# Agents with Character: Evaluation of Empathic Agents in Digital Dossiers

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## Abstract

*We propose a theory of user engagement with empathic agents (Interactive PEFiC) that features a fundamental involvement-distance trade-off to explain the mixed emotions users may experience while interacting with anthropomorphic software. For the experimental evaluation of our theory, we designed an environment for agent applications in the cultural heritage domain. In this context, we will introduce the notion of digital dossiers, which contain information about contemporary works of art, including video-recorded interviews with the artist. In this area of application, we intend to investigate the efficiency and effectiveness of guidance offered by empathic agents, the characteristics of which may be varied across the parameters distinguished by the PEFiC-model. For the technical realization, we will use the DLP/STEP platform, which supports agent applications in rich-media 3D environments.*

**Categories and Subject Descriptors:**
**General Terms**: Design, Human Factors, Theory
**Keywords**: Empathic agents, virtual environments, rich media, user involvement, digital dossiers

## 1. Introduction

Agents may be regarded as a merger of technology resulting from research in artificial intelligence (agent technology) and computer graphics (humanoid animation). Making agents empathic typically stems from human-computer interaction. A well-known example is the Ananova virtual newscaster, which presents the latest news in so-called video reports that are created using 'a unique combination of computer animation, text-to-speech and real-time information systems.' Other applications of empathic agents include the Signing Avatar, (a system that allows for translating arbitrary text in sign language for the deaf), talking heads in a variety of e-commerce applications, and the agent-bots in virtual environments, such as Active Worlds, blaxxun Community, and Adobe Atmosphere. Clearly, there is such a great diversity of systems in which empathic agents play a role, for which it is not always easy to establish how essential the agent's contribution is, that it is hard to find the common denominator of this type of applications.

In this paper, we will attempt to establish a connection between on the one hand a theory of user engagement with empathic agents as the common denominator (Section 2) and on the other hand, the notion of digital dossiers (Section 3) as the area of application and experimentation (Section 4). We will prompt some ideas regarding agent representations in Section 5, briefly describe our software platform in Section 6, and conclude with certain problems, such as contamination of effects between agents and application domain (Section 7).

## 2. User engagement with empathic agents

Agents may be designed to perform autonomously, classical information processing tasks, such as searching for and

retrieving information, filtering and classifying information, conversion of formats, and information storage. Compared to traditional ways of interaction (command line, dialog boxes), agents supposedly improve user involvement with the computer system [13] and would help reaching user goals, such as handling information (e.g., filtering and forwarding e-mail, doing information searches), buy goods (e.g., autonomous negotiator agents), or seeking entertainment (e.g., Alexbot playing the IRC Jeopardy game).

The use of agents in human-computer interaction engages the user in a two-way 'face-to-face' dialogue where the agent supposedly provides task-relevant information and meaningful feedback. An anthropomorphic agent is typically presented to the user as a mediated figure, embodied conversational agent, or animation agent to guide the users to the information sought for, the goods they want to buy, etc. It is believed that employing humanoid communicators reduces reluctance and increases involvement and credibility to use the services offered (e.g., buy, sell, inform, distribute work, etc.). Yet, although reluctance may be decreased, the question remains whether the application of agents facilitates task performance (e.g., increasing efficiency and effectiveness) or merely serves as a nice diversion?

Dehn and Van Mulken [3] provide an overview of empirical work in the area and found that an animated agent does not necessarily improve a user's comprehension or recall of information. The added value has more to do with motivational aspects. For instance, learners may be willing to spend more time with the learning application when an agent is present, or may feel less anxious in a comprehension test conducted by a synthetic tutor. Whatever the effect of an agent may be, the central issue is that the goals of the user are satisfied by the agent and that the work process towards those goals is facilitated. That is, the agent should be relevant to the task at hand (be it information or entertainment, communication, or composition) and should support rather than impede the work process (raising positive instead of negative outcome expectancies) (cf. [8], p. 494, p. 463, p. 455). Commercial systems such as Microsoft's Bob and Clippit, kiosks such as the Postal Buddy and the anthropomorphic bank teller machines, or the Ananova news reader have failed because they either gave irrelevant information or slowed down computer processing and therefore, transaction time. Agents that distract one's attention from information processing tasks invariably invoke irritation and negative feelings [1, 24]. More extremely, many IRC channels do not allow software robots or 'bots' because it is hard telling a good bot from a bad bot (e.g., as programmed by a hacker [20].

