met. Smart systems are doing magic [3], like stated in Arthur C. Clarke's third law [8]: *"Any sufficiently advanced technology is indistinguishable from magic"*, or as Leigh Brackett let one of her characters say [4]: *"Witchcraft to the ignorant, ... Simple science to the learned."*

Nobody cares about a system doing just the right thing however this can be performed. Smart systems are more perceived in a phenomenological than in a functional way. Mental models for smart systems and environments are models about the application domains and the environments themselves. So they are mainly problem-based behavioral models without a deep conceptual or technical substrate. In some cases they are even superstitious.

A user will experience and enjoy a smart system as being a piece of technology that just does, what it needs to do without caring about technology. Smart cars just drive us well and keep us safe [46]. Smart houses perform nicely and know what we like and need [13] [14]. Smart phones provide connections and media channels to the people we like to communicate to without having to take care about numbers, networks or rates. As a result, the problem to build a smart system is more a challenge to find out and understand what people like and need and less a problem about engineering and technology.

Smart systems can typically be viewed as physical cultural tools in the sense of Vygotsky [6]. As successors of hammers and other physical tools they enable people to achieve things in the world. Like smart houses and cars are, in a very general sense, becoming tools that are going to be passed over generations, while being improved and enriched in form and behaviour through a long-term cultural development and adaptation. It is not their inner mechanism which is important, but rather what can be achieved by them in a social and cultural context.

3.2 Mental Models for Intelligent Systems

In contrast to a smart system, the algorithms of an intelligent system follow the lines of reasoning a knowledgeable person would expect. Humans who are experts in certain areas know how problems can be solved and what kind of information is needed for a solution. They have criteria and methods to evaluate the quality of the results. Opposed to a best solution, an intelligent system will use weak general heuristics as well as strong problem specific methods for the search and will prove that the solution is satisficing for the problem at hand. To be sure that the solution derived by the intelligent system is valid and proper, the user might ask for explanations and justifications about how the solution has been derived or chosen.

It is a challenge for the implementation of intelligent systems to choose knowledge representations and inference methods that come close the representations, general heuristics and specific problem solving methods in the users' mental models. Much work has been done in the areas of artificial intelligence [2] [7] [35] [48], cognitive science [39], cognitive engineering [26] [33] [49], and cognitive design [47] to meet this goal.

However, the price to implement a system as an intelligent system may be high in contrast to its utility. Many real world problems can be solved sufficiently with a simple algorithm without much of a semantic knowledge representation layer. These systems will not be able to explain what they do, they are just "known" by their users to be usable, i.e. that they usually come up with a sufficient solution. This utility-cost relationship, i.e. the economics for system development is one reason why we won't find many knowledge-based systems in use today. Another problem is the performance of intelligent systems. They are often much too slow and resource consuming to solve the problems as needed under real conditions. Users will not accept waiting long for a result, just for the benefit, that they might get an explanation they actually won't ask for. A third problem that has been experienced with intelligent systems is the high effort to maintain the knowledge bases and the inference engines. We need specialized knowledge engineers with a deep understanding of the problem domain as well as the mental models of the users; otherwise the system developed will not follow rational expectations.

Opposed to smart systems being physical tools, intelligent systems have more the nature of psychological tools ("tools of the mind") referring to Vygotsky [6]. They provide intrapsychological functions helping to self-reflect the mental models as well as interpsychological functions enabling users to justify the decisions by the help of system explanations.

3.3 Mental Models for Wise Systems

When people are using social platforms like Web 2.0 systems [30] to solve problems, they will mainly use natural language patterns and search engines to find information. The information fragments found will only in rare cases be the solution itself, but they can be building blocks, ratings, links, opinions, experiences, and the like. Therefore a social system used as an application system needs human linguistic, social and cultural procedures and heuristics to process the questions to select and to construct answers out of the stored utterances and co-constructions of the social crowd. The mental model needed to use a social platform will be a socially trained, culture-sensitive and critical mind to formulate a question well and read, rate, aggregate, adapt, and integrate the findings into a solution or answer construct.