These findings are consistent with research results regarding media effects on information processing and attitude formation. Although information processing may be impeded by realistic, anthropomorphic visuals, the process of attitude formation may be stimulated (cf. [16]). Human-like creatures evoke stronger emotions than bare texts or icons. Quite predictably attitudes tend to become negative in the case of anthropomorphic agents that distract one's attention from information processing tasks. Serious information processing is but one task of computer users, however. Information on the Web that is usually skipped by users (e.g., advertisements) may get peripheral attention due to anthropomorphic agents [2]. The agent's vividness may enhance perceived presence, which plays a pivotal role in generating more favorable attitudes toward the advertisement in the Web site and stronger intention to revisit the Web site [ibid]. Web agents that help a user to navigate through a new program are deemed less irritating than Web agents that give unsolicited opinions on traditional tasks, suggesting that task variation is much more important than anthropomorphic design variation [1]. Although task variation indeed is important to design choices, design choices presumably have an independent effect on user evaluations. In health care communication, for example, interaction with patients is much more important than medical information to influence patients. Carefully designed anthropomorphic agents may add to the repertoire of interactive health care communication [25].

The present research wishes to contribute to design theory for (multi-) agent systems by investigating the end-user experience of mediated figures and agents as realistic personalities so as to optimize task performance, to persuade, and to entertain. The present generation of digital guides and assistants, however, is often rejected as task-irrelevant, unreliable, or plainly irritating [24].

An integrative account of human experience with fictional characters, such as empathic agents, is provided by Hoorn and Konijn [10]. and empirically supported by [15]. The model of Perceiving and Experiencing Fictional Characters (PEFiC) (Figure 1) originates from the study of literature, film, and theater, linking up with theories of emotion psychology, person perception, and interpersonal communication.

PEFiC regards empathy as a psychological state of being concerned with another person, as a witness or a bystander. The somewhat looser conception of empathy used in the agent community is called involvement in PEFiC. Within the PEFiC-framework, involvement encompasses more than empathy alone. Involvement is regarded a process that combines several approach tendencies, among which empathy plays an important role but also challenge, admiration, and sympathy. From the perspective of human-agent interaction, involvement may be a more fruitful notion because the user experience may be far richer than 'being concerned' with an embodied computer application. PEFiC explains which factors are important in establishing involvement (involvement

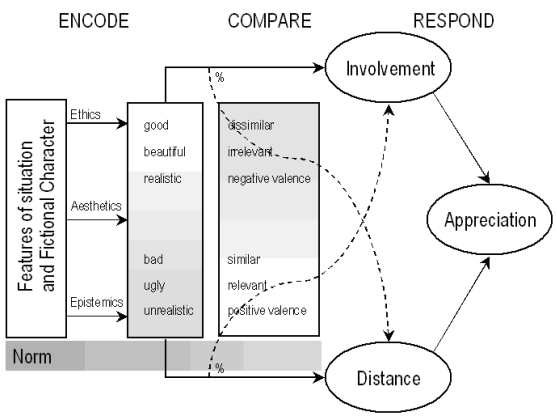


**Figure 1. Model of perceiving and experiencing fictional characters, including empathic agents. Features that are relevant to the goals and concerns of the user evoke emotions. Distinctive features that are appraised positively and intersecting features that are appraised negatively can increase both involvement and distance (see %-sign). If bad features are appraised positively, an approach tendency may occur, whereas a negative appraisal of good features may cause an avoidance tendency. A second PEFiC process is started relatively independently if the norms of the individual are contrasted with the norms of significant peers ('What do the others think of it?').**

that might but does not have to come in the form of empathy). Moreover, PEFiC emphasizes the role of distance, the counterpart of involvement, as a contributor to the user experience of agents. The fact that many Office Assistants are hidden by the user each time they appear may indicate that avoidance tendencies are active as well.

Applied to interactive environments [26], PEFiC predicts that liking of the agent or perhaps user satisfaction (factor *Appreciation*, cf. like/dislike and please/displease in [17] is fed by the simultaneously active processes of *Involvement* (e.g., empathy, sympathy, challenge) and *Distance* (e.g., antipathy, irritation, boredom) (Figure 1). There are six factors that determine the level of involvement (e.g., in the form of empathy) and distance (e.g., in the form of irritation). If an agent is designed to help and support the user, the user will - perhaps unconsciously - assess the agent as a 'good' force in the environment. If an agent or other application is designed to spy on users, to damage system files (e.g., a hacker's bot), or unintentionally causes computer crashes, it will be assessed as a 'bad' force (cf. approve/disapprove in [17]). Quite like characters on the silver screen, then, PEFiC assumes that agents are judged for their Ethics (good vs. bad). The *Aesthetics* of an agent has to do with its appeal in terms of look and feel. A beautifully shapen and fluently moving figure will be judged as more attractive than an agent with ugly graphics and clumsy gestures. Related to this issue is the level of realism a user attaches to the agent (factor *Epistemics*). It will make a difference if, for example, medical information is communicated by a realistic video doctor or by an unrealistic cartoon. The popularity of avatars seems to warrant the assumption that users like to converse with a digital lookalike (factor *Similarity*), which may have a positive impact on user involvement. Agents that are more similar to the user (e.g., in looks and behavior) may be more involving than dissimilar agents. The core of user involvement and distance, however, will probably lie in the combination of (task-) relevance and valence. *Relevance* (after [8, 17]) is the assessed importance of the agent with regard to user goals (e.g., seeking instruction and/or entertainment). *Valence* (after [8, 17]) is the expectancy of a positive outcome or a negative outcome of using the agent (e.g., 'If I use the agent I will have fun' vs. 'If I use the agent I will waste a lot of time'). The factor *Norm* pertains to the judgments of significant peers. If a user likes a Windows agent but this is not done in a UNIX community s/he is a member of, the appraisal of the agent will be affected by the peer group norms [11]. PEFiC predicts that the positive tendencies will load on involvement and the negative on distance but that maximum involvement is not necessarily the most desirable state. A tele-operating surgeon may be supported by a virtual tutor but s/he should focus on the patient and not so much on the agent. A certain amount of distance, then, is equally important to establish involvement that is not too compelling, thus evoking the highest level of appreciation or user satisfaction.

The 6 factors that the PEFiC-model discerns (Ethics, Aesthetics, Epistemics, Similarity, Relevance, and Valence) have 2 levels each, which establish the involvement-distance trade-off. For a full-fledged evaluation of the PEFiC-model as applied to agents, $2^6 = 64$ characters or agent types need to be developed. These (subsets of) 64 agent types are evaluated in terms of involvement, distance, and appreciation by users of, for example, instruction or entertainment applications. Because the 64 agent types reflect the systematic combination of the factor levels within PEFiC, this factor matrix provides the user with a database of agent types from which s/he can choose the right type of agent to the right mood or goal s/he has. This may be quite important, for example, to increase the fun factor of an application or to be addressed in an appropriate way (e.g., experts do not want to converse with a cartoon paperclip and cyberpunks do not want a smooth Mister good guy drooling over their Web sites).

In the future, the user should be able to smoothly navigate through a 'MetaMorph box' of agent types to adapt the agent to his or her personal taste and needs, making the agent, for instance, more similar to the self, less ugly, and just a little bit bad.

## 3. PEFiC in digital dossiers

As a suitable domain to create evaluation scenarios for the MetaMorph box so to test the predictions of the PEFiC-model, we next want to introduce the concept of 'digital dossiers'.

Digital dossiers are to be understood as a collection of information that may be viewed from different perspectives and that essentially contains, apart from textual information, rich media information in the form of video-recorded interviews, audio, and images. Each dossier is a collection of documents concerning a particular person or matter, in this case, contemporary artists and their work. The notion of a dossier is closely related to that of an archive, but there is a different focus, because an archive is a place where public records are kept or they are the records and material itself (Webster New World Dictionary).

The digital dossiers are deployed in a project performed in cooperation with the Dutch Cultural Heritage Institute (ICN) [1] in the context of the International Network for the Conservation of Contemporary Art (INCCA) [2] . In short, the idea is to develop digital dossiers for individual artworks, allowing professionals to deal with the information in an integrated, highly interactive fashion. We developed a prototype of a VR that realizes a digital dossier for selected works of a particular artist. The digital dossiers represent the information that is available for a particular work of art, or a collection of works. The digital dossiers should be multimedia-enhanced, that is include photographs, audio and other multimedia material in a compelling manner.

Although there are many possible ways to realize a digital dossier, in one case study centered on the Dutch artist Marinus Boezem, we have chosen a spatial metaphor for display, the artist's atelier, which gives access to the available information. The artworks as well as the information about the artworks is present in the virtual atelier, and in addition, in one corner of the atelier there is a projector with which a video recording of an interview with the artist can be shown. The artist, in the form of a humanoid avatar, is available as an agent, waiting in the corner of the atelier, to answer questions about his work (Figure 2).