The successful construction and provision of social platforms to enable people to use them effectively and efficiently needs mechanisms to decode human communication by a semantic analysis, extract relevant information, keep the context information, standardize the information and construct the answer to create solutions that look like human articulations. To be able to do this in a successful way, linguistic, social, and cultural forms of analysis and construction will be needed.

A basic framework for wise systems might be derived from the early findings in semiotics, where the relationships between signs, objects and cultural interpretations have been analyzed. The semiosis, i.e. the construction, binding and loading of cultural signs to objects, activities, or meanings as a foundation for the coding and decoding processes in human communication is a basic construct for collective intelligence. Computational semiotics tries to discuss and understand semiotic processes between human users and computer technology [1] [23].

In respect to wise systems, Vygotsky can be referenced one more time with his third main concept called the "zone of proximal development". The most common understanding of this concept is that an individual in communication and collaboration with other individuals will be able to solve problems on a more advanced level than acting alone [6].

3.4 Summary about Mental Models

To summarize about the mental models that match the three different system paradigms of smart, intelligent and wise system we might concentrate on the contents of the mental models that need to be available in a human user to use the systems in a successful way. Some basic differences between the mental models that can be associated with the paradigms can be found in Table 2.

Table 2. Mental Models for Interactive Systems and Environments

Paradigm	Smart	Intelligent	Wise
Mental Models	shallow application domain	deep application domain	generally accepted articulations about the application domain
	syntactic knowledge and rules	semantic knowledge and reasoning	pragmatic and cultural knowledge and language

4. INTERACTION

After discussing the three paradigms of smart, intelligent and wise systems as well as their reflections in their users' mental models, it shall be discussed, how users might interact with these systems.

4.1 Interacting with Smart Systems

According to their characteristics, interacting with smart systems should be simple, self-explaining, intuitive or even natural. Except self-explaining, which has been defined in the ISO 9241-110 standard, these criteria rather reflect the wishful thinking position of users than any formal approach. However, it makes clear that smartness can only be reached by interaction principles that do not expect to educate or train users in a special way before they are able to interact with the systems. Especially when it comes to invisible computer systems [28], interactions will not be performed explicitly or even consciously between humans and the embedded and hidden computer applications.

The challenge for the interaction methods chosen and implemented in smart systems is to make sure, that the systems will be able to process the proper signals taken from the users and their environments to control the applications. Smart interaction will sometimes not be perceived as interaction at all, since the system just behaves well. Other situations will make it necessary, that users have to interact with the systems explicitly. In these cases the interactions methods and their syntax have to be chosen well, based on the capabilities, behaviors and expectations of the users. There will be a need for cognitive modeling of the user's goals and behaviors to get a sound foundation for the design of these systems. Most of the work done in cognitive science and cognitive engineering has been drawn from well defined work situations [23] [33]. In work domains a task analysis based on organizational analysis can be done properly and straightforward. Analyzing and designing interactions for non-experts in open application domains seems to be at least difficult, since there are no clear references and structures for tasks and contexts.

Industry is often using the smart system approach for complex consumer products like houses [13] [14], cars [46], or phones when users like to have high comfort and low perceived complexity. The systems shall be intuitive and natural. However, in many cases users just adapt to the consumer products believing after a while that they are intuitive, natural or easy to use. Research is ongoing, to define, how intuitive user interfaces can be defined and developed [24] [25].

4.2 Interacting with Intelligent Systems

In contrast to interacting with smart systems, intelligent systems will be approached like assisting, counseling or problem solving collaborators. The users expect the systems being knowledgeable similar to human experts. As a result they will try to communicate with these systems in terms of the application domain. They think that they can feed information or questions into these systems and receive solutions or answers or trigger actions through these systems. Intelligent systems will always be present for their users. They might disappear physically in an environment, but the users will always bear in mind that they are there, perhaps just behind the walls and panels. Other than smart systems, intelligent systems will therefore be approached more or less explicitly, even in cases when they are invisible.