We wish to elaborate on the idea of the artist as agent by systematically varying the agent types of the MetaMorph box to represent the artist. While the user performs a navigation or a search task through the digital dossiers, the artist agent can show different behaviors and have different appearances in various evaluation scenarios. In Section 4, we will discuss how the navigation and guidance through the dossiers may be adapted such that these tasks resemble controlled laboratory conditions.

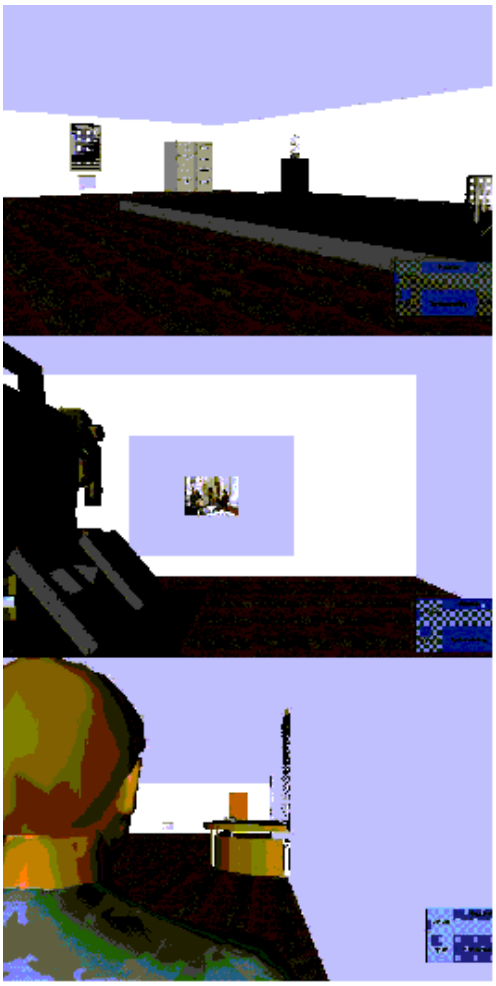

**Figure 2. Screenshots from an initial application of an artist's dossier (Multimedia Casus Practicum, VU, http://www.cs.vu.nl/∼eliens/casus/). From top to bottom: Artist's atelier with chest of drawers, watching the interview with a projector, and following the artist on a tour.**

## 4. Evaluation scenarios

We proceed from the assumption that our agents function primarily as guidance in complex interaction tasks with some information system, i.e. the digital dossiers, although

1 http://www.icn.nl/
2 http://www.incca.org/

conversational agents can take other functions as well, such as a conversational partner in language learning or a demonstrator in learning certain skills. There are two paradigms of interaction in complex environments, namely pure navigation and guided tours/presentations that are based on some narrative structure. Both paradigms can be augmented using empathic agents, which in the case of navigation might merely give directions and, in the case of guided tours, may explain what is going on, possibly offering the user a choice of continuations. The applicable validation scenario(s), then, could be:

Navigation - pure interactivity
Guided tours - using some narrative structure
Agent-mediated - navigation and guided tours

For experimental purposes, navigation by pure interactivity resembles most a forced-decision reaction-time task. User evaluation can be tested under two conditions: Agent-mediated navigation versus unmediated navigation. Two questions arise, then, which regard the efficiency of agent-mediated navigation in terms of increased speed and decreased error percentages as well as regarding the levels of involvement, distance, and appreciation (i.e. user satisfaction) in both conditions. The task users could perform is to find certain information in the digital dossiers (e.g., 'find an article' or 'watch the interview'). Users can complete this search task by clicking a correct or incorrect object or widget. This way, experimental trials consist of 'searches,' which actually are simple decisions between two (hypertextual) options (e.g., click *Chest of drawers* vs. click *Projector*, Figure 2). After the decision, feedback is provided on the selected information (correct-incorrect). Together, the sequence of simple decisions between pairs reflects an extended navigation through a (narrow) hypertextual structure in which users check whether a selected object is the right choice or not. In the agent-mediated condition, agents of various kinds serve to either correctly cue or wrongly cue a choice option. In subsequent experiments, adding choice options can extend the width of the navigation structure. The dependent variables are the online click speed and error percentage of decision making between the options to measure task-execution efficiency and filling out a structured questionnaire offline[14] to evaluate the agent's (emotional) effectiveness (Relevance and Valence), look (Similarity, Ethics, Aesthetics, Epistemics), and feel (Involvement, Distance, Appreciation).

## 5. Developing the metamorph box

As mentioned in Section 2, the MetaMorph box ideally contains 64 systematically varied agent types that together reflect the full of Interactive PEFiC. In one condition of our preliminary experimental set-up, the navigation task the user performs to search the digital dossiers is guided by an empathic agent. In different user groups, this agent should take different forms and show different behaviors, according to systematic manipulation.

*Task-relevance* could be manifested in agent behavior that is of direct importance to the user task (relevant behavior is to cue the choice option) or showing behaviors with little weight to the task (irrelevant behavior). Irrelevance could be produced by offering help and tips on, for example, word processing, or like Microsoft's Narrator, by reading aloud interface code as if it concerned regular contents. To increase task-relevance of the agent, users could receive a reward if they expose the fastest and most accurate performance of their group. *Valence* is varied by helping the user with the task (correct cues foster a positive outcome expectancy) or by deceiving the user with incorrect cues (provoking a negative outcome expectancy). *Similarity* may be established by presenting an avatar (based on a photo of the user) or a dissimilar person. *Ethics* can be manipulated by presenting polite and friendly or impolite feedback (cf. Agneta and Frida [19]) and aggressive proactive behavior. *Aesthetics* can be induced by designing agents that have, for instance, average face shape and symmetry, ideally arched eye-brows, etc. (see, among others, [7, 18, 21]). Ugliness can be evoked by strong deformations of the ideal shapes and showing signs of disease. Different levels of *Epistemics* can be established by showing photo-realistic mediated persons (e.g., Andrette) [3] or, for example, unrealistic cartoon figures (cf. Bonzi Buddy) [4] .

## 6. Interactive PEFiC powered by DLP+X3D/STEP

In Section 2, we outlined a theory of user engagement with empathic agents (the PEFiC-model) and concluded that (a subset of) 64 agent types is needed (the MetaMorph box) to systematically explore the main factors that motivate user engagement. In Section 3, we introduced the notion of digital dossiers as a suitable application domain to develop the MetaMorph box for. In this section, we will briefly describe the DLP+X3D/STEP agent platform, which enables user evaluation of agents in a natural setting, i.e. during exploration of the digital dossiers in a cultural heritage project. Following [22], we give an outline of the technical requirements of an empathic agent 'to be able to reuse and adopt' the agent in future applications. 'Stating the technical parameters also helps to judge the design of the [agent] independent of the limitations of the implementation or technical resources available' [22].

3 http://www.bigscience.com/
4 http://www.bonzi.com/BonziBUDDY/BonziBUDDYFREE.asp

DLP+X3D is a high-level platform for 3D and rich media virtual environments based on agent-technology, using the languages DLP, Java, and VRML. On top of this platform, a scripting language STEP was worked out for specifying humanoid movements and gestures, based on dynamic logic. The platform supports, for example, embodied conversational agents [6] and an avatar conductiong music [23].

From our background [5], we have a clear preference for Web-based real-time 3D environments with a strong programmatic interface. Our requirements with respect to a platform supporting such environments may be summarized as having a declarative language for agent support, multiple threads of control for multiple shared objects, and distributed communication for networking capabilities (TCP/IP). This excludes systems that rely on offline rendering, but also systems that rely on the native graphics of a particular machine. In addition, we rather program the dynamic behavior than creating it with advanced authoring tools. Nevertheless, our approach allows for easily incorporating content produced by such tools. However, this stance may easily be misunderstood, and should certainly not be taken as to advocate a hacker's approach to developing agent-based systems. On the contrary, we adopt a fully declarative approach, meaning that the code should be understood as a specification of the desired properties of the system, and not (only) by means of an operational interpretation based on some complex execution model. In fact, our platform is unique in that it is uniformly logic-based, both on the level of specifying the cognitive processes of the agents as in the specification of gestures and actions. And to the extent possible, even events within the 3D environment are controlled by a logical specification of sorts.

The language DLP is a distributed object-oriented extension of Prolog [4]. It supports multiple inheritance, nonlogical instance variables and multi-threaded objects (to allow for distributed backtracking). By merging DLP with VRML, using the VRML External Authoring Interface, the DLP+X3D platform was created. This approach allows for a clear separation of concerns, modeling 3D content on the one hand and determining the dynamic behavior on the other hand. The first release of the DLP+X3D platform was used to create agent-based multi-user virtual environments, deploying a logic-based declarative language providing support for intelligent agents.