Many intelligent systems in this sense have been build in the form of expert systems, where the user can feed data into, start the inference process and receive results in appropriate time and format. Some systems take data and provide decision support information. They deliver rated options and explain how the results and their ratings have been calculated or derived, i.e. how valid or certain they are. If the users withdraw some of their a-priori data, the intelligent system will backtrack and come up with different solutions like in non-monotonic reasoning [7]. Human and machine build a dynamic system feeding information into each others problem solving processes.

Intelligent systems are generally not very robust. Their problem solving capabilities often break as soon as certain strict conditions cannot be met. Even problem solving systems using weak heuristics will often come to their limits. Trained users will usually accept this steep slope of degradation, since this the case in certain forms of human intelligence as well. There is no expectation that intelligent systems will be working through some magical mechanism like smart systems. So the foundation for human-computer interaction for intelligent systems is, first of all, rationality. The user interface for an intelligent system will reflect this: clear input and output structure, processing indicators, information coding that supports evaluation, as well as justified results, which are rated by probability- or certainty-factors or can be explained by a logic deduction.

4.3 Interacting with Wise Systems

The interaction with systems like Web 2.0 social platforms and applications means interacting with human information and communication repositories. Rich media consisting of written text, photographic images, and drawings, as well as audio and video clips will be the material processed or delivered by these systems. Interacting with these materials means users will be editing, annotating, linking, rating, adding and connecting media units. The social system will process and integrate the changes, relate it to other information chunks in the social repository and will reflect the assimilation by presenting the material in an integrated form, showing new conglomerates, relations and priorities. The users might recognize their own contributions in some cases, in other cases they will have no indication how they will affect the whole aggregation of information by their own contributions. In some cases the information will be attributed to their authors, in other cases the information will just be assimilated and socialized without any trace of the contributors or initial owners.

Users will use social platform as long they can get some benefit. The benefit needs not necessarily be solutions for their problems or answers for their questions. Users will still contribute as long as they can see that their own contributions will be used by others through the social network. Being a contributor who has been positively rated by other users will be considered as an honor and privilege. Mark Surman and Darren Werschler-Henry summarize this like follows [18]: *"In Commonspace 15 minutes of fame is better reward than money."*

Social platforms use social criteria to evaluate their success and functionality. Good platforms and good user interfaces are those that are used by many. Bad platforms are those who are avoided or criticized by a majority of users. Good users are those whose contributions have been used, rated, or referenced by others. For example, Wikipedia has been accepted by many, even when the personal contribution cannot be identified by others as such. The Flickr social image database shows and rates personal contributions by comments, references and access rates. Blogs or micro-blogs like Twitter are ranked by readers and followers.

The user interface for a social platform has to be a reflection of the crowd using it. It has to reflect how many, how often, how successful or how accepted information has been contributed and used. The platforms have to show that they are living, growing and have to give the participating individuals, i.e. their members, the impression that they are a part of it. Therefore the basic user interface pattern for social platforms will be a kind of mosaic of contributions, annotations, ratings and utterances of members. As a result the interface is a mosaic-like reflection of these members or users themselves.

4.4 Summary about Interactions

Interacting with systems of the three paradigms smart, intelligent and wise will be different. The paradigms meet the requirements and capabilities of different target groups and different applications. Some basic characteristics can be found in Table 3.

Table 3. Interaction Methods for Different Paradigms

Paradigm	Smart	Intelligent	Wise
Interaction Methods	mainly implicit data input and behavioral output	mainly explicit information input and information output	implicit or explicit rich media input and ordered mosaics of media output

5. ROLES AND VALUES

The paper started with three basic approaches and paradigms to make computer systems and interactive media fit better to human requirements, mental and physical capabilities and expectations. Each of the paradigms has its advantages, weaknesses, technical challenges and even flaws in their definitions and foundations. A question might be, whether there is a system as well as a mental architecture that would enable us to mix these three approaches according to the needs of users and the capabilities of technologies. Therefore a basic question remains: What are the main indicators to decide whether a system or medium should be implemented as a smart, an intelligent or a wise, resp. social system? The following outline shall help to answer this question.