Although a platform as described above offers powerful computational capabilities, this is clearly not enough to create embodied conversational agents with a rich repertoire of gestures. On top of the DLP+X3D platform, then, we developed the STEP scripting language for defining gestures and driving the behavior of our humanoid agent avatars [12].

STEP is based on dynamic logic [9] and allows for arbitrary abstractions using the primitives and composition operators provided by our logic. The rationale underlying STEP is somewhat different from what is found in approaches relying on animation tools or low level scripting languages. STEP offers the means to model complex gestures on a high level in a purely declarative fashion.

## 7. Some issues and pitfalls

Certain issues and pitfalls in evaluating agent characteristics are discussed next and may partly supply a list of things to do. PEFiC seems promising to evaluate user engagement with empathic agents but one of the first things that should be added is the interactive aspect [26]. Many issues may arise in this sense, for instance, whether the agent should maintain a model of the user [22] regarding demographic variables (e.g., cultural background) and personality traits (e.g., cognitive styles), proactive behavior, agent autonomy, and task difficulty [ibid].

There are also a number of problems in evaluating agent characteristics and determining the effectiveness of the agent as distinct from the effectiveness of the application. One issue worth mentioning is that the complexity of the domain of cultural heritage will make it (even more) difficult to distinguish between the effectiveness of the application (the digital dossiers) and the usefulness of the agent (providing guidance in using the dossiers). Additionally, when it comes to testing task-related issues, we face the fact that there is only a limited number of experts who have sufficient knowledge to use the dossiers in an effective way, for example, in preparing an installation of the work of art in a museum or exhibition gallery. Thus, for testing the MetaMorph box with a sufficient number of users, we should restrict the user tasks to exploration and tasks requiring limited expertise.

## 8. Conclusions

To contribute to the design of user support by means of humanoid software, we proposed the Interactive PEFiC framework to explain user engagement with empathic agents. Appreciation (i.e. user satisfaction) is fostered by the parallel processes of involvement (e.g., empathy, sympathy, challenge) and distance (e.g., antipathy, irritation, boredom). However, a certain amount of distance is not seen as harmful to user satisfaction but a necessary compensation to avoid total immersion in the application or full identification with the agent, in other words, to avoid mixing up fiction with reality. PEFiC distinguishes 6 factors (Ethics, Aesthetics, Epistemics, Similarity, Relevance, and Valence) with 2 levels each that govern the involvement-distance trade-off. Systematic variation on these dimensions would call for 64 agent types (the MetaMorph box) to be evaluated in interaction with the user.

To make a first inventory of some of the technical requirements, possibilities, and limitations, we discussed the software platform DLP-X3D/STEP (Section 6). This platform is suited for agent support in Web-based, real-time 3D environments and has a strong programmatic interface. We developed digital dossiers for contemporary artists and their works as one of the target demonstrators of DLP-X3D/STEP to allow professionals to search relevant information in an integrated and interactive way. The digital dossiers will serve as an environment to conduct navigation and search experiments with users, with or without the help of empathic agents, thereby not only measuring user engagement but also speed-accuracy trade-offs in executing agent-mediated tasks.

Concerning the design of the agent's 'personality,' it is not entirely clear what design rules we should apply to make an effective and focussed choice among the many characteristics represented by the MetaMorph box. Any combination of appearance, gestures, and speech characteristics will likely involve multiple factors in the PEFiC-model. Given the complexity of digital dossiers, we should moreover identify parts of the dossier, related to specific subtasks. For example, to allow for well-focussed experimentation with agent characteristics related to the task at hand, we can control the guidance offered by the agent when users view the video-recorded interview to find particular information.

The carry-back-home message we want to provide is that we collected all the ingredients needed to conduct proper agent research:

- An empirically tested model of engaging fiction characters
- Test scenarios in the real-life application domain of digital dossiers
- DLP+X3D/STEP technology to support virtual environments and characters

These points have shown useful independent from one another and are ready to be integrated, thereby introducing certain notions that are uncommon in the agent community (e.g., ethics, empathy as an aspect of involvement, involvement-distance trade-off, digital dossiers).

However, to experimentally evaluate empathic agent systems, we should develop a small consistent set of design parameters for digital dossiers allowing for controlled experimentation in the given task domain. Finally, developing the MetaMorph box may offer possibilities to test Interactive PEFiC and in the future offer the user enhanced personalization of the interface but unfortunately, characters need to be designed along non-existing guidelines for the representation of graphics, speech, and gestures. In our future work, we cannot only be researchers in that respect, we shall have to be a bit of an artist as well.

## 9. Acknowledgments

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