5.1 Roles and Values of Smart Systems

Smart systems are what the general consumer likes to have: systems that just do what they are expected to do. Most users will never ask why a system succeeded in doing what he or she needs and expects. Smart systems may be shallow, even dumb from a computational or representational point of view. The only challenge is, whether we find a way to make users believe and feel that they get what they want and need. Sometimes they will have to adjust their expectations to make it possible.

Smart systems don't need to be rational or explanatory; they just have to deliver an outcome that is consistent to some perhaps even subconscious expectation. Nobody will ask why the lights in a house are switched on where they are needed and nobody will ask how a car saved a life by controlling the brakes in a certain way. They just do it. No learner will ask why a learning system presents new content instead of the one that has already been learnt successfully; nobody will ask why a refrigerator contains the food that is wanted right now; but everybody will ask why a system does the opposite and fails.

Smart systems are needed where nobody likes to care about data, functions, situations and user interfaces. So they are especially useful for everyday life of any kind of user. These users are not even interested whether a function has been performed by a computer or any other type of machine.

Smart systems are hidden and silent performers. They do daily magic. The better they perform and the better they are hidden the less anybody will care or talk about them.

5.2 Roles and Values of Intelligent Systems

Intelligent systems are something the knowledge worker needs, to do his or her work. Therefore such systems need to be effective, efficient, satisficing and rational. They solve difficult problems or support users doing it by themselves. Being intelligent means being capable of finding satisficing solutions according to rational expectations and needs.

Knowledge workers might ask, why the system "thinks" that the solution is appropriate and correct. The system has to be capable to answer this question in terms of the user's mental model in respect to the problem definition, the application domain as well as the derivation processes that it went through.

Intelligent systems are needed in complex application domains where users reflect about information, functions, strategies or options. They are useful in complex work domains where the human attention, reasoning, memory or speed is not sufficient or available to solve the tasks. Intelligent systems might do their processing automatically or under human supervision. Supervisory control systems are a typical human-machine paradigm, where intelligent systems find their place in a flexible form of human-machine division of labor [32] [36] [37].

Intelligent systems are mind tools or assistants. They take input, apply complex chains of logic or calculations and deliver solutions. Users try to understand, follow and improve them.

5.3 Roles and Values of Wise Systems

Who needs wise or social systems? We need these systems as extensions as well as partial replacements for human communication. Social platforms are repositories for human articulations processed in a shallow way to search, compile, classify, rate, and present the information in an appropriate linguistic or other natural communication form. The systems reflect more or less what people have provided, but aggregate this information to some higher level. Only a shallow form of knowledge representation like classification ontologies, thesauri and other linguistic structures and tools are needed to deliver the open answers to open questions. There is no way and no need for explanations.

Social systems are needed by potentially everybody to deal with questions or curiosities in everyday lives. They are synthesized utterances crystallized from a murmuring global communication network. The more articulations of individuals have been assimilated, the wiser the answer might be apprehended.

Social systems are turntables, aggregators and filters for large bodies of information that have been coded in human language, rich media and cultural signs. They are needed where cloudy questions and needs meet only partially decoded information to produce answers that will be more references to other answers than rational derivations. Whether this will be called wisdom is just a matter of culture and social values.

6. CONCLUSIONS

In the paper three paradigms for interactive systems and media have been discussed: smart, intelligent and wise systems. All the three paradigms are reflections of human perceptions, consciousness, knowledge, values, activities and communication.

- Smart systems meet to some extent unexpectedly the expectations of their users when they provide comfort or do some daily magic; they sense and act.
- Intelligent systems solve problems in a rational way like humans do and are able to reflect and explain their threads of inference; they solve and justify.
- Wise systems reflect human knowledge and wisdom by accessing and aggregating human articulations and behaviour of social groups in cultural or subcultural contexts; they classify, combine and reflect.

These three system types can be seen as very fundamental paradigms for interactive systems, since they reflect human emotions, behavior, rationality, and expectations. System developers might be thinking about these paradigms before they start to develop any interactive system. It could improve the chances to better interface to people, their contexts, and their cultures.

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